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ACTIONABLE KNOWLEDGE FOR SUSTAINABILITY AT THE WATER-LAND NEXUS: AN INQUIRY INTO GOVERNANCE AND SOCIAL LEARNING IN TWO RIVER BASINS IN LUXEMBOURG

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Dedication

To my family, especially Alethea

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Summary

Abstract

The thesis offers in-depth empirical insights into diverse factors that foster or hinder collective capacities of actors to address sustainability challenges at the water-land nexus. It focuses on how relations, knowledge, and practices in diverse organisations and professions engaged in governance and social learning processes in the Syr and Upper Sûre river basins in Luxembourg have changed following the entering into force of the EU Water Framework Directive in 2000. Finding that contradictions in water and land systems grow while spaces for self-organisation and meaning-making shrink, the thesis raises fundamental questions concerning both dominant supply- and growth-oriented paradigms and managerial approaches to sustainability. New approaches are needed to embrace interrelations between ecological and social regeneration.

Originality and contributions of the thesis

The thesis takes its point of departure in the EU Water Framework Directive (WFD) of 2000. By obliging member states to restore aquatic ecosystems to a ´good ecological status´, it is one of the most ambitious pieces of EU environmental legislation. The thesis examines sustainability challenges at the nexus of water, environment, agriculture and other forms of land use in two river basins in Luxembourg to analyse how the EU WFD has contributed to changing how they are addressed.

Sustainability science and adaptive governance have pointed to several gaps in human-environment interactions. Some scholars diagnose discrepancies between formal environmental objectives and ongoing deterioration of ecosystems. Others focus on gaps between science and action.

By investigating what makes knowledge actionable for sustainability, the present thesis addresses these interrelated gaps. It makes several research contributions. Firstly, it offers an analytical framework that is tailored to the analysis of how diverse contexts and factors shape what is actionable for individual actors; and, conversely, how these contexts may undergo changes as a result of engagement in governance and social learning processes. Most inquiries into actionable knowledge focus on researcher-led processes. In contrast, the framework serves to analyse what knowledge actors in Luxembourg have acted upon in their professional lives, and if and how the EU WFD has contributed to changes in established practices by fostering social learning. The framework is based on the assumption that meaning-making is crucial to human knowing and doing and, furthermore, that narratives can help to cast light on how actors understand and address sustainability challenges.

Secondly, under-researched in the literature, the analytical framework is tailored to the investigation of organisational contexts. Knowledge and practices are often institutionalised in particular organisations and professions whose members share certain narratives and paradigms. Therefore, what is actionable for individual actors may crucially depend on their organisational contexts and professional knowledge. The framework thus serves to analyse how individuals and organisations may undergo changes in the course of governance and social learning processes, and how they are interrelated. Situated at intersections of formal policies and society, ecosystems and technical infrastructures, organisations and professions are considered potential vehicles of transformative change in water and land systems. By explicitly considering organisational and professional knowledge, the thesis goes beyond the widely established distinction between scientific and local knowledge.

Thirdly, the thesis develops an analytical grid that enables the characterisation and mapping of different approaches and paradigms in water and land governance. It facilitates the analysis of tensions and synergies by considering what governance modes (top-down/network/bottom-up) and management purposes (anthropocentric/integrated/ecocentric) diverse organisations and policies have pursued. When applied to empirical analysis, the analytical grid is suitable to cast light on how transformative changes in water and land systems, in policies, and organisations may go hand in hand.

Finally, the thesis interprets the EU WFD as a hybrid regulatory framework that combines different paradigms. The WFD includes elements from adaptive and integrated water management that promotes social learning as crucial for sustainability transformations. At the same time, the thesis also identifies elements from a "managerial ecological restoration paradigm" that seeks to attain ambitious environmental objectives via hierarchical governance and scientific expertise. Ecocentric managerial approaches to resource governance have received little attention in WFD-related research so far.

On this basis, empirical inquiry provides tentative answers to the following research questions:

1. *How can a kind of knowledge be conceptualised that fosters collective action for sustainability?*
2. *How has the EU WFD changed water and land governance and management in Luxembourg?*
3. *What factors facilitate or hinder the emergence of social learning and actionable knowledge for sustainability?*

Thematic focus and methods

The thesis is located in transformative sustainability science and conducts a comparative case study. The research questions, thematic focus, and results have emerged iteratively from engagement with actors who are professionally engaged in Luxembourg´s water and land systems, from scientific literature, and data generated via diverse qualitative methods.

***Thematic focus and structure of the case studies*:** The thesis rests on a qualitative inquiry into governance and social learning in two river basins that followed upon the entering into force of the EU WFD. The directive formally obliges EU member states to restore their water bodies to a ´good ecological status´ by 2027 at the latest. The case studies analyse formal and informal governance processes in the Syr and Upper Sûre basins, with a focus on the role of two river basin organisations (the Upper Sûre River Contract and Syr River Partnership) in fostering social learning. The river partnerships bring together governmental actors, municipalities, intermunicipal syndicates, and other local and national actors, including from agriculture. They were founded following the entering into force of the EU WFD and its national transposition.

In the Upper Sûre basin, the case study concerns the preparation of new drinking water protection zones around the Upper Sûre lake (a national drinking water reservoir) that will restrict agricultural and other local activities to improve water quality. The case study analyses interplays between formal regulatory processes preparing the protection zones and efforts of the Upper Sûre River Contract, municipalities, and farmers to be actively involved in the process. Furthermore, it analyses how farmers and the national water supplier SEBES concluded a cooperation (LAKU) that entailed experimentation with new ´water-friendlier´ farming techniques, with support of the Upper Sûre Nature Park and its River Contract.

The Syr case study analyses efforts of the Syr River Partnership and member municipalities to contribute to improving water quality by addressing pollution sources and by carrying out projects such as river restorations in the Syr valley. The case study juxtaposes them with formal governance

processes relating to national implementation of the EU WFD, Floods, and Habitats Directives that aim to restore aquatic ecosystems to a good status and enhance flood protection via river restorations and other measures. Furthermore, the case study analyses formal and informal processes that concern the extension of a local wastewater treatment plant. Its capacities have been overstretched by growing quantities of municipal and airport wastewater, resulting in pollution of the Syr river and its protected Natura 2000 areas.

Empirical analysis concentrates on national WFD implementation and activities of the river partnerships in the period from 2000 to 2019. At the same time, the case studies include an extensive analysis of contexts. The case studies are composed of five parts:

- PART I: Historical and contemporary governance contexts
- PART II: Governance processes relating to the national implementation of the EU Water Framework Directive and the creation of the Upper Sûre and Syr river partnerships (2000-2012)
- PART III: Governance processes in the Upper Sûre basin relating to the elaboration of new drinking water protection zones (2012-2019)
- PART IV: Governance processes in the Syr river basin relating to water quality and river restorations (2012-2019)
- PART V: Comparative analysis of governance processes in the two river basins

Adapted from the Management and Transition Framework (see below), the analysis of processes is structured into sequences of eight to 14 so-called ´action situations´ that denote specific sub-processes or situations. For each action situation, the case studies examine details as regards governance (modes, phases, and levels), actors involved (social relations and roles), formal and informal institutions (e.g. laws and values), diverse types of knowledge and information, and other ´input´ and ´outcome´ factors. The method has been chosen with a view to identifying interplays between formal and informal governance processes.

Transdisciplinary research design, qualitative interviews, and collaborative workshops: The thematic focus, selection of action situations, and empirical data have emerged from transdisciplinary and qualitative research methods. The thesis has been conducted in the framework of the NEXUS FUTURES project that pioneers transformative sustainability science in Luxembourg. Research has encompassed regular exchanges with members of the NEXUS FUTURES reference group that is composed of representatives of the two river basin organisations, the Ministry of the Environment, the national Water Management Authority (AGE), the national water supplier SEBES and other water syndicates, of an agricultural cooperation, other researchers, and citizens.

Furthermore, the thesis builds on qualitative interviews and informal conversations with roughly 60 actors that have included farmers, farm advisors, and governmental agricultural actors, the national Nature and Forest Agency (ANF), environmental and municipal organisations, and consultants (in addition to the aforementioned actors).

Finally, the author has organised two stakeholder workshops at the Syr and Upper Sûre where participants collaboratively elaborated systems diagrams and action fields for water and land governance and management in the two river basins. Among them were the main topics chosen for the case studies.

Triangulation with diverse data: Qualitative interviews and workshops have been triangulated with data derived from 17 site visits and guided tours, from observations at 15 meetings (incl. public stakeholder events and working group meetings), and from extensive documentary research. The

documents included diverse formal policy documents (incl. laws and management plans), organisational documents (such as reports, minutes, etc.), and press articles.

Key concepts and terms

The thesis takes its point of departure in the assumption that tackling sustainability challenges in complex social-ecological systems necessitates profound changes in knowledge and practices. Context-specific approaches are needed that embrace complexity, uncertainty, contingency, and the highly normative character of sustainability. Formal regulation, public funding, and scientific expertise alone are not sufficient. Rather, adaptive governance and transformative sustainability science stress the importance of non-scientific knowledge and social learning. In doing so, scholars build on a broad definition of governance that encompasses both formal processes and informal self-organisation of diverse actors. Furthermore, it builds on a broad definition of water and land governance systems as composed of actors, formal and informal institutions, ecosystems, and infrastructures.

The thesis elaborates on the concept of multiloop social learning from the Management and Transition Framework (MTF, Pahl-Wostl et al., 2010) to analyse the extent and depth of social learning in governance processes. Based on MTF and similar approaches, the thesis defines social learning as entailing changes in social relations, knowledge, and action that enhance collective capacities of actors to address sustainability challenges in their contexts. In contradistinction to single loop learning ("business-as-usual"), double loop learning emerges when actors fundamentally question and revise own roles, knowledge, institutions, and practices. Social networks composed of diverse actors who participate in informal and formal governance are considered particularly conducive to double loop social learning. Triple loop learning denotes paradigm shifts in the entire governance system.

Social learning and knowledge *for sustainability* entails the idea that actors need to become aware of harmful consequences of their own practices and take actions to adapt and transform them (elaborated from Tabara & Pahl-Wostl, 2007). In adaptive governance, social learning is thus considered key to the capacities of societies to *adapt* to changes in external environment and, furthermore, to *transform* patterns in human-environment interactions.

***Conceptualisation of actionable knowledge (research question 1)*:** The thesis conceptualises knowledge as emerging from personal meaning-making and action that is inextricably interrelated with diverse contexts. The thesis draws on American Pragmatism, symbolic interactionism, transformation research, organizational and professional learning theories, and Science and Technology Studies (STS) to conceptualise the following nested contexts (composed of diverse informal, formal, and material factors):

- *Personal contexts*: sphere of meaning-making and personal circumstances;
- *Transactional contexts*: "contexts of co-presence" (Giddens, 1984) , including *local* contexts where actors interact directly with water and land (Wiek & Larson, 2014);
- *Organisational contexts*: environments of formal organisations, professional and local communities, and social networks;
- *Macro contexts*: social and cultural spheres of society (incl. EU and national formal governance) and material spheres (incl. bio- and techno-spheres).

Sustainability requires transformative changes in and across these contexts of actor engagement. The conceptual and analytical framework devotes particular attention to organisational contexts. Organisations provide actors with meaning- and action-frames that often shape how challenges are understood (knowledge) and addressed (i.e. action). The thesis defines organisations broadly as

denoting collectivities that share rules, values, and practices that may reflect certain paradigms and be engrained in shared narratives (Argyris & Schön, 1996; Knorr Cetina, 2007; Tsoukas, 2005).

The thesis posits that knowledge that is to be actionable for sustainability for actors needs to both resonate with and challenge established meaning- and action-frames. Furthermore, the analytical framework extends actionable knowledge to encompass the concept of ´narrative identity´. It rests on the assumption that actors will tend to act on the basis of their sense of *who they are* (Somers, 1994). Members of different organisations may thus hold different narrative identities. Furthermore, the conceptual framework distinguishes between the following overlapping community-based knowledge types:

- *Local knowledge:* skills and understandings relating to local phenomena that flow from engagement in local communities and contexts;
- *Professional knowledge*: occupation-based skills and understandings institutionalised in particular professional communities (with scientific knowledge as a sub-type that is warranted by scientific communities);
- *Organisational knowledge*: skills and understandings relating to the functioning of organisations (e.g. internal decision-making procedures, task distributions, and roles).

In order to identify social learning, the case studies investigates if and how the knowledge and actions of diverse actors undergo changes in the course of governance processes: river basin organisations and other nongovernmental environmental actors, farmers, municipalities, water suppliers, and governmental actors. Furthermore, based on the literature (incl. König, 2018, Hadorn et al., 2008, Grunwald, 2016), the thesis develops an analytical framework to analyse different dimensions of local, professional, and organisational knowledge:

- *Normative dimension* (*why*): purposes and framings of challenges;
- *Systems dimension* (*what*): scopes and factors considered;
- *Transformation dimension* (*how*): preferred means of social and material engagement (e.g. governance modes and management interventions).

The thesis conceptualises actionable knowledge as potentially emerging from double loop social learning when actors converge towards common understandings of challenges and on how to address them along these dimensions.

Conceptualisation of changes in water and land governance and management (research question 2): The thesis draws on the Management and Transition Framework (MTF) and other adaptive and systems approaches to analyse governance and management in complex social-ecological systems (SES). It adopts a broad understanding of governance as encompassing both formal policy and informal governance processes.

The thesis focuses on changes in approaches and paradigms that shape how specific organisations engage in water and land systems. Paradigms may also be formally institutionalised in regulatory frameworks such as the EU WFD. To structure analysis, the thesis develops an analytical grid composed of:

- a vertical axis: governance modes,
- a horizontal axis: purposes and means attributed to material engagement/management.

As regards the first, the thesis builds on established governance modes: hierarchical (top-down) formal governance, network governance (cross-scale involvement of diverse stakeholders), and community-based governance (bottom-up). As regards the horizontal axis, the thesis distinguishes between

anthropocentric, integrated, and ecocentric purposes attributed to water and land management. On this basis, the thesis investigates several paradigms. The EU Water Framework Directive has been widely interpreted as signalling a paradigm shift away from the incumbent ´command-and-control´ paradigm towards an adaptive and integrated paradigm. ´Command-and-control´ combines top-down governance (i.e. formal regulation based on science) with narrow anthropocentric purposes, namely drinking water supply and flood protection based on technical infrastructures. Pollution is mainly addressed via technological ´fixes´ (such as wastewater treatment).

In contrast, adaptive and integrated paradigms pursue broad anthropocentric purposes aiming for pollution prevention, diverse services delivered by ecosystems to humans, and nature-based ´solutions´ (such as river restorations) that strengthen ecological regeneration capacities. Network governance is the preferred governance mode, with stakeholder involvement and the consideration of non-scientific knowledge types as hallmark. In adaptive governance, the aim of social networks is to bring together diverse nongovernmental and governmental actors in cross-scale and cross-sectoral informal and self-organised processes that are considered to be particularly conducive to social learning and experimental approaches to ecosystem management. Network governance requires flexible regulatory frameworks as key elements in fostering self-organisation.

The thesis devotes an entire part (part 4) to the characterisation of different paradigms identified in the literature. In addition to the above-mentioned, it elaborates on the productionist paradigm in agriculture and on agroecological approaches. Furthermore, it adds two ecocentric paradigms: an "ecocultural community paradigm" and a "managerial ecological restoration paradigm". The main reason for doing so is that a few scholars have interpreted the EU WFD as an expression of a technocratic approach to environmental protection (e.g. Ollivier, 2004).

Adding these paradigms serves to extend the analytical scope of the inquiry into transformative changes at the water-land nexus in Luxembourg. Notably, it enables the author to investigate not only *dominant* paradigms, but also other approaches (e.g. of nongovernmental actors). On this basis, the thesis compares water and land governance in the Syr and Upper Sûre river basins *before* and *after* the entering into force of the EU WFD.

***Conceptualisation of social learning and facilitating and hindering factors (research question 3)*:** The case studies inquire into factors that have facilitated or hindered the emergence of social learning and actionable knowledge in informal governance processes in the Syr and Upper Sûre river basins. In doing so, the thesis adapts the social learning scheme of the Management and Transition Framework (MTF). It does so by embedding processes in the *diverse* contexts outlined above (including related informal, formal, and material factors) and by devoting particular attention to (changes in) local, professional, and organisational knowledge. Unlike most of the literature, the scheme developed explicitly considers not only *intended* outcomes, but also *unintended* effects.

The case studies focus on the role of the Syr River Partnership and Upper Sûre River Contract in facilitating the emergence of social networks. In bioregional approaches to adaptive management, river basin organisations are considered potential facilitators of network governance (e.g. Huitema & Meijerink, 2017). Therefore, the thesis analyses factors that have facilitated or hindered the river partnerships in rallying diverse actors around a ´common cause´ and in fostering social learning.

Main findings

Changes in water and land governance and management following the entering into force of the EU WFD (research question 2)

Via the national water law of 2008, the EU WFD has contributed to profoundly changing *formal* purposes, scopes, and preferred means in water governance in Luxembourg by pursuing aquatic ecosystem health in river basins, pollution prevention (incl. via the ´polluter-pays´ principle), and nature-based ´solutions´ to flood protection (e.g. via river restorations). Never before has water governance been based on as extensive scientific studies and data as following the EU WFD. This has contributed to growing awareness of the need to improve aquatic ecosystem health. The introduction of a central Water Management Authority (AGE), of river partnerships, and of formal public participation processes has meant that new additional actors entered water governance. It also signalled the possible emergence of network governance.

Before, in Luxembourg (as elsewhere) water management aimed primarily to secure drinking water supply and mitigate flood risks. It was mainly in the hands of municipalities and intermunicipal water infrastructure operators. Municipalities continue to hold autonomy in urban water management today. In addition, the national water supplier SEBES delivered drinking water from the Upper Sûre dam. At the national level, water competences used to be dispersed among several ministries and administrations. Ecosystem-based management at the scale of river basins did not exist, nor did formal public consultations and stakeholder involvement. Furthermore, the EU WFD led to closer integration of formal water and environmental policies (e.g. of management objectives and plans as regards water bodies and areas protected under the EU Habitats Directive) and increased coordination with agricultural policies (e.g. via new funding schemes for farmers).

However, the case studies also find that national WFD implementation has formally institutionalised top-down managerial approaches to ecological restoration. In Luxembourg, the EU WFD and related policies have reinforced technical framings of water-related challenges based on scientifically- and legally-defined ecological criteria. The EU WFD aims for context-specific water management tailored to specific water body types. However, as the EU WFD itself, national implementation has neglected *social* contexts, criteria, and processes. As a result, formal governance has focused on water quality alone. In the case studies, technical framings have also extended to formal public consultations. Furthermore, most action situations analysed concerned the elaboration of plans and measures, rather than implementation.

In addition, having maintained their autonomy, national WFD implementation continues to depend strongly on municipalities (with state co-funding). There have been no obligations and few incentives for municipalities to cooperate across municipal borders at the scale of river basins. National WFD implementation thus added an additional scale to water management, but without attaching clear functions to it. Municipalities have tended to pursue bottom-up approaches that typically prioritise social infrastructures (e.g. housing, childcare facilities, cultural offers), transport and water infrastructures (concerning drinking water supply and wastewater treatment) rather than ecological restoration projects. Often, however, restoration projects are elements of broader local development projects.

Furthermore, the case studies find that demographic and economic developments continue to be key drivers of water and land governance and management in Luxembourg. In both the Upper Sûre and the Syr case studies, there are examples of how national public interests directly related to economic and demographic growth have taken precedence over regional development objectives and more extensive stakeholder involvement (Upper Sûre) and over environmental objectives (Syr).

Furthermore, the case studies also suggest that agriculture continues to be centred on conventional food production for world markets (i.e. a productionist paradigm). However, there are some signs of growing recognition of environmental concerns (reflected in public funding schemes). At the same time, only 5 % of farms have ´gone organic´. Farmers explain this by reference to a lack of demand among consumers in Luxembourg for (more pricey) *domestic* organic products.

On this basis, the case studies find that the EU WFD has contributed to increasing paradigmatic hybridity and contradictions in Luxembourg´s water and land systems. M*aterial* improvements in the state of aquatic ecosystems have remained modest. By 2015, only three water bodies had reached a "good ecological status". It is not expected that WFD objectives can be reached by 2027. The third draft national WFD management plan for the period 2021-2027 adds climate change, low levels of water in water bodies, and demographic and economic development to the list of main obstacles to reaching objectives (AGE, 2018d).

Therefore, overall, the case studies have found few signs of wider paradigm shifts in Luxembourg´s water and land systems (i.e. triple loop social learning). Water and land governance and management have *formally* become more integrated, but there continues to be a large gap between formal objectives and the state of ecosystems. Regulatory frameworks such as the EU WFD are only one factor in a much larger system in need of transformative change.

Facilitating and hindering factors for social learning in the Syr and Upper Sûre river basins (research question 3)

The case studies offer insights into informal, formal, and material factors that can facilitate or hinder social learning and the emergence of actionable knowledge among actors engaged in water and land governance. The Syr and Upper Sûre river basins have been defined based on hydrological and administrative WFD criteria. Starting as Interreg projects that preceded national WFD transposition, the Upper Sûre River Contract and Syr River Partnership have initiated self-organised processes that have contributed to making river basins contexts of social and material interaction between diverse actors. Today, there are more social relations and activities that aim for integrated water management at the scale of river basins than before.

At the same time, the case studies find that network effects in the processes analysed have not reached out equally across sectors and scales. The emerging social network in the Syr valley has centred on local and national actors committed to environmental objectives, hardly including farmers and other agricultural actors. Only few measures to improve aquatic ecosystem health have been carried out across municipal borders. Despite efforts of the Syr River Partnership and its members, the network did not obtain responses concerning one of the major causes of pollution of the Syr river, notably, airport wastewater. In the Upper Sûre case, more notable social network and learning effects were identified. Facilitated by the Upper Sûre River Contract, they consisted in a new cooperation between farmers and the national water supplier SEBES (LAKU) that launched experiments for more ´water-friendly´ farming. Social learning, however, did not extend to the exploration of new farming models. Whilst the Ministry of the Environment and the Water Management Authority (AGE) supported the cooperation, relations between local and governmental actors have remained tense. Stakeholder involvement in the elaboration of new drinking water protection zones around the Upper Sûre lake have remained limited to the revision of technical details in the course of the formal public consultation and related meetings held on the upcoming draft regulation.

With the exception of LAKU, most of the action situations analysed in both river basins predominantly concerned the preparation of new policies, plans, and measures rather than their implementation.

While processes in the Upper Sûre region all concerned the new future drinking water protection zones, processes in the Syr basin have been characterised by fragmentation as a result of weak coordination and the absence of overarching processes.

Overall, the case studies identify some signs of social learning, but they have mainly been limited to single loop social learning. The following summarises the main hindering and facilitating factors.

Organisational context factors: The case studies provide substantial evidence that organisational factors are crucial in facilitating and hindering social learning in governance processes. The case studies ascribe the respective challenges that the Syr River Partnership and the Upper Sûre River Contract have met in expanding social networks to different organizational structures and relations in the river basins that reflect different histories.

In 2012, the Syr River Partnership and Upper Sûre River Contract were formally set up by their parent organisations, municipalities, and the Ministry of the Interior, based on the national water law that transposed the EU WFD. The river partnerships are financed 50/50 by the government and participating municipalities. In 2013, the Ministry of Sustainable Development took over water competences from the Ministry of the Interior. The overarching aim of the river partnerships has been to associate diverse actors in the river basins to integrated water management, thereby potentially assuming the role of boundary organisation in the creation of social networks. Without legal personality and limited own resources, the river partnerships have remained part of their parent organisations, the Upper Sûre Nature Park and, respectively, the environmental NGO natur&ëmwelt Fondation Hëllef fir d´Natur (HfN).

As part of the Nature Park, the Upper Sûre River Contract has been located at the organisational backbone of a region that has had a decades-long tradition of cooperation between municipalities, farmers, and farm advisors, other agricultural actors, and the environmental staff employed by the Nature Park. The Upper Sûre Nature Park is founded on the cooperation between municipalities and ministries. Its creation, however, followed upon the mobilization of municipalities, farmers, and other local actors against diverse plans that consecutive governments had prepared for the region since the 1950s to protect the national drinking water reservoir. In the “pioneering times” of the 1980s and 1990s, local strives for more self-determination resulted in a host of projects that sought to integrate regional development and agriculture with water and environmental protection (incl. via regional products). In this sense, the Upper Sûre region is an example of a community-based “bioregion” that is largely congruent with a hydrologically defined area (McGinnis, 1999). In 2012, the Upper Sûre River Contract assumed an informal mandate to coordinate stakeholder involvement in the elaboration of the new drinking water protection zones to “give the region a voice”. Thereby, it partly inscribed itself in narratives of local actors “defending” regional against national interests. The River Contract could also build on existing social networks of the Nature Park. Regional cooperation, however, had not extended to the nearby national water supplier SEBES. Local actors have perceived the water suppliers as mainly serving the interests of Luxembourg City and the Southern municipalities. SEBES was in charge of the dossier that provided the basis for the elaboration of the protection zones law.

In contrast, the Syr basin is an example of an ecosystem-based “bioregion” where hydrological boundaries hardly reflect local and organisational structures and identities. Local communities do not share common narratives associated with the small Syr river. Furthermore, they do not have a history of cooperation centred on the river basin. Therefore, the Syr River Partnership has not been able to build on pre-existing cooperations between the 15 municipalities that make up the river basin. Furthermore, part of natur&ëmwelt Fondation HfN, the Syr River Partnership belongs to a national

environmental NGO that has roots going back to 19th century environmentalist organisations. The environmental NGO has been active in purchasing land to restore wetland habitats in the Syr valley and across the Grand-Duchy to "help nature". Volunteers and staff have carried out environmental protection activities, sometimes facing opposition from local farmers. Its administrative seat is located outside the river basin. In the processes analysed, the emerging social network of the Syr River Partnership has been composed of committed individual actors; however, organisational municipal commitments to the cooperation have been weaker. At the same time, the Syr River Partnership has had better working relations with the Water Management Authority (AGE) and the Ministry of Sustainable Development than the Upper Sûre River Contract.

The case studies find that different contexts and narratives have been crucial factors in the governance processes analysed, notably by shaping mutual perceptions and the quality of relations. They offer part of the explanation for why network effects in the Upper Sûre region have included actors from diverse sectors, while cross-scale effects have remained limited. In the Syr basin, cross-scale network effects have been stronger, while cross-sectoral effects within the region have been more limited. The differences thus point to strengths and weaknesses of ecosystem-based, respectively, community-based forms of bioregionalism and illuminate some of the challenges that different river basin organisations may face as boundary organisations.

Finally, the histories of the public administrations for water (AGE), nature (ANF), and agriculture (ASTA) themselves have been found to be highly relevant to better understand some of the contemporary coordination challenges. They can partly be ascribed to tense inter-organisational relations that have grown historically. Often, tensions seemed to have had origins in events or developments from years or decades ago. When AGE was created in 2004 within the Ministry of the Interior, it took over competences for aquatic ecosystems previously held by the ANF that had been in charge of forestry, hunting and fisheries since 1840 and of environmental protection measures since 1965. The ANF has pioneered the first river restorations in Luxembourg (including in the Syr valley), which is reflected in "environmentalist narratives" of ANF administrators. After AGE had been created, ANF stayed in charge of ecosystems (under the Ministry for Sustainable Development). AGE built on the technical water management unit of the Ministry of the Interior that was mainly composed of engineers. Hence, the two administrations until 2013 belonged to different ministries, with competences overlapping, and AGE staff initially less experienced in aquatic ecosystem management. AGE also took over competences in river regulations held by ASTA since 1883, because river regulations and agriculture had been closely interrelated.

River restorations usually require the cooperation of the three administrations. Narratives that are passed on to colleagues offer one potential explanation for why *some* interorganisational relations have hardly changed even when individual actors changed.

Formal process factors: The entering into force of the EU WFD was received with enthusiasm among environmentalists in Luxembourg who expected to be more actively involved in water management. This was the main reason for why the parent organisations of the river partnerships launched their Interreg projects. National implementation of EU water and environmental legislation has contributed to more funding opportunities for nongovernmental actors in Luxembourg. However, it has also resulted in more regulation and a greater emphasis on scientific expertise. This has been identified as a hindering factor for self-organisation and social learning in the river basins. The thesis suggests that regulation and requirements have contributed to increasing gaps between formal objectives and actions ´on the ground´ in a number of ways.

Firstly, compared to before, the preparation of laws, management plans, and concrete measures has become more extensive and more tied to formal and scientific requirements. This has greatly increased

administrative burdens on governmental and nongovernmental actors, made procedures lengthier, and led to coordination challenges. When asked about the most notable changes in the past twenty years, *all* actors interviewed referred to increasing regulative requirements and administrative burdens, many of them feeling severely stretched. Examples studied include the national WFD management plans, the dossier preparing new drinking water protection zones (Upper Sûre), a concept on aquatic habitat connectivity (Syr), and feasibility studies for river restorations (Syr). The two latter suggest that river restoration projects face increasing requirements before being granted authorisations and public funding. Science-based requirements have served to ensure the ecological effectiveness of restrictions and measures in improving ecosystem health. In the processes analysed, however, they have also significantly slowed down projects in reaching the point of implementation.

What has further added to lengthy procedures was that the administrations for water (AGE) and nature (ANF) have had difficulties in reconciling their interpretations of WFD, respectively, Natura 2000 provisions on aquatic ecosystem restoration. Intricate requirements and criteria are the reason that nongovernmental actors are encouraged to plan their projects with specialized consultancies. Not all consultants, however, have yet become competent in applying all requirements. Authorisation and funding procedures for projects hardly take into account local or professional knowledge or social criteria. These factors have reduced spaces for experimentation.

Secondly, technical framings and procedures have also been applied to the participation of nongovernmental actors in water management in general, and in public consultation procedures in particular. River partnerships, municipalities, and other nongovernmental actors have been expected to primarily contribute to implementing pre-defined measures of the national WFD (and Natura 2000) management plans. Some actors have felt that pressure to fulfil environmental targets was passed ´down´ to them. The case studies suggest that actors are increasingly evaluated - and evaluate themselves - based on numbers and ´box-ticking´.

Formal public consultations have tended to serve the revision of technical details of management plans and laws, rarely opening processes for wider dialogues that would open spaces for reframing. Many actors who submitted contributions did so based on studies and assessments of consultants and agricultural advisors. On the basis of the above, the case studies find that ´expert systems´ have further expanded and consolidated far beyond formal governance. Among governmental actors, there is a widespread belief in the superiority of scientific expertise, with few holding that local and professional knowledge could improve the quality of laws, plans, and assessments. Many local and environmental actors do not share this view.

Finally, the Syr case suggests that the “polluter-pays” principle and legal and administrative requirements are not consistently applied to major polluters. For reasons of “overriding public interest”, the airport has been allowed to overcharge an intermunicipal wastewater treatment plant with wastewater containing deicing substances for decades, with un- or insufficiently treated airport and domestic wastewater having regularly polluted the Syr river during winter months as a result. The Syr River Partnership and its member municipalities have not received a response to their complaints and requests for access to data on the extent of the pollution. The Syr case study identifies the problem as one of the few concerns that municipalities and the river partnership share.

In both river basins, there have been actors who have taken - or considered to take - legal actions. The case studies suggest that legal actions have been considered as a last-resort means if all other efforts failed. The case studies also interpret some of the reactions as a way for actors to defend their narrative identities. Therefore, the case studies offer some evidence that increasing regulation contributes to tensions between governmental and nongovernmental actors. These factors have added to the diagnosis that barriers to self-organisation and meaning-making grow.

Informal process factors: The processes analysed offer insights into various hindering factors for dialogues and the emergence of common understandings among diverse actors. The deepest divide has been identified between environmental and agricultural actors, both nongovernmental and governmental. The analysis of divergent narratives and imaginaries of landscapes (wetlands, in particular) contributes to cast light on this divide. While environmentalists have striven to restore traditional cultural "mosaic landscapes" regretting the loss of pre-industrial wetlands and biodiversity, many farmers and agricultural actors tend to regard pre-industrial agriculture as "primitive", to associate it with hunger and "unhealthy" wetlands that can spread water-borne diseases. In the view of many farmers, environmentalists cling to idealised images of extensive "Heidi agriculture" unsuitable for modern production, while many environmentalists have the impression that conventional farmers simply "do not want to change".

In the Upper Sûre region, these divides surfaced in discussions about future restrictions on agriculture in the area that resulted in significant tensions between local farmers and the Ministry of Sustainable Development. A mutual lack of trust has also been identified as a possible reason for why farmers and other local actors were not involved more actively in the elaboration of the future protection zones. Tensions were aggravated by two factors: a pesticides accident that contaminated the Upper Sûre lake (that was followed by pesticide findings in emergency groundwater wells) and national elections. The pesticides accident confirms the significance many scholars attribute to hazard events. In the case of the Upper Sûre, the threat to national water security moved the debates about conventional agriculture into public and political arenas rendering relations even more difficult. Furthermore, years later, the drinking water protection zones became objects of national elections campaigns, marked by conflicts between local conservative deputies and mayors and the Green Party heading the Ministry of Sustainable Development. Due to polarised relations, the Upper Sûre River Contract (perceived as ´on the side´ of conventional farmers and conservative mayors) was unable to act as boundary organisation. The present thesis thus contributes with evidence on how political factors can hinder the emergence of cross-scale networks and social learning.

In the Syr basin, the analysis of a river restoration project of 2003 (that was followed by an extensive pasture project) and of a public consultation that preceded the declaration of a Natura 2000 area as national wetland reserve also casts light on divides between environmental and agricultural actors. The case study points to divergent narratives and concerns relating to wetlands as a hindering factor in bringing environmentalists and agricultural actors together in the management of restored areas.

At the same time, the case studies also identify a number of factors that can facilitate the emergence of social networks and social learning. The examples of the founding periods of the river partnerships and of LAKU suggest that few factors may be as effective in fostering social learning and knowledge-for-action as ´knowledge-*in*-action´. In these examples, a sense of shared purpose and trust emerged among actors from action-oriented and experimental social processes driven by committed self-organising individuals.

The LAKU example is particularly interesting, because it entailed a significant change in role of the national water supplier SEBES. The cooperation resulted from an agricultural working group that the Upper Sûre River Contract had convened to contribute to the elaboration of the new drinking water protection zones. From the working group emerged a social network that brought together actors who had had few or tense contacts before: conventional and organic farmers, farm advisors from competing advisory services, on the one hand, and the national water supplier SEBES, the Water Management Authority, and the Ministry of Sustainable Development, on the other. In the framework of the working group and LAKU, the actors engaged in knowledge co-creation via joint seminars, excursions and experiments that fostered shared hands-on experiences. The excursions and

experiments, in particular, contributed to building trust between the partners and enabled them to develop their professional knowledge in a manner that brought together social and sensory experiences, inspiration derived from best-practice examples from abroad, and scientific water quality and soil data. On this basis, participating farmers and farm advisors developed new technologies and farming practices that aimed to reduce soil erosion, nitrate wash-outs and pesticide use in a manner adapted to their local social and material contexts (incl. soil and landscape conditions). The experiments have been knowledge- and technology-intensive necessitating significant professional and organizational learning. Individuals with a high level of personal commitment drove the cooperation.

The case studies point out that LAKU experiments entailed significantly fewer administrative requirements compared with river restorations and other measures along rivers. Some of the techniques developed by LAKU have begun to be rolled out across the Grand Duchy. At the same time, experimentation with innovative farming techniques primarily served single loop learning. The main objective of participating farmers was to be able to maintain their business models after the entering into force of the new drinking water protection zones and related restrictions.

As regards social relations, roles, and narratives, however, the case study also identifies some signs of double loop professional and organisational learning. The most notable changes identified were the open acknowledgement and discussions of harmful environmental consequences of agriculture among farmers and their efforts to reduce them. They were accompanied by slight changes in narratives that suggested that farmers, after all, did not only produce food, but also contributed to “drinking water production”. The case study interprets this as a possible first sign of an expanded productionist paradigm among farmers. Moreover, SEBES extended its role as technical infrastructure operator to encompass cooperation with local actors to reduce water pollution *at source*. This may be a sign of changes in technical water management towards more adaptive approaches that include social engagement and pollution prevention. The latter is supported by the fact that SEBES will coordinate the elaboration and implementation of voluntary measures in the future drinking water protection zones among farmers, municipalities, and other actors.

Another insight based on the above-mentioned examples confirms the widely established view that the personal commitment of leading individuals is crucial to self-organised processes. Adding a narrative perspective, the thesis investigates how personal commitment has been related to narrative identities. A strong sense of purpose and self-efficacy drove actors to take “fate in own hands”, based on the belief that it is possible “to change things for the better”. Finally, the case studies also confirm the argument that the personal commitment of pioneering individuals can be a first step towards new and stronger *organisational* commitments and interorganisational relations.

Material factors: The case studies point to several material factors that hinder social learning and adaptive approaches to water and land management. Demographic and economic growth and agriculture have continuously increased pressures on aquatic ecosystems and landscapes (MECDD, 2020). Encroaching settlements and urban infrastructures have continued to decrease land availability and increased land prices, aggravated landscape fragmentation, biodiversity loss, and produced growing quantities of effluents flowing into Luxembourg´s small rivers. Furthermore, during the entire period covered by the case studies (i.e. since the 19th century), structural changes in agriculture towards larger and more specialised high-investment farms cultivating more land and producing larger quantities have continued. At the same time, intensification has hardly increased revenues. The dependence of farmers on leased land has increased to 60 %, with leases also on the rise. On average, Luxembourgish farmers earn less than the minimum salary in Luxembourg (SER, 2016, 2018).

Competition for land between diverse actors has intensified, with farmers increasingly unable to keep up with price hikes. Finally, changing weather patterns attributed to climate change (incl. longer drought periods) add to pressures on water bodies (e.g. sinking water levels) and agriculture.

These developments are hindering factors for self-organisation and adaptive water and land management, as access to (affordable) land is a precondition for river restorations and agricultural extensification. The Syr case study suggests that land availability is one of the most significant material factors hindering river restoration projects. Furthermore, less freshwater in rivers increases the proportions of effluents and thereby reduces the potential impact of restorations and other measures on water quality. As regards the Upper Sûre basin, the case study suggests that diverse pressures on farmers have added to perceived shrinking ´rooms for manoeuvre´, despite generous public funding schemes.

Based on the above, the thesis concludes that diverse contradictions in water and land systems grow while spaces for self-organisation and meaning-making shrink.

Concluding insights on actionable knowledge for sustainability (research question 1)

The case studies provide substantial evidence in support of the assumption that what actors perceive as meaningful - and, hence, actionable - is closely related to personal and shared narrative identities. Changes in narratives can be important indicators of the depth of social learning. The case studies compare narratives of different actors who have been particularly actively involved in governance processes: environmentalists, farmers, and municipal officials. In each of these communities, actors hold different landscape imaginaries. Imaginaries contribute to shaping what actors consider desirable in water and land management, but they also contribute to conflicts (e.g. “diverse mosaic landscapes”, “grassland for modern food production”, “recreational green spaces”). The conclusions propose that an exploration of diverse ´ecocultural landscape imaginaries´ could serve as a point starting-point to stimulate new dialogic spaces and processes between these – and other – actors.

Actor engagement in informal governance processes crucially depends on spaces for self-organisation and meaning-making. Despite significant differences in the narratives of actors who have engaged actively in social networks, the thesis also identifies a number of similar elements:

- a strong identification with and care for specific environments and activities (e.g. a sense of vocation, place and/or nature attachment),
- a sense of self-efficacy and desire for self-determination,
- a drive towards ´getting things done´ in a self-organised manner.

The more insurmountable barriers and contradictions in water and land systems seem, the greater the need for human agency, creativity, and imagination. The more diverse governance systems are in terms of actors, scales, and paradigms, the greater the need for processes and projects that bring them together. Therefore, the thesis concludes with a plea for actionable knowledge and combines it with reflections on how environmental governance can be developed further to embrace interrelations between ecological and social regeneration.

Abbreviations

ASTA	Administration of Technical Agricultural Services *Administration des services techniques de l'agriculture (ex-´Service agricole´)*
AGE	Water Management Authority *Administration de la gestion de l'eau*
ANF	Nature and Forest Agency *Administration de la nature et des forêts (ex-´Administration des eaux et forêts´)*
CAP	Common Agricultural Policy
CRHS	Upper Sûre River Contract *Contrat de Rivière Haute-Sûre / Gewässervertrag Obersauer*
DEA	*Distribution d'Eau des Ardennes* (inter-municipal syndicate that supplies Northern Luxembourg with drinking water)
EU	European Union
LAKU	*Landwirtschaftlech Kooperatioun Uewersauer* (Upper Sûre agricultural cooperation)
LNVL	Luxembourg Nature and Birds Protection League *Lëtzebuerger Natur- a Vulleschutzliga*
MAVDR	Ministry of Agriculture, Viticulture and Rural Development *Ministère de l'Agriculture, de la Viticulture et du Développement rural*
MDDI	Ministry of Sustainable Development and Infrastructure *Ministère du développement durable et des infrastructures*
MECDD	Ministry of the Environment, Climate and Sustainable Development *Ministère de l'Environnement, du Climat et du Développement durable*
n&ë	*natur&ëmwelt* (environmental NGO)
ONR	National Land Consolidation Office *Office national de remembrement*
P&Ch	National Roads Administration *Administration des ponts et chaussées*
PNHS	Upper Sûre Nature Park *Parc naturel de la Haute-Sûre / Naturpark Öewersauer*
SEBES	*Syndicat des eaux du barrage d'Esch-sur-Sûre* (syndicate supplying Luxembourg with drinking water from the Upper Sûre dam)
SER	Rural Economy Department *Service d´économie rurale*
SIAS	*Syndicat intercommunal à vocation multiple* (multi-purpose inter-municipal syndicate in the Syr basin)
SIDEST	*Syndicat intercommunal de dépollution des eaux résiduaires de l'Est* (inter-municipal syndicate for wastewater treatment in Eastern Luxembourg*)*
SNL	Luxembourg Naturalist Society *Société des naturalistes luxembourgeois*
STATEC	National Institute of Statistics and Economic Studies *Institut national de la statistique et des études économiques*
WFD	Water Framework Directive

1 INTRODUCTION

"Action is, in fact, the one miracle-working faculty of man…" (Arendt, 1998)

Water is one of the most significant sustainability challenges the world faces today affecting both humans and ecosystems (Pahl-Wostl, 2015; Vörösmarty et al., 2010). It is a resource shared by all humankind (Ostrom et al., 2002).

Sustainability requires profound transformations across diverse contexts of human social and material engagement. Since the 1990s, calls for paradigm shifts in water and land governance and resource management have grown stronger (Cortner & Moote, 1994; Gleick, 2000; Patterson & Williams, 1998; Röling & Wagemakers, 1998; Thompson, 1994). They have been accompanied by an emphasis on the need for social learning and knowledge conducive to action that contributes to fundamentally changing human-environment interaction (Berkes & Folke, 2002; Dietz et al., 2003; Holling et al., 2002; König, 2018). Relying on governments and scientific information and data alone is not sufficient (Evans, 2012; Kates et al., 2001; König, 2018; Ostrom et al., 2002; van Kerkhoff & Lebel, 2006). Nongovernmental actors and human agency are key in governance systems and their transformation (Pahl-Wostl, 2015; Wiek & Larson, 2012).

Water and land are embedded in complex social-ecological systems dynamics (Binder et al., 2013; Pahl-Wostl, 2015). Therefore, sustainability challenges require the overcoming of silo-thinking. There is a growing recognition of the need to go beyond mono-disciplinary and mono-sectoral perspectives. For example, inter-governmental bodies and researchers have begun to promote a nexus perspective on water, energy, and food (BMU, 2011; Hoff, 2001; König, 2018; Pahl-Wostl, 2015; Stirling, 2015c). Nexus thinking could be a "game-changer" in supporting a new way of framing cross-sectoral problems (Pahl-Wostl, 2015). Sustainability challenges are inherently complex and entail highly normative choices (König, 2018; Pahl-Wostl, 2015; Stirling, 2015c). For this reason, transdisciplinary and transformative approaches in sustainability science engage directly with society to contribute to building capacities for collective action that takes into account complexity, uncertainty and normative ambiguity (König, 2018; Ravetz, 2018), while also engendering "empowering hopes" (Stirling, 2015c).

The thesis adopts a nexus perspective that investigates governance and social learning processes in coupled water and land systems, with a focus on the Syr and Upper Sûre valleys. They are conceptualised as encompassing diverse actors, ecosystems, infrastructures and markets, regulatory frameworks, social norms and cultures (Pahl-Wostl, 2015; Wiek & Larson, 2012). The thesis examines sustainability challenges relating to the chemical quality of surface water bodies and the health of aquatic ecosystems in relation to agriculture and other forms of anthropogenic pressures exerted by economic and demographic developments. The focus on land systems reflects a perspective that goes beyond the anthropocentric focus on food production, recognises diverse agricultural services (Dendoncker & Crouzat, 2018), and takes into account other forms of land use.

The overarching purpose of the thesis is to provide insights on and raise questions about how societies can cultivate human knowledge and action in a manner suitable to foster sustainability pathways tailored to specific social and material contexts.

1.1 Research questions and contributions

Research question 1: *How can a kind of knowledge be conceptualised that fosters collective action for sustainability?*

Transformative sustainability science aims to leverage the marvellous capacities of humans to know and do things differently, actively contributing to shaping the future (König, 2018). During the past decades, transformative sustainability science has developed a broad range of methods and design criteria to facilitate collaborative processes to foster knowledge among multiple stakeholders that helps them address sustainability challenges, thereby seeking to counteract a widening gap between scientific knowledge production and society/practice (König, 2018; Lang et al., 2012; Schneidewind et al., 2016). They have been accompanied by an emphasis on the importance of local, experiential and practice-based knowledge, and context-specific approaches (Berkes & Folke, 2002; Fazey et al., 2006; Raymond et al., 2010; Weber et al., 2014).

Empirical inquiry in adaptive governance and management has pointed to the importance of self-organisation and information in local communities and/or river basins in common-pool resource management (Meijerink & Huitema, 2017; Ostrom, 2009). Furthermore, transformative science has inquired into the importance of meaning-making and experiential social and material engagement in what makes actors depart from established routines and explore new paths in the pursuit of sustainability (König, 2018; Singleton, 2015; Van Poeck et al., 2018). These communities conceptualise knowledge and action as part of ongoing social learning processes in how actors understand and seek to address challenges.

However, less empirical transformative research has been dedicated to how meaning-making relates to professional and organisational contexts outside academia. This is surprising given that many scholars point to the significant role of organisations in transformation processes (e.g. Amel et al., 2017; Bouwen & Taillieu, 2004; Hahn et al., 2006; Holling et al., 2002), often based on organisational learning theories (e.g. Argyris & Schön, 1996). The research gap is even larger as regards professional knowledge. Outside sustainability science and adaptive governance and management, professions are attributed a crucial role in how societal problems are defined, what we know about them, and how they are ´solved´ (e.g. Schön, 1983). It has been analysed how, in today´s knowledge societies, *non*-scientific professions increasingly use and produce scientific data and information (e.g. Knorr Cetina, 2007). Nonetheless, in sustainability science and adaptive governance and management professional knowledge of e.g. farmers or conservationists tends to be subsumed under local or experiential knowledge, if explicitly considered at all (Fazey et al., 2006; Ingram, 2018). The present thesis addresses this shortcoming by examining the role of professional and organisational knowledge of diverse nongovernmental and governmental actors in the areas of water, agriculture, and ecological conservation. Relations with specialised scientific/technical knowledge receive particular attention. Finally, using the concepts of paradigms and narratives, the present thesis inquires into how meaning-making and action relate to paradigms and narratives shared in specific organisations, professional and local communities. Narratives can cast light on assumptions and imaginaries that underlie how actors frame and seek to tackle resource challenges (Chabay et al., 2019; Chase, 2011; Elliott, 2005; Jasanoff & Kim, 2015). Thereby, they may point to the existence of collectively shared paradigms. Furthermore, narratives may be at the heart of actor identities, and may inspire new ways of imagining human-environment relations (Chabay, 2020; Ezzy, 1998; Maggs & Robinson, 2016). The present thesis develops a conceptual and analytical framework tailored to the empirical analysis of these factors.

Research question 2: *How has the EU WFD changed water and land governance and management in Luxembourg?*

In the past millennium, water governance and management have been dominated by top-down governance, specialised science, and a focus on engineered infrastructures to secure water supply and flood protection (Ison et al., 2007; Kallis & Nijkamp, 2000; Pahl-Wostl et al., 2011). Agriculture served food supply (Dyball & Newell, 2015; Thompson, 1994). The EU WFD has been interpreted as signalling a paradigm shift towards integrated water management (Jager et al., 2016; Pahl-Wostl, 2015). It obliges EU member states to restore water bodies to a "good ecological status", thereby expanding the scope of water management to aquatic ecosystems and biodiversity, necessitating coordination with environmental and agricultural policies, projects, and actors (EC, 2000). Reflecting a nexus perspective, water management, environmental conservation, and agriculture increasingly become part of landscape management serving multiple purposes (Pahl-Wostl, 2006a; Schindler et al., 2014). The EU WFD recommends that water governance be extended to nongovernmental actors, for example, via social networks (EC, 2003b, 2000). In addition to formal public consultations, active stakeholder involvement is promoted as a way to consider "non-expert knowledge", to foster social learning, and develop approaches tailored to local conditions in river basins (EC, 2003b).

Focusing on the Syr and Upper Sûre river basins, the thesis therefore investigates if, firstly, WFD implementation has resulted in the emergence of organisational changes, network governance, and a greater consideration of local and professional knowledge in efforts to improve water quality. Particular attention is devoted to the role of the Syr and Upper Sûre river partnerships, as river basin organisations can play key roles in fostering local engagement and facilitating cross-scale and cross-sectoral coordination of resource management (Huitema & Meijerink, 2017). Secondly, it investigates if and how professional management practices of water authorities and facility operators, farmers, and municipalities have changed, if they have contributed to improving the state of aquatic ecosystems, and what other factors drive water quality and land use in Luxembourg. Finally, the analysis of narratives serves to provide evidence for the extent to which social learning and paradigmatic changes may be underway in the purposes, scopes, and means that actors apply to water and land governance and management.

There are several graphic representations and analytical grids for governance modes and social coordination mechanisms in the literature (e.g. Defourny & Nyssens, 2012; Pahl-Wostl, 2009; Pahl-Wostl & Knieper, 2014). However, few embrace resource management as such. Therefore, the thesis develops an analytical grid serving to characterise water and land use systems and their transformation along a governance and a management axis, mapping trajectories, synergies, and tensions between diverse policies and actors.

Research question 3: *What factors facilitate or hinder the emergence of social learning and actionable knowledge for sustainability?*

Building mainly on the concept of multi-loop social learning as developed in the Management and Transition Framework (Pahl-Wostl et al., 2010), empirical analysis serves to analyse and compare the extent to which social learning and actionable knowledge have emerged from the governance processes in the two river basins, and how conducive they have been to transformative change. Scholars from diverse scientific communities have examined social learning in relation to sustainability and resource challenges, to factors that facilitate or hinder social learning, and possible effects and outcomes (e.g. Bouwen & Taillieu, 2004; Folke et al., 2005; Ison et al., 2007; Medema et al., 2014; Mostert et al., 2007; Pahl-Wostl, 2006; Peters & Wals, 2013; Röling & Wagemakers, 1998; Steyaert & Jiggins, 2007; Van Poeck et al., 2018; Wiek et al., 2014). With the exception of some approaches and frameworks (e.g. Ostrom, 2009; Pahl-Wostl et al., 2010; Wiek & Larson, 2012), few of them attribute

equal importance to formal, informal, and material factors. A few studies explicitly consider factors relating to river basin organisations and (other) formal organisations, but focus mainly on institutional design (Huitema & Meijerink, 2017; Mostert et al., 2007; Wiek et al., 2014), organisational commitment (Sol et al., 2018), and/or intra-organisational interaction (Wals & Schwarzin, 2012).

The present thesis makes a contribution to the literature by examining how knowledge, relations, and actions in diverse organisations, professional and local communities, evolve in the course of governance processes and in interaction with ecosystems, and what factors facilitate and hinder the emergence of social learning. Special attention is paid to interrelations with personal meaning-making and narratives as potentially crucial informal factors in making knowledge ´actionable´.

Context of the thesis:

The PhD thesis has been conducted in the framework of the NEXUS FUTURES project co-funded by the Ministry of the Environment[1]. Pioneering transformative sustainability science in Luxembourg, the project is situated at the science-policy-practice interface and seeks to support social learning at the nexus of Luxembourg´s water and land systems (König, 2018). Its reference group provides a forum for engagement between researchers, river partnerships, national authorities, water suppliers, farmers, and other actors. The thesis has emerged from dialogues with members of the reference group, from interviews, collaborative workshops, site visits, and informal conversations complemented by extensive documentary research.

1.2 Thesis structure

The thesis is composed of twelve parts that are grouped as follows:

- Concepts: parts 2 – 4
- Methods: part 5
- Case studies: parts 6 – 11
- Conclusions: part 12

Concepts (parts 2 - 4)

Part 2 of the thesis starts out by positioning the main approaches and concepts used from transformative sustainability science and adaptive governance and management (and, more specifically, the Management and Transition Framework) within their scientific fields, relates them to one another, and highlights differences and similarities with other scientific fields and concepts. It concludes by outlining the basic assumptions of the author of the thesis, reasons for adding concepts from American Pragmatism and symbolic interactionism, organisational and professional learning, and Science & Technology Studies, and the main research contributions.

Part 3 is the core conceptual part. It develops a conceptual and analytical framework on actionable knowledge tailored to the empirical study of knowledge and actions of individual and organisational actors in governance and social learning processes. It draws on the above-mentioned fields and approaches to construct an actor-centred framework that serves to structure inquiry into how various systemic contexts and related formal, informal, and material factors influence actor engagement in governance processes. The contexts themselves may undergo changes as a result of social learning processes (feedback loops). Notably, the framework develops the diagnostic approach of the

[1] See website: sustainabilityscience.uni.lu

Management and Transition Framework (MTF) further. At the heart of the framework is the conceptualisation of actionable knowledge along three dimensions: normative (why), systems (what), and transformation (how) dimensions. These dimensions are used to construct an analytical grid tailored to the mapping and analysis of approaches and paradigms in water and land governance and management.

Part 4: Drawing on diverse scientific strands in water, agricultural, and environmental governance, part 4 characterises some of the main paradigms and developments that have shaped water and land systems in Western industrialised countries since the 19th century. The objective is to facilitate the analysis of water and land governance in Luxembourg that has been closely interwoven with other European and Western industrialised countries. The part encompasses preindustrial paradigms, modern-industrial paradigms (´command-and-control´ in water management and the productionist paradigm in agriculture), adaptive and integrated approaches to water management and agriculture (incl. agroecology), an emerging top-down managerial ecocentric paradigm originating in ´traditional´ approaches to ecological restoration, and tentative outlines of an ´ecocultural community´ paradigm. The latter has been constructed from diverse scholars seeking to fundamentally reframe human-environment relations. On the basis of these paradigms, the EU Water Framework Directive is analysed as a hybrid and partly contradictory framework that combines ecocentric, anthropocentric, and integrated paradigms as well as hierarchical and network-based governance modes.

Research design and methods (part 5)

Part 5 elaborates on the transdisciplinary design that has structured the research process and on the methods used to gather empirical data for the case studies: collaborative stakeholder workshops, qualitative interviews, site visits, observations, and document analysis. It also outlines details of the main analytical categories of the diagnostic approach of the Management and Transition Framework and its database that have been adapted for - and applied to - the Syr and Upper Sûre case studies.

Case studies (parts 6-11)

Part 6 provides an introduction to the case studies that outlines core elements of a systems perspective on challenges at the water-land nexus in the Syr and Upper Sûre case studies. It does so, firstly, by briefly describing diverse challenges in the basins that stakeholders identified at collaborative NEXUS FUTURES workshops. Only some of them are covered in-depth in the subsequent case studies. Secondly, it outlines general characteristics of the two river basins as regards hydrology, populations and land use, and technical infrastructures (notably, water treatment plants) that play a role in the case studies.

Part 7 (part I of the case studies) analyses and compares historical and contemporary governance contexts in Luxembourg and, more specifically, in the Syr and Upper Sûre basins. Starting in the 19th century, it covers governmental and nongovernmental organisations, policies, landscapes, and technical infrastructures that have been found to be relevant to understand governance processes at the water-land nexus in the river basins following the national transposition of the EU WFD. The historical contexts are divided into four phases in water and agricultural governance and management that are outlined from diverse perspectives (based on interviews and documents). They encompass preindustrial times, industrialisation (emergence of growth- and supply-oriented paradigms and of first environmental organisations), post-WWII reconstruction and European integration (intensification of growth- and supply-oriented paradigms, including construction of the Upper Sûre dam), and the last quarter of the 20th century with its EU and national water, environmental, and agricultural policies, and bottom-up environmentalist initiatives and community-based approaches. The latter self-organised activities in the Syr and Upper Sûre valley (by the Fondation HfN, respectively, the

predecessor of the Upper Sûre Nature Park) are discussed in more detail, because they provide early examples of informal governance processes that produced actionable knowledge (*research question 1*). Furthermore, the organisations involved are the parent organisations of today´s Syr and Upper Sûre river partnerships.

Part 8 (part II of the case studies) analyses formal and informal governance processes (2000-2012) that relate to the implementation of the EU Water Framework Framework directive in Luxembourg, the creation of the national Water Management Authority (AGE), and the creation of the Syr and Upper Sûre river partnerships. They were launched in the framework of self-organised EU co-funded projects. The process analysis is structured into eight ´action situations´. The case study includes analyses of the national water law of 2008, of the 1st and 2nd national WFD management plan, and of the foundational activities and formal institutional set-up of the two river partnerships. The part concludes with a discussion on how the EU WFD has changed formal water governance in Luxembourg (*research question 2*). For the first time, water governance in Luxembourg was directed towards environmental objectives and included elements of network governance. At the same time, national WFD implementation also strengthened hierarchical regulation- and science-based approaches to water governance and management.

Part 9 (part III of the case studies) analyses formal and informal governance processes relating to the preparation of new drinking water protection zones in the Upper Sûre region (2012-2019). It is structured into 13 action situations. They concern formal processes preparing the draft law on the new protection zones (including a public consultation), informal processes relating to efforts of the Upper Sûre river partnership to coordinate local stakeholder involvement, and to the creation of the formal agricultural cooperation LAKU. LAKU activities have included experiments with new farming techniques. The analysis also encompasses a discussion of how a pesticides accident that contaminated the national drinking water reservoir influenced governance processes. The concluding discussion of changes in water and land governance (*research question 2*) and of facilitating and hindering factors for social learning (*research question 3*) identifies formal and informal barriers to stakeholder involvement, but also points to action-oriented self-organisation as main facilitating factor for the emergence of social learning and actionable knowledge.

Part 10 (part IV of the case studies) analyses formal and informal governance processes relating to water quality and river restorations in the Syr basin (2012-2019), with a focus on three consecutive river sections. The analysis is structured along 14 action situations. Governance in the Syr basin has been fragmented. In the absence of overarching governance processes, the analysis takes up three different strands that all concern water quality in the Syr river. They are, firstly, self-organised efforts of the river partnership and particular member municipalities to implement projects aiming to improve river structures and address sources of pollution (including wastewater). Secondly, formal processes relating to EU WFD implementation (addressing flood protection and the extension of a wastewater treatment plant) are analysed (including a public consultation). Thirdly, the part analyses formal processes relating to the implementation of environmental policies in the Syr Natura 2000 valley, including the declaration of a part of the Syr valley as national wetland reserve that included a formal public consultation. The part starts out with the analysis of a river restoration that was carried out in the Natura 2000 area preceding national EU WFD implementation. No other major river restoration has been implemented along the Syr since. The project illustrates diverse challenges in the management of restored areas. The concluding analysis discusses coordination challenges, tensions, and contradictions in water and land governance in the basin (*research question 2*) that along with diverse other factors have hindered the emergence of double loop social learning in the Syr valley (*research question 3*).

Part 11 (part V of the case studies) compares the governance processes in the Upper Sûre and Syr basins to draw broader conclusions on some of the challenges and tensions in water and land governance in Luxembourg today (*research question 2*). It summarises informal, formal, and material factors that can facilitate or hinder social learning (*research question 3*). Finally, it returns to the conceptualisation of actionable knowledge for sustainability (*research question 1*). It does so by elaborating on how meaning-making, personal and shared narratives have influenced how environmentalists, farmers, and municipalities have engaged in governance processes and addressed challenges (why, what, how). The part concludes by arguing that self-organised processes and projects that create spaces for meaning-making among diverse actors are indispensable for the emergence of actionable knowledge for sustainability.

Part 12 contains the final conclusions of the thesis. In contains a summary of the overarching findings and research contributions, reflects on conceptual and empirical limitations of the thesis as well as questions for further research, outlines recommendations for policy and practice, and an outlook on transformative sustainability research in Luxembourg.

CONCEPTS

2 CONCEPTUAL POSITIONING

This part serves to position the thesis conceptually. It discusses key concepts used from diverse strands of scientific literature and relates them to one another, identifying synergies and research gaps. Furthermore, it elaborates on basic assumptions underlying the thesis and on the main scientific contributions it seeks to make.

Positioned at the science-governance-practice interface, the thesis sets out to develop an analytical framework suitable to analyse the emergence of actionable knowledge among actors who engage professionally and locally in water and land governance. The framework considers interrelations between processes of actor engagement, and multiple informal, formal, and material contextual factors. The main objective is to structure empirical inquiries into facilitating and hindering factors with a view to organisations, professional and local communities.

To achieve this, the thesis builds mainly on transformative sustainability research and adaptive resource governance and management that promote the engagement of nongovernmental and non-scientific actors (along with their diverse knowledge types) in social learning processes as a way to support behaviour changes and paradigm shift across diverse contexts of human-environment interaction. It draws on transformative sustainability science to position actionable knowledge. Furthermore, it positions the Management and Transition Framework (MTF) in relation to adaptive governance and management, and related approaches to social learning. Furthermore, the present thesis uses concepts from Science & Technology Studies, American Pragmatism and symbolic interactionism, transformation studies and organisational and professional learning.

Combining diverse conceptual perspectives allows the researcher to engage with research ´objects´ in different ways, thus potentially enriching the scope of interpretations, casting light on uncertainties in interpretation, conceptual ´blind spots´ and possible contradictory insights emerging from the same data (see methods chapter 5). The MTF perspective directs attention to how actors may contribute to enhance adaptive and transformative capacities of governance systems in complex social-ecological systems (SES). The transformative research strands selected for present purposes highlight the role of meaning-making, experiential learning, and narratives in transactional relations between actors and their environment, partly drawing upon concepts from American pragmatism and Science & Technology Studies (STS). The present thesis elaborates on the STS perspective in more detail, in order to analyse the political, normative and historical dimensions of how societal and organisational epistemic cultures and practices, imaginaries (and related narratives), modern science, technologies and material landscapes, have mutually shaped each other. Finally, the organisational learning perspective adopted from, among others, Chris Argyris and Donald Schön serves to underscore the argument that sustainability research would benefit from devoting more attention to organisational and professional learning and knowledge.

2.1 Paradigms and sustainability science

Conceptions and assumptions pertaining to how researchers conceptualise sustainability, science and knowledge are closely interrelated. What actionable knowledge for sustainability is conceived to be, what purposes it is to serve, ideas on how it may be fostered and enacted are intimately related to how sustainability and the role of science themselves are understood.

The present thesis positions itself in the field of sustainability science. Generally speaking, sustainability researchers seek to better understand interactions between society and the biophysical environment and to contribute to making interactions more sustainable entailing efforts of linking knowledge to action (Kates et al., 2001; van Kerkhoff & Lebel, 2006) or, put differently, to bridge the gap between disciplinary science and society (Wiek et al., 2012). The Brundtland definition and the UN 2030 Agenda for sustainable development provides the field with a frequently cited common denominator (UN, 2015; WCED, 1987):

> *"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987).*

Referring to social equity between generations and three pillars of sustainability, the document stresses that society and economy need to be transformed to preserve environmental life-support systems. Moving the human dimension into the spotlight, the definition reflects an anthropocentric perspective (Grunwald, 2016).

Sustainability is a deeply normative concept (Spangenberg, 2011). Ecological challenges cast doubt upon prevailing ways of knowing and doing (König, 2018). Critical reflections are needed on "how to do better things" rather than "to do things better" (Wals & Schwarzin, 2012). This argument extends to science itself. Sustainability science seeks to transform the ´why´ and ´how´ of science (Spangenberg, 2011). Frequently rooted in ´post-normal science´, it seeks to produce knowledge that contributes to action by addressing challenges in a manner that transgresses disciplinary boundaries, openly recognises normative ambiguities, and emerges from continuous social learning processes about complexities and uncertainties in human-environment systems (Funtowicz & Ravetz, 1993; Kates et al., 2001). Systems thinking, cooperation, and dialogues serve to overcome monocausal linear thinking and disciplinary fragmentation and to involve non-scientific actors and their knowledge. The objective of sustainability science is to build social capacity to deal with sustainability challenges and to nurture changes in institutional frameworks and practices across actor groups, spheres, and scales (Grunwald, 2016; Kates et al., 2001; König, 2018; Pahl-Wostl, 2015; Wals & Schwarzin, 2012; Wiek et al., 2012). ´Post-normal science´ provides outlines for a problem- or challenge-driven science that requires new criteria for quality concerning scientific knowledge, processes and methods, including for how to deal with uncertainties and how to engage in societal and normative debates (Funtowicz & Ravetz, 1993; König, 2018).

A vast and diverse field, sustainability science encompasses different scientific communities using diverse quantitative, qualitative and/or participatory methods and approaches that flow from different ontological, epistemological, and axiological assumptions and aspirations that can often be attributed to different disciplines (e.g. the natural or human and social sciences) (Grunwald, 2016; Stirling, 2015c). Assumptions and aspirations shape how researchers conceptualise sustainability, knowledge, and relations between science and society. Scholars distinguish between "naturalist-objectivist" versus "culturalist-subjectivist" (Grunwald, 2016), "descriptive-analytical" versus "transformational" (Wiek & Lang, 2016; Wittmayer & Schäpke, 2014), "hard" versus "soft" (Röling & Wagemakers, 1998; Woodhill & Röling, 1998, based on Checkland), "managerial" versus "procedural" and "participatory"

approaches (Maggs & Robinson, 2016), or between "science *for* sustainability" and "science *of* sustainability" (Spangenberg, 2011).

The present thesis makes a distinction between descriptive-analytical and transformative approaches that roughly reflects some of the above-mentioned polarities. Furthermore, the present thesis joins scholars who have developed integrative and "regenerative" approaches within transformative strands of sustainability science (see below). They embrace the normative and processual character of sustainability and scientific knowledge, engage directly in social processes in a transdisciplinary manner to act as catalysts for transformational change (Schneidewind et al., 2016), whilst also considering limits to biophysical carrying capacities of the Earth. Scholars will often work in interdisciplinary teams and may use a mix of qualitative, quantitative and participatory approaches (Creswell, 2014; Stirling, 2015c). A brief review of different approaches to sustainability and underlying assumptions serves to clarify the positioning of the present thesis in relation to different scientific fields and paradigms in sustainability science. It also provides a background for some of the paradigms identified in water and land governance and management (see part 4).

Paradigms have a two-fold importance in the present research. Firstly, the present inquiry itself is shaped by specific assumptions. It seeks to contribute to meta-paradigmatic scientific reflections in resource governance and management, where there have been calls for paradigm shifts for decades (Cortner & Moote, 1994; Gleick, 2000; Patterson & Williams, 1998; Röling & Wagemakers, 1998). Secondly, the main object of the thesis is to examine if and how paradigmatic shifts have emerged in how actors govern, manage, and engage with water and land in Luxembourg. Before elaborating on different approaches to and conceptualisations of sustainability, it is therefore pertinent to start out with a discussion of the concept of paradigms itself.

2.1.1 Scientific and social paradigms

Many scientific preoccupations with paradigms originate in reflections about the nature of science and scientific knowledge. Reflections have since extended to studies into the nature of knowledge and the role of paradigms in systems and society at large.

2.1.1.1 Constructivist, interactional, and participatory

Paradigms have become an established way of positioning scientific research to make assumptions that guide researchers explicit (Creswell, 2007; Lincoln & Guba, 2000; Rallis & Rossman, 2012). Paradigms are commonly defined as belief systems that are attached to a particular worldview and certain principles (Denzin & Lincoln, 2011; Lincoln & Guba, 2013). Shaping framings, assumptions, cognition and representations, paradigms provide models or metaphors for how to engage with the world (Heron & Reason, 1997).

Thomas Kuhn was one of the first to link scientific knowledge production to paradigms. Scientific communities hold particular paradigms that provide individual scientists with an accepted common model as to which research questions to pose and how to solve them. He likened "normal science" to puzzle-solving, where fundamentally new questions and insights that do not fit in tend to be suppressed. Unlike prevailing positivist views of science that believed in an objectively discoverable and representable reality, he argued that scientific knowledge was inextricably interlinked with how a scientific community is organised:

> *"Scientific knowledge, like language, is intrinsically the common property of a group or else nothing at all. To understand it we shall need to know the special characteristics of the groups that create and use it" (Kuhn, 1962).*

Kuhn´s argument contributed to the rise of the paradigm of constructivism. Many sociologists and anthropologists have since studied the "constructivist and contextual nature of science" (Knorr Cetina, 1981), i.e. how organisational modes and particular meaning-frames shape scientific knowledge production (Knorr Cetina, 1981; Weingart, 2010). In Science & Technology Studies (see below), Karin Knorr Cetina associated paradigms with the "epistemic cultures" of particular communities. Epistemic cultures are defined as:

> *"sets of practices, arrangements, and mechanisms bound together by necessity, affinity, and historical coincidence that, in a given area of professional expertise, make up how we know what we know. Epistemic cultures are cultures of creating and warranting knowledge" (Knorr Cetina, 2007).*

Epistemic cultures shape strategies and identities of its members. They are closely interrelated with the general knowledge culture of society that contributes to sustaining or discouraging certain epistemic outcomes (Knorr Cetina, 2007).

For present purposes, this part treats different constructivist, interactional, and participatory approaches together, because they share a rejection of positivism and may be difficult to distinguish from one another (Denzin & Lincoln, 2011; Röling & Wagemakers, 1998). The classic variant of social constructivism based on Berger and Luckmann (1966) focuses on the role of social institutions and processes in the building of knowledge and action. It has been criticised for reducing ´reality´ to the purely social (Vera, 2016). Science & Technology Studies, on the other hand, adopt an interactional stance on social constructivism that attributes more importance to the material environment and tools (inspired by Latour). Knorr Cetina argued that epistemic cultures and practices are interwoven with material devices and objects in self-referential cognitive circuits (Knorr Cetina, 1991, referring to (Maturana & Varela, 1987)). Paradigms and knowledge are not only held in the minds of individuals, but are actively constructed and reinforced through objects and physical action (Knorr Cetina, 1991). STS scholar Sheila Jasanoff has extended interactional constructivism to include the idea of co-production. Sociopolitical orders, scientific knowledge, technologies, practices and identities co-produce each other. Therefore, distinctions between the "natural or social", "the human or non-human" itself are constructed, and become themselves objects of scientific inquiry (Jasanoff, 2006).

The reason for why the present thesis treats STS scholarship together with constructivism is mainly that, despite two-way relations between the social and the material[2], Jasanoff does refer to socially and culturally conditioned perceptions of reality. Furthermore (and unlike Latour) she retains human agency as a category separate of non-human agency for normative reasons (Jasanoff & Kim, 2015)[3]. Similarly, Maturana and Varela (associated with interactional stances) stress that cognitive action takes place in language (i.e. as social acts) and is a characteristic feature of "humanness", which for them, too, has ethical implications (Maturana & Varela, 1987)[4]. At the same time, their emphasis on the

[2] "Constructivism does not imply that social reality is ontologically prior to natural reality […]"(Jasanoff, 2006)

[3] "The preoccupation with hybridity also risks establishing a troubling normative equivalence between non-human and human agents. […] it is still humans and their collectives who can imagine a world […]" (Jasanoff, 2015)

[4] "Likewise, to disregard the identity between cognition and action, not to see that knowing is doing, and not to see that every human act takes place in languaging and, as such (as social act), has ethical implications because it entails humanness, is not to see human beings as living entities […] We have delved into social dynamics which points up a basic ontological feature of our human condition that is no longer a mere assumption, that is, we have only the world that we bring forth with others, and only love helps us bring it forth […] It is not the knowledge that a bomb kills, but what we want to do with the bomb, that determines whether or not we use it. Ordinarily we ignore it or deny it, to sidestep responsibility for our daily actions […]" (Maturana & Varela, 1987, p.248)

"structural coupling" between living beings and their environments stresses that knowledge emerges in cognitive acts that result from mutual interaction between mind and body, the mental and material, "that brings forth a world" (Maturana & Varela, 1987). It is on these grounds that Maturana and Varela coined the saying "All doing is knowing and knowing is doing", emphasizing the significance of action and experience in (acts of) knowing (Maturana & Varela, 1987)[5].

Based on these and similar assumptions, Heron and Reason have developed a "participatory inquiry paradigm" to underpin action research and other forms of co-operative inquiry (Heron & Reason, 1997). Their main argument is that human actors participate experientially in a "co-creative dance" between mind and "cosmos", in which a clear distinction between subject and object cannot be upheld. As regards research, the paradigm puts "human flourishing" at its center and rejects unilateral control of research processes by researchers. The SAGE handbook on qualitative research has included the participatory paradigm as a paradigm in its own right, with its emphasis on action and spirituality as main distinguishing factors (Lincoln & Guba, 2000).

The present thesis, based predominantly on interactional assumptions (see below 2.3.1), regards scientific paradigms as heuristic devices that serve to guide research and call for reflexivity about underlying assumptions, merits and limitations. No one paradigm can be expected to offer the most adequate way of engaging with specific issues. For this reason, modern qualitative social researchers can be ´bricoleurs´ who take approaches from various communities (Denzin & Lincoln, 2011). By "thinking with" different concepts, different possibilities of interpreting data will offer themselves (Jackson & Mazzei, 2012). The present thesis thus makes an attempt at a conceptual "inter-ontology crossover" or "multi-paradigm analysis" (Geels, 2009, 2010). It does so based on the American pragmatist view that inquiry entails engagement with a variety of people, concepts, methods and ´things´ that can be constructed according to "what works" in relation to a specific purpose, whilst having to provide compelling arguments and ´evidence´ for the choices and interpretations made (Denzin & Lincoln, 2011). This stance is further elaborated below (2.3).

2.1.1.2 Axiological, ontological, epistemological dimensions

Scholars from systems thinking, sociology, environmental psychology and other scientific fields have used paradigms as heuristic devices to conceptualise and analyse patterns in systems and societies, and their transformation (Dyball & Newell, 2015; Meadows, 1999; Scott et al., 2016). Elaborating on Kuhn, Fritjof Capra defined "social paradigms" as "a constellation of concepts, values, perceptions, and practices shared by a community, which forms particular vision of reality that is the basis of the way the community organises itself" (Capra, 1996). Concepts such as worldviews, narratives, metaphors, myths and mental models are closely related to this understanding of paradigm.

In sustainability science and environmental governance, an increasing number of researchers have called for new paradigms reconfiguring relations between science, society and practice, both in society at large and in water and land governance, in particular (Cortner & Moote, 1994; Folke et al., 2005; Ison et al., 2013; Pahl-Wostl, 2006b; Patterson & Williams, 1998). In the systems analysis of Donella

[5] In his theory of material engagement, Malafouris has developed cognitive theories and the actor-network-theory of Latour further. In his conceptualisation of the extended "embodied mind", he situates material engagement (e.g. with tools and artifacts characteristic of humans as homo faber) as prior to human sense-making and intentionality, which he regards as situated not in the human brain, but in relations and entanglements between brain, body and world that co-constitute each other in contextualised processes. He, thereby, rejects anthropocentrism that regards "humans at the centre of reality" and as measure of all things (Malafouris, 2013).

Meadows, paradigms have a particularly prominent place. They rank as one of the uppermost leverage points to transform a system:

> *"Paradigms are the sources of systems. From them, from shared social agreements about the nature of reality, come system goals and information flows, feedbacks, stocks, flows and everything else about systems […] people who have managed to intervene in systems at the level of paradigm have hit a leverage point that totally transforms systems. In a single individual it can happen in a millisecond. All it takes is a click in the mind, a falling of scales form eyes, a new way of seeing. Whole societies are another matter. They resist challenges to their paradigm harder than they resist anything else". (Meadows, 1999)*

Along with most other scholars cited here, Meadows pins her hopes for paradigm shifts to society´s capacity for self-organisation and individuals´ powers to transcend paradigms (Meadows, 1999; Pahl-Wostl, 2015; Westley et al., 2002). A number of transformative researchers seeking to tackle "root causes" of unsustainability have built on this idea (e.g. Abson et al., 2017; Ives et al., 2018; O'Brien & Sygna, 2013).

Paradigms (and research perspectives or approaches[6]) can be studied according to three dimensions: axiology, ontology, and epistemology (Heron & Reason, 1997; Patterson & Williams, 1998)

Axiology: Adopting an interpretivist approach characteristic of qualitative research, the present thesis attributes overriding importance to the axiological dimension of human knowledge and action. In philosophy, axiology concerns ethics, aesthetics, and religion or, more broadly, spirituality (Lincoln & Guba, 2000). It asks questions about ´the good life´, what is desirable, intrinsically worthwhile and valuable (Heron & Reason, 1997). Foregrounding axiology, directs attention to human meaning-making. The basic assumption is that - in science as in all walks of human life - what is deemed ´good´ or ´appropriate´, ´desirable´ or ´meaningful´ guides overarching purposes of action and knowledge, the framing of issues, the kind of questions asked, more immediate goals pursued and methods and tasks chosen, and criteria by which they are judged (Heron & Reason, 1997; Patterson & Williams, 1998; J. R. Ravetz, 1971). Sustainability challenges make ´why´ questions regarding human ends, action and engagement with the environment particularly pressing (Bateson, 2000). They call for reflexivity on purposes and paradigms pursued (Popa et al., 2015; Spangenberg, 2011).

Ontology: Ontology concerns claims and assumptions about the nature of reality, human experience and human nature. (Rallis & Rossman, 2012) Positivist approaches assume the existence of a fairly stable and predictable reality "waiting to be discovered", while constructivists regard reality as primarily socially constructed (Patterson & Williams, 1998). Constructivist and participatory stances regard human experience and human nature as based on meaning-making, rather than as on rational and instrumental considerations. Some authors refer to narrative ontologies or narrative qualities of human life flowing from an emphasis on human experience (Lincoln & Guba, 2000; Patterson & Williams, 1998; Somers, 1994). Furthermore, as outlined above, interactional and participatory approaches focus on interplays between (material) reality and social constructions, with cognition, experience and action establishing interrelations. For example, Polanyi regarded the body as the "ultimate instrument of all our external knowledge", because it is through the body that we experience the world (Polanyi, 1966).

[6] What distinguishes them is, as regards paradigms, these dimensions are part of a net or coherent framework of assumptions that, by comparison, is less developed in research perspectives (Denzin & Lincoln, 2011). The present thesis uses ´approach´ as a generic term to cover both paradigms and perspectives.

Epistemology: The epistemological dimension concerns the nature of human knowledge and how humans can know the world. In contrast to interactional and constructivist stances outlined above, positivism holds that reality can be known (completely or partially) and described objectively by detached observers via propositional and representational knowledge that reflects generalizable and universally valid ´truths´ or laws. Knowledge tends to be equated with explicit *scientific* knowledge and regarded as a product that is cumulative and based on objective evidence derived from systematic methods and procedures (Meusburger et al., 2008; Raymond et al., 2010). Positivism thus rests on the belief that "facts" and "values" can be distinguished from one another (Böschen & Wehling, 2004). However, as a result of growing awareness of unintended ecological and societal consequences of positivist science, science, in general, has become more reflexive increasingly acknowledging uncertainties in scientific knowledge or, put differently, the importance of recognizing "what it does not know" (nonknowledge) (Böschen & Wehling, 2004). Furthermore, sustainability science rests on a call for a greater recognition of non-scientific types of knowledge and ways of knowing (Caniglia et al., 2020; S. Peters & Wals, 2013; Raymond et al., 2010).

What methods researchers choose flow to a large extent from the axiological, ontological, and epistemological assumptions underlying paradigms. In general, sustainability challenges call for reflexivity along all of these dimensions (Popa et al., 2015).

As suggested above, many scholars in sustainability science to the overarching objectives of the UN 2030 Agenda for Sustainable Development. At the same time, natural and quantitative sciences (prominent in descriptive-analytical branches of sustainability science) tend to lean towards positivist approaches to knowledge production, while constructivist and interactional approaches tend to dominate qualitative social science approaches to sustainability. Furthermore, scholars differ on whether they consider society, economy, and the environment on equal footing (*weak sustainability*) or whether societal and economic purposes need to be subordinated to environmental concerns considering their dependence on ecosystems (*strong sustainability*) (Grunwald, 2016)[7]. Part 4 below discusses specific paradigms in water governance and resource management.

2.1.2 Descriptive-analytical sustainability science: Example of planetary boundaries research

Descriptive-analytical streams of sustainability science analyse complex cause-effect relations and elaborate risk assessments relating to sustainability challenges and develop models to forecast developments typically based on extrapolations (Spangenberg, 2011; Wiek & Lang, 2016). A prominent example is planetary boundaries research that adheres to a strong version of sustainability by assuming that the Earth system imposes "non-negotiable constraints" on human activities (Rockström et al., 2009; Steffen et al., 2015). It studies environmental impacts of human activities on biophysical aspects of life-support systems necessary to meet fundamental human needs (Griggs et al., 2013; Kates et al., 2001). Planetary boundaries research rests on the diagnosis that industrialisation was the dawn of a new era of planet Earth, the Anthropocence, in which humans have become a "global geophysical force" matching or perhaps even overwhelming the forces of nature herself, with climate change as just one of the most disconcerting consequences (Steffen et al., 2007).

In order for humanity to remain within (or return to) a "safe operating space", researchers develop models that serve to predict Earth system behaviour, determine systemic thresholds in environmental

[7] Grunwald (2016) refers to different forms of capital (on the one hand, natural capital and, on the other, human or artificial capital, incl. social, economic and cultural capital) and debates on to which extent artificial capital can substitute natural capital.

processes and possible ´tipping points´ when the risks of environmental hazards would increase significantly (Rockström et al., 2009a). While recognising substantial scientific uncertainties in predicting system dynamics and assessing risks, the planetary boundaries concept rests on the belief in the reliability and "predictive powers" of the natural sciences enhanced by ever-more data (Cornell, 2015; Steffen et al., 2015). In the face of apocalyptic prospects, humanity needs to stabilize biophysical processes (e.g. the climate) by reducing harmful emissions and overexploitation.

Earth system science and the planetary boundaries approach can be attributed to positivist assumptions. The role of science is to serve as a ´warning system´ and to provide scientifically sound evidence to inform public decision-making and debates in society about transformation options and their implementation, while not itself engaging directly in these processes (Cornell, 2015). A clear distinction between ´facts´ and ´values´ is upheld. Therefore, planetary boundaries research can be attributed to a "information deficit model of behaviour change" that rests on the belief (or hope) that societies will steer in another direction based on scientific information and data (Maggs & Robinson, 2016).

2.1.3 Transformative sustainability science

Transformative sustainability research, on the other hand, seeks to contribute to transforming prevailing ways of knowing and doing in society by engaging actively in social processes (König, 2018; Schneidewind et al., 2016). While scientific ´expert´ knowledge is necessary (both quantitative and qualitative), sustainability is a societal – rather than scientific or technical - project that requires "epistemological pluralism" (Peters & Wals, 2013). Therefore, transformative research seeks to address sustainability challenges in a transdisciplinary manner. It does so by (co-)designing and providing methods for collaborative processes that foster knowledge for sustainability actions. This is commonly referred to as knowledge co-production (Peters & Wals, 2013; Schneidewind et al., 2016; Stirling et al., 2018; Wyborn et al., 2019). The present thesis uses the term "co-creation" for designed collaborative processes to avoid confusion with the STS understanding of co-production (see 3.1.2.4).

Some transformative researchers call for "open knowledge systems" coupled to social-ecological systems, in which knowledge is not regarded as cumulative and finite, but as resting on tacit meanings and diverse interpretations of information and data that flow from contextual practices and action (Tabara & Chabay, 2013). Knowledge can be expressed in multiple forms, and requires neither a single language nor universal applicability (Fischer, 2000; Tabara & Chabay, 2013). Sustainability learning aims to foster different ways of knowing and types of knowledge that enhance awareness of – and inspires efforts to improve – how human action and institutions interact with ecological systems, and vice versa (Tabara & Chabay, 2013).

Knowledge that is to close "gaps" between science and society and action has many different names and connotations in the literature. It should be "solution-oriented" (Wiek et al., 2012), "transformational" (Hadorn et al., 2008), provide action-oriented "knowledge-how" or "how-to" practical knowledge (Caniglia et al., 2020; Wittmayer & Schäpke, 2014) or, finally, knowledge that is "actionable" (Caniglia et al., 2017; König, 2018; Wiek & Lang, 2016). Some stress that such knowledge should generate interventions whose likely effectiveness is based on empirical evidence (Caniglia et al., 2017; Wiek & Lang, 2016), others prioritise that knowledge and actions envisaged should be socially robust, strengthen reflexivity (Schneidewind et al., 2016) and societal and social capacities, e.g. to deal with complexity and uncertainty (König, 2018). Socially robust knowledge is strongly contextualised

knowledge that emerges from social processes that involve frequent testing and improvements. It is embraced by diverse actor groups, but, at the same time, *prospective* in being "capable of dealing with unknown and unforeseeable contexts" (Nowotny et al., 2001).

The term "actionable knowledge" has been chosen for the present thesis, as it was originally used by Chris Argyris for collaborative inquiries and learning (Argyris, 1993; Argyris et al., 1985) [8] and is rooted in similar assumptions as the present thesis. Actionable knowledge is not primarily about utility and effectiveness, but about human competence and values (Argyris, 1993).

Transformative sustainability science is predominantly rooted in constructivist, interactional or participatory paradigms that are closely related to action research, mode-2 science and transdisciplinary research that regard knowledge-as-process tied to learning processes (Raymond et al., 2010). Action research engages people in collaborative processes, in order to provide them with means to take actions to resolve specific problems (Stringer, 2014; Wittmayer & Schäpke, 2014). ´Mode 2´ research puts contextualisation, applicability, and ´service to society´ (including organisations and industry) at the forefront of science. In order to be "socially robust" knowledge needs to be highly contextualised, processual and empirical, be subject to scrutiny and improvement and capable of anticipating the unexpected (Nowotny et al., 2001). Transdisciplinary research seeks to engage people in transformative learning processes to address challenges and to overcome knowledge fragmentation (Fam et al., 2017). They have in common that they refute the idea of ´context-less´ knowledge, promote a processual understanding of knowledge and seek to leverage self-organisation, of which scientists are a part, but ´on tap´ not ´on top´.

Rooted in some of these and similar traditions, transformative researchers regard sustainability as a normative-ethical concept and ´regulative idea´ that cannot provide ready-made answers on what to do (or what *not* to do). Instead, it needs to rest on dialogues and *procedures* to reach agreements on context-specific ways to address challenges and continuous learning (Grunwald, 2016). Thus understood, sustainability can be understood as an emergent property of societal dialogues (König, Robinson et al., Maggs & Robinson) or of collective decision-making (Röling & Wagemakers, 1998, Woodhill & Röling, 1998).

There are several reasons for why researchers focus on the "human dimension" and support social deliberative processes. Firstly, sustainability poses wicked problems. Social problems are "wicked", because the very definition of problems and possible ´solutions´ depend on normative judgments and choices as to what kind of human society, life and future are considered desirable. For this reason alone, ´solutions´ need to be context-specific and can rarely be transferred. In addition, there are not ´optimal´ and ´definitive´ solutions´. In complex systems, solutions cannot first be tested in laboratory experiments, are bound to create irreversible consequences and new problems. (Rittel & Webber, 1973) Secondly, considering the human dimension of sustainability challenges, transformation pathways require changes in how people think and engage with each other and their material environments that cannot be prescribed or induced by information and data alone (Maggs & Robinson, 2016). Behavioural changes are most likely to emerge through self-organised social learning processes, in which actors co-create actionable knowledge (Argyris & Schön, 1996; Ison, 2010; Lewin & Grabbe,

[8] Argyris wrote: "Actionable knowledge is not only relevant to the world of practice; it is the knowledge that people use to create that world" (Argyris, 1993)

1945; Wiek et al., 2012)[9]. This entails a profound re-thinking of the nature and role of science and knowledge.

Whilst not refuting the idea that there are limits to biophysical carrying capacities of planet Earth, transformative scholars regard objectivist science as insufficient for and potentially misguiding transformative change (Grunwald, 2016; Maggs & Robinson, 2016; Stirling, 2015a). In addition to rejecting positivist beliefs and the ´information deficit model´ to behaviour change, criticism points to the consolidation of the powerful role of ´scientific expert advice´ in modern societies that is regarded as supporting technocratic approaches that tend to favour one-size-fits-all solutions and end-of-pipe technological fixes ignorant of contextual conditions of application (Hoffmann-Riem et al., 2008). Thereby, it may perpetuate some of the factors – or even the "mindset" - that have contributed to sustainability challenges in the first place (Spangenberg, 2011)[10].

Furthermore, the narratives associated with such approaches often focus on control and limitations to be imposed on human activities, rather than on opportunities (Stirling, 2015a). Instead, transformative researchers call for new paradigms, ethics, narratives, metaphors, myths, imaginaries or worldviews, in order to address causes of unsustainable human-environment relations (Abson et al., 2017; Amel et al., 2017; Chabay, 2020; Grunwald, 2016; Gunderson & Holling, 2002; Ison, 2010; Jonas, 1979; König, 2018; Maggs & Robinson, 2016; Meadows, 1999; Pahl-Wostl et al., 2011; Parodi, 2008).

As discussed above, the present thesis adopts a broad understanding of paradigms that encompasses all of these concepts and terms. Sustainability discourses and ´narratives´ need to focus on hope, human imagination and creativity, if they are to inspire changes in behaviours and practices (Chabay et al., 2019; Maggs & Robinson, 2016; Stirling, 2015a). They need to foster agency that rests on caring, solidarity, responsibility and self-discipline and "open up imaginations of the multiple contending kinds of societies in which human ways of being can unfold" (Stirling, 2015a), showing options between "techno-managerialism and ecocidal fatalism" (Castree, 2014).

"Regenerative sustainability" offers a narrative that cultivates positive impacts of human activities as a way to improve both environmental conditions and human quality of life, addressing questions of "meaning, purpose, happiness, and identity" (König, 2015; Maggs & Robinson, 2016; Robinson et al., 2013). For some scholars, unsustainability directs attention to human and non-human beings as ontologically interlinked, dissolving the dichotomy of ´nature´ and ´culture´ (often based on cognitive theories, STS and/or network actor theory), giving rise to conceptualisations of hybridity and entanglement (Stirling, 2015, Maggs & Robinson, 2016). It may no longer be plausible to treat "human" and "natural" history as distinct (Castree, 2014). Or, put differently:

[9] This idea originates in action research. One of the fathers of action research, the psychologist Kurt Lewin found: "An individual will believe facts he himself has discovered in the same way that he believes in himself or in his group. The importance of this fact-finding process for the group by the group itself has been recently emphasized with reference to re-education [...] It can be surmised that the extent to which social research is translated into social action depends on the degree to which those who carry out this action are made a part of the fact-finding on which the action is to be based". He described "re-education" as a "change in culture" that entailed the acquisition of a new system of habits, standards, and values: "It is a process in which changes of knowledge and beliefs, changes of values and standards, changes of emotional attachments and needs, and changes of everyday conduct occur not piecemeal and independently of each other, but within the framework of individual's total life in the group" (Lewin & Grabbe, 1945)

[10] Spangenberger refers to "Einstein´s "dictum that a problem cannot be solved by the same mindset that helped create it" (Spangenberg, 2011)

"The ´environment´ sounds like an external context of human action. But ecological issues have come to the fore only because ´the environment´ is in fact no longer external to human social life but thoroughly penetrated and reordered by it. If human beings once knew what ´natural´ was, they do so no longer. What is ´natural´ is now so thoroughly entangled with what is ´social´ that there can be nothing taken for granted about it any more" (Beck et al., 1994).

Some scholars also take their point of departure in the American Pragmatism of John Dewey, focusing on transactional engagement and relations between the individual and his/her social and material environments (König, 2018; Maggs & Robinson, 2016; Van Poeck et al., 2018). This will be stance adopted in the present thesis (see 2.3.2.1). What these different approaches to sustainability and science share is a preoccupation with intimate links between knowing and action, culture and nature, that come together in experiential learning.

2.1.3.1 Integrative approaches to sustainability and actionable knowledge

Scholars explore different paths to overcome divides and fragmentation not only between science and society, but also within sustainability science and in relation to disciplinary science.

Whilst there are ongoing debates and reflections about quality and design criteria, doing transformative research is not a matter of "either-or", but of pragmatically and reflexively integrating different paradigms, perspectives and approaches in co-creation processes (Caniglia et al., 2017; Grunwald, 2016; König, 2018; Popa et al., 2015; Ravetz, 2018; Schneidewind et al., 2016). The current thesis takes American Pragmatism and post-normal science as a conceptual basis. Both rest on the idea that the credibility and legitimacy of knowledge production can be assured via iterative reflexive processes and conjointly defined criteria, for example, within an extended peer community (Ravetz, 2006). Pragmatism lends itself to ´mixed methods´ (Creswell, 2014) and offers a way out of the dichotomy between value neutrality and value relativism (Popa et al., 2015).

Grunwald and associated scholars have developed an integrative concept of sustainable development, which combines a procedural and normative understanding of sustainability with a number of substantive principles (Grunwald, 2016).

Many scholars stress needs for knowledge integration, e.g. in relation to joint strategies and (decisions on) actions (Caniglia et al., 2020; Raymond et al., 2010) and/or the need for reframing and ´conceptual change´ (Bouwen & Taillieu, 2004, Scholz et al., 2014). While there are many different understandings (and a lot of vagueness) on what ´knowledge integration´ might imply, a clear distinction can be made between those scholars who regard knowledge as a ´product´ and those who regard knowledge as a process (e.g. Bouwen & Taillieu, 2004, Raymond et al., 2010).

In the procedural view, knowledge integration refers to an iterative learning process that rests on dialogic communication that engages diverse scientific and non-scientific actors and perspectives, not to the assembling of a "puzzle" (Grunwald, 2016). Different types of knowledge and ways of knowing become elements in open learning and co-creation processes, mutually enrich each other and lead to enhanced understandings among individuals and groups, including of uncertainties that may engender new questions and ´knowledge needs´. This understanding of ´integration´ means that such knowledge does not have to be translated into a single language or mode of representation (Tabara & Chabay, 2013). Knowledge integration becomes part of continuous learning and knowledge co-creation.

The main pillars of the integrative sustainability concept, as in the Brundtland definition, rest on ensuring human health and social justice (human livelihood), on sustaining natural resources (for

society and economy) and ensuring equality of opportunities and participation. In addition, it specifies the idea that opportunities for action need to be preserved (Grunwald, 2016). The concept does not adhere to ´strong sustainability´; among others, in order not to foreclose social deliberation. However, "essential" natural resources such breathable air, drinking water and fertile soil ("natural capital") need to be preserved and critical thresholds defined. Pollution and the use of renewable resources should not overstrain their regeneration capacities.[11] What exactly this means in terms of more precise context-specific objectives, prioritisation and means depends on participants and process. The integrative approach subscribes to an "enlightened form of anthropocentrism" (Grunwald, 2016).

As mentioned above, capacity-building and the co-creation of actionable knowledge among diverse actors and their respective knowledge (e.g. local and scientific) are among the main missions of transformative sustainability science. Sustainability scientists have developed diverse methods to support social learning and collaborative knowledge integration and co-creation in multi-actor settings. They aim, in particular, to foster systems-thinking (capacity to deal with complexity and uncertainty), empathy and understanding for diverse perspective (reflexivity), self-organisation for collective action and contextualisation[12]. Some are centred around different knowledge types – or judgement types (Burt & van der Heijden, 2008) - considered necessary to tackle sustainability challenges (Grunwald, 2016; König, 2018; Pohl & Hirsch Hadorn, 2007; Wiek & Lang, 2016), including as competencies in sustainability learning and education (Wiek et al., 2011)[13] [14]:

- *Knowledge on perceived realities* (or systems knowledge): understanding of complex system dynamics, causalities and uncertainties, especially as regards interactions between social and ecological systems, with regard to a certain issue or challenge, often combined with "*knowledge about emergent futures*", including possible long-term effects of current action and patterns (of futures knowledge) (Grunwald, 2016; König, 2018)
- *Knowledge on values* (or normative or target knowledge): includes value judgements concerning the need for change, what is considered desirable and awareness of diverse values and possible normative conflicts
- *Knowledge for action* (or transformation or action knowledge): knowledge about how to reach objectives and overcome obstacles via political, technical, social, legal, cultural and other possible *means* of acting

Disciplinary scientific contributions (e.g. empirical data and models) are considered particularly valuable – or even indispensable (Grunwald, 2016) – as regards systems understanding.

[11] Nonrenewable resources should be preserved over time by reducing their use ("sufficiency"), by increasing their productivity ("efficiency") or substituted by renewable resources ("consistency") (Grunwald, 2016).

[12] They include: Collaborative Conceptual Modelling (CCM) in human ecology (Dyball & Newell, 2015; Newell & Proust, 2018), diverse scenario approaches (Drenth et al., 2018), participatory modelling and concept maps (Halbe et al., 2013; Pahl-Wostl, 2015; Scholz et al., 2014), design for joint experiments and real-world labs (Caniglia et al., 2017; König et al., 2016), design criteria and principles for transdisciplinary research processes (Lang et al., 2012; Pohl & Hirsch Hadorn, 2007), Soft Systems Methodology and ´rich pictures´ (Checkland & Scholes, 1990) and collaborative conceptual systems mapping (König, unpublished).

[13] In the literature, the term ´knowledge types´ is often used for, for example, local and scientific types of knowledge. As the four ´sustainability knowledge types´ mentioned here are meant to serve knowledge integration and co-creation, they will throughout the thesis be referred to as "meta-knowledge types" or "dimensions" of community-based knowledge types

[14] This scheme is similar to "Practical Theory Building" that is composed of "discovering and analysing what is", "debating and determining what should be" and "closing the gap between what is and what should be", seen as main elements of transformative processes of reflection and action (´praxis´) in sustainability learning (Peters & Wals, 2013).

Actionable knowledge is sometimes equated with ´knowledge for action´, ´action-oriented knowledge´ or ´transformation knowledge´ (Caniglia et al., 2020; König, 2018; Pohl & Hirsch Hadorn, 2007; Wiek & Lang, 2016). When understood in this way, actionable knowledge combines judgments about "socially robust and acceptable and desirable courses of action, with insights on the functioning of organisations and institutions as sedimented forms of social practice that may pose barriers to change or lock-ins of undesirable practices and some strategic insights on how these might be overcome" (König, 2018). Nonetheless, few scholars conceptualise links between actionable knowledge, these four meta-knowledge types and knowledge and practices in specific organisations or professions. It will be argued below that this is a potential shortcoming that may hamper efforts to foster actionable knowledge.

In contrast to most authors, the author of the present thesis investigates actionable knowledge as potentially emerging from a combination of these "meta-knowledge types", in order to emphasise its normative and meaning-making dimensions, rather than its strategic character. In this sense, the understanding of actionable knowledge that will be further developed in the course of the thesis is closer to the "practical wisdom" (or *phronesis*) coined by Aristotle. It can be understood as a guide "in what should be done and how to act – in a moral, ethical, and political rather than technical and instrumental sense" (Peters & Wals, 2013). Phronesis denotes a "moral disposition to act wisely, truly, and justly; with both goals and means always open to review" (Kemmis, 2012).

Furthermore, there are interesting parallels to the dimensions of paradigms discussed above. In the literature, the four ´meta-knowledge types´ outlined above are rarely explicitly associated with paradigm shifts. However, ontological assumptions could be regarded as shaping systems knowledge, and axiological assumptions as guiding normative knowledge. All of them raise epistemological issues concerning what participants regard as meaningful, legitimate and useful knowledge. ´Transformation knowledge´ would emerge from the ´operationalisation´ of all of the three dimensions. Crucially, what will be actionable knowledge for particular actors is thus assumed to depend on how well knowledge resonates with underlying assumptions and experiences. At the same time, actions for transformative change might necessitate a profound revision of assumptions adapted to contexts.

Finally, the present thesis draws on another central idea of Grunwald (2016). Inspired by Jonas (Jonas, 1979), Grunwald stresses that sustainability encompasses the principle that the opportunities of present and future generations to shape their futures via self-organised action and participation in governance should not be diminished. The pursuit of sustainability calls for the further development of democracy based on participatory approaches that foster deliberation, reflexivity and self-organisation via innovative institutional arrangements:

> *"Die partizipative Ausrichtung der Idee der Nachhaltigkeit ist eine Aufforderung zur Weiterentwicklung bestehender Demokratien, um mit den Anforderungen nachhaltiger Entwicklung besser umgehen zu können. Partizipative Formen deliberativer Demokratie bilden ein unverzichtbares Element dieser Weiterentwicklung" (Grunwald, 2016).*

Moreover, sustainability needs to be accompanied by a recognition that the fulfilment of immaterial needs are essential for human flourishing, equal opportunities, dignity and non-violent conflict resolution, including education, culture and aesthetic and spiritual experiences, recreation, social integration and communication (Grunwald, 2016). Jonas stressed that the "emergency ethics of an endangered future" calls for actions that do not only secure future *survival* of the species man, but that "keep open the horizon of possibilities" for the permanence of "genuine" human life (Jonas, 1976). According to the "imperative of responsibility", man should consider the "future wholeness of man" in present choices (Jonas, 1973).

This dimension of sustainability is particularly interesting with a view to actionable knowledge. Firstly, the freedom and opportunity to act in a self-organised manner is a crucial precondition for actionable knowledge (and, indeed, responsibility). Secondly, actionable knowledge for sustainability should then aim to preserve and increase opportunities for all generations to shape their present and future. From this perspective, sustainability is not a state to be attained, but an *idea* that guides efforts to understand and meet environmental, social and economic challenges in human-environment relations in ongoing social (learning) processes (Cornell et al., 2013).

Finally, it is important to point out that although the present thesis is firmly anchored in transformative sustainability science, it will mainly investigate actionable knowledge *independently* of participatory processes designed by researcher (with the exception of two collaborative workshops). Instead, it will inquire more generally into on what kind of knowledge actors tend to act on and how it emerges within social learning and governance processes that aim for sustainability. In order to learn more about what makes knowledge actionable, and how science can potentially contribute to fostering it, such a study may be well worthwhile.

2.1.3.2 Spheres and factors of change

The breadth and depth of transformative changes required for sustainability are daunting, encompassing the environment, society, and economy. Scholars use multiple concepts to conceptualise the all-embracing nature of necessary change. They can be distinguished according to whether they adopt scalar and hierarchical or non-scalar and networked perspectives, whether they are actor- or system-centred, and whether they include social *and* material aspects.

Some authors take over the three "pillars" of sustainability and refer to them as *spheres* (Keen et al., 2005). Others speak of "spheres of transformation" that can include political, practical and personal spheres (O'Brien & Sygna, 2013) or social and cultural, material, and personal spheres (König, *unpublished manuscript*). The addition of the personal sphere reflects the importance attributed to personal meaning-making and behaviour in sustainability. The concept of spheres is also used to distinguish between personal, interpersonal and contextual spheres, highlighting the need for "dialogic interaction" between actors (Wals & Schwarzin, 2012). One of the most detailed actor-centred schemes identified is based on nested "spheres of influence" of individual action: private and personal, social networks (e.g. friends), organisational, public (e.g. voting) and cultural (e.g. norms) (Amel et al., 2017). It is similar to a framework of nested *layers* that includes individuals and their interaction in one layer ("co-production intervention processes and outcomes") that is embedded in sociocultural layers of groups and organisations, policy systems and institutions and, finally, social and cultural norms (Wyborn et al., 2019).

Similarly, others focus on *levels* of social organisation (individual, groups or organisations, society). Sometimes, distinctions are made between micro-level (individuals), meso-level (organisations or ´regimes´) and macro-levels (social and material exogenous environments or ´landscapes´) (Geels, 2005; Geels & Schot, 2007). In governance, a distinction is often made between local, regional, national, EU and global levels of decision-making, tied together via horizontal and vertical links (Newig & Koontz, 2014a). Scholars adopting a scalar perspective argue that changes need to take place across local, regional (and/or river basin), national and global *scales* (Cash, 2000; Kates et al., 2001; Wilbanks, 2006), while agency itself is "intrinsically localised", with global scales driven by cumulative overarching processes and structures (Wilbanks, 2006).

In contrast, both systems perspectives and perspectives from sociology and human geography tend to focus on *flows* and *networks*. The latter refer to de-localising effects of modernity, globalisation and digitalisation (Beck, 2016; Castells, 2000)[15] that "perforate" scalar and territorial forms of social organisation and environmental governance (Bulkeley, 2005). The former conceptualise relations and dynamics in the world as complex systems consisting of stocks and flows (including "living systems" tied together in a "web of life", Capra, 1996). They interact and communicate with each other in networks characterised by nonlinear and contingent behaviour that emerges from complex causal feedback loops (Capra, 1996; Dyball & Newell, 2015; Gunderson & Holling, 2002; Macy, 1991; Meadows, 1999)[16]. Seen from the perspective of such ´flattened ontologies´, sustainability "is fundamentally a matter of flow management – of controlling the rates of processes that alter the levels of resource and pollution stocks" (Dyball & Newell, 2015) or it is maintained by "relationships among a nested set of adaptive cycles", in which internal controlling variables are connected with and responsive to external variation (Gunderson & Holling, 2002).

The present thesis develops a framework that seeks to integrate these diverse perspectives, despite their partly divergent ontological assumptions. Scalar and non-scalar perspectives can be compatible, because networks and flows are situated in space and time and interconnect, for example, particular physical places and entities. The "space of flows" and the "space of places" co-exist (Castells, 2000). Furthermore, hierarchies of levels of social organisation may *partly* be dissolved by networks, but certain levels (e.g. national states) continue to be institutionally established loci of authority. They may come together in polycentric governance resting on a "politics of scales *and* networks" (Bulkeley, 2005, italics added).

Furthermore, focusing on social learning and actionable knowledge, the present thesis adopts an actor-centred perspective that embeds agency in multiple social and material contexts. We can only hope to enhance our understanding of actors, if we analyse the contexts in which they act and interact (Giddens, 1984). Actors are anchored in specific places and time and embedded in wider spaces of scales and hierarchies, networks and flows (including via digital communication) that provide *contexts* for their lives. Finally, as discussed above, what may be appropriate approaches to sustainability depends crucially on contexts.

At the same time, the term ´context´ itself is used in several different ways. For example, Nowotny, Scott and Gibbons refer to "contexts of application" of (scientific) knowledge and the need to expand its contextualisation to include "contexts of implications" by which they mean its impacts and consequences, e.g. via technologies (Nowotny et al., 2001). Their understanding reflects the two

[15] "Our society is constructed around flows: flows of capital, flows of information, flows of technology, flows of organisational interaction, flows of images, sounds, and symbols. Flows are not just one element of the social organisation: they are the expression of processes dominating our economic, political, and symbolic life […] I propose the idea that there is a new spatial form characteristic of social practices that dominate and shape the network society: the space of flows. […] The spatial articulation of dominant functions does take place in our societies in the network of interactions made possible by information technology devices. In this network, no place exists by itself, since the positions are defined by the exchanges of flows in the network. Thus, the network of communication is the fundamental spatial configuration: places do not disappear, but their logic and their meaning become absorbed in the network." (Castells, 2000)

[16] Capra (1996) on living systems as networks: "In nature, there is no ´above´ and ´below´, and there are no hierarchies. There are only networks nesting within networks". Communication in living systems does not denote information transmission, but coordination via mutual structural coupling (Capra, 1996; Maturana & Varela, 1987). Systems thinking is therefore characterised by "thinking in terms of networks" or "networking thinking" (Capra, 1996).

different – but complementary – approaches to ´contextualisation´ that have strongly influenced transformative inquiries into sustainability: one is to analyse challenges and possible solution-options in their *systemic* contexts by considering social, ecological and technological factors and feedbacks, overcoming ´silo-thinking´ (e.g. "think globally", "network thinking"). The other is to analyse the challenges in their *local* contexts and to promote context-specific ways of tackling them, e.g. by engaging stakeholders in face-to-face communication and cooperation (e.g. "act locally").

Other scholars distinguish between "internal" and "external contexts of pre-existing forces" (Medema et al., 2014) or between "transactional and contextual environments" (Drenth et al., 2018) to draw a distinction between those contexts that actors can influence directly and those that are more difficult for them to change (Amel et al., 2017; Wyborn et al., 2019, see also above). In contradistinction to some of these scholars, the present thesis does not draw an *a priori* distinction. Such a hierarchy of ´influenceable´ spheres does not fit well with notions of interconnected scales and flows. It neglects that actions *do* have remote consequences (be they positive or negative) in far-off places of the world, whether intentionally or not. Moreover, diverse social movements have illustrated that single individuals and groups *can* influence governance across the globe.

The brief review above suggests that sustainability science would benefit from a conceptual clarification of ´contexts´. Such a clarification would contribute to the conceptualisation of transformative change itself. Moreover, in contrast to some of the frameworks that focus (almost) exclusively on social and cultural factors, there seems to be a need to consider ecological, technological, and other physical factors more systematically. The present thesis therefore sets out to develop an analytical framework that combines an actor-centred perspective with notions of hierarchies of spatial scales and social organisations of cross-scale networks and multiple spheres composed of both social and material factors.

2.2 The Management and Transition Framework (MTF)

Some of the assumptions and preliminary working definitions provided above have emerged through an iterative engagement with the Management and Transition Framework (MTF) developed by Claudia Pahl-Wostl and associated researchers (Pahl-Wostl et al., 2010). It is the point of departure for the inquiry into social learning and governance processes of the present thesis. Not tied to any specific theory, it provides a flexible conceptual and analytical framework that lends itself to interdisciplinary and transdisciplinary inquiries. It has been chosen, because there are few other frameworks that are tailored to the empirical analysis of water governance and social *processes* in an actor-centred manner, whilst considering multiple spatial scales and levels of social organisation and social and material factors. It allows for a context-specific empirical analysis and, at the same time, comparability across cases that is in contrast to other frameworks briefly discussed below[17].

The overall purposes of the MTF approach is to support sustainability transformations in human-environment relations by contributing to scientific understanding of water governance and by developing actionable knowledge for societal actors (Pahl-Wostl, 2015). Paradigm shifts in water governance and management are "part of a broader societal transformation towards sustainability"

[17] For example, the Multi-Level Perspective (MLP) concentrates on interaction and alignments between activities and developments that take place between niche (micro), regime (meso) and landscape (macro) levels that (may) lead to sociotechnical transitions and system changes. However, it will not be considered, because it is tailored to the analysis of technological innovation and has a strong focus on markets (Geels, 2005).

(ibid.). Rooted in complex systems theory, it rest on a conceptualisation of societal and ecological systems as interdependent, rather than as separate or antagonistic (ibid.).

The MTF is centred on the concepts of social learning developed by Chris Argyris and Donald Schön and on the ´communities of practice´ of Etienne Wenger. These will be briefly discussed in the following. At the same time, the present thesis sets out to complement and expand the MTF by several aspects. It does so, firstly, rooted in the assumption that meaning-making is a constitutive element in how actors engage with each other and their environments (American pragmatism and symbolic interactionism). Furthermore, meaning-making will be related to organisational and professional contexts and their interrelations with individual and collective identities and practices (Argyris & Schön and Tsoukas). The third reason is that the present thesis, by using STS, devotes more attention to normative issues in governance, and how they are intertwined with knowledge systems and material environments. These additional aspects come together in an elaboration on how narratives and imaginaries can contribute to stabilising and transforming prevailing paradigms and patterns of behaviour in (learning) processes of groups and societies. Narratives are assumed to, potentially, lend themselves more easily than ´mental models´ to empirically investigate paradigms, actor engagement and transformative change. In the following, therefore, the positioning of the present thesis will be discussed in relation to, first, adaptive governance and management and social learning and, secondly, in relation to American Pragmatism and symbolic interactionism, Science & Technology Studies (STS) and organisational and professional learning.

2.2.1 Adaptive governance and management in social-ecological systems

The Management and Transition Framework (MTF) draws on diverse concepts and frameworks. They include the Social-Ecological Systems Framework (SESF) that was developed by Elinor Ostrom to investigate common-pool resource management and is interrelated with Institutional Development Analysis (IAD) and adaptive and polycentric governance. The MTF also builds on adaptive resource management research. Based on the concept of complex adaptive systems (CAS) and adopting an anthropocentric perspective, the MTF and SESF frameworks have in common that they serve to analyse constellations and processes that arise from feedbacks between co-evolving environmental and human systems and have ecological consequences that affect human well-being[18] (Binder et al., 2013).

2.2.1.1 Adaptive capacity and resilience

In the 1970s, scholars of ecology and ecosystem management (notably, C.S. Holling) have drawn on the concept of complex adaptive systems (CAS) to characterise adaptive change in ecological systems. Among others, they have coined the concept of resilience that they later extended it to coupled *social*-ecological systems (Folke, 2006; Holling, 1973, 2001). Complex adaptive systems are characterised by nonlinear system behaviour, cross-scale self-organisation and interplays of multiple and diverse factors that cause discontinuous change and emergent phenomena that are complex, uncertain and contingent (Folke, 2006; Holling, 2001; Pahl-Wostl, 2015). Resilience refers to the capacity of a complex system to absorb external perturbations without qualitative changes to its structure, i.e. its main functions (Holling, 1973). The adaptive capacity relies on adaptation that allows for temporary changes in system functioning via re-organisation and renewal (Berkes & Folke, 2002; Folke, 2006). When

[18] Binder et al. (2013) distinguish between ecocentric and anthropocentric perspectives among the frameworks that serve to analyse coupled social-ecological systems (Binder et al., 2013). The planetary boundaries approach mentioned above is associated with the Earth Systems Analysis (ESA), an ecocentric framework that examines impacts of human activities on global biophysical dynamics (Rockström et al., 2009a).

adaptive capacity is low, a system becomes vulnerable to external influences and self-organisation between variables may no longer be able to sustain its main functions ("regime shift") and enter into "collapse", e.g. when a lake shifts to a degraded state due to phytoplankton bloom (Allen et al., 2014; Folke, 2006; Holling, 2001). From this perspective, sustainable development describes processes that foster adaptive capabilities of systems *and* create opportunities and novelty. They rely significantly on biodiversity and - in the case of (self-organisation in) human systems - on flexibility, foresight, intentionality, communication (understood as the "transfer and storage of experience", Holling et al., 2002), social memory (understood as accumulated experiences informing community debates, Folke et al., 2005) and creativity (Carpenter et al., 2002; Holling, 2001). Theories on resilience and adaptive change have informed the SESF and MTF as well as other frameworks on social-ecological systems, adaptive governance and management (Binder et al., 2013)[19].

2.2.1.2 Common-pool resource management and institutional analysis in SES

The political economist Ostrom is one of the founders of the SES concept and of common-pool resource theory. A common-pool resource (such as water) is a resource that is available to several people (who are difficult to exclude) and subject to degradation because of overuse or pollution that inhibit its regeneration (Dietz et al., 2002; Ostrom, 2010a). The Social-Ecological Systems Framework (SESF) serves to analyse why some social-ecological systems are sustainable while others collapse due to overharvesting (Ostrom, 2009). The framework is structured along a wide range of variables that are used to analyse relations between microsituational face-to-face interactions between resource users (e.g. local communities), governance systems (norms and rules), resource units (e.g. fish quantities) and resource systems (Ostrom, 2009, 2010a). Based on case studies, Ostrom found that face-to-face interaction within communities enhances trust, reciprocity, joint strategies and agreements and, thereby, reduces individualistic overharvesting for the sake of increased "joint payoffs". Therefore, when users have autonomy to self-organise and to craft own informal or formal collective choice rules, long-term sustainability of common-pool resource systems is more likely, as has been the case in traditional communities for centuries (Dietz et al., 2003; Henry & Dietz, 2011; Ostrom, 2010b). Based on this insight, they argue that effective environmental governance depends to a large degree on that information about stocks and flows (including uncertainties) and the impact of human-environment interactions is congruent in scale with environmental events, so that (local) communities can adapt their resource use and collective rules to prevent the deterioration of common-pool resources (Dietz et al., 2003). Moreover, as biophysical conditions and community attributes vary across places, there can be no one-size-fits-all solutions (Ostrom, 2009).

Ostrom developed the Institutional Analysis Development framework (IAD) that serves the study of diverse institutional settings and patterns of human interactions and is centred on the concept of microsituational "action situations" that bring together the above mentioned variables and generate particular outcomes. The Management and Transition Framework has taken over the concept of action situations. The present thesis uses action situations to structure the case studies (see methods 5.6.1).

[19] Developed by Gunderson & Holling, the theory of panarchy provides an integrative interdisciplinary framework that characterises complex adaptive systems by asymmetric interactions and cascading cycles of change between hierarchical levels and scales (Allen et al., 2014; Gunderson & Holling, 2002). A heuristic model or "metaphor", it can serve to improve ecological and systems knowledge through monitoring, experiments and hypotheses testing that serve better quantification, measurements and anticipation of "regime shifts", among others (Allen et al., 2014; Holling, 2001). However, its metaphorical and conceptual use has so far been more frequent than its empirical application (Allen et al., 2014).

While not making prescriptions, Ostrom formulated a number of design principles that increase the likelihood of effective commons governance and can be used to "specify the structure of a game and predict outcomes" (Ostrom, 2010a)[20]. SESF and IAD partly draw on game theory and rational choice models of behaviour that emphasise utility considerations (relations between costs and benefits) as main drivers of human behaviour (Binder et al., 2013; Dietz et al., 2002; Ostrom, 2009; Young, 2002)[21].

2.2.1.3 Adaptive governance and (co-)management

Community-based self-organisation, an emphasis on access to – and flows of - information and a rejection of blueprint solutions are among the main features of adaptive governance (Dietz et al., 2003). The academic field of adaptive co-management builds on common-pool resource governance. Defined as "a process by which institutional arrangements and ecological knowledge are tested and revised in a dynamic, ongoing, self-organised process of learning by doing", adaptive co-management argues in favour of community-based power-sharing arrangements and practices, and the combination of local and scientific knowledge (Folke et al., 2005). In bioregional approaches, co-management centres on the bioregional scale, for example river basins. Bioregionalism promotes decentralisation, more engagement of local communities and a stronger consideration of local, traditional and indigenous knowledge in the governance of local ecosystems and resources (Cook et al., 2016; Huitema & Meijerink, 2017; McGinnis, 1999).

However, as nonlocal influences on resource systems increase (e.g. due to transboundary environmental pollution), the ideal of *local* self-governance has increasingly been supplemented by an emphasis on cross-scale or polycentric institutional arrangements (Armitage et al., 2008b; Folke et al., 2005; Ostrom, 2010). For example, scholars in adaptive (co-)management, including bioregionalism have examined the emergence of ´bridging or boundary organisations´ (such as river basin organisations) and of self-organised cross-scale networks, in which local "user groups" and nongovernmental and governmental organisations (from municipal to international) draw on local and scientific knowledge to resolve issues conjointly (Armitage et al., 2008b; Folke et al., 2005; Hahn et al., 2006). Adaptive governance thus promotes the idea of informal governance (and knowledge) systems relying on self-organisation and networks that span across different organisational levels that influence formal policies via horizontal and vertical linkages and provide arenas for learning, novelty and innovation (Armitage et al., 2008b; Folke et al., 2005). Common-pool resource management and adaptive governance argue in favour of polycentric arrangements characterised by the existence of multiple independent decision-making centres that coordinate themselves via information flows and rely on flexible rules that allow for re-organisation, e.g. based on new knowledge (Dietz et al., 2003; Ostrom, 2010a). Adaptive governance thus relies on a flexible mixture of formal and informal governance, hierarchical, market- and community-based management (Dietz et al., 2003). The Management and Transition Framework and present thesis elaborate on these governance modes.

[20] The design principles encompass boundary, position and choice rules (governing which actors should participate, how resource boundaries are to be delineated, actor positions and rights), information rules (governing monitoring and information sharing), aggregation rules (governing decision-making arrangements, rule enforcement and conflict resolution), payoff rules (governing the distribution of costs and benefits) and scope rules concerning possible outcomes (Ostrom, 2010a).

[21] At the same time, discussing the "social-practice model", IAD scholars such as Young, Henry and Dietz have sought to go beyond the ´thin rational actor model´ and Ostrom herself stresses the need to consider "complex motivational structures" of individuals, both emphasising the importance of social context, belief systems and societal schemata in actors seeking to conform with social expectations and developing trust (Henry & Dietz, 2011; Young, 2002).

The emphasis on flexible frameworks is based on the following "principal lesson of adaptive management research":

> *"Fixed rules are likely to fail because they place too much confidence in the current state of knowledge, whereas systems that guard against the low probability, high consequence possibilities and allow for change may be suboptimal in the short run but prove wiser in the long run" (Dietz et al., 2003).*

Adaptive governance and management are vast academic fields and the two terms are sometimes used interchangeably. From a resilience perspective, adaptive governance and management pursue the purpose of improving human-environment interactions by adapting purposes, policies and practices in such a manner as to enhance resilience and to create "synergies between economic development, technological change and the dynamic capacity of the natural resource base to support social and economic development" (Folke et al., 2002). Governance creates the structures and processes for social coordination, the negotiation of trade-offs and decision-making and provides "a vision and direction for sustainability". Management concerns their operationalisation and monitoring (Folke et al., 2005). One of the main management means is to improve ecological and systems knowledge by observation, interpretation and trial-and-error learning (e.g. via experimentation), in order to cope better with uncertainty and to enhance social responsiveness to ecosystem dynamics. (Berkes & Folke, 2002; Folke et al., 2005; Medema et al., 2008; Pahl-Wostl, 2006)[22].

SES and adaptive governance and management concepts have been influential in informing diverse approaches in environmental or ecological and agricultural management that consider complex interplays between social and ecological systems and promote better adaptation to and strengthening of diverse ecosystem processes, functions and services (Röling & Jiggins, 1998; Schaich, 2009; Swart et al., 2018; Woodhill & Röling, 1998). Scholars argue, for example, for expanded concepts of environmental restoration that engages local communities (Schaich, 2009; Swart et al., 2018), for "ecologically sound agriculture" (Röling & Jiggins, 1998) or "agroecological farming systems" (Dendoncker & Crouzat, 2018) that seek to integrate diverse ecological, social, cultural and economic factors and objectives, in order to enhance overall system resilience. Generally, most of the adaptive and integrative approaches apply the concept of ecosystem services to analyse and balance diverse ecosystem functions and services with regard to human well-being (see also chapter 4.3).

Together, these and similar approaches signal possible paradigmatic shifts away from hierarchical and sectoral governance that relies mainly on natural scientists and engineers and control-oriented management that have prioritised the exploitation of natural resources for human benefits. Calls for transformative change rest on the awareness of the interconnectedness and complexity of sustainability challenges and heralds moves towards adaptive, integrative and ecosystem-based management, also referred to as "holistic landscape management" (Pahl-Wostl, 2006a), that will be further discussed throughout the thesis (see also Akamani, 2016; Folke et al., 2005; Pahl-Wostl, 2015; Schaich, 2009). However, despite the existence of integrated approaches and increasing awareness of their need, sectoral approaches to water, environment and agriculture persist. A nexus perspective in

[22] "open SES-embodied knowledge systems" – calls for a better coupling of "Human Information and Knowledge Systems with social-ecological systems change", "to create different types of knowledge and to integrate different types of knowledge configurations capable of interacting with our social-ecological systems in improved ways" (Tabara & Chabay, 2013)

governance (and research!) – e.g. on the water-energy-food nexus – could therefore be a "game-changer since it implies an entire reframing of the problem perspective" (Pahl-Wostl, 2015). The present thesis seeks to make a small contribution to this. While not dealing with energy, it does examine water governance at the interface of agricultural and environmental management and transport.

2.2.1.4 MTF positioning

In arguing in favour of adaptive water governance and management and polycentric cross-scale arrangements, MTF builds on the above-mentioned frameworks and concepts. Elaborating on SESF and IAD, the MTF has taken over the concept of action situation of face-to-face interaction as building-blocks of water governance processes, along with formal and informal institutions, actors and biophysical conditions as main variables that influence governance and management processes and outcomes (Pahl-Wostl, 2015). Moreover, it attributes equal importance to self-organisation and context-specific approaches, flexible institutional frameworks and the rejection of blueprints and panaceas. Moreover, the "diagnostic approach" that Pahl-Wostl adopts to analyse complex cause-effect relations between multiple factors in water governance processes and their outcomes, originates in the SESF (Ostrom et al., 2007; Young, 2002).

At the same time, the MTF distinguishes itself from SESF by not focusing on institutional arrangements and design principles as such. Instead, it serves to analyse if and how social learning emerges in informal and formal governance processes. Furthermore, the two frameworks are based on different ontological and epistemological assumptions. Pahl-Wostl distances herself from rational-choice theories of action, and, instead, adopts a perspective that combines systems thinking with the idea that transformative change in governance results from human agency, purposefulness and knowledge. With reference to Giddens and symbolic interactionism (Goffman, see 2.3.2.1), she argues that human knowledge and actions depend on how actors give meaning to and interpret rules, draw on knowledge and frame particular situations. For this reason, the MTF encompasses "situated knowledge" as a category to denote knowledge that actors "activate" in a particular situation. The fact that people make sense of issues in different ways and have different perspectives on problem-solving is inherently valuable (Pahl-Wostl, 2015).

As other scholars in adaptive governance and sustainability science, the concept of ´mental models´ is used to explain how actors turn information into knowledge that is meaningful and the underlying assumptions that shape their actions (Allen et al., 2014; Dewulf et al., 2009; Dyball & Newell, 2015; Fazey et al., 2006; Folke, 2006; Meadows, 1999; Pahl-Wostl, 2015; Scholz et al., 2014). In MTF, the concept serves to conceptualise how individual experience, cognitive biases and social norms shape how actors process information from the social and physical environment in particular situations. Mental models and, particularly, cognitive biases help to explain routine behaviour as based on selective information processing and the adoption of roles and behavioural "scripts" that conform with the institutions of particular communities and provide heuristics that help actors to take action in a complex world by reducing processing efforts. Mental models are closely related to the paradigms held in particular epistemic communities. Members who share a paradigm are likely to hold similar mental models and reinforce each others´ beliefs (confirmation bias) (Pahl-Wostl, 2015). By focusing on routines as (cognitive) heuristics (rather than as socially determined protocols), Pahl-Wostl also rejects the idea that societal rules and expectations *determine* behaviour. Instead, agency manifests itself to the degree that roles and rules are interpreted in a manner that deviates from established standards

and norms, that new knowledge is created and action departs from established routines. Agency relies on human purposefulness and the anticipation of particular outcomes. Learning can be understood as feedbacks that take place between purposes, (anticipated) outcomes and means of achieving them (Pahl-Wostl, 2015).

Essential for the "transformative capacity" of governance systems, the concept of "agency" provides the foundation for the conceptualisation of transformative change. "Transformative capacity" lends more weight to the role of human purposefulness and knowledge in complex systems than "adaptive capacity". While not explicitly positioned as such, transformative capacity seems to serve as a bridging concept that considers the transformative dimension of adaptation and resilience in social-ecological systems in its own right and links it directly to human agency and learning (Pahl-Wostl, 2017). While intentional design alone will not produce transformative change, it nonetheless requires the capacity of human actors to re-interpret and reframe rules, acquire new knowledge and to take intentional action. Both adaptive and transformative system change results from a "combination of purposeful design and processes of self-organisation and emergence" that are complex and contingent (Pahl-Wostl, 2017).

Finally, compared with SESF, IAD and adaptive governance and management approaches, the MTF approach attributes more importance to the normative dimension of sustainability and resource challenges. It does so, firstly, by underlining that uncertainty in governance systems extends to *normative* uncertainty and ambiguity about goals to be achieved, and to appropriate responses to challenges that depend on contexts and cultures (Pahl-Wostl et al., 2008b). *Qualitative* risk assessments based on deliberation need to complement technical and quantitative risk assessments (Pahl-Wostl, 2015). Secondly, the view of actors on challenges will depend significantly on how they are framed, including value judgements, and there are likely to be divergent frames of reference and conflicts (Dewulf et al., 2005). This adds to the need for social learning.

2.2.2 Multiloop social learning

The present thesis takes its point of departure in established conceptualisations of social learning and, in addition, of multiloop social learning, as developed within the Management and Transition Framework (MTF) based on the seminal work of Chris Argyris and Donald Schön *Organisational Learning II* (Argyris & Schön, 1996). It combines them with the Pragmatist understanding of learning, knowledge and action of John Dewey elaborated below.

2.2.2.1 Social learning as boundary concept

Social learning is suitable to serve as a boundary concept between diverse strands of transformative sustainability science and the adaptive governance and resource management literature. The social learning perspective underscores the role of human agency in system transformation. In the transformative literature, the emphasis tends to be placed on self-organised processes that bring together scientists and non-scientists, and foster joint action, scenarios and visions that may be conducive to transformative cognitive, relational and behavioural changes across ´all walks of life´. The SES and adaptive governance and management literature tends to focus on how formal and informal institutional arrangements, diverse knowledge types (e.g. local and scientific) and information flows contribute to fostering ecological knowledge and decentralisation that enhance adaptive capacity and resilience in resource systems (Folke, 2006; Young et al., 2006). The MTF combines elements of both.

Generally, these approaches share the basic assumption that societies and actors can only hope to be able to meet sustainability challenges by engaging in ongoing collaborative learning processes that create spaces for and leverage self-organisation. Social learning fosters knowledge and capacities to cope with complexity, uncertainties and emergence, to revise prevailing social structures for improved human-environment interaction and to devise context-specific self-organised action that is socially robust and deemed suitable by diverse actors (Bouwen & Taillieu, 2004; Ison, 2010; Keen et al., 2005; König, 2018; Pahl-Wostl, 2015). Concepts from cognitive theories (notably, Bateson, Maturana & Varela, 1987, Capra, 1996), learning theories (e.g. Kolb, 2015), organisational studies (Argyris & Schön, Senge, Wenger) are frequently cited across diverse strands (Armitage et al., 2008a; Craps, 2003; Ison, 2010; Keen et al., 2005; König, 2018; Röling & Wagemakers, 1998; Steyaert & Jiggins, 2007). Learning rests on a processual understanding of knowledge ("knowledge-as-process"). It is closely tied to action and experimentation (Keen et al., 2005). Knowledge is often considered to rest on tacit and embodied forms of knowing that is and cannot be articulated explicitly (Polanyi, 1966).

What makes learning "social" is that it goes beyond changes in individuals and enhances collective capacities for actions in communities or networks (Pahl-Wostl, 2015; Reed et al., 2010). Knowledge (co-)creation in informal settings is at the heart of social learning and is to foster trust among participants, changes in shared practices and roles, mental models and interpretations of institutions and, thereby, the capacity for collective action (Pahl-Wostl, 2015). More specifically, some authors also refer to "sustainability learning" that "requires that people become aware and understand the impacts of their own everyday actions on ecosystems in a way that helps them to develop agency, take responsibility, and modify their behaviour and institutions accordingly" (Tabara & Chabay, 2013, Tabara & Pahl-Wostl, 2007). For present purposes, social learning will be understood as aiming for capacity-building and the fostering of actionable knowledge that supports transformative change towards sustainability.

The emergence of social networks is a precondition for social learning among actors from diverse organisations, communities and levels (Folke et al., 2005). The MTF is based on the idea of social networks that bring together diverse actors in regular meetings around specific issues and are defined by open and evolving membership (Pahl-Wostl, 2015). By bringing together nongovernmental and governmental actors, social networks can be particularly suitable to establish links between informal learning processes and formal policy-making. The MTF derives the concept of social networks from Etienne Wenger who coined the term "communities of practice" to denote emergent, self-organised and open communities that engage members from diverse organisations to create, share, organise or revise knowledge on particular issues through shared practices and that develop a sense of common identity. (Wenger, 2008)

Compared with much of transformative sustainability research, MTF devotes more attention to formal governance and management processes, material factors such as infrastructures and the state of ecosystems, and interdependencies with human and ecological well-being (e.g. via the concepts of ecosystem services). Compared with the adaptive governance and management literature, the MTF attributes more importance to normative ambiguity, conflicts and meaning-making. Notably, MTF has been chosen because it is one of the few conceptual and analytical frameworks that is tailored to the analysis of social learning processes in interplays between formal and informal governance. It is therefore suitable for a multifactorial analysis that seeks to take into account diverse levels and factors of social organisation and material contexts and how they may be changed in the course of such processes.

2.2.2.2 Multiloop social learning, transformative change, and actionable knowledge

Pahl-Wostl is one of several scholars who have used the concept of multiloop social learning to analyse how adaptive and transformative changes may emerge across levels of social organisation (Armitage et al., 2008a; Bouwen & Taillieu, 2004; Medema et al., 2014; Pahl-Wostl, 2015; Sol et al., 2013).

The concept of multiloop social learning stems from Argyris and Schön who developed the concept of single- and double-loop learning to analyse and foster kinds of inquiries and learning that enable actors to overcome the instrumental adaptation of established problem-solving routines (single loop or incremental learning) and lead to a reframing of purposes and to entirely new problem-solving repertoires (double loop learning), spanning individuals and their collectivities (i.e. organisations). Building on Lewin and Dewey, Argyris was among the first scholars to introduce the term ´actionable knowledge´. He promoted the idea that scientific and organisational inquiry should foster a kind of knowledge for action in organisations that would encourage double loop learning and the tackling of nonroutine problems considered "embarrassing or threatening the status quo" (Argyris, 1993)[23]. In ´action science´ scientists engage directly with practitioners (Argyris et al., 1985). Since then, actionable knowledge has assumed multiple connotations denoting knowledge *about* and *for* action produced in collaborative inquiry as well as the kind of knowledge that people use *in* action.

Double loop learning bears strong resemblance with concepts on individual transformative learning when understood as "change in particular frame of reference or worldviews" (Sipos et al., 2008) or as entailing a "transformation of experience" (Kolb, 2015).

With respect to social learning in groups, scholars have followed Argyris & Schön in associating double-loop learning with increased reflexivity and a critical revisiting of collective norms, values and paradigms (Bouwen & Taillieu, 2004; Keen et al., 2005; Medema et al., 2014; Pahl-Wostl, 2015; Sol et al., 2013). By engaging with diverse actors with different perspectives, actors may develop reflexive and critical stances to prevailing paradigms and framings and deliberatively decide to break with and transform established behavioural patterns (Pahl-Wostl, 2015). The symbolic interactionist Erving Goffman examined how roles and framings shape the interaction of participations in particular situations without, however, being pre-determined (Goffman, 1981). Pahl-Wostl and other scholars in water management have used Goffman to analyse role-taking and barriers in cooperation and social learning resulting from differences and ambiguities in how actors frame situations, issues and uncertainties (Dewulf et al., 2005; Gray, 2004; Pahl-Wostl, 2006a, 2015a). The MTF relates roles and framing to the mental models of actors and the paradigms institutionalised in their communities. Double-loop learning requires changes in mental models, roles and reframing of deeply engrained assumptions and may thus support paradigm shifts (Pahl-Wostl, 2015).

[23] Argyris conceived of learning as emerging from the detection of a mismatch between intentions and consequences. In single loop learning, behaviour is revised to achieve desired purposes (instrumental problem-solving); in double loop learning, the intentions and purposes are critically examined, giving rise to new meanings and criteria by which problems, specific situations and problem-solving strategies are judged. It is different from "applicable knowledge", because it suggest (how to produce) new meanings, while it is up to actors "to select the specific words" (p.52). Moreover, actionable knowledge is not only normative and descriptive, but also prescriptive in including specifications about skills and behaviour necessary for implementation (Argyris, 1993). In an earlier work, Argyris, Putnam and Smith promoted "action science" to create "usable knowledge" that would serve "action for change" and, at the same time (and, in their view, unlike "action research"), contribute to new theories of action, practical knowledge (or an "epistemology of practice") and (social) change (Argyris et al., 1985). In the works cited above, the term "usable" was replaced by "actionable", perhaps because of its instrumental connotations.

In addition, a number of scholars have taken up the notion of triple loop learning from organisational theory (Armitage et al., 2008a; Keen et al., 2005; Medema et al., 2014; Pahl-Wostl, 2015)[24]. For some, triple loop learning goes beyond double loop learning by entailing the *consolidation* of new assumptions and values within groups (Keen et al., 2005), others describe it as a kind of ("transformational") meta-learning within groups (learning-how-to-learn) that may lead to the questioning and, eventually, the revision of rules for decision-making (Armitage et al., 2008a; Medema et al., 2014). Pahl-Wostl reserves triple loop learning exclusively for paradigm shifts at societal level, entailing both profound changes in formal regulatory frameworks, and in wider cultural values and belief systems, power relations, discourses and practices. Triple loop learning is equated with "regime shifts" and with *societal* learning that profoundly change the structural context in which social learning takes place (Pahl-Wostl, 2009, 2015). As the societal context may hinder double loop learning among groups (through regulation or informal norms), double and triple loop to mutually influence – reinforce or constrain – each other (Pahl-Wostl, 2009). Put differently, systems change, individual and collective behavioural changes tend to go hand-in-hand. For the same reason, transformative change crucially depends on interrelations between diverse informal and formal processes (Pahl-Wostl, 2015).

Building on Argyris and Pahl-Wostl, and for present purposes, the present thesis regards actionable knowledge as closely associated with double loop learning and as potentially contributing to triple loop learning. The present thesis thus sets out to investigate what factors facilitate or hinder the emergence of double loop social learning and actionable knowledge in interplays between informal and formal governance processes. Actionable knowledge for sustainability is assumed to inspire actors to explore new modes of social and material engagement to enhance ecosystem health and to potentially contribute to wider transformative change in human-environment interaction.

2.3 The thesis

The present thesis elaborates on the Management and Transition Framework by tailoring some of its key concepts to the empirical inquiry into actionable knowledge. It combines it with other concepts, in order to construct an actor-centred multi-contextual analytical framework on actionable knowledge.

2.3.1 Basic assumptions

The present thesis takes its point of departure in the core assumptions of post-normal science that "facts are uncertain, values in dispute, stakes high and decisions urgent" (Funtowicz & Ravetz, 1993). This means that it considers system complexity, unpredictability, contradictions and diverse normative perspectives as integral elements of the practice of science itself and of the issues under investigation. Contradictions may be defined as "a set of problems or tasks that cannot be resolved within the terms of reference (or ´paradigm´) in which they have been conceived, and, hence require creativity (Ravetz, 2006). Inquiry does not uncover general ´truths´, but deals with context-specific challenges whose understanding is derived from the triangulation of data constructed from multiple perspectives, sources and methods, and serves to contribute to dialogues about how to tackle them (see methods 5.2.1).

Furthermore, it adopts a pragmatist stance on scientific inquiry that elaborates on and combines some of the above-mentioned concepts from transformative sustainability science, SES, adaptive

[24] While some scholars refer to Argyris and Schön, a review has established that the concept of triple loop learning does not appear in any of their published work (Tosey et al., 2012). Pahl-Wostl refers to Hargrove (2002).

governance and management and social learning. It adds concepts from American Pragmatism, symbolic interactionism, organisational studies and STS, in order to elaborate on underlying interactional theories of knowledge, learning and action in more depth.

In American pragmatism, scientific inquiry entails interpretations ("to understand is to grasp meaning", Dewey, 1910), judgement and engagement with a variety of people, concepts, methods and ´things´ that can be constructed pragmatically according to "what works" in relation to a given purpose and problem. But scientific inquiry is not entirely relative. Compelling arguments and evidence have to be provided for choices and interpretations made and put to reflexive and systematic scrutiny (Denzin & Lincoln, 2011; Popa et al., 2015). This is done in iterative cycles of making, testing, and revising hypotheses in practice through observation and reflection (Dewey, 1938b; Kolb, 2015; König, 2018). In line with post-normal science, the ´extended peer community´ of the present thesis is composed of practice partners and scholars who are members of the project´s reference group and the supervisory committee of the thesis and colleagues (see methods 5.1).

The present thesis adopts an interactional and interpretivist approach to qualitative analysis inspired by ethnography. Ethnography construct interpretive "thick descriptions" of people´s actions and experiences that cast light on how they make meaning by inquiring into the complex web of underlying cultural and conceptual structures of signification that order their behaviour and, at the same time, make it distinctive (Geertz, 1973). Culture is the "fabric of meaning" that shape the interpretation of experiences and guide action. Discontinuities, Geertz argues, are some of the "main driving forces in change" (ibid.). Similarly, Pragmatists do not focus on the reproduction of culturally pre-determined schemes associated with certain groups or contexts, but stress the possibility – and desirability – of a departure from mainly unconscious habitual dispositions, for example, when situations are experienced as problematic and call for creative new ´solutions´. (Gross, 2009) While adopting an actor-centred approach (akin to methodological individualism), the present thesis thus does not give priority to either agency or structure in the formation of purposes, but investigates factors in situation- and context-specific interplays that facilitate or hinder agency.

Furthermore, the present thesis takes a narrative perspective that assumes that it is through narrativity that people create continuity in and make sense of a world in constant flux, constructing and reconstructing their social identities and purposes (Ezzy, 1998; Somers, 1994)[25]. Narratives can be regarded as the discursive expression of particular assumptions, worldviews or paradigms (Chabay, 2020; Chase, 2011; Elliott, 2005; Somers, 1994). The notion of narratives has been chosen, because it opens up a conceptual perspective that might lend itself more easily to an empirical investigation of actionable knowledge, identities and paradigm shifts among actor groups than, for example, inquiries into mental models, and may hold particular explanatory power (see methods 5.3 and below). Furthermore, in constructing and analysing governance and social learning processes as meaningful sequences of situations and events (i.e. plots), the present thesis itself creates "second-order narratives" (Elliott, 2005).

The above-cited Pragmatist, ethnographic and narrative approaches have far-reaching ontological, axiological and epistemological implications. Following the "narrative turn" in the social sciences (Denzin & Lincoln, 2011), the focus on narratives has become defining for some of the scientific communities that regard the construction of meaning as fundamental to human behaviour and experience (Patterson & Williams, 1998). It carries ontological and epistemological implications:

[25] In the qualitative sciences, it was postmodernism that triggered a "narrative turn" focusing on texts and storytelling (Denzin & Lincoln, 2011).

"These concepts posit that it is through narrativity that we come to know, understand, and make sense of the social world, and it is through narratives and narrativity that we constitute or social identities" (Somers, 1994).

Ontologically, narrative approaches reject the rationalist tradition of Descartes that regards thought and action, mind and body as ontologically distinct (Geertz, 1973; Gross, 2009; Somers, 1994). Thoughts (incl. narratives) establish relations and partake in the world by shaping physical action and, thereby, social and material contexts (Ezzy, 1998; König, 2018). Actors and their social and material surroundings come together in transactional encounters, mutually shaping one another (Dewey, 1938a). The axiological dimension captures the idea that meaning-making and action flow from purposes and values that are, simultaneously, personal and social. Personal and collective narratives stabilise identities and provide normative orientation in a complex world (Chabay et al., 2019; Ezzy, 1998). Finally, the epistemological dimension concerns how cognition and experiential knowing rest on how significance and meanings are drawn from experience and events through predominantly tacit ways of knowing. Narratives and emplotment help to make sense, create coherence and continuity. Paradigms of particular communities shape and guide perception, action and knowledge by providing frames of interpretation and repertoires (established practices) for problem-solving (see above).

Furthermore, although the present thesis adopts an actor-centred approach, it is embedded in a systems perspective that regards sustainability as necessitating a change of unsustainable patterns of human behaviour and underlying structures of human-environment interaction. It is tempting to anchor the thesis in Meadows´ systems perspective that regards paradigms and "mental models" as *the* source of system behaviour and as among the uppermost "leverage points" for change (in addition to system goals and self-organisation), even more so as the thesis attributes such prominent roles to paradigms and self-organisation (Meadows, 1999). However, this conceptualisation conveys a rather hierarchical and monocausal model of system behaviour and change, which does not seem adequate to address feedbacks in complex social-ecological systems. Instead, the present thesis bases itself on the conceptualisation of complex adaptive systems of Holling, Gunderson and associated researchers, with feedbacks resulting in discontinuous change, nonlinear behaviour and surprises (see above). It conceives of social systems as qualitatively different from ecosystems, considering complex and "dynamic causation" between them (Carpenter et al., 2002; Holling et al., 2002; Westley et al., 2002). Finally, Capra´s ´web of life´ adds a spiritual dimension that embraces the interdependence of humans and ´nature´ bound together in the circular causality of living systems of networks and communities, in which humans are but one partner (Capra, 1996, see also 4.4.2).

2.3.2 Additional perspectives and concepts

Based on Argyris, the present thesis understands actionable knowledge as knowledge that resonates with and, at the same time, challenges existing meaning- and action-frames emerging from double-loop learning (see above). It sets out to analyse the role of organisational and professional contexts in narrative identities and meaning-making among practitioners. It relates governance and management approaches to organisational and broader societal and cultural contexts, including their historical dimensions.

2.3.2.1 American Pragmatism and symbolic interactionism

An inquiry into actionable knowledge requires a base in theories of knowledge, learning and action. The MTF framework refers to the theory of structuration of sociologist Anthony Giddens, in order to explain patterns in human-behaviour and interplays between agency and structures in micro-situational social processes (Binder et al., 2013; Pahl-Wostl, 2015). For Giddens, knowledgeability,

purposefulness and reflexive monitoring are at the heart of human agency. Through knowledgeability and action, agents intervene causally and purposefully in the world, interpret rules and are able to consider factors that are not present in the immediate context of interaction, such as remote consequences of their actions. Agents are responsible and can be held accountable for their actions, because they in any given situation *could have acted otherwise,* not because they can control outcomes (Giddens, 1984, 2013). Giddens, however, does not say much about what meanings *mean* to individuals, nor does he address learning as such. The present thesis draws on the American Pragmatism of John Dewey and symbolic interactionism to address these points.

Experiential learning and personal knowledge (John Dewey): The "philosophy of experience" of John Dewey helps to address the experiential and transactional dimension of learning and, hence, of knowledge. Thought serves to guide action in solving problems and to pursue meaning. Learning denotes the "emancipation and enlargement of experience" from routines or habits, traditions and "appetites" through reflection and the formation of (new) purposes (Dewey, 1910, 1938a). Experience does not only happen within the individual, but in transactional encounters through which the individual simultaneously is shaped by and creates social and physical circumstances that enter the series of ongoing experiences (Dewey, 1938a).

A number of scholars have taken up these notions. It has been formative for the concept of organisational learning of Argyris and Schön (see below). David Kolb partly based his influential "experiential learning cycle" on Dewey, placing experience as "organising focus" at the heart of learning and defined learning as "transformation of experience" (Kolb, 2015). Dewey´s conception of learning has informed approaches to knowledge co-creation in sustainability science (König, 2018), to the analysis of interplays between "reciprocal transformation of the self and the world" in social learning and sustainability transitions (Van Poeck et al., 2018), and to "a new way of seeing, a new way of being in the world" through shared experience in transformative learning (Singleton, 2015).

Narrative identity and symbolic interactionism: A number of scholars have pointed to the significant role of narratives and narrative identities in shaping cognition, behaviour, beliefs and visions in environmental governance and sustainability transformations (Chabay et al., 2019; Jones & McBeth, 2010) and individual and collective behaviours, imagination and visions for the future (Chabay et al., 2019). Narratives reflect individual and social identities and their respective contexts and cultures and can, at the same time, change them (Chabay et al., 2019; Ezzy, 1998; Somers, 1994). Narratives can contribute to collective behaviour change by inspiring new ways of imagining relations to others and the environment (Chabay et al., 2019) or by making people more aware of environmental challenges than "just facts" (Jones, 2014). Some structuralist approaches analyse how policy narratives can serve as "tools for influencing policy change" by influencing collective opinions and policy outcomes in negotiation processes (Crow & Jones, 2018; Jones & McBeth, 2010) [26]. In transformative sustainability

[26] For example, Jones & McBeth (2010) have built on the group-grid cultural theory of Schwarz & Thompson (1990) and Douglas (1996) to develop a Narrative Policy Framework to test how the employment of hierarchical, individualist and, respectively, egalitarian policy narratives influenced how participants responded to different issues and possible solutions ("narrative persuasion" and "transportation"). Similarly, Verweij et al. (2006) have used cultural theory to construct ideal-typical egalitarian, hierarchical and individualistic "policy stories" used by actors in climate change debates.

science, scholars have analysed how narratives (e.g. of NGOs) have supported local communities in their efforts to become more sustainable (Chabay et al., 2019)[27].

The current thesis takes up these notions as a promising entry point into what may constitute actionable knowledge and what factors may hinder or facilitate double- and triple-loop learning. Symbolic interactionism provides the conceptual basis to do so.

Symbolic interactionism originates in American Pragmatism and places similar emphasis on meaning-making in interactional processes. It places (even) greater store on agents as "free", privileging the notion of contingency over the analysis of collective patterns of behaviour (Carter & Fuller, 2015). The American Pragmatist and social psychologist George Herbert Mead is one of its ´fathers´ and taught together with Dewey at the University of Chicago. Mead distinguished himself from Dewey in his emphasis on how mind and self (identity) evolve in social and cognitive processes, in which individuals and communities mutually shape each other (Denzin, 2017; Mead, 1934). A person´s socially constituted self (or personality) encompasses an introspective "I" and a social "me" that relates to his position (or roles) and attitudes towards others in society. The focus on acts of communication among individuals and in groups (Mead, 1934) was foundational for the Chicago school of symbolic interactionism, with Herbert Blumer and Erving Goffman as most prominent representatives (Carter & Fuller, 2015). Symbolic interactionists tend to place greater emphasis on history, identity and biographies, symbolic meanings (e.g. in language and texts) and the "stories people tell" than American Pragmatists (Denzin, 2017). As mentioned above, Goffman, provided a source for MTF in terms of how issues might be reframed and how roles may change in the course of double-loop learning. Goffman partly built on Blumer who emphasised that "joint action" (understood as deliberate alignment of *different* types of behaviour, rather than as identical behaviour) should be analysed with a view to how common interpretations of situations and actions have emerged historically among actors and what *alternative* possibilities and uncertainties existed (Blumer, 1986).

The present thesis uses a symbolic interactionist understanding of "narrative identity", in order to analyse how narration and action shape each other. Narrative identity provides people with a fluid continuity in life, because they act upon interpretations of the present that are shaped by past experiences and anticipated futures, whilst also reinterpreting past actions in light of present experiences and possible futures (Ezzy, 1998). In the present thesis, such reinterpretations are considered potentially important elements of the reframing of issues, behavioural and transformative change. Furthermore, an individual´s narrative identity is closely related to social narratives – or "culturally given plots" and "repertoires" –of the groups and the society, with which individuals interact (Ezzy, 1998)[28].

2.3.2.2 Organisational and professional learning

Emphasising the social dimension of knowledge, learning and narrative identities directs attention to the organisational and professional contexts, in which actors are embedded. Most scholars share the constructivist notion that knowledge is community- and practice-based. The notion of ´epistemic

[27] It seems closely related to calls for new metaphors to re-think ways humans engage with ´nature´ and envision their position in the world (Dyball & Newell, 2015; Raymond et al., 2013)

[28] Ezzy´s conception of ´narrative identity´ combines a symbolic interactionist with a hermeneutic approach (Ricoeur). However, it is deemed beyond the scope of the present thesis to elaborate in more detail on the hermeneutic tradition.

communities´ has been introduced above to denote communities that share a specific paradigm (Knorr Cetina, 2007). At the same time, the present thesis argues that inquiries into governance, social learning and paradigms would benefit from going beyond the established dualism between local and scientific communities. This means, notably, to consider a larger variety of organisational and professional communities and their respective knowledge types and narratives.

There are numerous references to the significant role of organisations in change processes. Organisations are "institutional arrangements that mediate the relationships between people and nature" (Holling et al., 2002). They guide actions and decisions of individuals and can "serve as vehicles to quickly mobilise collective action" (Amel et al., 2017). Organisational changes are indispensable for transformations towards sustainability (Amel et al., 2017; Hahn et al., 2006). In organisational studies, organisations have been defined as entities that "create and define problems, develop and apply new knowledge to solve the problems, and then further develop new knowledge through the action of problem solving", interacting with and shaping their environments (Nonaka et al., 2000). Senge and Scharmer have developed frameworks and approaches to organisational learning that advocate systems thinking as a basis for a kind of organisational learning that is based on collaborative inquiry, intrinsic motivation, new ways of perceiving problems (reframing) and visions, in order to enhance collective capacities to deal with complex challenges (Page, 2018; Scharmer, 2007; Senge, 1990). This has been taken up by many sustainability scholars (e.g. Reed et al., 2010). Systems thinking in organisations is regarded as a prerequisite to enhance "organisational sustainability", understood as reflexive and resilient communities that anticipate change and respond to emergent crises (Wals & Schwarzin, 2012).

As outlined above, several concepts from organisational studies have influenced sustainability science and adaptive governance and management approaches. In particular, the concept of single- and double-loop *organisational* learning of Argyris & Schön has been very influential. Organisations are "environments for knowledge" that provide "action frames" within which individuals think and act (Argyris & Schön, 1996). Organisations can be formal or informal (e.g. a student group or similar). What defines groups or communities as organisations is that they have established common rules and delegated certain tasks. Similar to the definition of social learning provided above, organisational learning is learning that is enacted tacitly by the members of an organisation, but goes beyond individuals by becoming embedded in an organisations´ environment, for example, in formal reference documents and new action strategies (Argyris & Schön, 1996).

Furthermore, the concept of "Communities of Practice (COP) of Wenger (Wenger, 2000) has provided a conceptual basis for the importance attributed to social networks in fostering social learning (see above). Social learning in networks has also been likened to "social *organisational* learning" (italics added) (Bouwen & Taillieu, 2004). Others point to organisational commitment as an important factor in fostering social learning (Sol et al., 2013). Finally, scholars have investigated the roles of bridging organisations in water governance (Berkes, 2009; Cook et al., 2016; Hahn et al., 2006; Meijerink & Huitema, 2017), of local communities (Berkes & Folke, 2002; Dietz et al., 2002; Folke et al., 2005), and of universities (König, 2015; Wiek et al., 2011) in adaptive and transformative change.

However, the present thesis argues that inquiries into social learning would benefit from examining a wider range of formal and informal organisations that participate in governance and social learning processes more closely and systematically. This applies particularly to non-scientific professional organisations and knowledge shared in these organisations. Not only are public administrations,

environmental organisations, water operators and municipalities largely neglected as organisational entities; what is particularly surprising is that professional communities are rarely recognised in their own right at all, although the engagement of "practitioners" is one of the hallmarks of collaborative approaches. Generally, the literature is dominated by limiting "epistemological pluralism" to somewhat simplistic binaries of local or experiential versus scientific knowledge, or of tacit versus propositional ways of knowing (Clark et al., 2016; Fazey et al., 2006; Raymond et al., 2010)[29]. For example, the knowledge of farmers – one of the few non-scientific professional groups to receive more widespread attention - is frequently described as "experiential" and "local" – even if some of the same scholars simultaneously note that farming in industrialised countries has become increasingly knowledge- and technology-intensive (Ingram, 2008; Kloppenburg Jr, 1991; Röling & Jiggins, 1998; Swart et al., 2018). The focus on experiential knowledge also neglects the formal education and organisational affiliations many practitioners are likely to have (Fazey et al., 2006). A few scholars recognise that many practitioners have "considerable technical training", but maintain a binary conceptualisation between "practice-based" or "practical" knowledge and "expert knowledge" (Weber et al., 2014).

Pahl-Wostl and associated researchers are among the few scholars identified in adaptive governance and management and sustainability research who frame challenges related to multi-actor governance in a way that explicitly considers professions and their practices. They argue that there is a "clearly identifiable epistemic community comprising (inter alia) researchers, water management practitioners, regulators, and technology manufacturers which can be characterised by a paradigm or mindset of how water management should be undertaken and which is reflected, and in some cases codified, in practices, laws, technologies, the nature of discourse, etc." (Pahl-Wostl et al., 2010). Double-loop learning entails that mental models of professionals – including farmers, ecologists, regulators and engineers - as well as their professional roles, standards and routines are called into question, reframed and revised, and also necessitates a reform of their formal education and training (Pahl-Wostl, 2015). A related study highlights the role of paradigms and different epistemologies in engineering practice and education (Halbe et al., 2015). Similarly, scholars using the Multi-Level Perspective (MLP) have argued that the agricultural regime is characterised by powerful actor networks that comprise scientists, officials, agro-chemical suppliers and farmers who share a techno-centric paradigm and narrative and pursue incremental innovation (Ingram, 2018).

Notwithstanding these examples, there are hardly any explicit references to organisational and professional knowledge and learning in the literature cited (outside organisational studies). Few conceptualise and analyse professional dimensions of sustainability transformations specifically and systematically. Due to this notable gap, the present thesis resorts mainly to Donald Schön´s seminal work "The Reflective Practitioner" to address learning and knowledge in professions (Schön, 1983).

[29] Raymond et al. (2010) provide one of the most extensive literature reviews on knowledge types in environmental management. ´Experiential/local knowledge´ is used as a generic category to denote indigenous, traditional ecological, local ecological, personal, lay, local or situated, tacit, implicit, informal, non-expert types of knowledge. ´Scientific´ denotes explicit and formal knowledge generated through "formalised processes". ´Hybrid knowledge´ denotes a mixture of the two former knowledge classes as well as knowledge "from other sources" that are not detailed further. While promoting "epistemological pluralism" and "knowledge integration", the paper illustrates the somewhat simplistic view of knowledge types that is prevalent in much of the literature. Not only do organisational and professional (or, for that matter, ´practice-based´) knowledge types not appear, the distinction also disregards that scientific knowledge encompasses tacit, implicit and informal elements and that local or experiential knowledge may contain explicit and formal elements.

Despite his diagnosis that there is a "crisis of confidence in the professions" due to unintended side effects of professional practices and professionally designed technologies, he notes (Schön, 1983):

> *"we conduct society´s principal business through professionals specially trained to carry out that business […] We look to professionals for the definition and solution of our problems, and it is through them that we strive for social progress" (Schön, 1983).*

Schön considered a*ll* professions and roles as embedded in particular institutional and organisational contexts. Professional knowledge rests upon an "epistemology of practice" that emerges from a specific institutional context (e.g. tied to formal disciplines and education, specific problem-solving strategies and "role-frames") and the tacit "theories of action" that practitioners develop via professional experience[30]. Tacit knowing includes practical skills that are acquired and carried out through the body, but cannot be put into words (Polanyi, 1966).

Building on Schön, and drawing on Dewey and Aristotle, Ellett makes more explicit that each profession has a specific *raison d´être* related to the services it provides to society, and specific aesthetic standards "for what is considered a ´job well done´". These aspects can come together in a practical form of wisdom (*phronesis*), understood as an affective disposition (or virtue) to perform tasks well and to make ´wise´ judgements that become part of the professional´s identity:

> *"For most professionals, then, being a good professional is a very important part of living a good life that holds serious implications for one´s self-identity and self-esteem" (Ellett, 2012).*

In order to address narrative and professional identities, the concepts of Argyris and Schön will be supplemented by the notion that organisations are communities that have grown historically and share a set of narratives expressing (often tacit) intentions, desires, and goals, an identity and collective memory that influence actions and relations, as integral elements of organisational knowledge (Tsoukas, 2005). At the same time, it is assumed that actors partake in multiple and often overlapping communities. Identity itself is constituted at the nexus of membership in multiple communities and emerges from the interaction of "divergent trajectories" that connect people with other people (in identification with or demarcation from) in networks spanning the local and global (Wenger, 2010).

It is not possible to make a clear-cut distinction between organisational and professional knowledge and learning. For the purposes of the present thesis, however, professional knowledge will mainly pertain to how practitioners (including researchers) carry out and relate to their specific professional practices, while organisational knowledge concerns how actors from diverse professions organise themselves and distribute and delegate tasks (see definitions in conceptual framework 3.1.3).

[30] Schön also notes that there is an increasing "professionalisation" of occupations that goes hand in hand with more specialised professional knowledge (a phenomenon frequently referred to as characteristic of the ´knowledge society´ (Beck, 1992; Knorr Cetina, 2007). However, universities have long neglected professional knowledge. He explains this by researchers´ commitment "to a particular epistemology, a view of knowledge that fosters inattention to practical competence and professional artistry" (Schön, 1983). One of the only references identified to Schön´s work in the sustainability literature was an article by researchers reflecting on their own scientific professional practice (Brown et al., 2005)

2.3.2.3 Science & Technology Studies

The present thesis draws on Science & Technology Studies (STS), because it provides a perspective on dynamics of stabilisation and transformation in society that is suitable to tie many of the above-mentioned conceptual strings together. It adds a focus on interrelations between policy-making, science and technologies, on the one hand, and social arrangements and cultures in society and specific communities, on the other, considering historical, normative and cognitive aspects.

In particular, the present thesis draws on the concepts of co-production, technoscientific culture and sociotechnical imaginaries, in order to enrich the analysis of paradigms, policies, knowledge, practices, narratives and identities in water and land governance and related (epistemic) communities and organisations. As has been outlined above, concepts such as multiloop social learning, resilience and transformative change rest on the assumption that sustainable human-environment relations require profound changes across multiple levels of social organisation, across temporal and spatial scales, and diverse contexts and spheres. Understanding epistemic cultures and practices, narratives and identities of specific organisations and communities requires an analysis into practices and historical and cultural contexts. In sociology, in particular, there are numerous references to how nowadays´ sustainability challenges have been caused by a combination of modernisation, industrialisation, capitalism and globalisation (e.g. Beck, 1992, 2016; Beck et al., 1994; Habermas, 1990). "Modern-industrial worldviews" (Amel et al., 2017) and scientific and technical-instrumental rationality privilege monocausal, linear, mechanistic and technocratic thinking, specialisation, technological advances and control, economic competition, short-to medium-term material gains, while neglecting environmental, social, ethical and spiritual dimensions of human-environment relations (Bateson, 2000; Beck, 1992; Capra, 1996; Jonas, 1973; Ravetz, 2018; Wals & Peters, 2018; Young et al., 2006). Unknown and unintended consequences have turned modern society into a "risk society" that is faced with increasing environmental threats that it seeks to either control by the very same means that have produced them (i.e. science and technologies) or to ignore (Beck, 1992).

Some scholars have related historical trajectories of paradigms and approaches in agricultural and water management to some of these macro-patterns. For example, scholars have linked changing agricultural and food system paradigms to scientific and industrial ´revolutions´ and urbanisation (Dendoncker & Crouzat, 2018; Dyball & Newell, 2015). Others have analysed how technical and control-oriented approaches in water management have been expressions of prevailing worldviews that regard relations between man and nature/water as antagonistic (Parodi, 2008) and reduce the value of water to its utility for humans and scientifically measurable biophysical properties (Henriquez & van Timmeren, 2017). These analyses, however, seem to be exceptions[31]. Overall, few scholars in sustainability science and environmental governance and management seem to have examined in detail how specific paradigms and related communities have emerged historically, and how they are embedded in wider political, societal, cultural and economic contexts. Drawing on STS, the present thesis is an attempt to address this shortcoming, in order to enhance understanding of how historical cultural, organisational, and material factors may facilitate or hinder social learning.

Pahl-Wostl and associated researchers *do* argue for a stronger consideration of culture to analyse how actors frame issues and problems and possible barriers to paradigm shifts (Pahl-Wostl, 2006b; Pahl-Wostl et al., 2008b). Legal frameworks, technologies, infrastructures and management practices are expressions of particular prevailing informal cultural-cognitive and normative institutions that are reproduced and shaped by actors and specific "epistemic communities" (see above). For example,

[31] Scholars working with the Multi-Level Perspective (MLP) have sometimes adopted more historical perspectives investigating interlinkages between social groups, technological innovation and regimes, such as in mobility transitions from horseback to automobiles (Geels, 2005).

culture may help explain differences in what information groups regard as meaningful, and how they interpret it (Pahl-Wostl et al., 2008b). In line with symbolic interactionism, Pahl-Wostl et al. argue in favour of an approach that constructs cultural frameworks guiding actors in an inductive and context-based manner rather than by pre-defining behavioural patterns and cultural ´profiles´[32]. The present thesis embraces this approach - however, with one exception derived from STS and some of the sociologists mentioned above.

The STS idiom of co-production rests on the assumption that social-political orders, cultures, practices and identities co-produce each other via interplays between diverse cognitive, social and material factors (Jasanoff, 2006). The foundational diagnosis of STS is that nowadays´ "knowledge societies" have emerged from a combination of advances in modern sciences, technologies and state-making that have given rise to a dominant "technoscientific culture" (Jasanoff, 2006). It is difficult to find – or even imagine – forms of social organisations, communities and ecological systems unaffected by science and technology. (Jasanoff, 2006; Knorr Cetina, 2007) As suggested above, epistemic cultures and practices are closely interwoven with broader societal culture.

The concept "sociotechnical imaginaries" describes close interlinkages between contemporary social-political orders, science and technologies and narratives and identities. Imaginaries provide society and communities with "common narratives of who they are, where they have come from, and where they are headed" that are expressed in political agendas and discourses, legal and administrative systems and financing instruments and shared understandings of how society functions (Jasanoff & Kim, 2015). Imaginaries produce "systems of meaning" that facilitate collective interpretations of social reality and play out in the "understudied regions between imagination and action, between discourse and decision, and between inchoate public opinion and instrumental state policy" (Jasanoff & Kim, 2009). For example, after WWII nuclear power in the United States has been framed in an imaginary that centred on the necessity to contain potentially uncontrollable and destructive risks, while the imaginary in South Korea was used to boost national scientific, technological and economic development and autonomy (Jasanoff & Kim, 2009). In both cases, science and technology played a dominant role in the imaginaries and in justifying political decisions.

From an STS perspective, this is symptomatic. Modern governance and legal systems rely heavily on scientific expert knowledge, especially for technical risk assessments. Whilst feeding into imaginaries, science provides policy-makers with an allegedly value-neutral and solid basis for decision-making, which tends to disregard uncertainties and conceal normative choices (Ezrahi, 2006; Jasanoff & Kim, 2015). Technologies and infrastructures tend to "freeze" social relations and arrangements that are tied to their production and maintenance and become part of the responses to new problems. In times of change, it may therefore not be possible to contest knowledge claims without calling into question established structures of authorities and related institutions (Jasanoff, 2006). New imaginaries and narratives may be necessary.

The present thesis will use the STS concepts to inquire into the role of imaginaries, science and technology in the history of water and land governance in Luxembourg, and how water management paradigms (along with related imaginaries and narratives) have been embedded in broader societal and cultural contexts, and how these have emerged, been stabilised, contested and transformed. Notably, this will be done with a view to the role of specific organisations and (epistemic) communities. The analysis will serve to inquire into historical and societal contexts of current approaches, and into

[32] Rejecting ´cultural stereotyping´ and deductive approaches that disregard empirical studies that suggest that individuals hardly ever behave according to one cultural (stereo-)type, Pahl-Wostl et al. (2008a) distance themselves from grid-group cultural theory and the cultural profiles developed by Thompson (Thompson, 1997),

related facilitating and hindering factors for and implications of double loop learning and transformative change.

It is important to note that the present thesis will use the term “co-production” exclusively in the STS sense. As all actors and social activities, the present thesis inescapably partakes in the co-production of knowledge and science, socio-political relations and orders, practices and narratives, underscoring the need for reflexivity, responsibility and humility[33].

2.3.3 Research contributions

The present thesis sets out to develop an actor-centred multi-contextual framework on actionable knowledge. Actionable knowledge is considered to potentially emerge from double loop social learning processes and to support transformative change in water and land governance that is regarded as part of a wider societal transformation towards sustainability. For present purposes, the thesis defines sustainability as an emergent property of dynamic processes of mutual adaptation and transformation in human-environment relations that strengthen ecological and social regeneration capacities and involve complex interplays between agency and structures, self-organisation, and emergence.

Actionable knowledge for sustainability needs to foster dialogues, cooperation, responsiveness and actions that aim to reconcile a better adaptation of human behaviour and resource use to ecosystem carrying capacities and dynamics with values of social equity and participation. It also needs to be transformative in opening up horizons of action, imagination and narration to create new opportunities and pathways for how we engage with our environments. Actionable knowledge needs to challenge prevailing ways of knowing and doing (König, 2018). At the same time, it can only be knowledge by virtue of being meaningful to actors and of resonating with their narrative identities.

How such knowledge may emerge is still under-researched. Efforts to conceptualise, analyse and foster actionable knowledge through collaborative processes would, notably, benefit from devoting more attention to organisations and professions as contexts of community-based knowledge-making, paradigms, and narratives. The present thesis addresses four main shortcomings identified in the literature:

- ´context´ is rarely conceptualised and addressed systematically,
- The role of *non*-scientific organisations and professions is under-researched in empirical studies (except local communities and bridging organisations), despite their assumed roles as ´carriers´ of paradigms and potential ´vehicles´ of transformative change,
- few empirical inquires analyse how historical contexts of paradigms, organisations, policies, infrastructures and landscapes - and related narratives - facilitate or hinder social learning in contemporary governance processes,

[33] The term ´co-production´ has various connotations in the literature (Stirling et al., 2018; Wyborn et al., 2019). In sustainability science “co-production” frequently denotes deliberate collaborative knowledge co-creation processes in multi-actor settings; in public administration, scholars such as Ostrom refer to co-production as the participation of a actors in the production of goods and services. Wyborn et al. have suggested to fuse the ´definitions´ of “co-production” of STS, public administration and sustainability science into a comprehensive understanding. Sustainability science could then be positioned as supporting knowledge co-production and transformative societal change in several ways: by deliberate design, by playing a part in the (emergent) co-production of institutional arrangements, and by generating particular societal outcomes. Thus understood, “co-production provides a framework to rethink science and its connection to society as a tool to meet grand societal challenges” (Wyborn et al., 2019).

- few empirical studies adopt a nexus approach to water, the environment, agriculture, and other forms of land use.

The present thesis sets out to make a significant contribution to the field by developing an analytical framework that conceptualises:

- how organisational and professional contexts (including paradigms) may shape approaches, knowledge, narrative identities and relations of actors in governance and social learning processes,
- how agency *and* wider societal and material macro contexts may contribute to the emergence, institutionalisation, and transformation of particular organisations and communities,
- how actionable knowledge may emerge and support transformative change across contexts,
- interrelations between water, environmental, and agricultural governance.

The role of organisational and professional contexts in shaping agency: How are individual actors who engage in governance processes influenced by the formal organisations and informal professional and local communities which they represent or identify with? With narratives of interviewees as a point of departure (triangulated with documents, observations and workshops, see methods 5.2.1), it offers a framework tailored to analysing the role of organisational and professional contexts in how actors engage with each other, how they frame challenges and what action strategies and methods they employ: public administrations, environmental organisations, farming professions, municipalities and water facility operators. The factors considered include formal and informal institutions and related assumptions, narratives and imaginaries that may shape professional knowledge and practices. Thereby, the present thesis seeks to construct, if and how the approaches of actors are guided by particular paradigms, how they evolve and what factors hinder or facilitate new modes of social engagement (e.g. in social networks), institutional reframing and revisions, new organisational and professional knowledge, and non-routine action. Notably, the framework to be developed will also serve to support the analysis of synergies, controversies, and conflicts between diverse actors. How can organisations support cooperation and social learning for sustainability?

The role of agency and societal and material macro-factors in shaping organisations and communities: Assuming that organisations are crucial in fostering agency and processes for transformative change, how do they change? With a point of departure in narratives of interviewees, the framework to be developed serves to consider how agency and broader societal factors contribute to changing organisations (their institutions and paradigms, narrative identities and practices) and interorganisational relations. Agency refers to actions of individual persons. Societal factors encompass formal policy-making, culture, public awareness, social norms and debates, science and the economy (macro-context). In the nascent framework and case studies, special attention will be devoted to policies (such as the EU Water Framework Directive), and how they affect organisational landscapes, and practices. Agency and societal factors are mentioned together, because it is assumed that they are closely interrelated. Ecological and technological factors are considered as mediated through agency and societal factors. The framework aims to facilitate the analysis of historical trajectories of organisations and paradigms. The thesis inquires into the historical contexts of organisations, policies, infrastructures, and landscapes that are key to the case studies in the Syr and Upper Sûre river basins. They analyse how (transformative) past changes in governance and management paradigms and approaches have been accompanied by changes in and among formal organisations, professional and local communities.

The role of actionable knowledge in transformative change: What kind of knowledge inspires actions that aim for transformative change? And how is it related to social learning? These questions have axiological, ontological and epistemological dimensions that direct attention to the possible role of

paradigms. The analytical framework to be developed will serve to analyse how actors frame challenges depending on their purposes and normative assumptions (axiology – normative knowledge), the scope they attribute to them based on perceptions of how factors are interconnected (ontology – systems knowledge, including ecological knowledge) and what means they deem appropriate to tackle them (transformation knowledge - methodology), including by which type of knowledge (epistemology). One objective is to use these analytical dimensions to investigate how they relate to paradigms and approaches of their organisations, professions or local communities. How are they expressed in their roles, narratives, and imaginaries? Most importantly, they will be used to structure the inquiry into social learning. Double loop learning would entail enhanced reflexivity, critical reflections on and changes along all of these dimensions.

A systems perspective on nexus challenges: Whilst centred on water, the present thesis conceptualises and analyses interrelations between water, environmental, and agricultural governance ecological, respective actors, policies, paradigms, and projects. In addition, the thesis touches upon regional and economic development, including transport.

3 CONCEPTUAL AND ANALYTICAL FRAMEWORK

This part develops a conceptual and analytical framework that serves to structure the inquiry into the research questions of the thesis:

1. *How can knowledge be conceptualised that fosters collective action for sustainability?*
2. *How has the EU Water Framework Directive changed water and land governance and management in Luxembourg?*
3. *What factors facilitate or hinder the emergence of social learning and actionable knowledge for sustainability?*

The framework is divided into two main chapters:

- Chapter 3.1.: Conceptualisation of actionable knowledge along three analytical dimensions in relation local, professional, and organisational knowledge types as embedded in multiple contexts (incl. related informal, formal, and material factors)
- Chapter 3.2.: Conceptualisation of multiloop social learning in water and land systems based on the Management and Transition Framework (MTF), and elaboration of the main analytical categories to analyse contexts, processes, and outcomes of governance processes with a view to factors that facilitate or hinder the emergence of social learning

The conceptual focus has emerged iteratively from dialogues with stakeholders and researchers, collaborative workshops, literature reviews and qualitative interviews, documentary analysis, and observation studies (see methods 5.1).

3.1 Actionable knowledge

The following elaborates on the main conceptual pillars of the present thesis, conceptualising how actionable knowledge for sustainability may be understood in relation to diverse types of knowledge and contexts. Actionable knowledge for sustainability needs to challenge prevailing ways of knowing and doing (König, 2018). At the same time, it is knowledge only in as far as it is meaningful to actors.

For present purposes, the thesis has defined sustainability as potentially emerging from dynamic processes of mutual adaptation and transformation in human-environmental relations that involve complex interplays between agency, intentional design, self-organisation and emergence across diverse spatial scales, sectors and levels of social organisation. Actionable knowledge for sustainability needs to foster dialogues, cooperation, responsiveness and actions that aim to reconcile the *adaptation* of human behaviour and resource use to ecological regeneration and carrying capacities with values of social equity and participation. *Transformation* may flow from action and knowledge that open new horizons for how actors engage with each other and the landscapes, which they inhabit (see conceptual positioning 2.3.3).

The current thesis argues that inquiries into actionable knowledge and social learning would benefit from a conceptualisation of context that differentiates between personal, transactional, organisational and macro contexts of actor engagement. With personal meaning-making as a basis, they provide different contexts, in which knowledge, paradigms, narratives, and imaginaries are institutionalised, enacted, and transformed.

3.1.1 A narrative approach to actionable knowledge and paradigms

The thesis investigates how knowledge that practitioners act upon is related to personal knowing and to shared community-based types of knowledge. In order to be meaningful (and thus to become knowledge), knowledge needs to resonate with experiences and assumptions of actors that may be closely intertwined with both personal narratives and with narratives and paradigms shared in organisational and societal contexts.

Narratives offer a promising conceptual perspective to inquire into interrelations between knowledge, paradigms, action, and contexts (see also conceptual positioning 2.3.1). Narratives can serve as a point of departure to explore meaning frames of actors, and how the emergence of new shared narratives may contribute to expanding and transforming meanings and actions (Chabay et al., 2019). Although narratives open up for a "plurivocity" of interpretations (Ricoeur, 1981), they can make assumptions that underlie knowledge and actions more explicit (Chabay, 2020; Chabay et al., 2019; Chase, 2011; Elliott, 2005; Somers, 1994).

In analysing narratives the present thesis pursues three main objectives (see also methods 5.3). Firstly, narratives serve to analyse how actors interviewed understand water and land-related challenges, processes, and relations (meaning-making). Secondly, the interpretation of narratives serves to identify assumptions and possible paradigms that may be shared in particular organisations and communities engaged in Luxembourg´s water and land systems. Reflecting the notion that paradigms are constructed ideal-typical devices, an important criterion for *justifying* the construction of paradigms in the first place is that narratives of individual actors (triangulated with other sources) reveal similar perspectives on challenges, purposes, and means to address them. A further important criterion for the construction of paradigms is whether they hold explanatory power in rendering knowledge, actions, and relations of actors engaged in governance processes more intelligible (i.e. meaningful and plausible).

Finally, narratives add a temporal and historical dimension to inquiries into actionable knowledge. The thesis will thus analyse narratives with a view to identifying significant factors and events that have influenced personal engagement of individual actors and actor relations in governance processes (or ´action situations´, see 5.6.1). In this way, narratives serve to (re-)construct both governance and social processes and relevant contexts, both contemporary and historical.

3.1.1.1 Narratives and narrative identities

Narratives are stories that are organised along a plot that evokes particular meanings by interconnecting different events, places, characters, and ´objects´ (Ezzy, 1998; Ricoeur, 1981). The plot rests on an organising theme (Ezzy, 1998). It situates events and characters in space and time (past-present-future), and weaves them into causally related dramatic moments, turning points and, typically, a resolution that conveys a specific moral at the end (Chabay et al., 2019; Elliott, 2005; Jones & McBeth, 2010; Somers, 1994). Single events, therefore, cannot be understood on their own (Ricoeur, 1981)[34].

[34] Distancing himself from structuralism, Ricoeur argues that the sequential and temporal elements of a narrative (i.e. the plot with its configuration and succession of events) is essential to understanding meaning. The plot cannot be dismissed as "mere surface manifestation" from which a "deeper" and a-temporal structure can be deducted, because "the unfolding of the action implies alternatives, bifurcations, hence contingent connections, which create the feeling of surprise, essential to the interest taken by the hearer or the reader of the narrative.

The narrative approach posits that how people act and know, and why, is profoundly related to their sense of *who they are* (Somers, 1994)[35]. Relationality, causal emplotment, selective appropriation, temporality, sequence, and place are characteristic features of how actors act in, experience and interpret certain situation (Somers, 1994). The understanding of narrative identity adopted here builds on Ezzy (1998) who bases himself on the symbolic interactionism of, in particular, Mead and Goffman, and the hermeneutics of Ricoeur[36]. While structuralist approaches tend to focus on how actors construct their identities based on a limited repertoire of available narratives that relate e.g. to gender, class or ethnicity (Somers, 1994), symbolic interactionist and hermeneutic approaches have a stronger emphasis on how interpretive processes, as basis for identities, differ between people and undergo changes over time. Hence, symbolic interactionists tend to regard narrative identities as more situation-specific, process-bound, reflexive, and fluid (Ezzy, 1998)[37].

The main idea selected for the purpose of the present thesis is that personal narratives, experience and action come together in ongoing interpretative and integrative processes that provide individuals with a sense of continuous and coherent self across time (Ezzy, 1998). The concept of narrative identity links narrativity and identity directly to action. How people act and seek to create continuity in their lives is closely related to the narratives they have constructed for themselves. Judgements on how to solve problems in the present flow from the *memory* of past events and the *foresight* of possible future consequences[38]. While this idea is similar to Dewey (see below), Mead also argues that human beings organise their experience and memories into a reflexive "self" (Mead, 1934). Remembered and anticipated events, and imagined futures, are constantly reconfigured to new plots in the light of the present, and become a person´s "self-narrative" that shapes action (Ezzy, 1998). Continuity thus rests on fluid relations between "being" and "becoming" (Ezzy, 1998; Somers, 1994)[39].

> *"Narrative identities are necessarily processual because they describe lived time, which is ongoing. Narrative identities are very much in-process and unfinished, continuously made and remade as episodes happen. As a consequence, self-narratives often appear confused and*

Finally, the unforeseeable outcome of the quest in terms of success or failure fills the entire story with a general air of uncertainty, which characterises the action as a whole precisely qua quest" (Ricoeur, 1981). "Therefore what we want to understand is not something hidden behind the text, but something disclosed in front of it" (Ricoeur, 1981). These quotes are provided here, because they provide arguments in favour of the MTF approach chosen for empirical analysis that is based on constructing and interpreting governance and learning processes on the basis of sequences of ´action situations´ (see below and methods 5.6.1).

[35] Or, in the words of Hannah Arendt: "In acting and speaking, men show who they are, reveal actively their unique personal identities and thus make their appearance in the human world […]" (H. Arendt, 1998)

[36] In discussing hermeneutics in relation to the human sciences, Ricoeur underlines the ontological dimension of efforts to understand texts (in the widest sense, including speech and action): "understanding ceases to be a simple mode of knowing in order to become a way of being and a way of relating to being". Conversely, through interpretation, being itself "is a question about the meaning of that ´being´". (Ricoeur, 1981)

[37] This view is close to sociologists who note that identity in modernity, increasingly, becomes a reflexive project, in which actors interpret and reflexively appropriate diverse meanings from specific societal and cultural contexts ("lifeworlds"), see also below (Habermas, 1983).

[38] As outlined in the conceptual positioning part, adaptive governance and co-management literature also attribute great significance to social memory. However, the hermeneutic and symbolic interactionist approach to memory differs in a crucial aspect. Rather than understanding social memory as "accumulated experience that informs community debates" (Folke et al., 2005, italics added), they stress that experience is constantly re-interpreted and re-made, and, hence, iterative rather than cumulative.

[39] Identity as "being" and "becoming" can also be described as "identity as a learning trajectory: We define who we are by where we have been and where we are going"; and as "identity as community membership: We define who we are by the familiar and the unfamiliar" (Wenger, 2010)

chaotic because of the disordered nature of life and because we cannot be sure how the story will end" (Ezzy, 1998).

It is a hermeneutic task to understand actions by interpreting possible human purposes ("why") by placing them into sequences of episodes (Ricoeur, 1981).

Furthermore, selves are constructed in "experiential transactions" within groups and communities, and their institutions (Mead, 1934). Only via the "detour" of action, understood as "the exteriorisation" of life, and the interpretation of the effects it produces, does man come to know himself (Ricoeur, 1981). Individuality emerges from a recognition of belonging to a community, combined with the need to be *different* from others (Mead, 1934). Applied to narrative identities this means that culturally given and dominant narratives provide "interpretive resources" that influence how individuals construct themselves in both identification with and in distinction from others (sometimes also referred to as ´othering´).

As narratives are formed in interaction taking place in specific environments, narratives reflect "the cultures and contexts in which they are embedded, exchanged, and modified" (Chabay et al., 2019). Narrative identities are inherently *social* identities that position individuals in relation to specific communities and to society at large (Ezzy, 1998; Somers, 1994).

"Each individual and each group, and community, is embedded in one (or across several) cultural environment(s) and operates in a physical, biological, political, and historical context. Collective identity pertains to making sense of one´s relationships to others in the community and also potentially some elements of the environment […]" (Chabay et al., 2019).

Hence, context needs to be considered to interpret and understand narratives (Chabay et al., 2019; Ezzy, 1998; Somers, 1994). Furthermore, individual identity is constituted at a "nexus of multimembership" in multiple communities, both private and professional (Wenger, 2010). From this point of view, learning is about much more than learning the rules of what to do in a specific context. The construction of identities necessitates learning how to reconcile multiple and possibly conflicting demands of *different* communities. Identity formation may involve continuous struggles to reconcile tensions, or at least to make multiple memberships coexist (Wenger, 2010). For this reason, the present thesis develops an actor-centred and multi-contextual framework that serves to allow for a differentiated analysis of how *diverse* contexts and related paradigms and narratives may shape knowledge and action.

3.1.1.2 Actionable knowledge: integrating narratives and paradigms

The conceptual positioning part has outlined the main dimensions that transformative sustainability researchers consider crucial for the capacity of actors to know and act for sustainability: systems, normative, and transformation knowledge (see conceptual positioning 2.1.3.1, and figure 3.1.). On the basis of the above and the elaboration on paradigms in the conceptual positioning part, these dimensions can now be related to narratives and paradigms. Paradigms have been defined as meaning- and action frames composed of axiological, ontological, and epistemological assumptions that are tied to specific epistemic communities, guiding its members in how they understand, frame, and seek to tackle challenges. They are wound up with material environments and tools.

Narratives are not necessarily expressions of particular paradigms. While paradigms are understood as providing a fairly coherent set of shared assumptions, narratives can express personal identities and certain *perspectives* that are not rooted in a community-based ´belief system´. Therefore, the narrative perspective on knowledge and action offers a broader analytical scope than the concept of paradigms.

Moreover, as outlined above narratives undergo constant change. In contrast, paradigms are institutionalised and materialised in diverse contexts and, therefore, less dynamic (i.e. more ´resistant´ to change). Finally, paradigms do not depend on being articulated in narratives or discourses.

Collaborative processes bring together multiple actors with different understandings shaped by personal and collective narratives, perspectives and/or paradigms, and related assumptions. What is actionable will crucially depend on these. These understandings can be analysed and compared along the following dimensions:

Normative dimension (why): Normative knowledge concerns human purposes and values that shape what actors regard as meaningful, desirable, intrinsically worthwhile and valuable, and how they act. They are an integral elements of actors´ narrative identities. The normative (or axiological) dimension encompasses ethics, aesthetics, and spirituality (see conceptual positioning 2.1.1.2). It shapes how actors understand and frame issues, what kind of questions they ask, and on the basis of which normative criteria they make judgements, e.g. in relation to sustainability challenges. These might be shared by epistemic communities who share a specific paradigm. They might also be deeply engrained in narratives about the personal and/or communal past (memory), present, and desirable futures (*how things ought to be)*. Narratives, therefore, can provide normative orientation (Chabay et al., 2019). They are also sources of emotional identification and provide motivational incentives to act in a certain manner (Chabay et al., 2019). At the same time, sustainability challenges call for a profound revision of purposes.

Of particular interest for the present thesis are assumptions about human-environment relations, and what ´purposes´ actors associate with their engagement with e.g. rivers, soil, and landscapes, e.g. through their management practices (see below 3.2.6). The thesis will elaborate on different "nature myths" and "metaphors" that may convey certain understandings of human-environment relations and be elements of narratives[40]. Coining the term "affective narrative expression", Chabay et al. (2019) propose that characteristic elements of narratives that hold strong emotional communicative power can often be distilled from a complete narrative. An affective narrative expression is a "memorable, easily communicable, and affective verbal and visual representation of the [narrative´s] core message" (Chabay, 2020; Chabay et al., 2019)[41]. The present thesis explicitly extends the concept of "affective narrative expression" to include metaphors, "myths", and imaginaries (see below 3.1.2.4).

Systems dimension (what): Systems knowledge encompasses understandings of the nature of systems, cause-effect relations and uncertainties, for example as regards interactions between social and ecological systems (what *is*). It is decisive for how a system is delineated, how boundaries are drawn (*scoping*). Paradigms hold particular ontological assumptions about relevant factors that drive change, connecting the past, present, and anticipated futures. These may be expressed in narratives. From a systems perspective, a particular value of narratives consist in enabling actors to identify, interpret, prioritise, and act on limited sets of systemic factors and interconnections rather than to be overwhelmed by chaos and uncertainty. Narratives thus lend themselves particularly well to making sense of complex interactions (Wilbanks, 2006). At the same time, the acknowledgement of uncertainties and "nonknowledge" is crucial as regards sustainability challenges (and, for that matter, as regards learning) (see also conceptual positioning 2.1.1.2 and 3.2.6.2 below).

[40] In the hermeneutic tradition, a metaphor is an "emergent meaning" located in a specific text (including speech and action) that illuminates the interpretation (and, hence, understanding) of the text as a whole by ´opening new worlds´ of meanings that rely on imagination (Ricoeur, 1981).

[41] Examples cited are iconic sentences such as "I have a dream" or "yes we can", or paintings such as Picasso´s "Guernica" used in anti-war campaigns that have strong affective dimensions (Chabay et al., 2019)

Transformation dimension (how): Transformation knowledge concerns judgements and decisions about how to tackle particular challenges, what means to use to overcome constraints and leverage opportunities (*what to do*), in order to reach certain purposes, and based on systems knowledge. Paradigms encompass practices and problem-solving repertoires institutionalised in epistemic communities. Narratives provide memories of past experiences, what was done and how, and with what outcome. By providing practical guidance, they can facilitate decision-making in complex situations (Chabay et al., 2019). However, sustainability challenges also call for a re-thinking of action strategies and means.

On this basis, the present thesis has developed a graphic scheme that will serve to structure empirical inquiry into diverse personal and community-based knowledge, paradigms and narratives, and how they may come together and evolve in the course of governance and social learning processes. Particular attention will be devoted to tensions and synergies that may hold interesting insights into factors that may facilitate or hinder the emergence of social learning and actionable knowledge among diverse actors. Finally, the approach adopted here has implications for how social learning, knowledge co-creation and integration are understood. From a hermeneutic perspective, knowledge integration (and co-creation) is a social interpretive (and learning!) process based on dialogic communication from which shared meanings and references emerge that may become a resource for – and be formed in - action.. Meanings do not have to cohere into a consistent closed system, but remain subject to iterative and diverse interpretations (Grunwald, 2016; Tabara & Chabay, 2013)[42]. Reflexivity as regards purposes, scopes and factors, and means is, simultaneously, a precondition for social learning and a possible outcome.

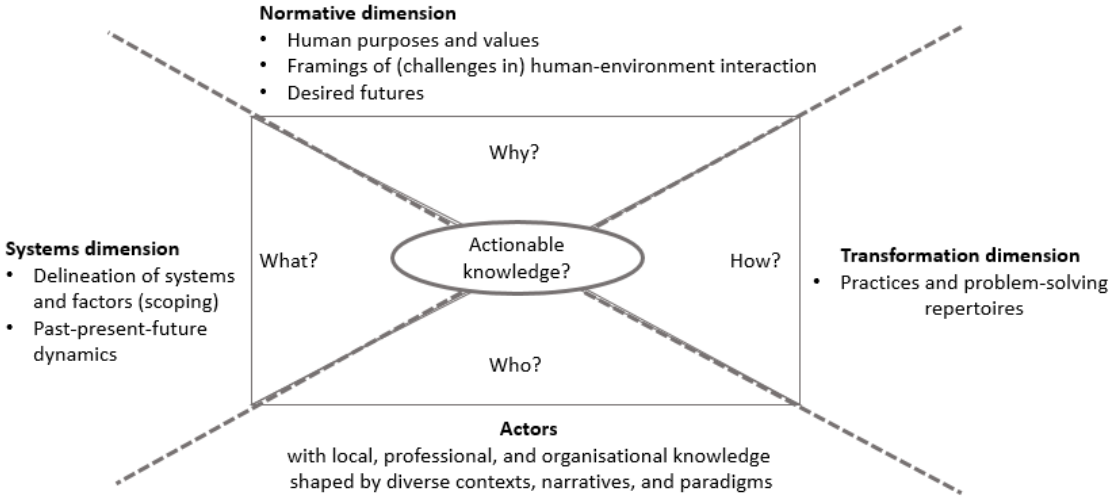

Figure 3.1 – Dimensions of actionable knowledge for sustainability relating to paradigms and narratives

[42] "Die Integration von Wissen für nachhaltige Entwicklung ist notwendig, sie ist schwierig bis theoretisch unmöglich, und sie scheint trotzdem in vielen Feldern durchaus zu funktionieren. Ich möchte sie konstruktiv dadurch auflösen, dass ich das Integrieren als Tätigkeit, als sozialen Prozess der Verständigung beschreibe, der mit Arbeit an der Bedeutung nachhaltiger Entwicklung verbunden ist. Qualitätsbeurteilung und Konsistenzüberlegung bleiben daher auf eine hermeneutische Rekonstruktion der Integrationsschritte verwiesen, um diese transparent und dadurch der Kritik zugänglich zu machen. Konstruktive Hermeneutik heißt hier, die ´black box´ der Integration zu öffnen und die bedeutungsrelevanten Schritte ans Licht zu zerren […] Der Dialog in der Alltagssprache über die Schritte der Integration, die Abwägungskriterien und vieles mehr ist nicht formallogisch abkürzbar – vielmehr ist auch hier ein ´wirkliches Gespräch´ erforderlich" (Grunwald, 2016). This understanding is close the arguments that knowledge integration requires neither a single language or mode of representation (Tabara & Chabay, 2013), nor universal applicability as a criteria (Fischer, 2000) (see also conceptual positioning).

3.1.2 Contextualising knowledge and action from diverse perspectives

The current sub-chapter elaborates on concepts that structure analysis into how different types of knowledge relate to transactional, organisational, and macro contexts.

The conceptual positioning chapter has pointed out that the concept of context in transformative sustainability research is as crucial as it is vague (see 2.1.3.2). The present thesis adopts a broad understanding of context, and argues that a differentiated consideration of multiple contexts may enhance analytical breadth and depth. Contexts connect social interaction to "much broader properties of the institutionalisation of social life" (Giddens, 1984). Social context can be understood as meaning frames and interpretive patterns that are part of the "lifeworld" of individuals and offer resources for knowledge, action, and communication, thereby facilitating cultural continuity, social integration and solidarity, and the socialisation of future generations (Habermas, 1983)[43]. Social scientists tend to focus primarily on social and cultural contexts, which reflects an understanding of context that focuses on institutional settings as shaping – and being shaped by - actions (Ezzy, 1998; Giddens, 1984; Somers, 1994). Arguing for an expanded understanding of context, the present thesis adds not only material factors relating to immediate (i.e. transactional) settings, but also considers the wider "context of implication" of actions. Nowotny et al. (2001) elaborate on the need for a twin "contextualisation" of *science* (see conceptual positioning 2.1.3.2). The current thesis builds on their definition. Considering the "context of implication" means to move beyond the "context of application" to set one´s "anticipatory vision" to the entanglements of social and material consequences and impacts that own activities may produce:

> *"While nobody can know precisely when and where a particular implication will arise or what will result from it, and while it is virtually impossible to assess its importance, there can (and perhaps ought to) be a forward look, a serious attempt to reflect and anticipate what the context of implication may hold – however much uncertainty may enshroud the effort" (Nowotny et al., 2001).*

Not only does knowledgeability connect actors with "absent influences" *on* and *of* their actions, actors also insert themselves physically in the world (Giddens, 1984). Through actions social and cultural lifeworlds are reproduced as well as material processes of life (Habermas, 1983)[44]. Practices are not only social, they are also material[45]. Few conceptualisations of *context*, however, consider this circumstance. To address this shortcoming, the present thesis understands context as encompassing

[43] "[die] Lebenswelt, die für die Verständigungsprozesse sowohl einen Kontext bildet wie auch Ressourcen bereitstellt. Die Lebenswelt bildet einen Horizont und bietet zugleich einen Vorrat an kulturellen Selbstverständlichkeiten, dem die Kommunikationsteilnehmer bei ihren Interpretationsanstrengungen konsentierte Deutungsmuster entnehmen. Auch die Solidaritäten der über Werte integrierten Gruppen und die Kompetenzen vergesellschafteter Individuen gehören – wie die kulturell eingewöhnten Hintergrundannahmen – zu den Komponenten der Lebenswelt. […] Die Lebenswelt reproduziert sich nämlich in dem Maße, wie diese drei, die Aktorperspektive überschreitenden Funktionen erfüllt werden: die Fortsetzung kultureller Überlieferungen, die Integration von Gruppen über Normen und Werte und die Sozialisation nachwachsender Generationen" (Habermas, 1983).

[44] "Auch die Theorie des kommunikativen Handelns rechnet also damit, dass die symbolische Reproduktion der Lebenswelt intern mit deren materieller Reproduktion zurückgekoppelt ist" (Habermas, 1983).

[45] The current thesis focuses on action rather than practices. The main reason is an underlying assumption that it is through social learning and action that practices can change. For present purposes, practices are defined as ordered performative activities within which "meaning and matter, the social and the technological, are inseparable". As a "mode of ordering" a practice can be regarded as the expression of a particular epistemology (i.e. in relation to a paradigm) as well as as an empirical phenomenon (Gherardi, 2017).

both ´webs of meanings´ and ´webs of causality´. Causality is inherently complex, uncertain, and unpredictable. Nonetheless, unsustainability not only calls for greater attention to physical impacts of human activities, in general, it also confronts actors with the ethical challenge to consider often remote and invisible ecological and social implications of their actions. In other words, sustainability challenges confront human actors with the ethical demand to *expand* the contexts they construct for themselves in and via knowledge and action. For present purposes, context therefore is understood as ´webs of meaning and causality´ that actors associate with particular experiences and situations, *and* that they themselves affect socially and materially by partaking in the world.

Hence, what are relevant contexts needs to be constructed both from the perspective of actors engaging in specific situations (for example, by analysing their narratives) and by considering possible consequences from diverse perspectives, for example, as part of social learning processes (see below). Furthermore, focusing on water and land governance and the role of laws such as the EU Water Framework Directive, the present thesis attributes greater importance to political formal governance contexts than many transformative and social science approaches (outside the political sciences). It reflects a systemic perspective on water and land systems as complex social-ecological systems (discussed below).

The multi-contextual framework developed by the present thesis thus encompasses:

- *Informal factors*: institutions, paradigms, narratives, informal knowledge and information, and interpersonal relations
- *Material factors*: ecosystems, infrastructures and technologies, goods and money, and material relations (e.g. practices)
- *Formal factors*: formal institutions (i.e. legally binding regulation) and information (elaborated below)

These factors come together in different constellations across scales and levels of organisation (see positioning chapter 2.1.3.2, the contexts outlined here come closest to Amel et al., 2017 and Wyborn et al., 2019) (see figure 3.2):

- *Personal contexts*: the personal sphere of meaning-making (König, 2018, Dewey, 1938), narrative identity (Chabay et al., 2019; Ezzy, 1998; Somers, 1994), and mental, bodily and material, and formal personal circumstances (e.g. legal rights) of individual actors (Amel et al., 2017; Dewey, 1938a)
- *Transactional contexts*: “contexts of co-presence” (Giddens, 1984) composed of social and material settings of “relational practices” (Bouwen & Taillieu, 2004; Pahl-Wostl, 2015) that encompass direct face-to-face interaction and material engagement (Blumer, 1986; Dewey, 1938a; Kolb, 2015; König, 2018; McGinnis, 1999; Singleton, 2015; Van Poeck et al., 2018; Wyborn et al., 2019)
- *Organisational contexts*: informal, formal and material environments of formal organisations, informal communities (e.g. local, professional), and social networks, and their collective narrative identities (Amel et al., 2017; Argyris & Schön, 1996; Bouwen & Taillieu, 2004; Chabay et al., 2019; Folke et al., 2005; Huitema & Meijerink, 2017; Knorr Cetina, 1991; Medema et al., 2008; Sol et al., 2013; Somers, 1994; Tsoukas, 2005; Wenger, 1998; Wyborn et al., 2019)
- *Macro contexts*: informal social and cultural spheres of society (including societal imaginaries and narratives), formal governance sphere, material biosphere, economic sphere, technosphere, including infrastructures (Amel et al., 2017; Dyball & Newell, 2015; Ezrahi, 2006; Giddens, 1984; Jasanoff, 2006; König, 2018; Pahl-Wostl & Knieper, 2014; Steffen et al., 2015; Wyborn et al., 2019)

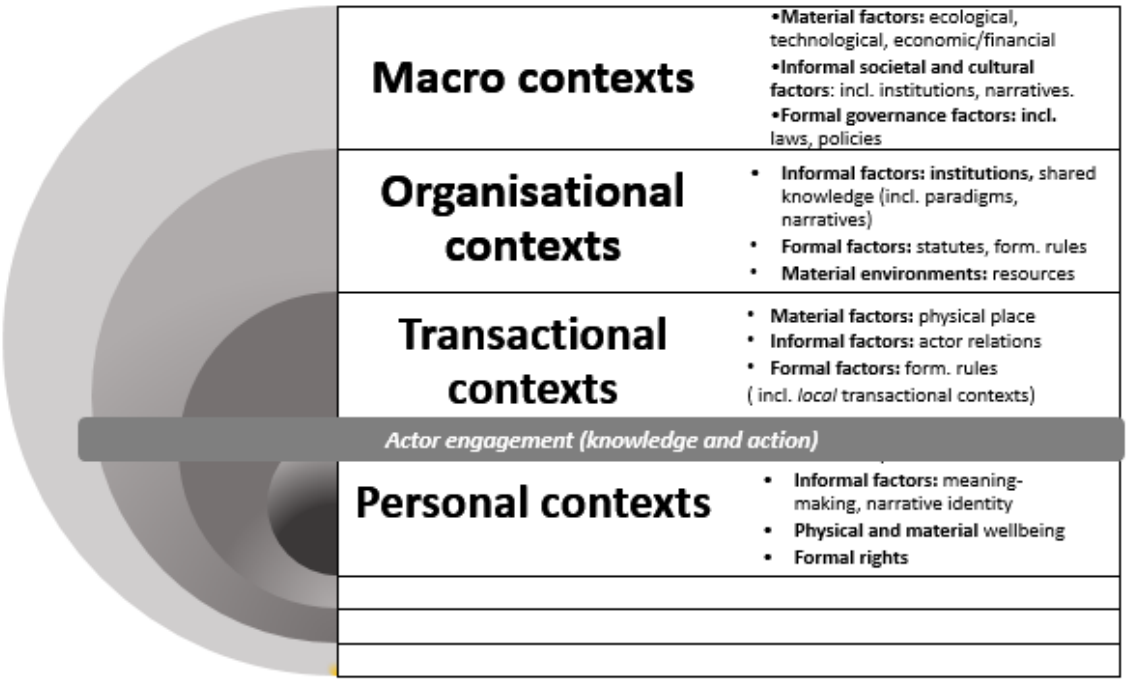

Figure 3.2 – Scheme that embeds actor engagement in multiple contexts (incl. related informal, formal, and material factors)

Although represented as ´nested system´, the multi-contextual framework does not presuppose a hierarchy of spatial scales or social levels. Instead, it is a hybrid scheme that opens the possibility to bring scalar and non-scalar (or "networked") perspectives together via criss-crossing interconnections. Thus, transactional and organisational contexts can be attributed to – and across – levels of social organisation and spatial scales, from local to global. Formal macro contexts can, for example, be national and EU-European, material flows global. The demarcation of relevant contexts needs to be based on research purposes, perspectives of actors and, furthermore, on the possible effects they produce.

Indeed, contexts do not only influence ways of engagement, but are themselves changed via actions that may be guided by particular narratives (Chabay et al., 2019; Ezzy, 1998). This is the performative dimension of narratives. In contrast to scholars who distinguish between concentric "spheres of influence" of individual actors (Amel et al., 2017; Drenth et al., 2018; Medema et al., 2014; Wals & Schwarzin, 2012; Wyborn et al., 2019), the present thesis does not *a priori* apply such a hierarchy (see conceptual positioning 2.1.3.2). In fact, one of the main assumptions underlying the inquiry into informal and formal governance processes in Luxembourg (based on the MTF scheme of Pahl-Wostl, outlined below) is that agency and social interaction *can* contribute to transformative changes in governance systems via (multiloop) social learning.

To investigate what factors facilitate or hinder social learning and the emergence of actionable knowledge, the present thesis thus investigates multiple contexts and their interrelations, starting with personal and transactional contexts of actors that provide the main sphere of personal meaning-making and agency. Transactional contexts of concrete situations of relational practices are particularly relevant as all knowledge is regarded as situated and because "[…] any knowledge that is actionable in any way will relate to a particular situation rather than to relationships among abstract concepts"

(Ravetz, 2018). This directs attention to the need to enhance understanding of how meanings and narratives are conjured up in direct social and material engagement.

Furthermore, as possible ´carriers´ of paradigms, organisational contexts are considered particularly relevant. They may strongly influence knowledge and narrative identities of actors, how they engage with each other, and with their material settings. At the same time, organisational contexts emerge from the (self-)organisation of people. Nonetheless, they may be better positioned than individual actors to contribute to transformative changes (Amel et al., 2017). This dimension, however, has remained underexplored in the literature.

Finally, all contexts are embedded in macro contexts of societies and planet Earth, and their informal, material and formal opportunities and constraints. The STS idiom of co-production helps to sharpen the analytical gaze to complex interrelations between these diverse contexts.

3.1.2.1 Personal context: American Pragmatism and interactional understandings

For present purposes, the personal context is understood as encompassing the personal sphere of meaning-making and formal, informal and material circumstances of individual actors. Formal rights (e.g. legal rights to vote and access to justice), socioeconomic circumstances, physical and mental well-being and private circles of family, friends, and neighbours are likely to affect why and how actors engage, for instance, in governance processes (Amel et al., 2017; Scott et al., 2016). Their configurations are elements of the human and learning ecology, in which personal learning is embedded (Dyball & Newell, 2015; Peters & Wals, 2013). The analysis of personal circumstances is not the main concern of the present thesis. Nonetheless, they will be considered as potentially significant, especially as regards nongovernmental actors.

The personal sphere of meaning-making shapes how actors learn, know, and act (König, *unpublished*), i.e. their relations with the social and material world (O'Brien & Sygna, 2013; Wals & Schwarzin, 2012). It encompasses personal factors that shape learning, knowledge and experiences (Van Poeck et al., 2018).

The present thesis takes over the understanding of human actors as purposeful, intentional and reflexive (Giddens, 1984, 2013). Purposes refer to consciously or unconsciously held longer-term ambitions and projects that provide actors with a sense of resolve´ and determination. Intentions refer to more immediate goals of daily and routine practices (see also conceptual positioning 2.3.2.1.). Accordingly, purposeful and intentional acts are those actions by which actors use and produce knowledge to achieve and reflexively monitor specific outcomes. Rather than pursuing single and isolated purposes, different purposes interweave in a dynamic "hierarchy", with priorities depending on particular situations and their contexts (Giddens, 2013).

The conceptualisation of actionable knowledge in the present thesis rests on particular theories of knowledge and action. It uses the American Pragmatism of Dewey as a basis for conceptualising personal knowledge, learning, and narrative identities.[46]

[46] Pragmatism places less emphasis on interrelations between mind and body than certain other theories (e.g. (de la Sienra et al., 2017; Maturana & Varela, 1987). For example, in order to overcome the separation into mind and body prevalent in Western thinking, some scholars differentiate between several layers of the "inner self" that includes bodily processes (composed of the nervous system, the embodied mind, mental states and emotions, and processes of decision-making), and another layer for the "outer self" (physical behaviour and action), regarded as closely interrelated (de la Sienra et al., 2017). However, Dewey´s emphasis on experience,

Personal knowledge and learning: The thesis regards knowledge as resting on experiential and practical ways of knowing (Heron & Reason, 1997, Fazey et al., 2006). In the American Pragmatist tradition, knowledge serves the purpose of making it possible for human beings to navigate well through life. Knowledge is directed towards problem-solving. Consequently, learning needs to relate to problems encountered by individuals, and grow out of and enrich their experience. Experience is the "means and goal of education" (Dewey, 1938). It is source of practical wisdom that provides insight, skills and "enjoyed perception" such as in the "art" of a good carpenter, pilot, or physician (Dewey, 2016).

Knowledge rests on the attempt to grasp meanings of objects and events (Dewey, 1910) to understand "the significance of what we see, hear, and touch" (Dewey, 1938). Meanings are a prerequisite for all knowing (Dewey, 2016). Knowledge is a mode of interaction that emerges in and from action, through which individuals establish experiential relations with other persons and "things" (Dewey, 2016)[47]. Knowledge and learning flow from a combination of "internal conditions" that encompass personal needs, desires, purposes, and capacities, and situation-specific social and physical conditions that shape experiences through *transactional* encounters (Dewey, 1938). Whilst experiences are often dominated by routines, traditions, and "appetites", the objective of education and learning is that individuals "emancipate" themselves from these, and enlarge their experience by expanded "worlds of meaning". It entails being open to and entering an "active union" with the situation at hand, (re-) evaluating consequences of own actions, forming new purposes, and selecting new means of action, based on reflection and observation, experimentation and "playfulness" (Dewey, 1910, 1938). Scientific knowledge and philosophy can contribute to this by rendering ordinary things more significant and "luminous", inviting further contemplation (Dewey, 2016).

Whilst Dewey does not refer explicitly to narratives, his conceptualisation of learning bears some resemblance with narrative stances. According to him, individuals live through series of ongoing experiences, in which the memory of past situations serves as an instrument to *judge* and deal with problems in situations that follow, thereby creating continuity (Dewey, 1938)[48] [49]. Judgement is an appreciative process that involves selecting and eliminating "cues to meaning" from data ("the raw material of reflection"), and to infer means to be employed and their effects. It rests predominantly on unconscious and implicit meanings that are "embodied in the workings of organic life", and closely associated with emotions that form certain dispositions towards their objects, e.g. of sympathy of

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and meaning-making has opened up for neurological investigations into how the "transformation of experience" goes hand-in-hand with changes in the brain (Kolb, 2015).

[47] "Yet if man is within nature, not a little god outside, and is within as a mode of energy inseparably connected with other modes, interaction is the one unescapable trait of every human concern; thinking, even philosophic thinking, is not exempt. […] A world characterized by qualitative histories with their own beginnings, directions and terminations is of necessity a world in which any interaction is intensive change – a world of partialities and particulars. […] Immature and undisciplined mind believes in actions which have their seat and source in a particular and separate being, from which they issue. This is the very belief which the advance of intelligent criticism destroys. The latter transforms the notion of isolated one-sided acts into acknowledged interactions. […] When he perceives clearly and adequately that he is within nature, a part of its interactions, he sees that the line to be drawn is not between action and thought, or action and appreciation, but between blind, slavish, meaningless action and action that is free, significant, directed and responsible. Knowledge, like the growth of a plant and the movement of the earth, is a mode of interaction; but it is a mode that renders other modes luminous, important, valuable, capable of direction, causes being translated into means and effects into consequences" (Dewey, 2016).

[48] Problem-solving, in the Pragmatist tradition, is not to be understood as instrumental, but rather as an attempt to understand and dissolve uncertainty and dissonance.

[49] In their plays and stories, Dewey notes, children organise and create coherence between meanings by blending them into a beginning, middle, and end. Through playfulness, they build up a world of meaning and a store of concepts that become part of an "imaginary world alongside the world of actual things" (Dewey, 1910).

antipathy (Dewey, 2016). The appreciative process is thus intuitive[50], and relies on a "sense" of what is relevant and perplexing that involves both an understanding of the situation derived from previous experience, and the recognition of "blind and opaque spots". Learning and long familiarity with similar situations enhance the ability for good judgement (Dewey, 1910)[51]. However, only some of the meanings surface to consciousness as ideas that can be articulated in language (Dewey, 2016)[52].

The distinction between tacit (or implicit) and explicit knowledge has become widely established in the sustainability literature and beyond, and is also adopted in the present thesis. All knowing rests on tacit knowledge (Tsoukas, 2005, Polanyi, 1966, Dewey, 1910). In this sense, all knowing is *personal* knowing (Polanyi, 1966). Tacit knowledge does not only refer to *meanings*, but – especially since Polanyi famously stated "we know more than we can tell" (Polanyi, 1966) - also to practical skills. *Tacit knowledge* can be understood as personal knowledge that is closely related to personal experience and meaning-making, and encompasses those aspects of knowing that are implicit in situations of perceiving, speaking, thinking, and acting", and cannot be made explicit (Abel, 2008; Fazey et al., 2006). Some of the implicit knowledge can be made explicit, understood as knowledge that "is articulated and unfolded, that is, displayable", be it in verbal, written, numerical, graphical or other forms (Abel, 2008). Explicit knowledge is often propositional.

Personal knowledge thus encompasses both tacit and explicit ways of knowing and doing closely related to narrative identities, fostered by experiences derived from social and material engagement (i.e. action), and undergoing change in ongoing personal learning processes (see figure 3.3).

Personal knowledge manifests itself in the capacity to enter transactional situations through thought and action, and to make and revise judgements on ´reality´, purposes, and means of action that rest both on a feeling for – and experience of - a situation and a recognition of puzzling elements. In sustainability science and contemporary sociology and philosophy of science, the admittance of ignorance (or "nonknowledge" (Böschen & Wehling, 2004)) assumes particular importance.

[50] "Long brooding over conditions, intimate contact associated with keen interest, thorough absorption in a multiplicity of allied experiences, tend to bring about those judgements which we then call intuitive; but they are true judgements because they are based on intelligent selection and estimation, with the solution of a problem as the controlling standard. Possession of this capacity makes the difference between the artist and the intellectual bungler" (Dewey, 1910)

[51] "To be a good judge is to have a sense of the relative indicative or signifying values of the various features of the perplexing situation; to know what to let go as of no account; what to eliminate as irrelevant; what to retain as conducive to outcome; what to emphasize as a clue to the difficulty. This power in ordinary matters we call knack, tact, cleverness; in more important affairs, insight, discernment. In part it is instinctive or inborn; but it also represents the founded outcome of long familiarity with like operations in the past. Possession of this ability to seize what is evidential or significant and to let the rest go is the mark of the expert, the connoisseur, the judge, in any matter" (Dewey, 1910). The "art of judgement" later (1965) became a hallmark of the appreciative system of Sir Geoffrey Vickers, in which appreciative judgements include judgements on "reality", "values" and "instrumental means" (Vickers, 1995). These judgement types form the basis of a "framework to understand purpose in Futures Studies" (Burt & van der Heijden, 2008) that can be directly related systems, normative and transformation knowledge as outlined above in relation to actionable knowledge for sustainability (König, 2018).

[52] In order to distinguish between intuitive and implicit meanings and consciously held and articulated ideas Dewey juxtaposes "acquaintance" (referring to the German "kennen" and French "connaître") with knowledge about or of something (or German "wissen" and French "savoir") that is related to knowledge "as classification" and "definition". Acquaintance is what allows human beings to grasp the significance of, for example, scientific ideas and findings, enriching imagination (Dewey, 1910, 2016). "Knowledge that the earth is round becomes acquaintance when, in some juncture of experience, the meaning comes home to us, as we say, or we get a "realizing sense" of it" (Dewey, 1938).

Furthermore, personal knowledge encompasses different types of knowledge that relate actors in different ways to their environments, many of them community-based. The figure developed (figure 3.3) visualises the two-way relations that interconnect personal knowing, narratives, and transactional engagement with the formal, informal and material factors of the diverse contexts elaborated in the following.

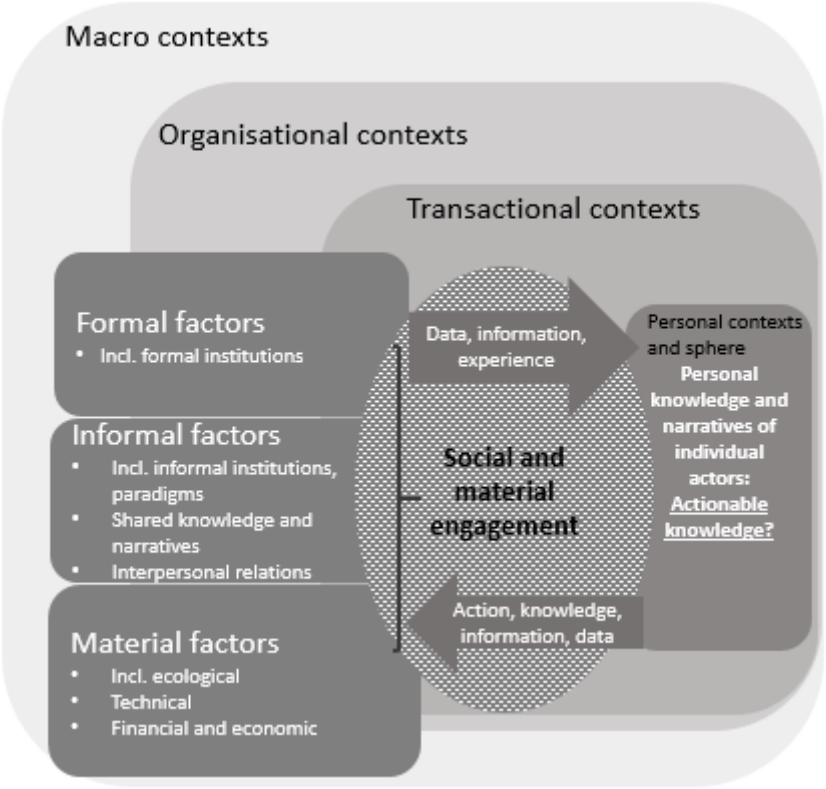

Figure 3.3 - (Actionable) knowledge of individual actors as emerging from situated engagement in diverse contexts

3.1.2.2 Transactional and local contexts: Meanings of place

Knowledge is a way of relating to and of engaging with the world in particular transactional contexts. The term "transactional context" has been chosen to underscore the transactional character of individual human knowledge and action, based on Dewey[53]. It is also used by other scholars (e.g. Drenth et al., 2018). For present purposes, transactional contexts refer to those social and material settings and places (or "locales", Giddens, 1984) that make up the experiential domain of direct actor engagement in micro-situations. "Contexts of co-presence" are the main carrying contexts of

[53] "In a word, we live from birth to death in a world of persons and things which in large measure is what it is because of what has been done and transmitted from previous human activities. When this fact is ignored, experience is treated as if it were something which goes on exclusively inside an individual´s body and mind. It ought not to be necessary to say that experience does not occur in a vacuum. There are sources outside an individual which rive rise to experience. It is constantly fed from these springs" (Dewey, 1938).

interaction and agency[54], in which actors intervene as purposeful corporeal beings in events-in-the-world, locating themselves in space and time (Giddens, 1984, 2013)[55].

Direct social engagement encompasses face-to-face interaction between individual actors. Material engagement denotes bodily actions through which actors engage with physical settings, e.g. via tools and technologies (Malafouris, 2013). They come together in situations and contexts of place-based transactional encounters.

Place denotes a particular locus that combines materiality with symbolic meanings that emerge from actors´ experiences and embeddedness (Amin, 2004; Cresswell, 2004; van Koppen & Bush, 2018). Some scholars associate places and their settings with *local* contexts (or "the local"). For the purposes of the present thesis, however, the term "local" is reserved for those settings, in which actors interact most directly with water and land. It encompasses "intersections among actors and social organisations, human (engineered) infrastructure and technology, and the biophysical environment and natural resources" (Wiek & Larson, 2012). Accordingly, transactional contexts and places can be associated with any level of social organisation (e.g. a governmental meeting room). At the same time, the current thesis focuses on *local* places and spaces (such as river basins) that make up the contexts of local transactional engagement.

Attachment to *local* places assume particular importance in some strands of, in particular, transformative sustainability science. Often inspired by phenomenology, scholars stress, for example, that "to live is to live locally, and to know is first of all to know the place one is in" (Cresswell, 2004). Place is regarded as a context "that frames, organises and anchors experience which is needed to extract meaning and construct knowledge" (Singleton, 2015). Place-based experiential engagement is particularly conducive to re-connecting people with nature (Ives et al., 2018), to sustainability learning, values and behaviour (Amel et al., 2017; Singleton, 2015). It underscores the role of emotional attachments and sociocultural meanings (e.g. embedded in narratives and traditions) through which individuals and local communities relate to the places in which they dwell (van Koppen & Bush, 2018).

However, in the understanding of the present thesis and as outlined above, transactional engagement and place attachment cannot be understood without reference to cultures, social organisation, and practices. How actors engage with their environments and their experiences, depend on how they construct the contexts of their interaction through their knowledgeability of "absent influences", such as institutions, that provide actors with interpretive schemes influencing the purposes they pursue, the meanings they ascribe to their social and physical environments, the judgements they make, and the actions they take (Giddens, 1984). Therefore, transactional engagement will be analysed in relation to not only the personal sphere, but particularly to local and professional organisational contexts and to wider macro contexts.

[54] This statement does not consider the growing importance of digital communication. Indeed, transactional contexts could also be taken to refer to virtual environments. These, however, are not treated in the present thesis.

[55] "I shall define action or agency as the stream of actual or contemplated causal interventions of corporeal beings in the ongoing process of events-in-the-world. The notion of agency connects directly with the concept of Praxis, and when speaking of regularized types of action I shall talk of human practices, as an ongoing series of practical activities. It is analytical to the concept of agency: 1) that a person ´could have acted otherwise´ and 2) that the world as constituted by a stream of events-in-process independent of the agent does not hold a predetermined future". (Giddens, 2013)

3.1.2.3 Organisational contexts: Organisational learning, STS, and adaptive governance

Formal and informal institutions of specific groups and communities structure transactional contexts and engagement through the knowledgeability of actors relying on interpretation (Giddens, 1984). Organisations provide settings for transactional engagement.

One of the main challenges in moving towards sustainability is that it requires close cooperation and coordination among actors and practitioners who belong to different organisations, in which they share different knowledge and related narratives, paradigms and institutions (Bouwen & Taillieu, 2004; Ingram, 2018; Pahl-Wostl, 2015). For the purposes of the present thesis, organisational contexts encompass social and material environments of formal organisations, informal communities, and social networks. Organisations may be local, regional, national or global, or a cross-scale mixture. Actors may belong to several – and overlapping – organisations. Depending on the situation and affiliations of participants, transactional contexts may thus be influenced by *several* organisational contexts (both formal and informal) that can be attributed to different spatial scales and levels of social organisation.

Definition of organisations: The broad understanding of organisations adopted for present purposes is based mainly on Argyris and Schön (1996) and Tsoukas (2005) who build on American Pragmatism. It is complemented by the concept of epistemic communities (Knorr Cetina, 2007). An organisation is understood as any collectivity that provides actors with "organised contexts" (Tsoukas, 2005), "behavioural settings" and "action frames" structured by institutions (Argyris & Schön, 1996) that have grown historically and are engrained in organisational narratives (Tsoukas, 2005). Organisational contexts are based on common implicit and/or explicit rules that pertain to action strategies, task distribution and membership (including roles), and to common resources (Argyris & Schön, 1996). Rules and roles connect certain types of behaviour to certain types of situations, thereby influencing how individuals think, and, and learn, and creating and sustaining behavioural routines and patterns (Argyris & Schön, 1996; Tsoukas, 2005). Organisations are more than the sum total of its individual members; at the same time, they rest on individual actors and action (Argyris & Schön, 1996, pp. XXII, 7, 12). Furthermore, organisations are considered "epistemic communities" if the creation and use of knowledge among members is guided and warranted by collectively held *paradigms* engrained in organisational epistemic cultures and practices (see also conceptual positioning 2.1.1.1) (Knorr Cetina, 2007).

What distinguishes a formal organisation from an informal one is that some of its rules and roles are explicit and formally institutionalised (e.g. in organisational statutes or rules of procedure), and that it has a legal personality or status that is anchored in a given country´s legal system (Argyris & Schön). Examples covered here are formal organisations professionally engaged in water and land governance and management, including river basin organisations (perhaps receiving the most widespread attention in the adaptive governance and management literature), public ministries and administrations, a nature park and water associations, and environmental organisations.

Unless specified otherwise, *local* communities and *professional* communities (e.g. of farmers) in river basins in Luxembourg, will predominantly be treated as providing *informal* organisational contexts, although they may also dispose of legal structures (e.g. municipal or occupation-based) that ascribe certain formal rights, obligations, and roles to them. This approach both reflects and seeks to nuance dominant perspectives in the literature that tend to focus on the informal character of local and professional communities.

In line with the understanding of local contexts outlined above, local communities are defined as composed of inhabitants of local places (e.g. villages) who share predominantly informal institutions, but who may also be organised in formal structures such as municipalities. Local communities provide contexts for local knowledge. [56]

Professional communities are defined as informal and formal organisations that are centred on a specific occupation that is based on an underlying discipline and applied science or ´engineering´ component, and on specific practices that members of the community have acquired through dedicated education and training paths, and through professional experience (elaborated based on Argyris & Schön, 1996). They provide contexts for professional knowledge, both scientific or non-scientific.

Organisational knowledge and narratives: Organisations provide contexts for community-based knowledge and learning. The present thesis elaborates on organisational, professional, and local types of knowledge. Professional and local knowledge are regarded as sub-categories of organisational knowledge. As discussed in the conceptual positioning chapter, local or experiential and practical or practice-based types of knowledge are often subsumed under one category (e.g. as informal knowledge) and juxtaposed with scientific knowledge (formal knowledge). In order to allow for a more differentiated analysis, the present thesis, in contrast, makes a distinction between local and professional knowledge, and, furthermore, treats scientific knowledge as a sub-type of organisational and professional knowledge. In line with constructivist and interactional stances on knowledge, all community-based knowledge types are regarded as experiential, situated, and practice-based.

Organisational knowledge can be defined as knowledge that emerges from learning processes that go beyond individuals and become embedded in organisational contexts in the form of shared purposes and values, problem framings, perceptions of organisational environments, rules, action strategies and means that members interpret and enact in specific situations (Argyris & Schön, 1996, Tsoukas, 2005)[57]. They flow from shared institutions, narratives, and sometimes collectively held paradigms. Organisational institutions, values and strategies are mediated through communication and information systems that can include physical objects such as organisational charts and workflows, records, technologies, and tools, etc. that serve members as organisational "memories", resources and references (Argyris & Schön, 1996). In the terminology of Argyris and Schön, these elements taken together shape an organisations´ belief and value systems – or implicit "action frames" (or "theory-in-use") - that members reproduce in daily interaction. Furthermore, organisations offer concrete settings within which individual members´ actions take place (Tsoukas, 2005).

Or, put yet differently, organisational contexts are "embedding environments" for epistemic cultures and micropractices through which members enact particular social and cultural meaning structures (including paradigms), create and warrant knowledge (Knorr Cetina, 2007).

Argyris and Schön have coined the concept of single and double loop learning (see conceptual positioning 2.2.2). Single-loop learning denotes instrumental learning that seeks to improve organisational performance by correcting errors and revising means of action. It is associated with hierarchical and control-oriented organisational strategies, in which issues are considered a matter of ´winning or losing´ and of "face-saving" (or "model I theory-in-use") (1996). In double-loop learning purposes, values, beliefs and assumptions are revised through a process of organisational inquiry that

[56] The present thesis does not deal with indigenous communities. They would, however, be considered a sub-category of local communities.

[57] This definition is congruent with the understanding of social learning elaborated in the positioning chapter and further below.

encourages individual freedom so that participants "can be origins of actions and experience high personal causation", the articulation of doubts and risk-taking (or "model II theory-in-use"). Although Argyris and Schön (1996) do not use these terms, double loop organisational learning encompasses aspects that can be related directly to the normative, systems, and transformation dimensions of actionable knowledge for sustainability, related narratives, and paradigms outlined above:

- *Normative dimension*: re-interpretation of role frames, values and "performance criteria", entailing a reinterpretation of "past experiences of success or failure", of internal conflicting views and interests "under conditions of complexity and uncertainty", and of "images of desirable futures",
- *Systems dimension*: new perceptions/descriptions of the organisational environment (including other organisations), including of causal connections between organisational actions, outcomes and future implications and demands
- *Transformation dimension*: re-interpretation of potentials and limits of (tacit and espoused) action strategies and means, and of organisational information and incentive systems in achieving desirable futures.

For present purposes, organisational knowledge is analysed along these dimensions. Furthermore, central to the present thesis is the understanding of organisations as historical communities that share certain narratives (Tsoukas, 2005). Organisational narratives are expressions of historically evolved collective understandings of, in particular, purposes and methods pursued by organisations. Members acquire narrative knowledge with years of (professional) experience, enhancing their sense of identity and belonging to the organisation. In informing decisions, judgements and actions in practice, narratives could be considered more important than rules for the functioning of organisations[58]. Unlike rules and propositional knowledge, narratives can guide actions when faced with novel situations and problems:

> *"To participate in a practice is to share in the narratives that a community of practitioners employs. [Narratives] are constructed around memorable episodes derived from participating in a practice. Unlike propositional statements, narratives are contingently linked to individual action, thus facilitating individual adaptation to a large number of unforeseeable circumstances. Furthermore, narration facilitates social interaction, preserves a community´s collective memory, enhances a group´s sense of shared identity as participants in a practice, and serves as a repository of tacit organisational knowledge" (Tsoukas, 2005).*

Treated as sub-categories of organisational knowledge, the above is also applied to professional and local knowledge.

Building on the above, and for present purposes, organisational knowledge will encompass tacit and explicit understandings and skills shared in formal and informal organisations. It may find expression in – and be interpreted from – explicit reference documents and physical objects. Organisational knowledge is considered as closely interlinked with specific paradigms and narratives that have emerged historically.

[58] "Rules on their own are imperfect coordinating devices; how they will be interpreted and applied in particular situations will always be uncertain. Therefore, rules need to be supplemented by narratives containing the collective memory of a social system and enabling it to cope with novel problems. Narrative knowledge is an indispensable input to effective action, because organised contexts, in addition to being institutions, are also practices. As practices, organised contexts are communal traditions having their own standards of excellence as well as their own internal goods which only participants can judge and achieve" (Tsoukas, 2005)

Non-scientific and scientific professional knowledge: The conceptualisation of non-scientific professional knowledge builds primarily on Schön and Ellett who partly base themselves on Dewey. For present purposes, professional knowledge concerns occupation-based understandings and skills used in professional life. Through their professional knowledge practitioners pursue specific purposes, have particular perspectives on relevant causal interconnections, and on means to be deployed. They rest on a professional ´ethos´ and typically on particular scientifically-informed understandings (e.g. an underlying discipline) that are developed through a combination of formal education and training, practical experience, and warranted by specific institutions. The purposes rest on a "raison d´etre" that professional communities ascribe to the services they provide to society. In addition to professional standards, it also includes aesthetic standards for what they consider a ´job well done´ (Ellett, 2012). Through practice, some professionals develop a practical form of wisdom (*phronesis*) that can be understood as an affective disposition (or virtue) and capacity to perform tasks well and to make ´wise´ judgements in specific situations as how best to carry them out (Ellett, 2012). Being a "good professional" may be an important element of the professionals "self-identity and self-esteem" (Ellett, 2012).

Similarly and building on Dewey, Schön uses the term "epistemology of practice" to describe how practitioners develop a (implicit) "knowing-in-action" that manifests itself in a certain way of "*seeing a*s and *doing as*" (Schön, 1983). As professional experience grows, they increasingly tacitly and automatically apply a stable repertoire of expectations, images, and techniques to situations they intuitively regard as similar. Some professionals thus develop an "artistry" in daily practice that cannot be taught, but only learned through experience (Schön, 1983). On the other hand, as routines take hold, practitioners will tend to reflect less on ends, problem framings, roles and strategies, and develop a cumulative repertoire of how to carry out the profession, even more so if the organisational context in which they are embedded remains stable. In this case, the practitioner increasingly erects a boundary between himself and the situation (ibid.). Practitioners may, however, begin again to "reflect-in-action", when recognising conflicting or inconsistent ends and unclear situations, often triggered by feelings of dissonance or surprise that result from a more intense *transactional* relation with the situation at hand, in which they suspend underlying assumptions and automatic routines. In this case (and very similar to organisational double loop learning), the practitioner may – partly intuitively and partly consciously – revise problem framings, tacit norms and appreciations that underlie action strategies and judgements, reconsider "facts", and "the role he has constructed for himself in the larger institutional context" (Schön, 1983). Double loop learning may thus imply the revision of the very ´raison d´etre´ of the profession, related aesthetic standards, and identity.

Schön notes an increasing tendency in the professions towards specialisation and applying instrumental and technology-driven problem-solving indiscriminately to situations, without giving particularities and professional contributions to "social well-being" sufficient thought. Similarly, Knorr Cetina diagnoses a growing "professionalization" of organisations and professions outside academia that require – and themselves produce – growing quantities of ´expert´ information (Garcia-Sancho & Knorr Cetina, 2018; Knorr Cetina, 2007).

The above can also be applied to scientific communities and knowledge that is becoming increasingly prevalent in modern knowledge societies. Based on empirical and ethnographic lab studies and contrary to assumptions about formalised contextless scientific procedures, Knorr Cetina found that scientific epistemic cultures and practices, as manifested in framing strategies and methods, are highly contextual, being influenced by personal, organisational, and societal contexts. Researchers are guided by an intuitive sense of what constitutes a "successful procedure" that is also engrained in "narrative

cultures"[59]. Their practices are interwoven with material devices and objects in self-referential cognitive circuits that can become part of their identities (Knorr Cetina, 1991, referring to Maturana and Varela, 1987). Moreover, scientific knowledge production may be influenced by utility and trade-off considerations regarding "money, time, competitiveness, manageability, and other ´non-scientific´ - yet necessary – goods" (Knorr Cetina, 1991). Apart from casting doubt on positivist conceptualisations of science, these exemplary aspects underscore that scientific knowledge production and communities can be analysed in a similar fashion as non-scientific professional ones[60].

Important differences between scientific and non-scientific professional knowledge, however, are that scientific knowledge, indeed, is typically produced along more formalised processes and sets of rules warranted by scientific communities, that findings are articulated in explicit, propositional, and written forms as a general rule, and that science aims for objectivity and general validity and applicability (Fazey et al., 2006; Raymond et al., 2010).

However, because the present thesis understands knowledge as resting on personal meaning-making and interpretations, scientific knowledge will generally be referred to as "formal scientific expertise or information" rather than as knowledge *per se.* This also applies to "knowledge" formally institutionalised in ´expert systems´ of formal governance and organisations (see below).

Local knowledge: Local knowledge is extensively studied in adaptive governance and co-management approaches, including bioregionalism (see conceptual positioning 2.2.1.3 and paradigms 4.3). Local knowledge is here used as a generic category that includes indigenous and traditional knowledge (Folke et al., 2005; Reid et al., 2006). It has been preferred to other terms, because "local knowledge" makes a direct link to "local contexts", as defined above[61]. Local knowledge is understood as encompassing mainly tacit and unwritten understandings of local environments held by a specific group of people and used in everyday life (Berkes & Folke, 2002; Fabricius et al., 2006; Fazey et al., 2006; Raymond et al., 2010; Reid et al., 2006). It is embedded in local customs, traditions, and memories that are often carried over from one generation to the next, and conveyed through « oral history" (or, we might say, narratives) (Fabricius et al., 2006). It has been most extensively studied in relation to indigenous communities, where local knowledge often serves to help people cope with day-to-day-challenges, e.g. to secure food and water, and to protect themselves against environmental hazard (Fabricius et al., 2006).

Local knowledge also creates a bond between local communities and their environments through emotional "place attachment" (Cresswell, 2004) or "sense of place" (Amin, 2004). Some scholars seek to reinvigorate this bond, as a way to foster a sense of identity and belonging, to re-connect people with their social and material environments, and to support sustainable community development (Amel et al., 2017; Goldstein, 1999; Hahn et al., 2006; Ives et al., 2018; McGinnis, 1999; Singleton, 2015) (see also chapter 4.4.2). For example, narratives can help to counteract alienation, strengthen collective memory and identities, and foster new local visions that inspire people to take action (Chabay, 2020; Chabay et al., 2019).

[59] Knorr Cetina, however, does not elaborate further on "narrative culture".

[60] Indeed, scholars have used Schön´s work *The Reflective Practitioner* (1983) to reflect critically on their own professional practices and social and ethical roles as scientists (Brown et al., 2005).

[61] Scholars on bioregionalism use various terms to describe local knowledge, among them: "(communal) place-(based) knowledge", "(local) community knowledge", "situated knowledge" and "contextual knowledge" (in McGinnis, 1999). "Place-based", "contextual" or "situated" knowledge have not been chosen, because all knowledge – albeit in varying degrees – is considered situated and place-based. For the same reason, "experiential knowledge" (Raymond et al., 2010; Weber et al., 2014) has not been considered suitable for present purposes.

As regards systems knowledge, scholars emphasise the importance of environmental or ecological knowledge of local ecosystems that has played a significant role in, especially, traditional resource management (Brosius, 2006; Folke et al., 2005). Ecological knowledge denotes the understanding of ecosystems and related uncertainties, and rests on the "ability to observe and interpret essential processes and variables in ecosystem dynamics", based on experience and learning-by-doing (Hahn et al., 2006, Folke et al., 2005). It is sometimes extended to knowledge of social-ecological systems dynamics (Berkes, 2009). Such knowledge is often engrained in social memory and narratives (Folke et al., 2005; Hahn et al., 2006):

> *"A collective memory of experiences with resource and ecosystem management provides context for social responses and helps the social-ecological system prepare for change. […] ´Social memory´ has been defined as the arena in which captured experience with change and successful adaptations, embedded in a deeper level of values, is actualised through community debate and decision-making processes into appropriate strategies for dealing with ongoing change. Social memory is important for linking past experiences with present and future policies" (Folke et al., 2005)*

Local knowledge thus provides a source of information about the history of ecosystem patterns and land use, traditional customs, and the history of e.g. local politics (Fabricius et al., 2006).

While many inquiries into local knowledge focus on the ´restoration´ of local memories, identities, landscapes, and practices, some scholars add a perspective that expands local knowledge and place attachment to include interconnections with larger (macro) contexts (Thomashow, 1999), and scientific knowledge (Goldstein, 1999). The above points are further discussed in relation to water and land governance paradigms below (see part 4).

3.1.2.4 Macro contexts: STS on co-production, imaginaries, and narratives

For present purposes, macro contexts are defined as composed of informal social and cultural spheres of society (including societal informal institutions, paradigms, and narratives), the formal governance sphere (based on formal regulation and legal frameworks), and the material spheres of the biosphere, technosphere (e.g. infrastructures), and economic and financial sphere. Macro contexts thus encompass both underlying structures and material stocks and flows of social-ecological systems. This understanding corresponds closely to an STS perspective that considers culture, formal governance, and technical infrastructures together (without making distinctions of levels). It is also close to a conceptualisation of natural resource governance systems that centres on actors, analysing their activities at the interfaces of social, natural, and built environments (Pahl-Wostl, 2015; Wiek & Larson, 2012, see chapter 3.2.1).

At the same time, it differs from others. For example, many scholars attribute societal culture and institutions to a sphere or level that is ´above´, ´deeper´ or more extensive than formal governance (Amel et al., 2017; Geels, 2005; Wyborn et al., 2019). Some of them include organisations at the same "meso" (or "regime") level than governance and management systems, which reflects an understanding of governance as encompassing both formal and informal institutions and actors (Geels, 2005). Others again distinguish between the ´invisible´ sphere of institutions of economic, political, social and cultural systems, and the sphere of observable and measurable phenomena (Meadows, 1999; O'Brien & Sygna, 2013). Finally, some schemes consider material aspects mainly as outcomes of actor interventions (Amel et al., 2017; Wyborn et al., 2019).

The main reasons for the current approach is that it adopts an actor-centred and systems perspective that focuses on *contexts* of actor engagement, and the assumption that it is appropriate to consider social and material factors as coupled rather than as separate. Concepts from Science & Technology Studies serve to investigate how agency and structure, social and material systems co-produce each other. They will be used to investigate interrelations between formal governance, modern science and ´expert´ knowledge, infrastructures, institutions and collective and personal narratives, and how they may have co-evolved together with modern-industrial paradigms and sociotechnical imaginaries.

Co-production: The STS perspective dissolves binary conceptions of human agency and structure, and of society and nature, investigating their constructed character, and how material, social, cognitive and normative aspects of human life have co-evolved historically (Jasanoff, 2006, 2015).

A core STS concept, the idiom of co-production provides an interpretive framework to analyse how structures of authority in society and governance, material environments, cultures and institutions, practices, cognition, and identities mutually stabilise and transform ("co-produce") each other across micro- and macro-scales (Jasanoff, 2006). Of particular interest to the present research are the interlinkages that STS scholars establish between political and social orders, on the one hand, and epistemic cultures and practices, on the other. (Jasanoff, 2006) A central argument is that policy-making and the institutionalisation of certain ways of knowing, forms of knowledge and expertise in society have mutually sustained each other (Ezrahi, 2006; Jasanoff, 2006). Modern state-making and democracies have relied strongly on scientific knowledge (and vice versa) that has become *the* measure of credibility and validity in contemporary knowledge societies and sociotechnical cultures, effectively side-lining other knowledge claims (Jasanoff, 2006, 2007; Knorr Cetina, 2007).

This has deeply influenced epistemic cultures and practices of not only scientific communities, but also of non-scientific organisational contexts, and of society as a whole (Jasanoff, 2007; Knorr Cetina, 1991). Furthermore, modern science and policy-making together have put into place large-scale infrastructures that, in their turn, have also contributed to stabilising current orders, particular epistemic cultures, and identities, by depending on particular communities and institutions for their maintenance (Jasanoff & Kim, 2015). STS thus investigates interplays between social arrangements and technologies. Conversely, the transformation of governance and institutions (including related power relations), epistemic cultures and practices of society as well as of scientific and other communities, and of technologies are interdependent. Increased participation in formal governance that engages citizens as active and imaginative agents and increases accountability and transparency, coupled with normative discussions about "social problems", are proposed as one possible way forward (Jasanoff, 2005). In terms of the understanding of social-ecological system dynamics, the STS perspective thus adds a focus that puts interlinkages between governance and science, technologies, institutions, practices, and identities to the fore.

The STS perspective underscores the need to regard sustainability transformations in water and land governance and management as part of wider transformative change. Furthermore, considering the growing significance of technologies, it provides substantial arguments in favour of devoting more attention to *technologies* in human-environment relations: "the more we are aware of and embrace the culture-technology-environment connection in our knowledge co-creation processes, the more successfully we will be able to transform prevailing ways of thinking and doing to make them sustainable" (König, 2018).

Imaginaries and narratives: One possible way in which governance, culture, technologies, and collective and individual identities mutually reinforce or transform each other are through imaginaries. Imaginaries denote "collectively held, institutionally stabilized, and publicly performed visions of

desirable futures, animated by shared understandings of forms of social life and social order" (Jasanoff & Kim, 2015). Closely related – and sometimes elements of – narratives, imaginaries connect systems of meanings and metaphors originating in human imagination with politics, public opinion, and action. Imaginaries have often been used in state-making and politics to drive advances in science and technology rooted in positive visions of social progress, whether related to nuclear energy, space missions, transport, biomedicine, or other (Jasanoff & Kim, 2009, 2015).

The functions and effects of such "sociotechnical imaginaries" are manifold. Firstly, in politics imaginaries have been used instrumentally to legitimise and gain public support for large-scale projects that have been all but purely technological, having entailed social re-arrangements, institutional changes, and the privileging of scientific knowledge over ´lay´ knowledge held by citizens. Imaginaries have contributed to framing policy debates and arguments, and to prioritising "public action", (Jasanoff & Kim, 2009). When formally institutionalised (e.g. in legal and expert systems), imaginaries become particularly powerful and durable by shaping administrative routines and financing instruments that, for instance, direct funds into durable infrastructures and technologies.

Secondly, imaginaries provide society with "common narratives of who they are, where they have come from, and where they are headed". (Jasanoff, 2015). By producing (tacit) systems of meanings they enable – and are expressions of – shared normative perceptions of social reality and futures, of what is good and evil that can unite society and particular social communities, create continuity, strengthen collective and individual identities, and a sense of belonging. (Jasanoff & Kim, 2009) At the same time, and in contrast to "grand narratives", they are less rooted in memories of the past, and more future-oriented (Jasanoff, 2015).

Finally, as narratives, imaginaries have a performative dimension that shapes action and practices through tacit rules and "performative scripts" on how to do things and what to strive for, and are materialised in technologies and material landscapes that make otherwise invisible imaginaries tangible (Jasanoff, 2015). Through action and technologies, humans contribute to shaping the world how they imagine it *is* and *should be*. Sociotechnical imaginaries, thereby (and similar to paradigms and narratives), bind human agency and identity together with "assemblages of materiality, meaning, and morality" that play out across micro-and macro-epistemic levels, contributing to institutionalised ways of framing and tackling challenges (Jasanoff, 2015).

3.1.3 Definition of key terms

The below outlines working definitions elaborated for the purposes of the present thesis. They are based on the previous conceptual chapters.

Sustainability is a normative concept that concerns human-environment and human-human interaction. It is defined as an emergent property of dynamic processes of mutual adaptation and transformation in human-environment relations that strengthen ecological and social regeneration capacities and involve interplays between human agency and institutions, self-organisation and emergence in complex social-ecological systems (elaborated from Grunwald, 2016; König, 2018; Pahl-Wostl, 2015; Robinson et al., 2013)

Agency: Through agency, human beings insert themselves causally and purposefully into the world, entering into transactional relations with others and material settings. The capacities to reflect on action and to "act otherwise" are characteristics of human agency (elaborated from Giddens, 2013; Dewey, 1983).

Context: webs of meanings and causality that actors associate with particular experiences and situations *and* that they themselves affect socially and materially by partaking in the world (elaborated from Giddens, 1984; Habermas, 1983; Nowotny et al., 2001).

The thesis makes a distinction between diverse contexts, each composed of diverse informal, formal, and material factors:

- *Personal contexts*: sphere of meaning-making and personal circumstances,
- *Transactional contexts*: "contexts of co-presence" (Giddens, 1984) that encompass face-to-face interaction and direct material engagement through which the actor and the social and material setting mutually shape each other (Dewey, 1938, e.g. in *local* contexts actors interact directly with e.g. water and land, Wiek & Larson, 2012),
- *Organisational contexts*: environments of formal organisations, professional and local communities, and social networks (see below),
- *Macro contexts*: social and cultural spheres (incl. formal governance), and material spheres (incl. bio- and techno-spheres).

Organisations: A formal or informal collectivity that shares sets of institutions (e.g. rules) and practices that provide members with meaning- and action frames, resources, and tools that shape how members understand and address challenges (Argyris & Schön, 1996). Meaning- and action-frames may be engrained in shared narratives (Tsoukas, 2005). Organisations are more than the sum total of individual members, but depend on individual actors who themselves shape organisations (Argyris & Schön, 1996). *Local* and *professional communities* are examples of organisations (often informal).

Narratives: Narratives are stories organised along a plot that evokes particular meanings by interconnecting different events, places, characters, and ´objects´. The plot rests on an organising theme that situates events and characters in space and time and weaves them into causally related dramatic moments, turning points and, typically, a resolution that conveys a specific moral at the end (elaborated from Chabay et al., 2019; Elliott, 2005; Ezzy, 1998; Jones & McBeth, 2010; Ricoeur, 1981; Somers, 1994). They may be personal or shared. Narratives can cast light on shared paradigms.

Narrative identities: The concept posits that individuals act on the basis of their sense of who they are. Narratives create continuity and fluidity in individual´s sense of self by building plots between past and future that are constantly reconfigured in the light of the present (elaborated from Ezzy, 1998; Somers, 1994). Narrative identities are constituted in relation to multiple communities (i.e. organisations, see above) and contexts (based on Wenger, 2010).

Affective narrative expressions: characteristic elements of narratives that hold strong emotional communicative power and can be communicated via verbal or visual representations (from Chabay, 2020; Chabay et al., 2019), including metaphors and imaginaries.

Epistemic communities: Epistemic communities are organisations held together by a shared paradigm that is engrained in epistemic cultures that denote sets of practices, institutional and material arrangements through which knowledge is created and warranted (Knorr Cetina, 1991, 2007).

Paradigms are meaning- and action frames that rest upon relatively coherent sets of axiological, ontological, and epistemological assumptions that shape purposes that actors pursue, how they understand, frame, and delineate systems and challenges, and action strategies they adopt. Paradigms can be formally institutionalised in regulation, organisational statutes, and professional standards. Paradigms are materialised in practices, objects, and material environments (elaborated from Denzin & Lincoln, 2011; Knorr Cetina, 1991; Lincoln & Guba, 2013; Pahl-Wostl et al., 2011)

Knowledge encompasses understandings and skills that rest on tacit personal meaning-making and are derived through transactional engagement in specific contexts. Some knowledge may be collectively shared and be made explicit by being articulated (elaborated from Abel, 2008; Dewey, 1910; Polanyi, 1966). Knowledge is shaped by narratives and collective assumptions (i.e. paradigms, see above). The thesis distinguishes between the following overlapping community-based knowledge types:

- *Local knowledge:* skills and understandings relating to local phenomena that flow from engagement in social and material local contexts,
- *Professional knowledge*: occupation-based skills and understandings that may be institutionalised in particular professional communities (with *scientific knowledge* as a sub-type that is warranted by scientific communities)
- *Organisational knowledge*: skills and understandings relating to the functioning of organisations (e.g. internal decision-making procedures, task distributions, and roles).

Actionable knowledge for sustainability: Knowledge that both resonates with and challenges institutionalised ways of knowing and doing and enhances collective capacities to address sustainability challenges in a context-specific manner. It inspires actors to explore new modes of social and material engagement to enhance ecological and/or social regeneration and to potentially contribute to wider transformative change in human-environment interaction. It can be analysed in relation to normative (why), systems (what), and transformation (how) dimensions. It may emerge from (double loop) social learning.

Social learning entails changes in social relations, knowledge, and action that enhance collective capacities for action, while taking into account complexity, uncertainty, and ambiguity.

Social sustainability learning: a kind of social learning that enhances the awareness of actors of harmful consequences of their actions and ecological deterioration, and fosters agency to adapt and transform own practices and institutions in a manner that aims to support ecological and social regeneration capacities (elaborated from Tabara & Pahl-Wostl, 2007).

3.2 Transformative change in water and land governance

The current thesis inquires into how actionable knowledge for sustainability can emerge and contribute to paradigm shifts in water and land systems. This conceptual chapter relates actionable knowledge to social learning and transformative change in water and land governance. It provides the main concepts to analyse the two research questions:

- *How has the EU Water Framework Directive changed water and land governance in Luxembourg?*
- *What factors facilitate or hinder the emergence of social learning and actionable knowledge for sustainability?*

It draws on the concept of multiloop social learning developed by Claudia Pahl-Wostl and associated researchers as part of the Management and Transition Framework (MTF). The MTF is tailored to the analysis of how multiple factors may facilitate or hinder the emergence of social learning in interplays between informal and formal water governance processes, such as in relation to the EU Water Framework Directive (WFD). MTF provides both analytical concepts and methods that are closely interrelated. Although difficult to tease apart, the following focuses on conceptual and analytical MTF

elements, whilst the methods part elaborates on analytical categories used for empirical analysis in more detail (see methods 5.6).

Tailored to water challenges, MTF positions resource governance as part of complex social-ecological systems and wider transformations towards sustainability. The present thesis expands the MTF approach to multiloop social learning in a number of ways. Firstly, it extends it to explicitly include land and agricultural governance and management. This reflects a perspective that water and agriculture are intimately related and are increasingly seen as part of environmental and landscape management (Cortner & Moote, 1994; Medema et al., 2014; Pahl-Wostl, 2006a). Secondly, it integrates the above conceptualisations of knowledge, paradigms, and contexts.

3.2.1 Water and land governance and management

Water and land are part of complex, co-evolving and interdependent social-ecological systems (Binder et al., 2013; Pahl-Wostl, 2015; Wiek & Larson, 2012). From a systems perspective, water and land systems are interconnected ensembles of multiple elements that for present purposes (and in line with the above 3.1.2) are grouped into material, informal and formal factors. Governance systems encompass:

- *Material factors*: ecological systems, the built environment, technical infrastructures and technologies, and economic/financial resources (Pahl-Wostl et al., 2015; Wiek & Larson, 2012)[62];
- *Informal factors*: social and cultural aspects and institutions (Pahl-Wostl, 2015; Wiek & Larson, 2012)[63], including, for present purposes, knowledge and information, paradigms and narratives;
- *Formal factors*: relating to formal governance, including formal regulative institutions such as the EU WFD (Pahl-Wostl et al., 2015[64]; Wiek & Larson, 2012) and, for present purposes, formal *organisational* institutions.

[62] For present purposes, economic and financial resources are attributed to material factors, economic and financial policies to formal factors, and informal institutions governing market behaviour (e.g. of producers, consumers, etc.) to informal factors. Wiek & Larson (2012) do not apply a categorisation, but list economic aspects alongside ecological, social, technical, legal, and cultural aspects. Pahl-Wostl et al. (2015) rarely mention economic factors.

[63] Pahl-Wostl (2015) distinguishes between normative and cultural-cognitive informal institutions (based on Scott, 2008, and Young, 2002): normative institutions reflect societal value structures that determine "what is considered to be appropriate in a certain societal context. Compliance is based on the desire to meet social obligations, to fulfil expectations of stereotypical roles and repertoires of context-specific actions". Cultural-cognitive institutions correspond to "dominant world-views that strongly influence meaning, understanding and perception of reality and of problem situations, how boundaries are delineated, and how the space for identifying problems and developing solutions is determined", including paradigms. Changes in normative and cultural-cognitive institutions are not explicitly negotiated, but enacted and emergent, e.g. in shared practices. Informal and formal institutions are interrelated, as they may mutually influence each other. For present purposes, "informal institutions" will be used as a generic term to encompass normative and cultural-cognitive institutions, including paradigms, shared narratives, and imaginaries.

[64] Formal regulative institutions "have formal legal structures, regulatory frameworks, and formalised professional rules of good practice typically codified in professional handbooks" (Pahl-Wostl, 2015, based on Scott, 2008 and Young, 2002). They are products of purposeful design, and an instrumental logic. Relying on interpretation, "compliance is based on expedience and an assessment of sanctions related to rule violation" (Pahl-Wostl, 2015). For present purposes, formal institutions will explicitly also be used for formal rules of formal organisations, such as internal rules of procedure.

The present thesis adopts a broad understanding of governance that encompasses both formal and informal processes, focusing on social actors and human agency as important drivers of water and land systems. What actors do with water and land, how, and why, is central to coupled social-ecological dynamics, and the reproduction and transformation of governance systems (Pahl-Wostl, 2015; Wiek & Larson, 2012). In the definitions provided by Pahl-Wostl and Wiek & Larson water governance is a social function (Pahl-Wostl, 2015) that lays out the framework for what objectives *management* is to pursue, within which boundaries, at what levels, and by what means, coordinating diverse actor activities, and water services (Wiek & Larson, 2012). For present purposes, therefore, governance is used a *general term*, with governance shaping how actors manage and engage with water and land via specific institutional arrangements and social coordination mechanisms. In its *specific use*, it denotes particular governance modes (see below).

Formal governance rests on formal policies and legally-binding regulation and is conducted by governmental actors following legal procedures. *Informal* governance refers to activities of mainly nongovernmental actors who self-organise to tackle specific issues and challenges, sometimes together with governmental actors (Pahl-Wostl, 2015)[65]. Because all human beings are water and food consumers, water and land governance directly concerns everyone.

The present thesis expands the understanding as follows: **Water and land governance** denotes a social function that shapes how actors engage with each other, based on specific purposes, social coordination mechanisms, scopes, scales, and means. Purposes concern relations between society and ecosystems, including desirable states of water bodies, soil, and landscapes. Governance emerges from complex interplays between formal and informal institutions, actors, and material environments that encompass ecosystems, infrastructures, and technologies.

Furthermore, a distinction can be made between different governance *regimes.* The reference to regimes usually originates in ecology and/or transition theories such as the multi-level perspective (see conceptual positioning 2.2.1). Regimes are based on the dominant formal and informal institutions and practices that shape governance systems (Pahl-Wostl, 2015), including their constellations of formal, informal and material factors, and human behavioural patterns. Regimes can be seen as resulting from paradigms shared by particular epistemic communities and materialised in, for example, professional practices and technologies (Pahl-Wostl et al., 2011). While Pahl-Wostl refers to *water* governance regimes, agricultural regimes have been defined in very similar terms, expanding the notion to explicitly include knowledge and information systems. For example, Ingram (2008) defines the dominant "agri-food regime" as encompassing cognitive, material, economic and social phenomena that are manifested in regulation, farming practices, supply chains, and in agricultural knowledge systems composed of actors such as farmers, advisory services, industries, education and research centres whose knowledge and practices are based on a shared paradigm and epistemology (Ingram, 2018).

[65] The present thesis takes over the MTF definitions of governmental and non-governmental actors: governmental actors are individual and collective public actors whose activities are part of – and represent - the legislative, executive and judiciary pillars of government (e.g. the government itself, parliaments, ministries and public administrations), while non-governmental actors are e.g. NGOs, private businesses, farmer associations, and research institutions (Pahl-Wostl et al., 2015). Municipalities and organisations with structural state participation can be difficult to place. For present purposes, municipalities and public-private bodies will predominantly be treated as nongovernmental actors, unless their activities represent central government. This definition, however, will have to prove its workability in empirical analysis. Examples are, for example, municipal water associations and river basin organisations with structural municipal and ministerial participation and public co-funding.

Governance regimes thus structure transactional, organisational, and macro contexts of actor engagement with water and land.

Water management refers to activities by which specific groups of actors develop and implement measures, and analyse and monitor resources, in order to achieve the purposes laid out by governance, entailing ongoing (social) learning (Pahl-Wostl, 2017). As the term ´management´ has strong anthropocentric connotations, the present thesis also uses the term ´engagement´, which is rarely used in the governance literature, but places greater store on *transactional* relations between humans and their environments (see above 3.1.2.2 and Higgs, 1997).

In the understandings adopted for present purposes (rooted mainly in adaptive governance and management), both governance and management rest on self-organisation and continuous experiential and experimental learning processes (Armitage et al., 2008b; Berkes, 2009; Folke, 2006; Holling, 1973; Ison et al., 2007; Medema et al., 2008, 2014; Pahl-Wostl, 2015). As basis of management, social learning is a process of managing change (Medema et al., 2014) or of managing "by change" (Folke, 2006), of learning from outcomes of policies and practices (Holling, 1973; Medema et al., 2008), and of "learning-by-doing" instead of a search for optimal solutions (Armitage et al., 2008b; Berkes, 2009; Ison et al., 2007).

Social learning and self-organisation are thus decisive for the adaptive capacity of governance systems. An adaptive and resilience-oriented perspective shifts purposes attributed to governance and management away from *controlling* change towards pre-defined objectives in systems considered stable towards strengthening capacities to cope with, adapt to, and shape change (Folke, 2006; Folke et al., 2002; Pahl-Wostl, 2015) (see also conceptual positioning 2.2.1). Building on Pahl-Wostl and Folke, the present thesis defines adaptive capacity as the ability to adapt processes and institutions in response to current or anticipated changes, taking into account complexity and uncertainty (Folke, 2006; Folke et al., 2002; Pahl-Wostl, 2015). In terms of governance, adaptive capacity flows from a combination of centralised top-down control with decentralised bottom-up processes that foster stakeholder involvement that is constantly adapted within flexible institutional frameworks (Pahl-Wostl, Mostert, et al., 2008b). In terms of management, adaptive capacity relies on ecosystem-based management and nature-based ´solutions´ (e.g. river restoration) that support ecosystem dynamics and regeneration capacities and are constantly adapted based on trial-and-error learning and ongoing monitoring (Berkes & Folke, 2002; Folke et al., 2005). Therefore, adaptive capacity is an emergent property of ongoing social learning processes, in which governance arrangements and management objectives and means are constantly adapted (Medema et al., 2014; Pahl-Wostl, 2006).

The transformative capacity of a governance system rests on possibilities to transform its overall purposes and functions (Pahl-Wostl, 2015). The emphasis on transformative capacity underscores the important role attributed to human agency as resting on capacities to profoundly re-interpret and reframe prevailing institutions and, thereby, to contribute to transforming regimes (Pahl-Wostl, 2017). Based on the above conceptualisation of actionable knowledge and on regenerative approaches to sustainability (see conceptual positioning 2.1.3), the present thesis adds human narration and imagination as integral elements of transformative capacity that unleashes human creativity and opens new horizons and opportunities for human action (Chabay et al., 2019; Maggs & Robinson, 2016).

On this basis and for present purposes, transformative change is defined as paradigm shifts that manifest themselves in structural changes in purposes, scopes, and means that collective actors (e.g. organisations) enact in water and land governance and, hence, in changes in constellations of formal, informal, and material factors across contexts of human-environment interaction (Pahl-Wostl, 2015). It encompasses transformations in epistemologies, values, technologies, practices in social and material engagement, formal regulation and informal institutions, and cultures (Cortner & Moote,

1994; Ingram, 2018; Röling & Wagemakers, 1998) inspired and accompanied by new narratives and imaginaries.

Transformative change may emerge from societal learning that takes place in complex and partly contingent interplays between agency and institutional design, self-organisation and emergence (P-W, 2017). The concept of multiloop social learning relates social learning to adaptive and transformative change in water and land governance systems. It corresponds to the procedural understanding of sustainability as an emergent property of dynamic processes of adaptation and transformation in human-environment relations fostered by societal *normative* dialogues (see conceptual positioning 2.1.3.1). Examining water and land governance and transformative change from a learning perspective itself marks a departure from approaches that have long been dominant. A cornerstone of adaptive water and land management and deeply normative concept, social learning serves to support transformative change in governance systems away from established sectoral paradigms that have primarily aimed to satisfy narrow anthropocentric needs (such as water and food), and towards human-environment interactions that embrace interdependencies between human well-being and ecosystem health.

The EU Water Framework Directive pursues similar overarching objectives. It aims for sustainable water management integrated with the environment, agriculture, transport, and regional policy (among others), in order to restore aquatic ecosystems to a good state. The introduction of public participation in river basin management serves to enhance dialogues and social learning among multiple parties (see paradigms 4.5). The present framework develops concepts that serve to analyse and compare these and other approaches.

3.2.2 Multiloop social learning

In transformative sustainability science and adaptive governance and management, social learning serves to foster shared understandings, social coordination and behavioural changes to meet sustainability challenges, while considering complexity, uncertainty, and normative ambiguity (see conceptual positioning 2.1.3). MTF defines social learning as “a process of multiparty interactions where actors engage in relational practices to assess and generate knowledge about a problem domain” (Pahl-Wostl, 2015). Social learning manifests itself in changes in practices and perceptions of individuals and groups, the development of trust and the capacity for collective action (Pahl-Wostl, 2015). This involves reducing conflicts and enhancing synergies (Lebel et al., 2010; Pahl-Wostl, 2015). For present purposes, social learning is defined as aiming to foster actionable knowledge for transformative change towards sustainability that enhances capacities for collective action and to cope with complexity and uncertainties. It expands understandings and experiences of participants. More specifically, learning for sustainability aims to enhance the awareness of actors of harmful ecological consequences of their own actions, and to support them in taking responsibility by developing agency to adapt (and transform!) their practices and institutions to limits of life-support systems (Tabara & Chabay, 2013; Tabara & Pahl-Wostl, 2007).

Social learning is the main social coordination mechanism associated with informal community-based and network governance (Ison et al., 2004; König, 2018; Pahl-Wostl, 2015). The concept focuses on how learning may bring about transformative changes across different scales – or contexts – of social organisation: individuals, groups, organisations, and society as a whole (König, 2018; Pahl-Wostl, 2015). Aiming to contribute to transformative change, the emphasis on social learning signals an attempt to replace or supplement hierarchical relations and compliance with formal regulation characteristic of established formal governance systems by bottom-up and cross-scale self-organisation between diverse nongovernmental and governmental actors (e.g. in social networks).

While top-down governance is associated with a strong reliance on specialised scientific/technical expertise and one-size-fits-all solutions, informal governance thrives on multiple knowledge types and ways of knowing (e.g. local and professional). It is considered particularly suitable (or even necessary) to foster context-specific approaches to ecological and social challenges.

3.2.2.1 Analytical categories

MTF provides a number of analytical categories to determine if and how social learning emerges in governance processes. Many of them are based on established concepts in adaptive governance and management (see conceptual positioning 2.2.2). In the MTF scheme, social learning covers *processes* that are based on relational practices among actors who are situated in a specific *context* and produce tangible *outcomes.* Among the possible outcomes are changes in social relations, knowledge (e.g. of challenges), the state of ecosystems and/or infrastructures. Outcomes change the context of governance and management via feedback loops. Relational practices denote task-oriented actions of at least two people that involve relational qualities such as reciprocity and reflexivity. Reflecting a constructivist approaches, relational qualities are considered to influence how substantive issues are understood and framed (Bouwen & Taillieu, 2004; Pahl-Wostl, 2015). In the MTF scheme, the context encompasses governance structures, actors and institutions, the natural environment, and technologies. The current thesis maintains this scheme, but introduces a number of differentiations (see figure 3.4 below):

- *Contexts*: specification of transactional, organisational, and macro contexts with categorisation of related formal, informal, and material factors;
- *Processes*: ´relational practices´ are explicitly understood as encompassing ´social relations´, ´knowledge´ and ´actions´;
- *Outcomes and effects*: differentiation between formal, informal, and material outcomes and explicit inclusion of unintended effects;
- *Feedbacks*: explicit distinction between social, organisational, and societal feedbacks.

Contexts: Integrating transactional, organisational and macro contexts along with the respective informal, formal and material input factors allows for a more differentiated analysis of factors that influence governance and social learning processes. Importantly, they include historical contexts. Contexts are not pre-given, but need to be constructed inductively from empirical inquiry into the ´webs of meanings´ spun by the participants in governance processes, and into the ´webs of causality´ of their actions. Contexts are likely to change during processes as a result of intra-processual learning feedbacks and/or external changes (e.g. new regulation, hazard events, etc.).

Processes: In order to create coherence between the contexts, factor and outcome categories all aspects associated with relational practices are divided into social relations, knowledge, and actions. Knowledge encompasses personal, local, non-scientific professional and organisational knowledge, and specialised scientific/technical knowledge (including interpretations of institutions) and, notably, underlying assumptions, paradigms, and narratives. Actions primarily denote physical interventions that change material environments (including professional practices) and produce tangible outcomes such as new products or services. Beers et al. (2016) and by Van Poeck et al. (2018) use similar categories:

- **Relations:** interpersonal relations and roles among actors, e.g. in social networks,

- **Knowledge relating to specific challenges:** personal, local, professional (incl. scientific), and organisational knowledge (incl. related institutions, paradigms, and narratives),
- **Actions:** actions producing tangible outcomes.

Based on these distinctions, social learning, for present purposes, is defined as entailing changes in social relations, knowledge, and in actions that enhance the capacities of a group or network to tackle specific challenges. Social relations, knowledge, and actions are inextricably linked with actionable knowledge. Based on the scheme developed for actionable knowledge (see 3.1 above), the case studies analyse how normative (why), systems (what), and transformation (how) dimensions of the community-based knowledge types of participating actors change in the course of informal governance processes. Changes and possible convergences among actors in the purposes, systems understandings, and means they attribute to their engagement with water and land will be interpreted as signs of social learning and as indications of its depth (see multiloop social learning below). Adding a transformative perspective, particular attention will be devoted to changes in narratives and imaginaries that may indicate changes in both personal meaning-making and paradigms.

Outcomes and effects: In line with the above, the scheme distinguishes between informal, material and formal effect categories. Effects are used as general term to denote all consequences of relational practices, including unintended effects. Outcomes refer to *intended* consequences.

Feedbacks: Depending on the extent to which outcomes enhance the capacities of single individuals, actor groups, organisations or society as a whole, learning will be referred to as social, organisational and/or societal. ´Social learning´ is kept as a generic all-encompassing term. Personal and organisational learning are additions to the MTF scheme. Social learning always presuppose changes in *personal* understandings and experiences.

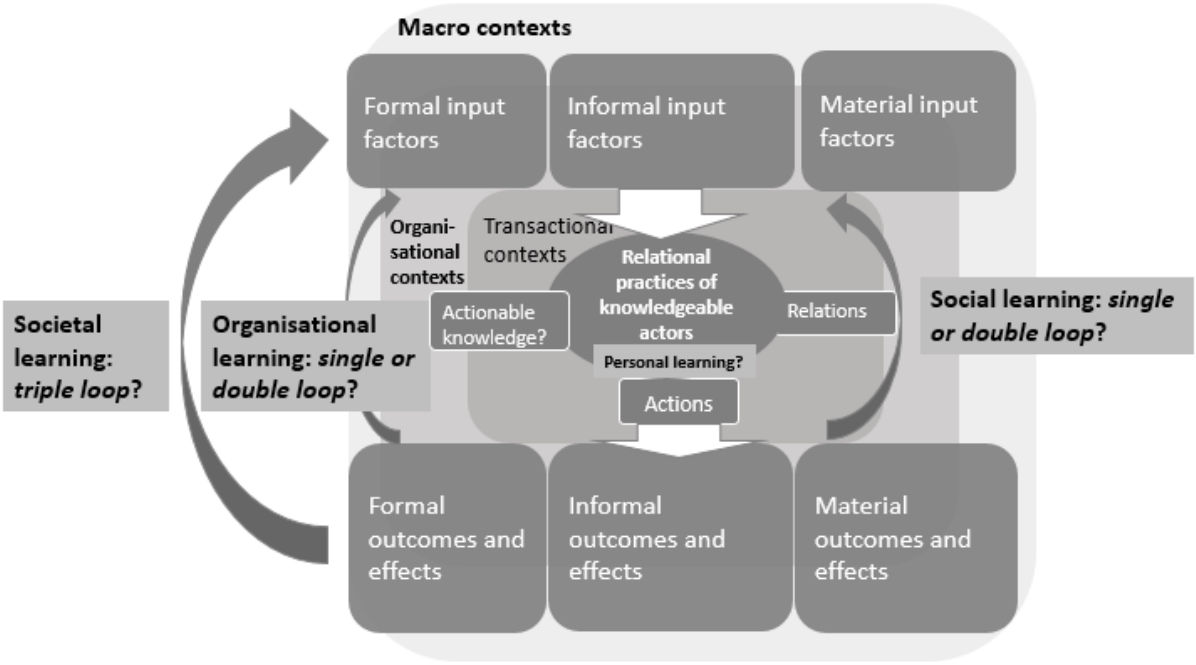

Figure 3.4 - Social learning scheme elaborated based on the Management and Transition Framework (MTF) and related approaches

3.2.2.2 Single-, double-, and triple loop learning

The concept of multiloop social learning builds mainly on Argyris & Schön, and has been widely used in transformative sustainability and adaptive governance research (see conceptual positioning 2.2.2 and above 3.1.2.3). Multiloop social learning provides a model for conceptualising how new knowledge, relations, and actions may emerge between diverse actors and contribute to transformative change.

In the MTF scheme, social learning is interpreted as single, double or triple loop depending on the depth of the reframing of institutions, knowledge and roles, and the extent of their institutionalisation (Pahl-Wostl, 2015). Single loop learning denotes incremental learning ("business-as-usual"), in which actors remain amongst their peers and adapt established routines without questioning basic assumptions and purposes. In double loop learning, actors begin to question prevailing purposes, understandings of challenges, interpretations of institutional constraints and opportunities ("reframing"), and established practices. Double loop learning may be accompanied by the emergence of new social networks, in which actors engage with new contacts outside their peer groups. Finally, paradigm shifts (or regime changes) emerge with triple loop learning when societal macro contexts undergo profound changes. Indications of triple loop learning are when new informal institutions begin to dominate public discourses and practices, when new regulatory frameworks consolidate, and new roles and identities emerge among actors and are institutionalised (Pahl-Wostl, 2015, see figure 3.4). Water governance and management are regarded as part of wider societal transformations rather than as isolated arenas. From a systems perspective, triple loop learning entails profound changes in dynamics of social-ecological systems or, put differently, in patterns in human-environment interactions.

The MTF regards formal institutions such as policies and legal frameworks as crucial as regards social learning because they may hinder the emergence of double loop social learning by constraining possibilities to fundamentally reframe challenges and revise actions. Conversely, double loop learning may also be facilitated by changes in formal regulation. Furthermore, revisions of policies may themselves be facilitated by the interaction of governmental and nongovernmental actors in social networks that provide spaces for thinking-out-of-the-box. On this basis, Pahl-Wostl argues that "transformative change requires informal learning cycles that are connected to formal policy processes" (Pahl-Wostl, 2015). The hypothesis is also based on the assumption that social-ecological systems cannot be steered by purposeful design alone, but that water governance and management require self-organisation and flexible responses to emergent phenomena that are more likely in informal governance.

The present thesis elaborates on the MTF understanding of multiloop social learning in several ways. Based on the above conceptualisation of (actionable) knowledge, it is assumed that double loop learning and paradigm shifts require profound changes in epistemic cultures and practices in local and professional organisations. They may be accompanied by changes in personal and collective narratives and narrative identities. In contrast to Pahl-Wostl who associates the dominant water governance regime with *one* epistemic community composed of multiple actor groups (see above and below), the present thesis will investigate single organisations and their narratives more closely, in order to identify possible differences and commonalities, and how they evolve in the course of social and *organisational* learning processes. Empirical analysis of interplays between governance processes will, in particular, examine the status of scientific/technical expertise in relation to local, non-scientific professional, and organisational knowledge.

On this basis, the concept of multiloop social learning is expanded in the following manner:

Single loop learning: Social relations, knowledge and narratives, and established routines are revised slightly to adapt to changing circumstances, actors remain within their established organisations: contexts remain largely unchanged, the cross-sectoral and –scale reach of informal governance processes remains limited.

Double loop learning: new social relations are sought beyond own organisations (e.g. in social networks) and new roles emerge. Prevailing knowledge, institutions, narratives and practices are questioned and begin to be reframed. Actionable knowledge fosters – and is fostered by - alternative ways of engaging with water and land (e.g. through experiments), further enhancing organisational and professional learning through new experiences. Personal, transactional, and organisational contexts begin to change, more cross-scale and cross-sectoral informal governance processes emerge, possibly in interplays with formal governance processes.

Triple loop learning: new social relations, knowledge, institutions, and practices take root across organisations and throughout society, informally and formally. They go hand-in-hand with new paradigms, narratives, and imaginaries. Interplays and convergence of diverse formal and informal processes foster transformative change (paradigm shifts) across all contexts of human engagement.

Based on the quality of feedback loops and the extent of contextual changes, learning is thus considered personal, organisational (incl. professional), and/or societal (see figure 3.4.). Furthermore, associated with double loop learning actionable knowledge for sustainability is understood as potentially contributing to such transformative changes.

3.2.3 Contexts: Analysing paradigms in water and land governance

Tailored to the analysis of macro and organisational contexts of governance and learning processes, the current thesis develops a grid that enables the mapping of paradigms and approaches in water and land governance and management. The grid serves to analyse diverse paradigms in water and land governance, based on qualitative interviews, organisational and policy documents (see methods chapter 5.2.1 and part 4 on paradigms). Most importantly, the grid is used to trace and analyse possible transformative changes in formal regulation and organisations that may have taken place in the past (e.g. before the EU WFD) and in the course of contemporary governance processes following the entering into force of the EU WFD. Based on the grid, the EU Water Framework Directive is characterised as a hybrid and partly contradictory construct (see chapter 4.5).

Many scholars distinguish between ´command-and-control´ (or ´predict-and-control´) and adaptive and integrated management paradigms in water systems. In agriculture and food systems, adaptive approaches (such as agroecology) are juxtaposed with ´productivity and growth´ paradigms. The present thesis ascribes these paradigms to narrow and, respectively, broad (or integrated) forms of anthropocentrism, and adds ecocentric paradigms less frequently discussed (see paradigms 4). Anthropocentric and ecocentric paradigms are expressions of different axiological, ontological and epistemological assumptions about human-environment relations that also find expression in different preferred means of how to organise social relations (governance) and how to manage and engage with material environments (management). This conceptualisation, therefore, corresponds to the four dimensions of actionable knowledge outlined above (who, why, what, how).

The grid combines governance modes with the purposes that humans have associated with their management of and engagement with water and land. More precisely, it develops the idea that paradigms and regimes can be characterised by different configurations of bottom-up, top-down and network modes of social coordination (vertical axis), on the one hand, and anthropocentric, integrated and ecocentric purposes, on the other (horizontal axis) (see figure 3.5).

Finally, the grid is based on the notion that paradigms are no stand-alone phenomena, but are formally institutionalised in policies and legal framework and informally institutionalised in epistemic cultures and practices of organisation ("epistemic communities"). In fact, rather than seeking to ´fit´ policies and organisations to paradigms, the present thesis uses policies, individual actors, and organisations as *starting-points* for empirical analysis, assuming that transformative change may manifest itself in changes, new synergies and conflicts among different epistemic communities and policies.

While the present thesis locates regulation and organisations in the grid, it is not meant to provide a static picture. Rather, the case studies trace their trajectories over time with a view to identifying significant changes such as moves from narrow to broad anthropocentrism or from an hierarchical top-down to a network governance mode. Placing actors and formal regulation in the grid thus structures the analysis of approaches and paradigms and facilitates the identification of transformative changes in water and land governance.

The classificatory system is a contribution to sustainability science and adaptive governance and management. To the best knowledge of the author no similar scheme exists, which encompasses both governance modes and management purposes. With its ´group-grid´ scheme, cultural theory is probably the closest (Douglas, 1996; Schwarz & Thompson, 1990; Verweij et al., 2006). However, there are significant differences, as cultural theory matches cultural profiles of individuals ("rationalities"), with certain governance approaches, and particular "myths" of nature.[66] Another grid that bears some resemblance has been developed by Pestoff (Pestoff, 1992). It serves to place social enterprises in relation to intersecting "rationales" of state (redistribution), market (for-profit) and communities (reciprocity) (Defourny & Nyssens, 2012). However, it is not related to environmental governance and management.

[66] Whilst relevant, the group-grid theory is centred on a distinction between individualised and collectivised behaviour, which is not a primary research concern of the present thesis. Furthermore, whilst elaborating on different conceptions of human-environment relations in different paradigms, the present thesis will only refer to the ´nature myths´ of Holling et al. (used in cultural theory) whenever it adds to conceptual arguments (Holling et al., 2002). It remains for empirical analysis to identify and interpret what possible metaphors and "myths" actors use in their narratives and statements. Furthermore, the group-grid categories seem rather stereotypical and static. Finally, the association of different rationalities with specific ´nature myths´ is all but straightforward and difficult to apply to governance. For example, the rationality of individualised and prescribed behaviour (associated with "nature capricious") is described as "fatalist", which, in the grid developed for present purposes, is difficult to relate to anthropocentric and formal governance and management. This may be why "fatalism" has not been added to the three divergent "policy stories" relating to climate change identified by cultural theorists (Verweij et al., 2006). Furthermore, there are discrepancies between the "procedural rationality" of the "hierarchist" that cultural theorists identify with the "nature perverse/tolerant" nature myth (Schwarz & Thompson, 1990), and the nature myth "nature resilient", for which Holling et al. (2002) use the same metaphor (picture), but associated with adaptive governance.

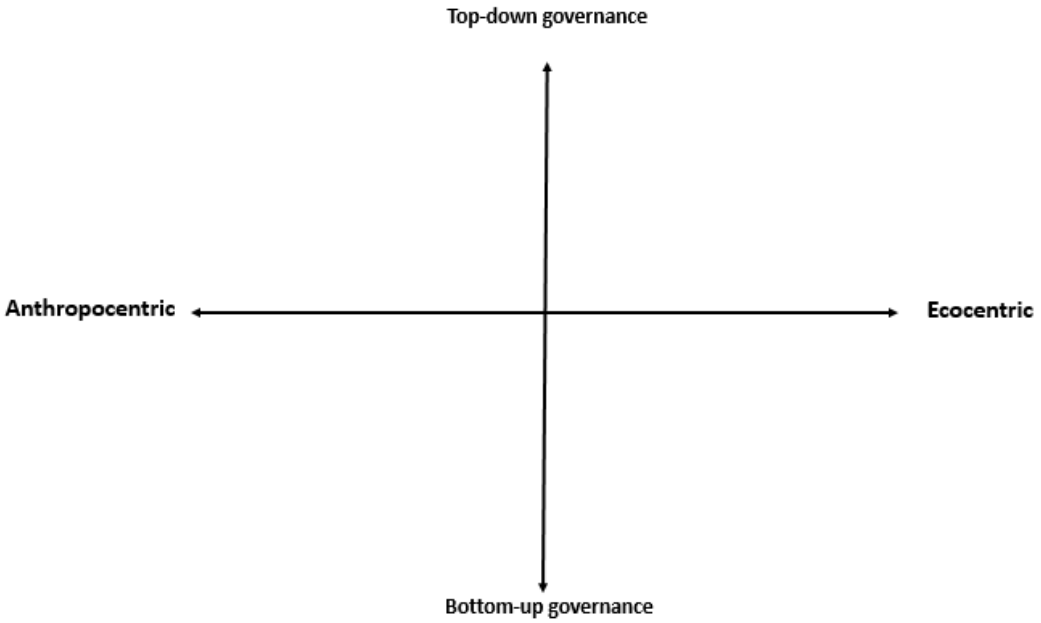

Figure 3.5 - Analytical grid to analyse approaches and paradigms in water and land governance and management

3.2.3.1 Governance modes

The vertical governance axis concerns social coordination mechanisms (human-human relations): how social relations in formal and informal governance are organised and coordinated: at what level, by whom, and with what knowledge and information.

The axis serves to position and juxtapose top-down, bottom-up and network governance approaches. The distinction between "bottom-up" and "top-down" as main poles is partly based on the assumption that dynamics in social-ecological systems emerge from combinations of bottom-up and top-down influences, e.g. between agency and societal institutions (Allen et al., 2014; Chabay et al., 2019; Folke et al., 2005; Pahl-Wostl, 2015). It is also closely related to the widespread distinction between the following governance modes: hierarchies, markets, and networks or communities (e.g. Evans, 2012; Ison et al., 2007; König, 2018; Pahl-Wostl, 2015).

Hierarchies are associated with incumbent ´control-and-command´ or ´predict-and-command´ paradigms in water governance (Akamani, 2016; Armitage et al., 2008b; Halbe et al., 2013; Pahl-Wostl & Knieper, 2014). Network- and community-based governance are hallmarks of adaptive approaches to water and land governance

Hierarchies (top-down governance): Hierarchies denotes governance that is carried out by state actors who rely primarily on formal regulation (Evans, 2012; Pahl-Wostl & Knieper, 2014). For this reason, ´hierarchies´ are sometimes equalled with ´formal governance´ (Pahl-Wostl, 2015)[67]. The mode is associated with a positivist belief in context- and value-free science and expert systems that deliver ´facts´ as allegedly ´objective´ basis for political decisions (Evans, 2012; Ezrahi, 2006; Jasanoff, 2005; Pahl-Wostl, 2015) (see also above 3.1.2.4). Generally speaking, "scientists first get the facts right, then

[67] The denomination "formal governance" has not been chosen. One of the reasons is that while hierarchically organised states may formally rely on regulation, informal relations may also play an important role. Especially non-democratic hierarchical systems may be prone to different kinds of informal favouritism (e.g. nepotism and corruption) (Pahl-Wostl, 2015).

decision-makers decide what to do based on these facts" (Evans, 2012). The dominant social coordination mechanism for inducing individual behaviour change is an instrumental use of policies that require compliance; innovation is driven by technology transfer (Ison et al., 2007; Ostrom, 2010a). In cultural theory, hierarchies are expressions of a procedural rationality that favours traditional and asymmetrical relationships based on a clear-cut distribution of competences and tasks (Douglas, 1996; Schwarz & Thompson, 1990).

Markets: Given the Luxembourgish context, ´markets´ do not receive much attention in the present thesis; it only touches on agricultural markets. It denotes a governance mode, in which non-state and economic actors (incl. consumers), and the production and exchange of goods are the dominant forces (Ostrom, 2010). It rests on a belief in utility-maximising human behaviour (rational choice) (Evans, 2012; Ison et al., 2007; Pahl-Wostl, 2015). ´Markets´ are associated with a belief in individualism, individual freedom and competition (Douglas, 1996; Schwarz & Thompson, 1990), combined with *some* state regulation (Evans, 2012; Pahl-Wostl, 2015). The market mode rests on market demand and supply and combines informal and formal governance (Pahl-Wostl, 2015). In the present thesis, economic policies and measures driven by state actors will be attributed to ´top-down governance´ and economic initiatives of non-state local and regional actors to ´bottom-up governance´. Large national or multinational companies play no role in the present thesis (if they did, the grid would be less suitable).

Communities and networks: Community- and network-based governance embraces informal, decentralised and participatory approaches to governance, in which non-state actors self-organise themselves around specific issues, based predominantly on informal institutions. More ´traditional´ perspectives focus on ´bottom-up´ governance within local communities (Newig & Koontz, 2014a), sometimes also referred to as "community involvement paradigm" (Halbe et al., 2013). In the adaptive (co-)management literature (including bioregionalism), it denotes community-based governance of local resources that rests primarily on local knowledge (see conceptual positioning 2.2.1). As regards water governance, river basins are considered a particularly suitable scale for ecosystem- *and* community-based management (Huitema & Meijerink, 2017; Meijerink & Huitema, 2017). For this reason, the introduction of river basin districts, along with public consultations in river basins, by the EU Water Framework Directive has been interpreted as a paradigmatic move towards adaptive water management (see paradigms 4.5).

Importantly (and drawing on cultural theory[68]), bottom-up governance in the analytical grid does not only denote l*ocal* governance arrangements, but also encompasses grassroots activities of national (or international) organisations, be they formal (such as environmental NGOs) or informal and occupation-based. It is also for this reason that the more encompassing term ´bottom-up´ has been preferred to ´local´ governance.

While empowering local actors, bottom-up governance may result in fragmented regimes (or patchworks), in which different rules and standards apply in different communities (Newig & Koontz, 2014a; Pahl-Wostl & Knieper, 2014). Partly for this reason, and considering the globalisation of ecological and social impacts and effects of human activities, the community perspective has increasingly given way to the idea of *network* governance. It denotes a governance mode, in which non-governmental and governmental actors self-organise to coordinate their activities horizontally across sectors and vertically across scales (e.g. from local to national) (Armitage et al., 2008b; Berkes, 2002; Dietz et al., 2003; Young, 2002). Network governance "involves voluntary partnerships between

[68] Cultural theory associates bottom-up governance with organisations such as social or green movements that share a collective identity, and rely on voluntaristic and egalitarian cooperation and solidarity (Schwarz & Thompson, 1990; Verweij et al., 2006).

diverse stakeholders to build consensus and the collective will and ability to act around a specific issue" (Evans 2012). The MTF refers to *informal* governance. The predominant social coordination mechanism relies on social learning and capacity-building through communication and coordination based on principles of reciprocity (rather than hierarchy), and the internalisation of institutions (rather than on compliance) as a basis for behavioural changes (Evans, 2012; Ison et al., 2007; Pahl-Wostl, 2015). In the grid developed, network governance is situated in-between bottom-up (i.e. community-based) and top-down hierarchical governance.

Network and community-based governance modes rest on "input legitimacy" based on an open and inclusive design of processes that provide opportunities for diverse participation ("all voices heard"). Legitimacy crucially relies on *perceptions*: processes and related institutions "must be seen as effective and legitimate by resource users or resistance and evasion will overwhelm the commons governance" (Dietz et al., 2003). This understanding contrasts with principles prevalent in hierarchical democratic systems that are based on formally prescribed rules for ensuring legitimacy based on democratic representativeness. In contrast to input legitimacy, "output legitimacy" refers to legitimacy that is derived from process *outcomes* (Pahl-Wostl, 2015).

Multi-level and polycentric governance: The governance axis is suitable to map different levels of decision-making as well as polycentric arrangements. As regards multi-level arrangements, both EU and national-level policy-making can be attributed to top-down governance. ´Centralised governance´ used by other scholars (which could have been used as another denomination for the vertical pole) would have been less suitable to capture the multi-level character of EU governance. Multi-level governance (or ´type I´ multi-level governance) is characterised by a formalised institutional architecture composed of multiple and nested levels of governance, in which each levels is endowed with specific and clearly delineated competences that, generally, do not intersect as, for instance, in federal states and the European Union (Newig & Koontz, 2014; Pahl-Wostl, 2015). For example, in the case of the EU Water Framework Directive, the EU level lays out the overall objectives and requirements to be transposed into national law. Depending on the national system, subnational levels (e.g. regions) may be in charge of implementation and the elaboration of specific measures (e.g. management plans), necessitating both vertical and horizontal coordination. In the analytical grid, subnational levels (such as river basins) are placed towards the ´bottom-up´ end of the vertical axis.

Finally, in the literature, the term polycentric governance has been coined to describe polycentric and hybrid arrangements, or ´type II multi-level governance´ (Newig & Koontz, 2014a). Polycentric governance encompasses a mix of hierarchical, network- and market-based modes of governance that come together in varying issue-specific constellations (Newig & Koontz, 2014; Ostrom, 2010; Pahl-Wostl, 2015). The degree of vertical and horizontal coordination distinguishes a fragmented from a polycentric regime (Pahl-Wostl & Knieper, 2014). The emphasis on polycentric governance reflects the view that governance is no longer necessarily bound to fixed and clearly demarcated scales and levels (see conceptual positioning 2.1.3.2). At the same time, hierarchical and network-based perspectives can be regarded as complementary, because spatial scales and levels of decision-making continue to play a role (Bulkeley, 2005). Thus, for example, top-down regulation may support – or even require - bottom-up organisation, such as in the case of the EU WFD (Craps, 2003). Normatively, the concept of polycentric governance is rooted in the idea that there are no "panaceas" (Pahl-Wostl, 2017) in governance and management, neither in terms of paradigms nor in terms of single adequate scale or level at which to treat a certain problem. Environmental challenges typically need to be addressed across multiple scales; whilst principles of good governance are key, the notion of ideal institutional

arrangements and “fits” thus needs to be replaced by an emphasis on issue-specific processes and coordination (Pahl-Wostl, 2015)[69].

Hierarchical governance is an integral element of polycentric governance (as is market-based governance). The emphasis on polycentric governance, however, rests on the diagnosis that hierarchies have not been conducive to learning. Hierarchical governance has often proven ineffective or even counterproductive in addressing environmental deterioration. Policy learning denotes “a deliberate attempt to adjust policy goals or techniques of policy development and implementation in light of the consequences of past policies and new information, so as to better attain the ultimate objectives of governance” (Pahl-Wostl, 2015). Highly regulated contexts, however, rarely promote ´thinking-out-of-the-box´ and tend to privilege one-size-fits-all ´solutions´. Network governance, in contrast, aims to open up informal spaces and processes that engage both governmental and nongovernmental actors in a manner that enhances the likelihood of policy *and* social learning.

In the present thesis, polycentric arrangements will be associated with paradigmatic hybridity, with the EU WFD examined as one example. The grid proposed, however, is less suitable than other classificatory schemes to visualise distinctions between fragmented and polycentric regimes (e.g. Pahl-Wostl & Knieper, 2014). Instead, the grid serves to map different actors and policies as part of a qualitative analysis of possible tensions and contradictions. In this sense, polycentricity does not refer to a stable state associated with a specific and fixed institutional architecture; rather, it would be an emergent property of ongoing coordination and cooperation efforts in hybrid regulatory and institutional landscapes[70]. Hybridity may result from the existence of different paradigms at different levels of social organisation, e.g. tensions between a dominant paradigm at the macro level and competing organisational paradigms (Halbe et al., 2013); or the macro context itself may become increasingly hybrid and contradictory as a result of emerging paradigm(s) institutionalised in new regulation.

The analysis of governance modes associated with different paradigms will be based on the scheme developed on actionable knowledge (see figure 3.1.): ´who´ are the main actors involved, and ´how´ is social coordination carried out (see table 3.1).

Governance axis: Analytical categories	
Who: actors involved	Governmental and/or nongovernmental actors? What knowledge and information?
How: governance modes and levels of social coordination	Hierarchical (top-down), network-based, or community-based (bottom-up) governance modes?

Table 3.1 - Categories to position governance modes of approaches and paradigms in governance axis of analytical grid on water and land governance

[69] Based on insights from case studies, Pahl-Wostl argues that “[…] an ´optimal´ spatial or temporal scale on which water should be governed or managed does not exist. Water-related problems are always multifaceted and addressing them requires the inclusion of more than one scale in space and time. Different aspects of water management issues need to be addressed at different scales. In order to assure good governance, reliance on transparent and effective cross-scale coordination and negotiation processes is essential” (Pahl-Wostl, 2015).

[70] Similarly, cultural theory favours “vibrant multivocality” that brings forth “clumsy solutions” to collective problems, based on a combination of diverse - and even opposing - forms of rationality (Verweij et al., 2006).

3.2.3.2 Management and engagement purposes

Management operates within the framework laid out by governance concerning the purposes, scopes and scales, and main means employed that shape human-environment relations and how they are perceived. The fact that the horizontal axis of the analytical grid is centred on the normative dimension reflects the assumption that human purposefulness and agency guide governance systems (Pahl-Wostl, 2015; Wiek & Larson, 2012).

Whilst there are several classificatory systems (e.g. grids) to analyse governance modes, empirical inquiries into management paradigms are rarely aided by schemes that facilitate comparison. The current thesis addresses this shortcoming. It takes over the definition of management paradigms provided by Pahl-Wostl et al. (2011). Its reference to epistemic communities has provided the basis for some of the main assumptions underlying the present thesis:

> *"A management paradigm refers to a set of basic assumptions about the nature of the system to be managed, the goals of managing the system and the ways in which these goals can be achieved. The paradigm is shared by an epistemic community of actors involved in the generation and use of relevant knowledge. The paradigm is manifested in artefacts such as approaches, regulations, engineering practices, models etc." (Pahl-Wostl et al., 2011)*

In order to facilitate analysis and comparison of management paradigms and approaches, the horizontal axis of the analytical grid distinguishes between different normative assumptions concerning human-environment relations and the purposes attributed to management and engagement (based on Jischa, 2005):

- *Narrow anthropocentrism*: nature provides resources for human use, and serves as sink, and can continue to do so *in*dependently of human use;
- *Broad anthropocentrism*: humans and nature are *inter*dependent, nature provides *diverse* services to humans that need to be preserved (including cultural, educational, recreational and aesthetic ones);
- *Ecocentrism*: nature has an intrinsic value.

The present thesis analyses different water and land management paradigms along the normative axis. In water management, the so-called incumbent "command-and-control" paradigm pursues narrow anthropocentric purposes focusing on drinking water supply and human safety (e.g. from floods). Likewise, yield-oriented agricultural paradigms focus on food production. In contrast, emerging adaptive paradigms in water, land, and agricultural management aim to reconcile and balance diverse benefits that nature delivers to humans. Using the concept of ecosystem services, adaptive and integrated water management as well as agroecological approaches aim for ecosystem-based and holistic *landscape* management that serves diverse human purposes while safeguarding biodiversity and ecological regeneration capacities (see paradigms part 4 below).

Ecocentric paradigms receive comparatively little attention in environmental governance. The present thesis seeks to contribute to societal and scientific debates by outlining two different ecocentric approaches: Managerial ecological restoration that seeks to spare nature of as much human influence as possible and seeks to restore specific ecological target states, e.g. in protected areas. The emphasis of the EU WFD on restoring water bodies and aquatic environments to a "good ecological status" will be interpreted as an example. Alternative ecocentric approaches regard humans and nature as having evolved together, and strive for a new "community" between them based on new modes of engagement. The paradigms are discussed in more detail in part 4. On this basis, and corresponding to

the distinction between narrow and broad anthropocentrism, the current thesis tentatively introduces a distinction between narrow and broad *eco*centrism, as a contribution to the literature[71]:

- *Broad ecocentrism*: nature and humans form a community based on the intrinsic value *and inter*dependence of all living beings;
- *Narrow ecocentrism*: nature needs to be protected from human activities as a precondition for ecosystem health on which humans depend.

The normative axis of the analytical grid does not only concern purposes, but also different scopes and means attributed to water and land management (see table 3.2). Scopes attributed to management can be sectoral or integrated. The former attributes separate purposes – and problem framings - to specific sub-systems of social-ecological systems (e.g. environment, society, economy) that are treated as *in*dependent from one another. Anthropocentric purposes – e.g. the use of resources for human benefits – are often achieved by technological means and one-size-fits-all and end-of-pipe ´solutions´ that seek to treat some of the ecological side-effects of human activities, while neglecting others. In contrast, adaptive and integrated paradigms seek to consider environmental, social and economic concerns horizontally across various sub-systems, regarding them as *inter*dependent, while favouring ecosystem-based approaches and a broad range of means to tackle complex challenges, focusing on the prevention of overexploitation and pollution, and on nature-based-based ´solutions´ rather than technological remedies (see part 4.3).

Finally, paradigms have a narrative dimension that may convey different underlying assumptions about causalities, metaphors, and ´myths´ of nature, including interactions between social and ecological systems. The present thesis partly draws on "metaphors of human-environment relationships" identified by Raymond et al. (Raymond et al., 2013). The metaphors reflect different ethics, management objectives and "success indicators". The thesis, furthermore, sometimes refers to the different "myths of nature" developed in adaptive governance and used in cultural theory to characterise assumptions about how interactions between social and ecological systems are to be governed and managed (Holling et al., 2002; Verweij et al., 2006). Unlike cultural theory, however, the present thesis does not associate paradigms *a priori* with particular "myths" or metaphors.

In general, a normative bias can be discerned in some of the literature. Hierarchical governance is predominantly associated with narrow anthropocentric purposes that aim for resource exploitation and privileges technical ´solutions´ and ´fixes´ without taking into account possible environmental and social feedbacks (similarly, market governance). Informal network- and community-based governance, in contrast, is assumed to be more conducive to adaptive and integrated approaches that pursue sustainability[72]. Instead, the analytical grid developed for present purposes allows to differentiate between both anthropocentric and ecocentric *top-down* policies, and between anthropocentric and ecocentric *bottom-up* governance. It explicitly expects hybrid and polycentric arrangements.

[71] Narrow ecocentrism, as understood here, largely corresponds to ecocentric "compositionalism": "Humans, as destroyers of pristine nature, have the moral obligation to remedy the disturbances so that nature can return to ´the integrity´ of the biotic communities´, i.e. the initial species structure and composition present in the absence of human disturbance". (Ollivier, 2004) Broad ecocentrism is similar to ecocentric "functionalism": "Mankind and its activities are part of the ecosystem. Humans have a moral duty to preserve the ´health of the ecosystem´ defined as ´normal´ functions and processes. This approach considers that human activities are an integral part of the system and don´t necessarily imply dysfunction, as long as the system is able to preserve its self-regulatory capacities in the face of disturbances […]" (Ollivier, 2004).

[72] The normative bias is particularly evident in cultural theory: hierarchical settings regard nature as controllable; individualistic settings regard nature as "benign" (or "resilient" (Verweij et al., 2006)) and as capable of recovering from exploitation (Schwarz & Thompson, 1990), and egalitarian settings regard nature as fragile and, therefore, to be treated with great care (Verweij et al., 2006).

Distinctions made between the poles are not clear-cut, but fuzzy and dynamic. The same applies to the positioning of policies and organisations.

Management and engagement axis: Analytical categories	
Why: overarching purposes	Anthropocentric, integrated, ecocentric?
What: scope and factors considered	Sectoral or integrated/systemic? Social and/or material (e.g. ecological) factors?
How: preferred means of material management and engagement (physical interventions)	Technology-driven or ´nature-based´?

Table 3. 2 - Categories to position approaches and paradigms in management/engagement axis of the analytical grid

3.2.3.3 Paradigms and the EU Water Framework Directive

Based on the analytical grid, part 4 analyses different paradigms in water and land governance that have been identified in the literature (see figure 3. 6 and table 3. 3):

Modern-industrial paradigms:

- ´Command-and-control´ water governance and management (top-down, anthropocentric)
- Productionist agricultural management (Top-down *and* bottom-up, anthropocentric)

Emerging adaptive and integrated paradigms:

- Adaptive and integrated water governance and management (network-based/bottom-up, broadly anthropocentric)
- Adaptive agricultural management, e.g. agroecology (bottom-up/network-based, broadly anthropocentric)

Emerging ecocentric paradigms:

- Managerial ecological restoration (top-down, narrowly ecocentric)
- Ecocultural community paradigms (bottom-up, broadly ecocentric)

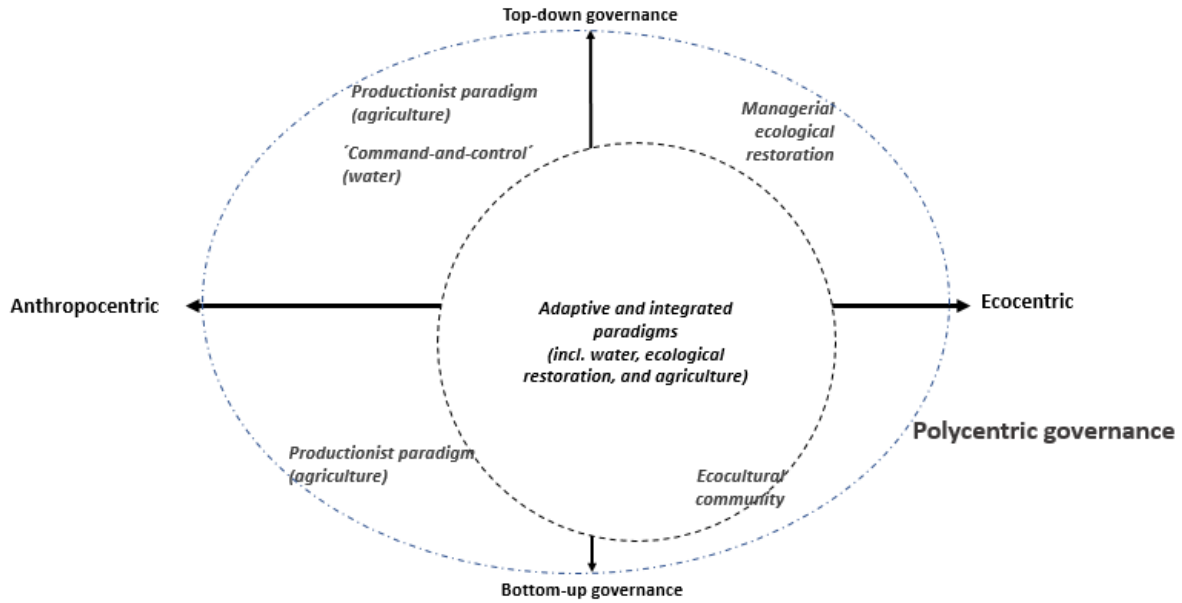

Figure 3.6 - Analytical grid: Positioning of paradigms within polycentric arrangements

Each of them holds different normative, ontological, and epistemological assumptions, narratives and imaginaries about human-environment relations. These assumptions shape not only formal governance, but also organisational contexts of actors professionally engaged in water and land systems. Each paradigm involves different actors and actor constellations. Adaptive and integrated paradigms (occupying fuzzy middle-grounds), in particular, aim to bring together diverse governmental and nongovernmental actors from diverse sectors and scales likely to pursue different approaches and paradigms.

As regards *water* governance, the most prominent paradigms that have shaped formal policy-making are summarised and compared in table 3. 3 below (based on part 4). The analysis of the EU WFD suggests that it provides a hybrid regulatory framework that combines elements from ´command-and-control´, adaptive and integrated, and managerial ecocentric paradigms (see chapter 4.5):

- A *top-down managerial ecocentric* approach pursuing the purpose of restoring aquatic ecosystems to a "good status" (by 2027 at the latest), including via protected areas and nature-based ´solutions´ such as river restorations, based on extensive specialised scientific/technical requirements and expertise;
- An *anthropocentric* focus on securing drinking water supply and on granting exemptions from ecological requirements on grounds including overriding public interest;
- An *adaptive and integrated* approach that aims for the integration of diverse sectoral policies and pursues a network governance mode with active stakeholder involvement and public consultations on management at the scale of river basins, based on polluter-pays, precautionary and preventive principles and nature-based solutions.

The case studies will investigate how EU WFD implementation has contributed to social learning changing transactional, organisational, and macro contexts in Luxembourg. Particular attention will be devoted to, firstly, interplays between formal implementation and informal governance processes, including the possible role of contradictions and tensions relating to the hybrid character of not only the EU WFD itself, but also of the organisational governance landscape. Secondly, empirical analysis will focus on approaches of governmental and nongovernmental organisations (including specific local and professional communities) in water and land governance in Luxembourg, and how they have evolved.

Paradigms in water governance and management	**´Command-and-control´**	**Adaptive and integrated**	**Managerial ecocentric**
Why: overarching purposes and narratives	Narrow anthropocentric purposes serving health and prosperity: provisioning ecosystem services (drinking water) for household and economic water security, flood protection	Broad anthropocentric purposes based on provisioning, regulating, supporting and cultural ecosystem services, water security (environment, households, economies), multifunctional landscapes, adaptive and transformative capacities, resilience	Ecocentric sectoral purposes aiming for the restoration of ecosystems to a specific target state (e.g. as regards biodiversity and water quality)
	Beliefs in and narratives about continuous progress made possible by economic growth, scientific and technological advances (B. Scott et al., 2016)	*Possible narratives to be identified based on empirical analysis*	*Possible narratives to be identified based on empirical analysis*
Who: main actors involved	National governmental actors, natural scientists, engineers and consultants, technology manufacturers	Non-governmental and governmental actors from diverse scales (including river basins) and sectors (e.g. agriculture, conservation, engineering), including researchers, diverse practitioners, citizens and user groups and local communities	National governmental actors, natural scientists, engineers and consultants
How: main mechanism of social coordination	Hierarchical top-down and sectoral governance relying on ´expert´ studies, formal regulation and public funding	Network governance embedded in multi-level polycentric arrangements	Hierarchical top-down and sectoral governance relying on ´expert´ studies, formal regulation (e.g. for protected areas), and public funding
	Theory of action and behavioural change: ´rational choice´ and ´information deficit model´	Theories of action: between ´rational choice´, routines as heuristic device and meaning-based paradigms	Theory of action and behavioural change: ´rational choice´ and ´information deficit model´

What: scope and factors considered	Focus on water bodies and resources, based on national-level linear predictive models (prognoses), hydrological simulations and technical risk assessments carried out by natural scientists taking into account biophysical and infrastructural factors, population and economic development estimates, but no two-way feedbacks	Focus on water as part of ecosystem-based holistic landscape management taking into account complex social-ecological system dynamics and feedbacks across scales and sectors (ecological, social, economic)	Focus on aquatic ecosystems and ecological processes, based on specialised scientific studies and simulations/modelling concerning biodiversity, anthropogenic pressures, and habitat structures
How: main means of material management and engagement (physical interventions) and related metaphors	Technical management based on ´grey´ infrastructures and technologies to increase (efficiency of) supply, flood protection, often end-of-pipe solutions tackling symptoms rather than causes of overexploitation or pollution (e.g. water treatment)	Adaptive and experimental management, with nature-based solutions (e.g. restorations) and green infrastructures as preferred means, prevention of pollution and overexploitation at source (e.g. via ´polluter-pays´ principle or payments for ecosystem services (PES), extensive local and scientific monitoring)	Management based on ´green infrastructures´ and other nature-based solutions (scientifically assessed), prevention of pollution and overexploitation at source (extensive scientific monitoring), minimisation of human activities in protected areas

Table 3. 3 – Comparison of paradigms in water and land governance and management (based on part 4)

3.2.4 Processes: Governance and learning cycles

The present thesis sets out to analyse informal and formal governance processes in Luxembourg that have followed the entering into force of the EU Water Framework Directive in 2000. It does so with a view to determining, firstly, if and how WFD implementation in Luxembourg has changed how actors govern, manage and engage with water and land (research question 2). Secondly, it analyses if multiloop social learning has emerged among actors in the course of governance processes, and what factors have facilitated or hindered its emergence (research question 3).

In order to structure empirical inquiry into processes and interplays, the present framework breaks down formal and informal governance processes into ideal-typical phases. In doing so, it builds on policy and learning cycles of the MTF (Pahl-Wostl, 2015), but aligns formal and informal governance cycles under common denominations and adds “evaluations” as a separate phase (for more details see methods 5.6.6).

The phases also correspond roughly to the OECD water governance cycle (OECD, 2015) and other cycles developed for adaptive management (Waylen et al., 2019). They are (see table 3. 4 and figure 3. 7):

- *purposes*
- *plans*
- *actions*
- *evaluations*

The phases outlined below are entirely ideal-typical. It is not assumed that governance processes (especially informal ones) can necessarily be broken down into clearly demarcated phases, nor that they necessarily follow the proposed sequence (or should do so). Indeed, they are assumed to be iterative rather than linear. Each phase is likely to involve different kinds of social coordination, knowledge, and actions.

Process phases and cyles	**Formal governance**	**Informal governance**
Purposes: framing and scoping of challenges, institutions and overarching objectives, possibly in conjunction with preliminary assessment of the current state/problems	e.g strategic policy objectives, policies, and legal frameworks	e.g. mission statements, charters
Plans; dialogues, negotiations and agreements on operational goals and policies, planning of measures (action or management plans), incl. distribution of rules, tasks and mandates, time, knowledge, funding, resource allocation and partners (including network-building via the mobilisation of additional actors)	e.g. operational objectives and measures elaborated in the framework of formal management and actions plans, including distribution of formal competences, allocation of public funds	e.g. joint plans, task distribution, funding strategies, mobilisation of additional support
Actions: implementation and experimentation, monitoring of progress, outcomes and effects (e.g. data collection)	Implementation and monitoring of measures	Carrying out of joint activities, experimentation, pilots, and other measures (incl. monitoring)
Evaluations: joint analysis of effectiveness of measures and of unintended and uncertain effects, and/or of reasons for non-implementation, possibly involving reporting	Formal progress and evaluation reports	Collaborative evaluation of outcomes and effects

Table 3. 4 - Phases and cycles in formal and informal water and land governance

Furthermore, the present thesis develops a scheme that visualises learning loops (figure 7). They include loops within formal and, respectively, informal governance cycles. Possible indicators of social learning are when actions are adjusted (single loop), when strategic and/or operational objectives are questioned and reframed (double loop), based on the evaluation of action outcomes and effects. The likelihood of double loop learning is assumed to be greater, when formal and informal processes intersect: for example, when stakeholder are engaged on in formal governance via public participation on formal management plans, or when governmental actors participate in social networks, e.g. on the elaboration of action plans (Pahl-Wostl, 2015).

Possible indicators of triple loop learning (i.e. paradigm shifts) would be, if overarching purposes and related formal and informal institutions are reframed across *many* different formal and informal governance processes, and that they, furthermore, become tangible in changing patterns in human-environment relations across diverse contexts.

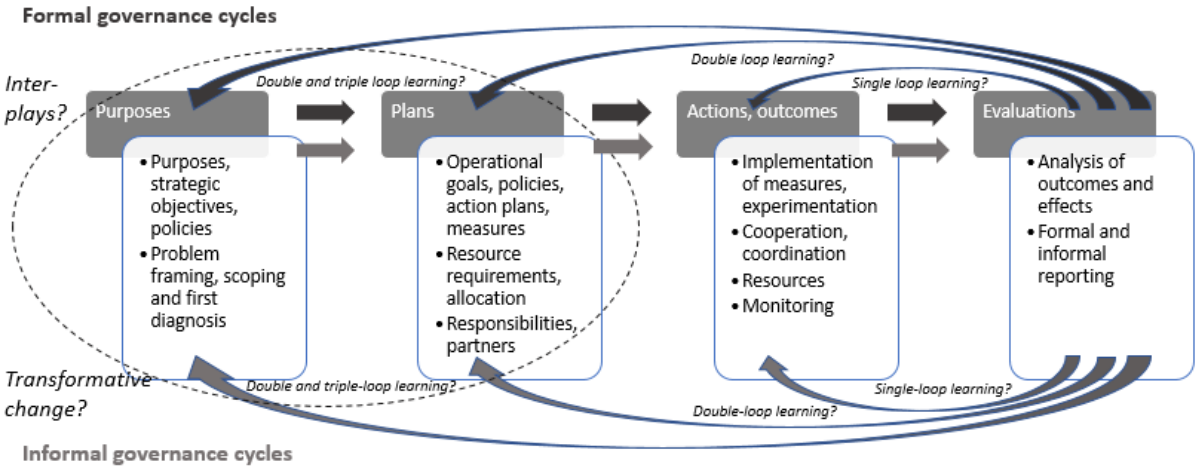

Figure 3.7 - Ideal-typical visualisation of possible social learning feedbacks in formal and informal governance cycles

It is important to note that the graphic is entirely conceptual (not temporal), and does not mean to suggest that formal and informal processes should follow these phases, nor that they should coincide or occur simultaneously in time. Plural perspectives, contradictions and tensions between (diverse) political processes and (diverse) social processes are integral elements of democracies, dynamic adaptive and transformative processes - and some of the most potent sources of learning, creativity and imagination, and, hence, of actionable knowledge.

The empirical analysis of sequences of sub-processes and situations in governance processes undertaken in the present thesis itself constructs a "second-order narrative" (Elliott, 2005). The construction of processes as *plots* will be done on the basis of narratives and statements of interview partners triangulated with other data sets (incl. from documents, observations, and site-visits) that will be interpreted by the researcher to form meaningful and plausible sequences that reflect research purposes, concepts, and methods (see methods 5.2.1 and 5.3). The approach is hermeneutic in a Ricoeurian sense, embracing the idea that meanings emerge from sequences of actions that locate actors in history (see above 3.1.1.1). Based on the MTF, the present thesis uses the notion of "action situations" to break down and analyse governance processes from diverse perspectives (see methods 5.6.1).

As discussed above, social learning entails changes in actor relations, knowledge, and actions. These aspects will be discussed in more detail in the following, considering formal, informal, and material factors that can facilitate or hinder, in particular, *double loop* social learning. The factors and effect

categories outlined in the following build on MTF (including studies on factors facilitating and hindering social learning from ten river basin case studies of Mostert et al., 2007) and various other sources. The main factors are summarised below (see tables 3. 5 and 3. 6).

3.2.5 Actor relations and roles

Network governance and adaptive management are based on actor relations, with social learning as main coordination mechanism. Governance and social learning processes are embedded in webs of power and trust dynamics (Medema et al., 2014). Network governance aims to bring together diverse actors who are likely to belong to different organisations and epistemic communities. Some of the actors may not have been involved in water governance and management before and may have had few contacts; for example, public authorities, farmers, engineers, conservationists, and citizens (Pahl-Wostl, 2015). This requires significant "relational learning" (Lebel et al. 2010). Of particular interest for empirical analysis are the following aspects:

- social networks and boundary organisations,
- interpersonal relations,
- organisational commitment and interorganisational relations.

While the first two have received significant attention in the literature, there has been less empirical research into how interorganisational relations may affect interpersonal relations and network dynamics, and vice versa. The following elaborates on relational aspects of social learning that concern both how interpersonal and organisational factors affect social engagement, and how they themselves may undergo change as a result of social learning.

3.2.5.1 Social networks and boundary organisations

Social networks have gained a prominent place in sustainability science and social-ecological systems approaches (see also conceptual positioning 2.2.1.3). In adaptive governance, social networks are typically defined as groups of diverse actors who meet regularly to discuss and collectively tackle specific challenges. The membership, rules and roles of social networks are more open and flexible than in established organisations (Pahl-Wostl, 2009). While network membership can include organisations, network dynamics depend crucially on the engagement of individual actors. Networks may, for example, be triggered by new regulation, funding opportunities, crisis events, or due to the growing awareness of problems that cannot be addressed by established practices and relations (Medema et al., 2014, Pahl-Wostl, 2015, Folke et al., 2005). In the course of governance processes (e.g. in the planning and action phases), networks might expand or diminish depending on how successful they are in keeping members engaged and in mobilising additional partners.

Social networks rely on ´input legitimacy´ that is usually based more on inclusiveness and diversity rather than on representativeness (Lebel et al., 2010; Mostert et al., 2007; Pahl-Wostl, 2015; Reed, 2008). By bringing together individuals from diverse governmental and nongovernmental organisations in informal open spaces and processes, social networks may blur formal power relations that may exist among members in other settings (Folke et al., 2005).

Bridging or boundary organisations may hold key roles in facilitating and driving the emergence of social networks. Bridging organisations thrive particularly in flexible spaces provided by social networks (Folke et al., 2005). The term ´boundary organisations´ rather than ´bridging organisations´ has been chosen for the purposes of the present thesis, as it implies the notion of acting within often fuzzy and dynamically evolving boundary spaces between different organisations, scales and

epistemologies, rather than as ´bridges´ between static entities[73]. River basin organisations are examples of boundary organisations. They receive particular attention in adaptive (co-) management, including bioregional approaches, and will also be studied in the case studies. As "special purpose organisations" (Huitema & Meijerink, 2017), river basin organisations have been introduced in many countries across the world to enhance the participation or self-governance of nongovernmental actors (e.g. local communities) in water governance. River basin organisations are based on the notion that hydrologically river basins are "logical units" for water resources management that, however, rarely correspond to political jurisdictions or decision-making structures, which, consequently, should be created (Huitema & Meijerink, 2017; Meijerink & Huitema, 2017). Huitema and Meijerink have elaborated on the design principles developed by Ostrom in common-pool resource governance (see 2.2.1.2) to establish four typologies of and analyse institutional power-sharing and coordination arrangements between local and nonlocal actors in multi-stakeholder river basin organisations (Cook et al., 2016; Huitema & Meijerink, 2017)[74].

Social networks, aided by boundary organisations and other possible leaders and facilitators, provide emerging organisational contexts for social interaction particularly that may be particularly conducive to double-loop social learning by (Pahl-Wostl, 2006a, 2009, 2015b):

- facilitating interplays between formal and informal governance processes (e.g. via their governmental and nongovernmental members),
- enhancing interpersonal and inter-organisational relations and commitment,
- enhancing reflexivity and normative debates about purposes, problem framings, and practices by bringing together actors with diverse perspectives,
- facilitating knowledge co-creation,
- developing alternative approaches to tackle challenges, e.g. via experimentation,
- supporting the emergence of new roles among members.

Availability of sufficient time and resources is essential to build networks – as are the status, objectives and ´rules´ (such as concerning membership, decision-making and distribution of costs and benefits (Ostrom, 2009)) of network initiatives and related boundary organisations (Huitema & Meijerink, 2017; Mostert et al., 2007). Extensive research has been carried out on these aspects. The present thesis focuses on how actors (re-)*interpret* and act on institutions, opportunities and constraints (informal and formal) rather than on the formal institutional setups themselves.

Roles: Social networks depend essentially on the commitment of their members and on skilful leaders and facilitators (Mostert et al., 2007). Emerging new roles among actors can serve as indicator for network dynamics and double loop social learning. Building on Goffman (see 2.3.2.1), MTF is based on the notion that roles do not simply exist, but are (self-) defined in a given social context and "linked to expectations about behaviour" of others (Pahl-Wostl, 2015). Transformative change towards adaptive management requires fundamental shifts in roles that have grown historically (Pahl-Wostl, 2006a, 2015b). For example, public administrations need to cease some of their authority as regulators, share

[73] Cash and Moser (2000) were among the first scholars to have used the term, referring to mediators between scientists and decision-makers at different scales. They based themselves on the notion of boundaries by Jasanoff for whom boundaries between science and policy were fuzzy and dynamically shifting. Originally, therefore the term was predominantly employed in relation to the transfer and use of scientific information at the science-policy interface. Reid et al. (2006), among others, extended the concept to include the facilitation of cross-scale information flows that included local and indigenous knowledge.

[74] The typologies include river basin organisations as bottom-up partnerships (type 4) controlled mainly by local actors, as coordinating organisations (type 3) that act as facilitators between diverse bodies, agencies (type 2) that have received a (governmental) mandate for one particular issue, and fully autonomous organisations (type 1) vis-à-vis governmental actors that control some of the water cycle (Huitema & Meijerink, 2017).

responsibilities and *become facilitators of* processes. Farmers may need to reframe their narrative identities from being food producers to supporting and delivering a wide range of ecosystem services, in close cooperation with other organisations. Engineers may need to develop skills in planning and implementing ´green infrastructures´ (Pahl-Wostl, 2006). Social networks provide contexts, in which actors can explore new roles, and how to cooperate with new partners.

In the course of informal governance processes, network members can adopt several, overlapping and evolving roles. The MTF scheme distinguishes between leaders, "policy entrepreneurs", external facilitators or mediators, scientific/technical experts, active and passive participants (Pahl-Wostl, 2015)[75]. *Leaders and facilitators* seek to steer networks in a certain direction, convene and make strategies for meetings (Mostert et al., 2007; Wiek et al., 2012). River basin organisations may assume leading and/or facilitating roles. They need to be perceived as having a certain legitimacy, and the necessary capacities to assume leadership (Pahl-Wostl, 2015). At the same time, the personalities and qualities of key ´leading´ and facilitating actors may be more important than the organisational structures and procedures that support the network (Folke et al., 2005; Hahn et al., 2006). "Transformational leadership" is characterised by recognising and seizing opportunities, overcoming constraints and barriers (e.g. conflicts), facilitating and ensuring transparent and non-technical information flows, identifying "knowledge gaps" and creating "nodes of expertise" for e.g. ecosystem management (Folke et al., 2005). *Policy entrepreneurs* may not actually steer the network, but contribute with innovative ideas, build coalitions and recognise windows of opportunities for action.

Active participants are those who contribute actively to a process as ´backbones´ of any collaborative process. With a view to informal governance processes and social learning, it is therefore particularly pertinent to examine who participates as active members, from which organisations, scales, and sectors. Active participants "share the risks, responsibilities, resources and rewards". But there may also be actors who actively try to "jeopardize a process and bargain for their own advantage" (Pahl-Wostl, 2015).

P*assive participants* are "by-standers" that participate in activities as observers, e.g. for a lack of resources (e.g. time) or organisational commitment (see below). Passive participants may be important, because their very presence might influence member behaviour and/or because they could potentially be important partners (Pahl-Wostl, 2015). Sometimes, external persons or organisations (e.g. boundary organisations) act as *facilitators or mediators* to resolve conflicts and contribute with independent experience. Finally, *scientific/technical experts* may be invited to contribute with specific expertise or advice on a particular topic of interest. Ideally, such experts act as "honest brokers" of scientific/technical knowledge. However, they may also be brought in strategically to strengthen the position of particular actors (Pahl-Wostl, 2015).

In the case studies of the present thesis, the emergence of social learning, the expansion of its membership, and changing roles among members will be examined under the outcome category "network effects" derived from Wiek et al. (2014). While the above has concentrated on *positive* network effects, empirical analysis will also consider negative network effects, such as when network dynamics weaken or disintegrate.

[75] Folke et al. (2005) distinguish between leaders, information brokers and knowledge interpreters, "salesmen" (who persuade others of benefits of engaging in networks), knowledge carriers and generators, stewards, facilitators, visionaries, inspirers, innovators, experimenters, followers, and reinforcers. However, as the roles seem overlapping and are not further defined and differentiated, they will not be discussed further.

Network effects are considered to be primarily informal, but may include formal outcomes, such as the setting up of formal joint projects or other institutionalised structures, funding arrangements or similar.

Effect category - Network effects: network(s) created, enhanced (e.g. through new or changing roles), expanded or reduced (elaborated from Pahl-Wostl, 2015; Wiek et al., 2014)

3.2.5.2 Interpersonal relations

The overarching purpose of social networks is to enhance relations among its individual members. Not least since the beginnings of common-pool resource management (see 2.2.1.2), face-to-face interaction has received prominent attention in governance and social learning processes. From a transactional perspective, too, regular shared experiences are essential (Van Poeck et al., 2018).

Scholarship on interpersonal relations includes analyses on the quality of interaction and communication in microsituations, and of how the quality of interpersonal relations evolves in the course of social learning processes. For present purposes, the category "interpersonal relations" encompasses both. When relational practices are characterised by reciprocity and reflexivity, it is most likely that collective capacities for tackling complex challenges are enhanced (Pahl-Wostl, 2015).

How actors engage in conversations to explore diverse perspectives strongly influences the emergence of shared understandings of challenges. Scholars have developed diverse methods to enhance informal and open exchanges, e.g. via "dialogic interaction" (Wals & Schwarzin, 2012) and "dialogic learning" (Wegerif et al., 2017). Principles include that participants listen to each other without judging (Medema et al., 2014), embrace differences in perspectives and values as enriching (König, 2018; Mostert et al., 2007), are comfortable to voice own views without fearing to jeopardise group harmony, and explore critical and divergent views (Wegerif & Major, 2019).

As regards the quality of interpersonal relations, the following factors are frequently cited in the literature as facilitating social learning: awareness of interdependence, reciprocity and reflexivity, trust and commitment, and conflict management. The recognition of interdependence enhances the willingness of actors to participate in networks (Bouwen & Taillieu, 2004; Mostert et al., 2007). For example, water authorities may need to recognise that the effectiveness of policies ultimately depends on their acceptance and implementation by local actors (Mostert, 2003b; Mostert et al., 2007). "Lived interdependence" entails the willingness of participants to enact complex relationships in continuous negotiations that are less about ´solving´ "social dilemmas", but as being "able and willing to live with imbalances and inequalities in a flexible and evolving way of giving and taking" (Bouwen & Taillieu, 2004). Double loop learning thus entails mutual engagement that is not about ´winning´ or ´losing´, ´right´ or ´wrong´ (to cite Argyris and Schön, 1996).

Trust entails that actors expect that others will stick to joint commitments and agreements (Mostert et al., 2008), and therefore makes social life more predictable (Folke et al, 2005)[76]. Trust-building thus enhances the confidence of actors that mutual engagement might produce better results than unilateral actions (Mostert et al., 2008; Sol et al., 2013).

At the same time, there are likely to be conflicts among actors, especially when power relations are asymmetric, past conflicts unresolved, situations, are polarised and/or when issues at stake have become ´hot topics´ in the public arena (Folke et al., 2005; Pahl-Wostl, 2015). If conflicts are not

[76] Hannah Arendt on the significance of trust in turbulent times: "The remedy for unpredictability, for the chaotic uncertainty of the future, is contained in the faculty to make and keep promises" (Arendt, 1998)

settled, some actors may seek to block actions and thereby jeopardize social learning. The ability to manage and settle conflicts, e.g. by boundary organisations or facilitators, is therefore crucial.

Closely related to trust is the motivation and commitment of network members (Medema et al., 2014; Mostert et al., 2007; Sol et al., 2013). Commitment can be understood as "the extent to which participants and their organisational backgrounds expend their resources on the goals of the project", including in terms of time and money (Sol et al., 2013). *Personal commitment* includes the passion and motivation of individual actors to participate, which may be influenced by past experiences of cooperation (Mostert et al., 2007). Importantly, scholars note, there may be discrepancies between personal and organisational commitments, for example as regards the "strategic agendas" of individuals and their organisations (Sol et al, 2013). Conflicting and rigid organisational mandates may impede personal involvement, and the emergence of trustful relations (Mostert et al., 2007). The support and ´leeway´ organisations grant to their members in engaging fully and flexibly in social networks is therefore crucial (Wenger, 1998).

For the purposes of the present thesis, relations between personal and organisational commitment will be closely investigated. It is assumed that interpersonal relations, levels of trust and conflicts may partly reflect inter-organisational relations, histories of cooperation, discrepancies in approaches (e.g. differences in paradigms) and narrative identities.

Effect category - Quality of interpersonal relations (informal): relational and communicative qualities among individual actors enhanced or worsened (based on the above and (Van Poeck et al., 2018))

3.2.5.3 Organisational relations

The significance of organisational contexts and, more precisely, organisational epistemic cultures and practices for social networks and the emergence of double-loop learning is two-fold. Firstly, organisational commitment may be decisive for the ability of members to participate flexibly and fully in networks and, hence, influence their personal commitment. Secondly, as potential ´intermediaries´ between social and societal learning, organisations are better positioned to enact and foster structural changes in institutions and practices than individuals (Amel et al., 2017). Organisational changes – and, hence, organisational learning – are a precondition for wider transformative change (Hahn et al., 2006) (see also 2.3.2.2 and 3.1.2.3).

As regards the first point, organisations of network members can facilitate or hinder double loop social learning in social networks. Organisational commitment implies that organisations encourage members to participate and that they are given sufficient time, leeway and resources to do so (Sol et al., 2013; Wenger, 1998). Organisational commitment may be affected by inter-organisational relations and trust and histories of past cooperation. It is also a matter of intra-organisational culture (see 3.1.2.3): an open and dedicated organisational leadership and non-hierarchical and flexible management structures that support spaces for self-organisation and individual autonomy are important facilitating factors (Amel et al., 2017; Folke, 2006; Wenger, 1998). Organisations may also have internal incentive systems in place that recognise and reward network activities (Wenger, 1998). In contrast, organisations with a "mode I theory-in-use" may be reluctant to commit to processes that may raise critical questions about their purposes and, therefore, grant members limited autonomy (Argyris & Schön, 1996; Armitage et al., 2008a).

Secondly, based on their engagement and experience in network activities, members may foster intra-organisational double loop learning, e.g. by bringing new information and knowledge to their home organisations and by encouraging them to introduce internal structural changes. These may include the revision of overall organisational purposes and strategies, funding allocation, the creation of new

departments or positions or new job descriptions (Amel et al., 2017; Mostert et al., 2007; Wiek et al., 2014). Adding insights from organisational learning (see 3.1.2.3), other organisational learning effects could include a reframing of internal interests and conflicts, of relations to other organisations, and of the organisational environment as a whole (Argyris & Schön, 1996). All of these changes may be based on the recognition of limits of existing organisational structures and strategies, and of new opportunities. The role of organisational knowledge is further discussed below.

Finally, entirely new organisations may be set up as a result of social learning processes to formally institutionalise network cooperation or elements of it , for example, via new river basin organisations (Hahn et al., 2006; Meijerink & Huitema, 2017).

Effect categories - organisational effects (based on Medema et al., 2014; Mostert et al., 2007; Sol et al., 2013; Wiek et al., 2014)

-**Organisational commitment**: support for network cooperation enhanced or reduced (mainly informal)

- **Organisational learning**: informal learning (e.g. revised tacit and explicit action strategies) and formal learning (e.g. revision of official organisational mission statements, strategies, rules)

- **New organisation(s)** and/or organisational mandates, positions and job descriptions, etc. (formal)

3.2.6 (Actionable) knowledge

Dialogues about the what, why, and how of tackling water and land challenges lay the foundation for governance processes. Framing involves determining the nature and causes of challenges, purposes to be achieved, at which scale, and by which means (Pahl-Wostl, 2015). Framing sets the scope and boundaries of joint actions. Framing dialogues should be pluralistic and open so as not to exclude actors by imposing certain perspectives, and in order not to restrain the imagination of participants. (Mostert et al., 2007; Pahl-Wostl, 2015) Framing, therefore, is highly normative and political. The emergence of shared understandings of challenges, therefore, will often require significant time, and are unlikely to emerge in situations of polarisation and distrust. How challenges are framed may be decisive for the support that social networks or policy-makers are able to mobilise in governance processes[77].

Sustainability challenges require new understandings of human-environment interaction. To challenge prevailing ways of knowing and to foster knowledge about complex causes and effects that lead to collective action is one of the main objectives of social learning. Sustainability learning has been defined as a kind of social learning that makes people aware of the harmful consequences their actions produce on ecosystems, receptive to ecological deterioration, changes their attitudes, and helps them develop the capacity and agency to adapt their behaviour and institutions to limits of life-support systems (Tabara & Chabay, 2013; Tabara & Pahl-Wostl, 2007). Epistemic aspects and indicators of double loop social learning can be referred to as “conceptual change” (Scholz et al.,2013), convergent “change in understanding” (Reed et al., 2010), “frames of reference” (Sipos et al., 2008) or “change in perception, knowledge” and “shared reframing” flowing from enhanced “reflexivity” (Sol et al., 2013).

[77] Framing has been the object of many scholarly articles and debates (Dewulf et al., 2009; Gray, 2004). However, it has been considered beyond the scope of the present thesis to enter into more details.

Different purposes and assumptions about human-environment relations underlie the epistemic cultures and practices of organisations. The distinction made above will help to guide empirical inquiry:

- Narrow anthropocentric purposes
- Broad anthropocentric purposes
- Broad ecocentric purposes
- Narrow ecocentric purposes

Furthermore, paradigms are considered to shape local, professional, and organisational knowledge and, thereby, how actors understand and address challenges (see 3.1.3 above and 3.3 below).

Actionable knowledge and double loop learning expand personal meaning frames and experience. Knowledge co-creation in social networks might be one of the most promising paths. The following discusses the epistemic dimension of social learning with a view to how water and land challenges and possible ways of tackling them are framed, along the dimensions identified of actionable knowledge (see figure 3.8):

- Normative dimension: *(re-)framing* of challenges in relation to specific purposes and institutions, including desirable states and futures (might be expressed in narratives and imaginaries),
- Systems dimension: *(re-)scoping* of challenges in relation to factors and cause-effect relations considered relevant, based on knowledge of past, present, and anticipated future dynamics
- Transformation dimension: *revising* action strategies and means of tackling challenges in relation to institutionalised practices, problem-solving repertoires, and strategies

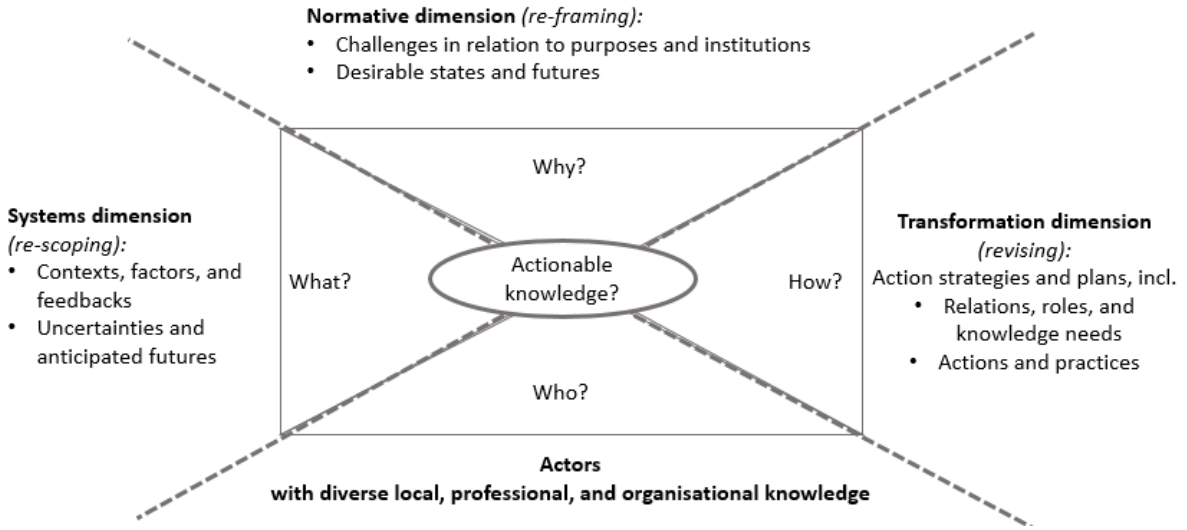

Figure 3.8 - Dimensions of actionable knowledge in relation to double loop social learning

3.2.6.1 Why: Normative dimension

Environmental deterioration and feedbacks such as climate change cast doubt on the narrow anthropocentric purposes that have been dominant in water and land governance. The EU Water Framework Directive obliges member states to restore their water bodies to a good ecological status, the EU Common Agricultural Policy has introduced stricter environmental requirements on agriculture. At the same time, most agriculture in Europe continues to depend on global competitiveness. Societal prosperity is still tied to economic growth. Sustainability challenges are wicked, necessitating normative debates and context-specific approaches. Against the background of contradictions and

ambiguity in current systems, scholars diagnose a high level of normative uncertainty (Funtowicz & Ravetz, 2008; Lebel et al., 2010). Social learning aims to enhance the reflexive capacities of actors to question their own purposes and to be able to relate to different purposes and sets of values of others, e.g. via "cognitive switching" (König, 2018). Others refer to the need for "normative learning" that aims to reduce normative uncertainty and foster a sense of shared purpose among diverse actors (Lebel et al., 2010). Double loop learning in social networks entails that purposes are reframed in a manner that enhances synergies and reduces conflicts between actors involved (Pahl-Wostl, 2015). Furthermore, existing regulation may need to be (re-)interpreted in a manner that makes it possible to reconcile possible tensions and contradictions.

Perspectives of actors on challenges and purposes to be pursued in water and land governance are likely to differ depending on the contexts in which they are embedded. Empirical analysis will investigate actor perspectives with a view to tensions and synergies, and how they evolve in the course of governance processes:

- *Purposes*: how actors understand and frame challenges in relation to purposes they pursue (e.g. narrow or broadly anthropocentric, ecocentric)
- *Institutions*: formal and informal institutions that shape framings, how they are interpreted, incl. related constraints and opportunities
- *Narratives:* How different purposes, institutions, and identities are reflected in narratives about the past, what is considered desirable in the present and in the future (including imaginaries)

The analysis will seek to identify factors that facilitate or hinder that established institutions are critically questioned and reframed, that tensions and contradictions are overcome, and that understandings of challenges converge. Particular attention will be devoted to, firstly, how formal regulative institutions (such as the EU WFD) and their interpretations have influenced informal governance and social learning; and, secondly, to organisational contexts and how social networks and boundary organisations facilitate the emergence of double loop learning among actors of different organisations and professions.

Finally, the understanding of sustainability learning outlined above included the idea that actors need to recognise - and be ready to assume responsibility for – possible harmful environmental effects of their actions and practices that they may not have acknowledged or addressed before. It will therefore be analysed if and how such awareness is accompanied by personal and organisational learning and reflected in changing narratives.

3.2.6.2 What: Systems dimension

Sustainability challenges call for contextualised perspectives that consider how complex interactions between multiple factors manifest themselves in specific (e.g. local) contexts, and related uncertainties (see conceptual positioning 2.1.3). Uncertainties in complex systems are ontological, because system dynamics are often unpredictable. They are also epistemological, because they raise questions about what knowledge, methods, and processes are suitable to come to grips with complexity and to interpret data and information (Halbe et al., 2013; Lebel et al., 2010).

Complex systems theory is at the basis of calls to treat water and agriculture as part of integrated landscape and ecosystem-based management, and to complement specialised scientific and technical expertise with other types of knowledge. Social learning aims to foster systems knowledge and the capacities of actors to deal with complexity, uncertainties and to anticipate possible futures by bringing together multiple perspectives and knowledge types, e.g. local and scientific (Grunwald, 2016; König,

2018; Wiek et al., 2011). Thereby, social learning seeks to enhance the individual and collective "capacity to expect the unexpected" (Folke et al., 2005). At the same time, it aims to strengthen "anticipatory competences" of actors, so that actions can be more than mere reactions to existing problems and occurring events (Wiek et al., 2011).

Adaptive governance and management stresses the need for ecological knowledge (e.g. as part of local knowledge) to enhance understandings of social-ecological interactions (Berkes & Folke, 2002; Folke et al., 2005). Enhanced ecological knowledge is a precondition for the capacity of actors to respond to environmental feedbacks in a contextualised manner, and, hence, for adaptive ecosystem-based and resilience-oriented approaches (Berkes & Folke, 2002; Reid et al., 2006). The emphasis on ecological knowledge encompasses an idea that is central to the definition of sustainability learning provided above: that actors need to develop a better understanding of the ecological effects that their practices have. The fact that many effects are imperceptible, remote, and contested supports arguments in favour of complementing local ecological knowledge by scientific knowledge (Berkes & Folke, 2002). By cooperating with each other (e.g. in the framework of citizen science projects), local communities and disciplinary scientists could enhance their understanding of ecosystem dynamics (Goldstein, 1999; Jasanoff, 2005).

For the purposes of the present thesis, ecological knowledge is considered an important element of systems knowledge and of *all* community-based knowledge types. The present thesis explicitly adds non-scientific professional and organisational knowledge. Considering ecological effects of professional and organisational activities – and their growing "professionalization", specialisation, and automatisation (Beck, 2016; Knorr Cetina, 2007; Schön, 1983) – ecological knowledge (scientific and non-scientific) will also be investigated with a view to professions and organisations.

Furthermore, the present thesis is based on the assumption that efforts to foster actionable knowledge would benefit from an actor-centred perspective that takes more strongly into account that knowledge and action flow from the embeddedness of actors in diverse personal, transactional, and organisational contexts. Actors need to become more aware of how their own and others´ actions and practices are interlinked with multiple contexts, both in terms of how they are shaped by and how they affect them. This includes, notably, an enhanced understanding of how e.g. local and professional practices *depend* on and, at the same time, *affect* water and land, and related ecological processes (i.e. ecological knowledge). Double loop learning would then entail that actors place challenges and actions in *other* contexts than before. For example, the framing and scoping of water challenges could encompass agriculture *and* local community life, and, conversely, agricultural challenges water and environmental management. Enhanced systems knowledge thus expands the scope applied to own and other actions, thereby altering the ´webs of meanings´ and ´webs of causality´ that are contexts.

In terms of governance processes, this means that just as the purposes attributed to water management and agriculture need to become more integrated, so does the scope in which challenges are understood and dealt with.

Finally, systems knowledge has a narrative quality in constructing ´stories´ about cause-effect relations in the present that are based on interpretations of past and possible future events (Wilbanks, 2006). Transformative sustainability science and adaptive governance are complementary in this regard. In adaptive governance, particular emphasis is placed on the importance of "social memory" in local communities and social networks as a source of resilience. Social networks provide spaces, in which communities can, for example, draw on experiences with past crisis events, how they emerged and how they coped with them. These experiences can be turned into strategies for the future (Folke et al., 2005; Hahn et al., 2006). Transformative sustainability science, on the other hand, is more future-oriented by seeking to strengthen anticipatory competences of actors via participatory scenario

processes that direct attention to “uncertainties, unknowns, possible disruptive events and multiple worldviews and values” and serve to help actors in deciding on how to shape possible future via their actions (e.g. Drenth et al., 2018).

On the basis of the above, the systems dimensions will be analysed with a view to how actors delineate the scope of challenges and what contexts and factors they regard as relevant, and how they narratively interweave challenges with interpretations of pasts and possible futures.

3.2.6.3 How: Transformation dimension

Transformation knowledge entails judgements about which courses of action to take, based on systems and normative knowledge (Grunwald, 2016; König, 2018). When scopes of challenges are expanded to reflect complex interrelations and multiple – partly conflicting - purposes, decisions about what actions to take also become more complex. To turn knowledge about complexity, contradictions and conflicts, uncertain effects and futures, and normative ambiguity into collective strategies and plans for action is a key challenge. Complexity can overstrain cognitive capacities, in which case actors may ´switch back´ to reproduce behavioural routines (Sonnleitner, 2018). Therefore, it is necessary to escape the “complexity dilemma” by breaking down complex challenges into simpler sub-systems and a limited set of factors to be tackled (Newell & Proust, 2018). In other words, actors need to reach a shared understanding of priorities and concrete actions to take (Hadorn et al., 2008). This is a highly normative process. Decisions about what to do are never value-neutral as they inevitably privilege particular actors, institutions and/or practices. They often rest on compromise and may require significant creativity (Verweij et al., 2006)[78]. Furthermore, if part of double loop learning, actions will often have a pioneering and experimental character that is tailored to specific contexts. For this reason, they may encounter significant institutional barriers that necessitate the identification of ´loopholes´ and ´rooms of manoeuvre´. Considering possible legal and financial obstacles, the knowledge of policy-makers and public administrators concerning formal procedures and public funding may be particularly valuable in social networks when moving to action.

Against this background, considerable strategic competence may be required on the part of network leaders, facilitators and participants. Strategic competence can be defined as “the ability to collectively design and implement interventions, transitions, and transformative governance strategies” by creatively circumventing obstacles and being able to mediate between participants (Wiek et al., 2011). Strategic competence requires familiarity with real-world situations, political understandings, practical, interpersonal, diplomatic, fundraising and financial skills, and – perhaps most of all - a drive towards ´getting things done´ (Pahl-Wostl, 2015; Wiek et al., 2011).

At the same time, the present thesis argues in favour of an understanding of transformation knowledge that goes beyond strategic and instrumental aspects. Based on Dewey (3.1.2.1) and Schön (3.1.2.3), the thesis assumes that experiments and experiential engagement between actors and their material environments may be particularly conducive to foster (double loop) social learning for sustainability. Open transactional encounters, in which established assumptions and routines are suspended, require flexible institutional frameworks and the absence of pre-defined goals (see also Kolb, 2015; Sipos et al., 2008; Van Poeck et al., 2018). In this sense, knowledge-for-action embraces the notion of knowledge-*in*-action via learning by doing that is also stressed by scholars in adaptive governance and

[78] Verweij et al. (2006) refer to “clumsy solutions” and “clumsiness” as an ideal condition in democracy. “Clumsiness” denotes the possibility to “generate widely accepted and successful solutions to social ills by constructing institutions in which all the voices are both heard and responded to”. It rests on the quality of processes as well as of outcomes.

management (see below). This understanding also underscores that learning needs to be inspirational, encourage agency and determination to explore novel options in “amusing, enjoyable and motivating ways” (Sipos et al., 2007). If and how shared narratives and imaginaries may contribute to this – or themselves emerge from transactional engagement - will be a subject of empirical analysis.

Monitoring and evaluation: There are no ´solutions´ to wicked problems (Rittel & Webber, 1973). “Solutions” are but tentative hypotheses to be tested in specific contexts. Their effects can only be judged *a posteriori*. Actions may not produce the expected outcomes and, moreover, may trigger unforeseen and undesirable consequences. Unexpected outcomes, however, are opportunities for learning (Huitema et al, 2009).

Monitoring and evaluating outcomes and effects of actions are therefore crucial elements in double loop learning. In experiments, actors constantly need to reassess how situations and contexts evolve, monitor effects of actions and, if necessary, reconsider and revise purposes and action plans. How to monitor joint activities and do evaluations should ideally be part of any plans for action, based on dialogues about criteria and indicators for what is to be monitored and evaluated, how, in which intervals and by whom (Lebel et al., 2010; Mierlo et al., 2010). A systems perspective would encourage the consideration of multiple factors. Evaluation based on the interpretation of data is best done collaboratively. It provides opportunities to reconsider original objectives, methods and means – in other words, to continue to learn from experiences (Mierlo et al., 2010). In addition, there may be internal or external reporting requirements. Aspects of particular interest for empirical analysis are, indeed, if and how evaluations are done and if there are learning loops in the governance processes under investigation, and, furthermore, what the status of specialised scientific expertise is in monitoring and evaluation. Especially in publicly funded projects, scientific data and studies may be required – or network partners themselves may decide on scientific monitoring.

To sum up the above exploration of different types of knowledge and how they relate to double loop learning and action in social networks, the following possible general *epistemic* outcomes of social learning can be retained for empirical analysis:

Outcome categories - epistemic and institutional effects:

- Convergent or divergent framing of challenges and purposes (based on Scholz et al., 2014)
- Normative knowledge: Enhanced reflexivity, overarching purposes and formal or informal institutions reframed (incl. paradigms and narratives) (Lebel et al., 2010; Sol et al., 2013)
- Systems knowledge: enhanced understanding of social-ecological system dynamics (past-present-future), including ecological knowledge (e.g. Folke et al., 2005; König, 2018)
- Transformation knowledge: Collective action strategies (incl. monitoring and evaluation)
- New formal institutions (e.g. policies)

3.2.7 Actions and tangible outcomes

For the purposes of the present thesis, ´action´ will mainly refer to physical actions that produce tangible material outcomes and effects, be they ecological and/or technological or relate to changes in practical skills and professional practices. Actions encompass diverse physical activities such as measures and experiments in ecosystems, pilot projects, the development of new technologies, services, and products (Wiek et al., 2014).

The present thesis investigates what kind of knowledge inspires actors to engage in collaborative action that aims for sustainability, and what are facilitating and hindering factors. Numerous governance and social learning processes do not reach this phase (Pahl-Wostl, 2015). In formal governance and management processes, how plans and policies are implemented ultimately depends on how individuals interpret and act on them (Medema et al., 2014).

In informal governance, moving to action is often important to keep up network dynamics. Participation in joint actions is often an indicator of the level of personal and organisational commitment to the social network. Actions may also reveal (new) institutional and material constraints or opportunities. From a transactional perspective, learning-by-doing and "lived experience" is essential to foster trust, develop new professional skills and practices, and to foster cognitive and behavioural changes (Bouwen & Taillieu, 2004; Kolb, 2015; Medema et al., 2014; Sipos et al., 2008; Van Poeck et al., 2018).

In the literature, considerable attention is therefore devoted to experiments through which actors gain hands-on experience with novel approaches and learn about system dynamics. Experimentation consists in interventions into a system that are constantly revised based on the monitoring of their effects and on other factors (e.g. changing contexts, objectives, etc.). In transformative and action research, there are numerous examples of experimental collaborative approaches that involve citizen science, living laboratories or real-world labs, to name but a few (König, 2018, 2013, Caniglia et al., 2017). In adaptive governance and co-management, there is a strong focus on governance and policy experiments relating to institutional design and public participation in formal governance processes, for example, in river basins (Huitema et al., 2009; Huitema & Meijerink, 2017). Other examples include community or regional development projects (Greif, 2000; Hahn et al., 2006; McGinnis, 1999; Sol et al., 2013). The case studies investigate factors that facilitate or hinder that experiments and other collective actions become opportunities for social learning.

Experiments and other actions can produce a number of material outcomes and effects that can be grouped as follows:

Ecological outcomes and effects: Prominent examples of adaptive water governance and management projects relate to the restoration of rivers and ecosystems as part of the creation of ´green infrastructure´ or other nature-based solutions (see paradigms 4.3). The EU Water Framework and Floods Directives give priority to projects that recreate wetlands and floodplains by allowing water to expand outside riverbeds. Agroecology experiments with diverse crops and cultivation techniques that aim to improve soil quality and water retention, among others.

Changes in professional practices: Through ecological and technological experimentation and projects, practitioners may develop new practical and professional skills and practices. Corresponding to the relative neglect of professional knowledge in the literature, few empirical studies in sustainability science and adaptive governance have analysed what factors facilitate or hinder changes in professional practices and what they entail. Focusing on professional farming practices (and touching upon other practices that have a direct impact on ecosystems), this thesis is an attempt to address this shortcoming.

Technological outcomes: Transformative sustainability research and adaptive governance tend to be sceptical of approaches that give priority to implementing technological means to improve supply or to tackle resource overexploitation or pollution rather than to prevent them at source ("end-of-pipe solutions"). They would usually by interpreted as signs of single loop learning (Pahl-Wostl, 2015).

Transformative sustainability research, however, *does* embrace the participatory development (co-design) of tangible and usable ´real-world´ products, such as technologies, goods, or services (e.g. IT

platforms or softwares) that can contribute to meeting sustainability challenges and are designed according to sustainability principles´. (König, 2018; Wiek et al., 2014)[79] Furthermore, efforts for "sustainable agriculture" rely partly on the development of new sophisticated technologies that reduce ploughing, and the use of fertilisers or pesticides (see 4.3.2).

Effect categories for ´tangible´ material outcomes and effects:

- Ecological effects: ecosystem-based projects or experiments, e.g. river basin restorations
- Technological effects: e.g. new technologies or ´products´ (Wiek et al., 2014)
- Changes in practical skills and/or professional practices

3.3 Summary of the framework on actionable knowledge: Main analytical elements

The framework has elaborated on a number of concepts and analytical categories to structure empirical inquiry. The case studies serve to develop the framework further, which includes the possibility that some concepts and categories will be fundamentally revised or discarded. The main analytical elements of the framework can be summarised with regard to the main research questions:

Research question 1: How can a kind of knowledge be conceptualised that fosters collective action for sustainability?

- A scheme conceptualising actionable knowledge as encompassing normative (why), systems (what), and transformation dimensions (how) of different knowledge types (personal, local, professional scientific and non-scientific, and organisational) (see figures 3. 1 and 3. 8)
- The conceptualisation of knowledge and action as embedded in diverse personal, transactional, organisational, and macro contexts (incl. related formal, informal, and material factors) that shape – and are shaped by – actor engagement (see figures 3. 2 and 3. 3.)

In particular, the case studies examine interrelations between actor engagement and knowledge shared in organisations, with a particular focus on narratives and paradigms.

Research question 2: How has the EU Water Framework Directive changed water and land governance and management in Luxembourg?

- An analytical grid conceptualising and positioning paradigms and approaches in water and land governance along a governance axis (bottom-up, network-based, top-down) and a management/engagement axis (anthropocentric, integrated, ecocentric) (see figures 3. 5 and 3. 6)

The case studies serve to identify, characterise, and compare different formal policies and approaches of actors to water and land governance and management *before* and *after* the EU WFD, as a basis for analysing possible tensions and synergies, and the emergence of social learning. How have the EU WFD and related policies contributed to transformative change in water and land governance and

[79] Contrary to Wiek et al. (2014), the present thesis does not take over "action plans" as "usable products", but considers them under "transformation knowledge". Neither does it consider "non-academic and academic publications" and media articles under this category.

management in Luxembourg? Can new forms of social and material engagement be discerned? Historical contexts and trajectories of organisations will receive particular attention.

Research question 3: What factors facilitate or hinder the emergence of social learning and actionable knowledge for sustainability?

- A scheme conceptualising social learning processes in relation to diverse formal, informal, and material ´input´ and ´outcome/effect´ factors (see figure 3. 4)
- A scheme that visualises ideal-typical formal and informal governance processes that serves to facilitate the identification of interplays and learning loops (see figure 3. 7 and table 3. 4)

The case studies serve to identify and characterise facilitating and hindering factors for multiloop social learning in interrelations between diverse actors and their contexts. The focus is on if and how the EU Water Framework Directive has fostered double loop social and organisational learning among actors professionally engaged in WFD-related governance processes, and on other facilitating and hindering factors (formal, informal, material). Of particular interest are changes in how actors engage with each other and with water, land, and soil in their professional lives. The main factors identified in the literature are summarised in table 3.5 below, with a focus on the transactional engagement of actors and related ´input factors´ and effects that may change personal, organisational, and macro contexts via feedback loops.

Actor engagement	Informal factors	Formal factors	Material factors
Macro contexts	**Social and cultural sphere:** • Societal institutions and narratives	**Formal governance sphere:** • Policies and regulation (e.g. EU WFD)	**Material sphere:** • Biosphere, ecosystems • Infrastructures, technologies • Economic/financial flows • *Crisis/hazard events?*
Organisational contexts (incl. formal organisations, professional and local communities)	• Organisational narratives, paradigms, practices • Shared knowledge, information, data • Network effects (incl. roles) • Quality of inter-organisational relations • Organisational commitment	• Legal status, mandates, procedures • Formal task distribution, roles • Formalised expertise, information, data	• Practices, activities • Built infrastructures, technologies • Economic/financial resources
Transactional contexts	• Quality of interpersonal relations enhanced? • Roles enacted/changed? • Knowledge, institutions enacted, re-framed? • Re-framing/-scoping of challenges, re-thinking action strategies? • Knowledge co-creation? • Experimental engagement?	• Formal institutions, roles enacted/revised? • Formal studies, information used/produced? • New formal organisations created?	• Physical place: ecological improvements? • Technologies, services used/produced?
Personal contexts	**Personal sphere:** • Personal knowledge and reflexivity • Narratives and narrative identities • Well-being **Informal context**: family, friends, neighbours, etc.	**Legal rights and status**	**Material conditions:** • Physical health • Economic/financial resources

Table 3. 5 – Summary of contexts and factors in governance processes elaborated from the literature

The below table 3.6 provides an ideal-typical account of a multiloop social learning processes in water and land governance.

Social learning in water governance	**Formal factors**	**Informal factors**	**Material factors**
Single loop learning	**Organisational contexts**: Formal organisational set-up unchanged **Macro contexts:** Hierarchical and sectoral governance and ´expert´ knowledge continue to dominate	**Organisational, transactional and personal contexts:** Actors stick to established communities, knowledge, and interpretations of institutions	**All contexts:** Water management centred on technologies, ecosystems used as sources and sinks
Double loop learning	**Macro and organisational contexts:** Hierarchical (sectoral) governance and ´expert´ knowledge continue to dominate , but formal public consultations open up for the consideration of local and professional knowledge in policies and plans, more cross-sectoral coordination	**Organisational, transactional and personal contexts:** Actors acknowledge ecological impacts of own actions, question prevailing institutions, knowledge and practices, seek new relations (incl. roles) and knowledge (e.g. within emerging social networks facilitated by boundary organisations)	**All contexts:** (Experiments with) more ecosystem-based water management and nature-based ´solutions´, measures to prevent pollution to improve aquatic ecosystem health
Triple loop learning (societal paradigm shift)	**Organisational contexts:** New formal organisations, institutions and relations **Macro contexts:** New formal governance regime	**Organisational, transactional and personal contexts:** New relations, institutions, knowledge, and practices are institutionalised among existing and new organisations **Macro context**: new institutions, narratives	**All contexts:** New practices, technologies, etc. profoundly change human-environment interactions

Table 3. 6 – Ideal-typical overview of possible phases in multiloop social learning processes including changes in contexts

4 Paradigms in water and land governance and management

Based on the analytical grid developed in the conceptual and analytical framework and on scholarly literature, the present part elaborates on different paradigms in water and land governance that have existed in Western countries before and following the industrialisation of the 19th century. Reflecting a nexus perspective, it includes paradigms relating to water, agriculture, and ecological restoration. The objective of this part is to enable the author of the thesis to place water and land governance in Luxembourg in a Western and European context by identifying ´typical´ and ´untypical´ features. It is important to note that the decision to characterise paradigms has emerged *iteratively* with the case studies. Furthermore, the characterisation of different paradigms serves as a basis for a differentiated analysis of the EU Water Framework Directive and the profound formal changes in introduced. The analysis of the EU WFD concludes this part.

4.1 Preindustrial paradigms

The histories of cultures and civilisations are tied to water and land. Water and land management have been technical, societal, and cultural endeavours. They are interwoven with technical advances and professions, flourishing and faltering societies, with human imagination, narratives, and arts. How humans have engaged with water and land reflect changing paradigms (or "*Weltbilder"*) engrained in the landscapes we inhabit (Parodi, 2008).

Pre-industrial time may seem long-gone; yet some of its hallmarks remain with us today, only reinforced by the later industrial revolution. The preindustrial heritage is two-fold: material and symbolic. Symbolically, it can be associated with two opposing contemporary narratives of human-nature relations that have strongly influenced contemporary paradigms. One of the narratives reflects ´anthropocentric-rationalistic´ views, the other a ´romantic´ perspective (Parodi, 2008): The former regards preindustrial eras as forerunners of modern-industrial times, focusing on history as characterised by human efforts to control nature via technologies to escape hardship and to grow. The ´romantic view´ privileges the idea that, before the onset of industrialisation, humans lived in communities that were ´closer to nature´ (see table 4. 1 below). Elements of both narratives will be briefly outlined below, starting with the former. No matter how the pre-industrial past is interpreted, it has certainly left its imprint on material landscapes.

Since human beings became sedentary 10 000 years ago[80], they have sought to expand limits of natural carrying capacities by controlling nature through creativity and advances in technologies (Dyball & Newell, 2015; Henriquez & van Timmeren, 2017) [81]. Notwithstanding religious and cultural meanings attributed to nature, water and agricultural management have been closely interrelated anthropocentric endeavours that served to secure access to drinkable water, to make land arable and to protect populations against floods (Pahl-Wostl, 2015). Riparian landscapes are among the oldest *cultural* landscapes in Europe (Schaich, 2009).

[80] The situation of nomadic hunters and gatherers was very different: They adapted their behaviour and relocated depending on the availability of resources and seasonally driven changes in environment´s carrying capacity. Dyball & Newell (2015) refer to a "respect for nature" paradigm.

[81] Perhaps Western anthropocentrism is rooted in Greek philosophy, notably, Aristotle´s hierarchical conceptualisation of the universe, with man (only reigned by God) reigning over all worldly beings and matter (B. Scott et al., 2016).

Before scientific ´discoveries´ of natural laws and the Enlightenment ´age of reason and light´ spread more widely in Western populations, many inhabitants must have seen their fate as at the mercy of capricious natural and/or super-natural forces[82]. Human beings strove to make habitats more inhabitable and predictable (Henriquez & van Timmeren, 2017). What could be referred to as an early "paradigm of ownership and control of environments", was centred on farmers labouring to prevent environments to return to their ´natural condition´ (Dyball & Newell, 2015). Settlements and towns grew as long as natural environments and human capabilities to collect, transport, and distribute water and to grow crops and livestock were able to provide sufficient resources (Henriquez & van Timmeren, 2017)[83]. Agricultural yields feeding populations of large historical towns were made possible by large-scale forest clearing, the domestication of animals and plants and, later, irrigation systems that used artificial canals (Henriquez & van Timmeren, 2017; Steffen et al., 2007). The "agricultural revolution" of the Middle Ages brought new tools and equipment (such as horse-drawn ploughs), three-field cropping systems and common herd grazing that led to the creation of open fields and further expansions of human activities (Dendoncker & Crouzat, 2018). The agricultural revolution made possible demographic growth and, after a long period of de-urbanisation, the rise of medieval cities in Europe. Since the Middle Ages (and reaching its peak with globalisation), a "paradigm of environments in the service of remote consumers" has accompanied the ownership and control paradigm, resulting in nutrient flows away from rural communities (Dyball & Newell, 2015).

> *"The reciprocities between cities, their surrounding hinterlands and the terrestrial and aquatic ecosystems that sustain them are the hallmarks of civilisation that remain with us today" (Henriquez & van Timmeren, 2017).*

Agricultural production became part of an extensive market-driven network (further expanded by colonialism), which produced large disparities in levels of power and status, affluence, land ownership, consumption (diets) and health both within and between urban and rural communities, with farmers and rural communities often hit by famines (Dyball & Newell, 2015)[84].

Until well into the 19th century, drinking water supply in Europe relied on local rivers, shallow hand-dug wells, public fountains, and door-to-door water sales. However, especially urban water quality was often so poor that wine or beer were safer choices. Human excrement, runoffs from households and businesses such as tanneries or slaughterhouses made streets filthy and rivers putrid. Many populations were haunted by infectious water-borne diseases and epidemics (Davies, 1996; Dyball &

[82] "[…] in the West, before modern science, the nonhuman world had not been expected to be deliberately ordered. In fact, even in heaven the planets had been termed "the wanderers", moving back and forth irregularly, as it seemed" (Meyer-Abich, 1996). It would thus seem that the "myth" of nature that comes closest to preindustrial paradigms is "nature capricious" (or ´nature flat´). In the group-grid cultural theory, it is "a random world", in which humans fatalistically cope with erratic events like in a lottery (Schwarz & Thompson, 1990). In contrast, for Holling et al. (2002) "nature flat" is a world that imposes no limitations on the ability of humans to change nature, it is infinitely malleable to human control and domination (Holling et al., 2002). This apparent contradiction can be resolved: either humans subdue, or they dominate. With modern science and industrialisation, this antagonistic view of human-nature relations drove control efforts seemingly to their extreme.

[83] Prominent examples of ancient cultures emerging along rivers include ancient Mesopotamia and the Persian Empire located at Tigris and Euphrates rivers, and the Roman Empire with its ½ million inhabitant capital, situated at the Tibet river, and extensive network of aqueducts (Henriquez & van Timmeren, 2017).

[84] Dyball and Newell use Medieval England as an example: "A very small percentage of the community occupied positions of high status, and enjoyed considerable affluence. Much of their wealth stemmed from their control of extensive land areas, and the environmental resources they contained". They included feudal landowners. Large gaps between rich and poor, powerful and powerless, would be further exacerbated on a global scale by colonialism and later globalisation (Dyball & Newell, 2015).

Newell, 2015; Henriquez & van Timmeren, 2017). Rudimentary waterworks that provided a free flow of (relatively) clean water existed mainly in wealthier areas of cities and were an "aristocratic luxury" until "elites" realised that poor public health and environmental conditions posed a risk to their own health (Henriquez & van Timmeren, 2017). This situation only changed with scientific discoveries of pathogens, the industrial revolution, and the rise of democratic nation-states.

The ´romantic´ reading of preindustrial times focuses on other aspects. One is the notion put forward by many adaptive governance and (co-)management scholars that before modern state centralisations (including the nationalisation of resources) and globalisation, the governance and management of natural resources in most places rested primarily on the self-organisation of local communities. Many of them were successful in sustaining them over long periods of time (Berkes, 2002; Berkes & Folke, 2002; Dietz et al., 2003):

> *"Locally evolved institutional arrangements governed by stable communities and buffered from outside forces have sustained resources successfully for centuries, although they often fail when rapid change occurs. Ideal conditions for governance are increasingly rare" (Dietz et al., 2003).*

Although this argument is most frequently put forward in relation to indigenous communities outside of Europe (Brosius, 2006), there is a widespread notion that ´traditional´ rural communities were more respectful of limits and responsive to changes in ecological environments thanks to their direct dependence on and experiential and spiritual embeddedness in nature (Davis, 2006). Based on findings from the co-management literature, these assumed intimate relations can be described by an "ecocultural community metaphor" that strives for integrity among spiritual, physical, and social worlds, especially in – but not limited to – indigenous cultures (Raymond et al., 2013). The co-management literature has nurtured an emphasis on local, traditional, and indigenous knowledge as resting on local customs, traditions, and oral history[85]. Local knowledge is regarded as including valuable ecological knowledge that has grown historically from trial-and-error learning. Some scholars establish direct connections between modern adaptive and traditional management approaches (Berkes, 2002; Berkes & Folke, 2002; Brosius, 2006; Fabricius et al., 2006):

> *"Traditional knowledge, in particular, is increasingly being recognised as holding lessons for adaptive managers. […] traditional knowledge can be described as adaptive because it acknowledges that environmental conditions will always change, assumes in many instances that nature cannot be controlled, and assumes that yields cannot be predicted […] Local people routinely adopt an integrated approach when assessing and managing ecosystems. Culture, natural resources, livelihoods, and management practices are viewed as part of the same system" (Fabricius et al., 2006)*[86]

As regards agriculture and water management, case studies suggest that a "tradition paradigm" (based on traditional/preindustrial farming methods and small farms) continues to play a role in some areas of Europe today (Halbe et al., 2015).

[85] In adaptive governance and co-management, local knowledge is used as a generic term that encompasses indigenous knowledge held by indigenous people and traditional ecological knowledge that has been built over generations and concerns relationships between living beings (including humans) and with their environment (Berkes & Folke, 2002)

[86] Thus understood, the depiction of traditional knowledge and approaches to resources management can be related to the nature myth of "nature evolving" that views systems behaviour as oscillating between discontinuous changes, chaos and order, and self-organisation (Holling et al., 2002)

Another related reason cited by scholars is that, before industrialisation, agrarian societies did not influence the global Earth system to the same extent as later in the so-called Anthropocene (see conceptual positioning 2.1.2)[87]:

> *"Preindustrial human societies indeed influenced their environment in many ways, from local to continental scales […] but they did not have the numbers, social and economic organisation, or technologies needed to equal or dominate the great forces of Nature in magnitude or rate. Their impacts remained largely local and transitory, and well within the bounds of the natural variability of the environment" (Steffen et al., 2007).*

Relying mainly on energy from wind, water, plants, and animals (i.e. for field labour), preindustrial societies did not use Co-2 emitting fossil fuels, coal, and oil to the same extent as would become characteristic of the succeeding Anthropocene. For this reason, simulations and models relating to, among others, carbon emissions and temperatures typically take 1850 as a baseline (Rockström et al., 2009b; Steffen et al., 2007). Furthermore, compared with today, semi-natural mosaic landscapes were characterised by more diverse flora and fauna, with many species depending directly on preindustrial forms of agriculture. Some scholars claim that, in Europe, biodiversity had never been as rich as just before the onset of industrialisation (e.g. Colling, 2005). The International Union for the Conservation of Nature recommends that baselines for nowadays´ biodiversity monitoring and taxonomies for red lists of endangered species go as far back as 1750, if possible (IUCN, 2015).

The examples provided here serve to illustrate that the preindustrial heritage is potentially as significant in relation to contemporary water and land governance as it is ambiguous.

Interpretations of preindustrial times	**´Romantic´ perspectives**	**´Anthropocentric-rationalistic´ perspectives**
Governance	Community-based, especially in rural areas	Elite-driven, undemocratic, stark social disparities
Management/engagement purposes	´Adaptive´ and ´integrated´ approaches in natural resource management and "tradition paradigm" in farming that reflected a systemic perspective	"Paradigm of ownership and control of environments", "Paradigm of environments in the service of remote consumers", availability of clean water as "aristocratic luxury"
State of the environment	Rich biodiversity thanks to preindustrial semi-natural and agricultural landscapes, limited impact of human activities on Earth system	Hardly ´natural´ environments left, landscapes as results of long-standing human control and domestication efforts, urbanisation, and colonialism
Associated narratives	Traditional agrarian societies as ´intact´, egalitarian, and "in sync with nature" (Scott et al., 2016)	Traditional agrarian societies as characterised by large social disparities, poverty, diseases, and famine

Table 4. 1 – Comparison of divergent perspectives on preindustrial times

[87] Examples cited are the megafauna extinctions during the late Pleistocene, the extinctions of the woolly mammoth in Eurasia and giant wombats in Australia during the last ice age (Steffen et al., 2007)

Notwithstanding significant differences in interpretations, preindustrial paradigms can be mapped as based mainly on local and bottom-up governance (including market-oriented trade) and in-between anthropocentric and ecocentric purposes (see figure 4.1). It will be a matter of empirical inquiry to investigate narratives to determine if and how the preindustrial past plays a role in water and land governance in Luxembourg today.

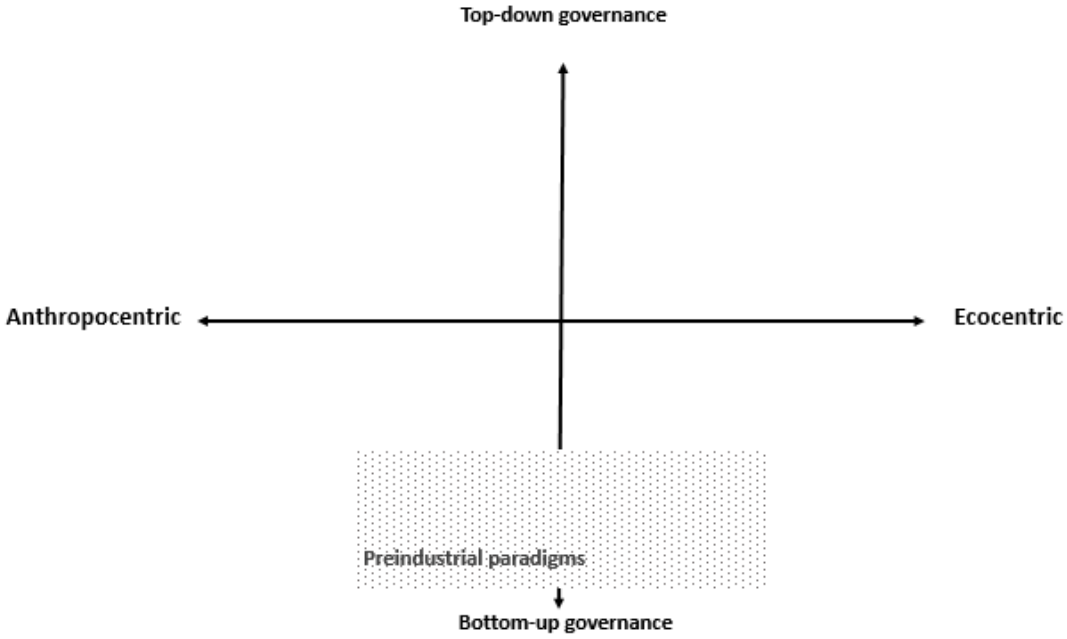

Figure 4.1 – Analytical grid: Positioning preindustrial paradigms

The graphic representation, however, needs to be taken with a grain of salt, because it does not capture the view that European societies, before the rise of modern democratic nation-states, were elite-driven and part of *global* trade flows.

4.2 Modern-industrial paradigms

The term ´modern-industrial paradigms´ covers paradigms and approaches to social organisation and human-environment relations based on hierarchical and market-based governance, modern science and narrow anthropocentric resource management driven by technologies and fossil fuels in the service of economic competition and growth. The ´command-and-control´ and ´productionist´ paradigms in water and, respectively, agricultural management are discussed as expressions of modern-industrial worldviews and practices, and, from an STS perspective, of "technoscientific cultures" (Jasanoff, 2006).

Modern-industrial worldviews can be traced back to the early modern philosophy (René Descartes[88]) and science (Francis Bacon[89]) of the Renaissance (including the scientific revolution, see e.g. Kuhn, 1962), to the Enlightenment[90], and to industrialisation. Enlightenment ideals rested on the belief that humans could and *should* control their own fate, emancipating themselves (incl. in science, ethics, and aesthetics) from the subordination under feudal and religious authorities, and ´natural forces´ (Ezrahi, 2006)[91].

The STS perspective stresses that Enlightenment ideals gave rise to dualistic notions of nature and society, mind and body, that are at the root of modern science, industrialisation, (democratic) hierarchical governance and nowadays´ "technoscientific cultures" (Jasanoff, 2006). Modern science is significant in several regards. On the one hand, resting on standardised methods, procedures and tools (warranted by scientific institutions and communities), science set out to realise Enlightenment ideals that science should be free of political and religious interventions and bias, and that knowledge should, in principle, be attainable by all citizens via teaching and learning (Ezrahi, 2006). On the other hand, disciplinary science and technologies have produced increasingly professional-instrumental, technical and specialised vocabularies that are, *de facto*, reserved to particular professional communities and institutions. Turning enlightenment ideals on their head, knowledge itself has become "something possessed by scientists and other experts" (Ezrahi, 2004)[92]. Technoscientific

[88] With his « I think, therefore I am » Descartes is often regarded as the ´father´ of modern anthropocentric ´sollipsism´ that isolated humans from nature (e.g. Scott et al., 2016). The famous statement was published in his « Discours de la méthode » in 1637 : « Et enfin, considérant que toutes les mêmes pensées que nous avons étant éveillés nous peuvent aussi venir quand nous dormons, sans qu'il y en ait aucune raison pour lors qui soit vraie, je me résolus de feindre que toutes les choses qui m'étaient jamais entrées en l'esprit n'étaient non plus vraies que les illusions de mes songes. Mais aussitôt après je pris garde que, pendant que je voulais ainsi penser que tout était faux, il fallait nécessairement que moi qui le pensais fusse quelque chose; Et remarquant que cette vérité, **je pense, donc je suis**, était si ferme et si assurée, que toutes les plus extravagantes suppositions des Sceptiques n'étaient pas capables de l'ébranler, je jugeai que je pouvais la recevoir sans scrupule pour le premier principe de la Philosophie que je cherchais » (Descartes, 1995, bolds added)

[89]In his utopia "New Atlantis", Bacon wrote in 1624: "The End of our Foundation is the knowledge of Causes, and secret motions of things; and the enlarging of the bounds of Human Empire, to the effecting of all things possible". (Bacon, 2016)

[90] "Aufklärung ist der Ausgang des Menschen aus seiner selbstverschuldeten Unmündigkeit. Unmündigkeit ist das Unvermögen, sich seines Verstandes ohne Leitung eines andere zu bedienen. […] Sapere aude! Habe Mut, dich deines eigenen Verstandes zu bedienen! Ist also der Wahlspruch der Aufklärung". Kant regards human inclination towards free thinking as a "seed" planted in humans by nature herself and as precondition for the freedom to act. This dignity should be reflected as a core principle of government that should make man "more than a machine" (Kant, 1974).

[91] The Enlightenment and modernity are at least as contested and ambiguous as the pre-industrial heritage. In order to "save" the project of modernity, the Enlightenment and democracy, Habermas stresses the normative and aesthetic values of cultural modernity (sometimes referred to as modernism) that freed science (and education), art, and ethics from political and religious despotism. Thereby, cultural modernity also provided a counterweight to societal modernisation associated with state centralisation and bureaucracy, a productivity-oriented economy, and technical-instrumental rationality (Habermas, 1983). Schiller is an example of an Enlightenment intellectural who, as forerunner of romanticism, was also a ´cultural modernist´. He wrote in 1795: "Nicht genug also, daß alle Aufklärung des Verstandes nur insoferne Achtung verdient, als sie auf den Charakter zurückfließt; sie geht auch gewissermaßen von dem Charakter aus, weil der Weg zu dem Kopf durch das Herz muß geöffnet werden. Ausbildung des Empfindungsvermögens ist also das dringendere Bedürfnis der Zeit […]" (Schiller, 1974) While the present chapter focuses on critical perspectives on societal modernisation (which largely neglect the emergence of democracy), the humanist values of cultural modernity and the Enlightenment can be regarded as foundational for some of the conceptualisations of sustainability by transformative researchers discussed in the conceptual positioning part 2.1.3. (e.g. Grunwald, 2016; Stirling, 2015a).

[92] In a similar vein, Millgram coined the term "The Great Endarkenment" to argue that the Enlightenment itself has undone its own achievements, with contemporary times being on "the verge of the new age of superstition"

cultures, according to Jasanoff, have "developed tacit knowledge-ways through which they assess the rationality and robustness of claims that seek to order their lives; demonstrations or arguments that fail to meet these tests may be dismissed as illegitimate or irrational" (Jasanoff, 2007). Adding to this paradox of modern science is the positivist beliefs in the objectivity of science that has become a powerful resource in the hands of policy-makers who can base (highly normative) decisions on allegedly value-free facts produced by increasingly specialised and institutionalised expert systems (e.g. risk and cost-benefit assessments) that are inaccessible to citizens and preclude normative societal debates (Ezrahi, 2006; Jasanoff, 2006; Knorr Cetina, 2007). Moreover, specialised scientific knowledge tends to conceal the risks and uncertainties that emanate from its own "achievements", be they technological, scientific or other (Knorr Cetina, 2007). Modern science has thus contributed to the establishment of hierarchical and technocratic structures of authorities (or ´knowledge monopolies´) and to hidden – but potentially exacerbating – risks (Beck, 1992). Finally, modern science and its materialisations – technologies and engineered infrastructures - have contributed to creating "high-cost realities" that tend to "freeze" social arrangements tied to their production and maintenance (including specific epistemic cultures and practices) that thus become part of the responses to new problems (Ezrahi, 2006; Jasanoff, 2006; Jasanoff & Kim, 2015; Knorr Cetina, 2007).

As "signature characteristics" of contemporary Western societies, science and technologies have penetrated identities, institutions, discourses and representations to such a degree that it is difficult to find – or even imagine – forms of social organisations and ecological systems unaffected by science and technology (Jasanoff, 2006). Ezrahi diagnoses a dominance of technical-instrumental rationality that finds expression in the widespread use of machine metaphors, technical vocabularies (Ezrahi, 2006), mechanistic and technocratic thinking. Examples of "sociotechnical imaginaries" that have entered modern imaginations (along with policy-making, funding schemes and infrastructures) by weaving together nationhood, public goods, technoscientific projects and future-oriented narratives relate, for example, to nuclear power, space programmes, GMOs, differing widely among countries (Jasanoff & Kim, 2009, 2015). In other words, modern science, social and political order, infrastructures and technologies and imaginaries have co-produced each other.

Whilst having cemented dualistic perceptions of relations between man and nature, the omnipresence of technologies and their effects has made the separation between ´nature´ and ´man´ even more constructed than it has always been (Jasanoff, 2006). Focusing on science, policy-making and technology, STS, however, rarely examines these relations, nor their economic dimension.

Other scholars examine how the seemingly infinite possibilities of technological advances fuelled industrialisation and, together with co-evolving new means of social and economic organisation, profoundly changed human-environment relations and the face of the Earth (Steffen et al., 2007). A "paradigm of limitless growth" emerged, in which human engagement with nature became centred on materialistic exploitation of resources and the pursuit of more efficiency and effectiveness (Dyball & Newell, 2015). Problem framings have focused on how to enhance human safety, food security and household and economic water security, in order contribute to public health, overall prosperity, and economic growth. Social and ecological systems were treated as separate and even antagonistic systems (Pahl-Wostl, 2015).

Growth and productivity paradigms are associated with a ´nature myth´ that regards nature as "infinitely malleable and amenable to human control and domination", and humans as capable of

due to the "hyperspecialisation" of ´expert´ knowledge that is impenetrable for citizens (Millgram, 2015). Similar criticism of the "dialectics of the Enlightenment" has been voiced by Horkheimer and Adorno (Horkheimer & Adorno, 1969) and many other scholars.

overcoming all obstacles to exponential growth (mainly thanks to technological ingenuity), in the name of progress (Holling et al., 2002; Scott et al., 2016). The "economic production" metaphor describes how nature and ecosystems are reduced to delivering maximum human and economic benefits in a unilateral and linear direction, without humans giving anything back in return (Raymond et al., 2013). In cultural theory, "nature benign" will forgive any individualistic and economically competitive behaviour by being robust enough to always return to a stable state (Douglas, 1996; Verweij et al., 2006). Overall, materialistic exploitation, technologies and consumerism have resulted in an increasing disconnection from nature, experientially, cognitively and emotionally, sometimes identified as a "root cause of unsustainability" (Ives et al., 2018).

Closely related to one another, agriculture and water management contributed significantly to making possible the transition that turned agrarian societies into industrialised and prosperous nation states. By focusing on the use of natural resources for human consumption and economic production, water and land management until the end of the 20th century (at least) has been dominated by a "sustained yield paradigm" (Cortner & Moote, 1994) that is closely related to the "paradigm of limitless growth". Science and technologies, agriculture, water management, economies, and societies co-evolved, making societies more prosperous, but at the price of the deterioration of ecosystems.

Towards the end of the 20th century, calls for paradigm shifts in water management and agriculture towards more adaptive and integrated approaches emerged. They will be discussed below, following the elaboration of the main characteristics of the "command-and-control" paradigm in water management and the "productionist paradigm" in agriculture.

4.2.1 Water: Command-and-control

The historical account of water management above describes the emergence and institutionalisation of a paradigm that adaptive governance scholars commonly and critically refer to as "command-and-control" (Akamani, 2016; Armitage et al., 2008b; Holling & Meffe, 1996; Kallis & Nijkamp, 2000; Pahl-Wostl et al., 2008a); or, with a view to flood management, as "predict and control" (Halbe et al., 2013; Pahl-Wostl et al., 2006). Alternative denominations are "water development paradigm" (Gleick, 2000), "sustained yield paradigm" (Cortner & Moote, 1994) or "expert-led managerial governing paradigm" (Jager et al., 2016). Given its domination in the 20th century as the "reigning regime" (Pahl-Wostl, 2015), early calls for a paradigm shift also refer to the "traditional paradigm" (Cortner & Moote, 1994; Ison et al., 2004). Its main governance and management characteristics are outlined below, based on the analytical grid (see table 4. 2 and figure 4. 2). It has to be noted that they are almost entirely through the lens of scholars who propose alternative paradigms and approaches.

Analytical grid for investigating paradigms	Command-and-control paradigm in water management
Why: overarching purposes and narratives	Narrow anthropocentric purposes serving health and prosperity: provisioning ecosystem services (drinking water) for household and economic water security, flood protection
	Beliefs in and narratives about continuous progress made possible by economic growth, scientific and technological advances (B. Scott et al., 2016)
Who: main actors involved	National governmental actors, natural scientists and engineers (including ´experts´), technology manufacturers (limited vertical and horizontal coordination)
How: main mechanism of social coordination	Hierarchical top-down and sectoral governance relying on ´expert´ studies, formal regulation and compliance
	Theory of action and behavioural change: ´rational choice´ and ´information deficit model´
What: scope and factors considered	Focus on water bodies and resources, based on national-level linear predictive models (prognoses), hydrological simulations and technical risk assessments carried out by natural scientists taking into account biophysical and infrastructural factors, population and economic development estimates, but no two-way feedbacks
How: main means of material management and engagement, and related metaphors	Technical management based on ´grey´ infrastructures and technologies to increase (efficiency of) supply, flood protection, often end-of-pipe solutions tackling symptoms rather than causes of overexploitation or pollution (e.g. water treatment)
	´Nature myths´ and human-environment relations: • nature as infinitely “malleable” (“nature flat”) or “forgiving” (“nature balanced”) (Holling et al., 2002) • “take, make, waste” relations (Amel et al., 2017) based on materialistic exploitation (Ives et al., 2018) and unidirectional ecosystem services use (Raymond et al., 2013)

Table 4. 2 – Overview of core elements of the ´command-and-control´ paradigm in water governance

Purposes: The paradigm pursues narrow anthropocentric purposes that serve human, societal and economic ends, based on provisioning ecosystem services (water supply), guaranteeing household and economic water security, including safety from floods.

Main actors: Governmental actors (ministries and public administrations in charge of water), natural scientists and engineers, and technology manufacturers are the dominant actors, consumers the main beneficiaries. They constitute an epistemic community that is "characterised by a paradigm or mindset of how water management should be undertaken and which is reflected, and in some cases codified, in practices, laws, technologies, the nature of discourse, etc." (Pahl-Wostl et al., 2010).

Social coordination: The dominant governance mode is hierarchical and based on top-down strategies and formal sectoral regulation, expert studies and public funding (Pahl-Wostl, 2017)[93]. Epistemic cultures and practices rely mainly on formal roles and procedures, beliefs in objective specialised scientific/technical knowledge and technological solutions (Pahl-Wostl, 2015). The paradigm has contributed to an "expert-based scientific monopoly on data and analysis" (Pahl-Wostl et al., 2008a). The dominant social coordination mechanisms associated with formal governance hierarchies is compliance with formal regulation. The underlying ´theory of action´ is rational choice, i.e. that actors will base their decisions and actions on what seems ´rational´ and in their interests, based on the information available to them, seeking to avoid sanctions and pursuing (financial or other) incentives (Pahl-Wostl, 2015).

Scope and factors: Water management has had a narrow focus on water bodies and resources, and related infrastructures, focused on national rather than local and context-specific conditions and needs. Based predominantly on hydrology, the understanding of cause-effect relations in the water system, the elaboration of predictive models for hydrological processes (including for infrastructures such as dams and canals), and hydro-economic models for the design and operation of infrastructures have been at its core (Sivapalan & Blöschl, 2017; Srinivasan et al., 2016). Typical goals of prediction have been to predict flooding events and to estimate future water availability and use, based on available data (e.g. demographic development, per capita water demand, economic productivity) in order to be able to determine the design and capacities of infrastructures (Gleick, 2000; Srinivasan et al., 2016). Although responding to societal needs (and wants), the biophysical system has been treated as independently of the social system, human behaviour and consumption patterns (as the climate) regarded as stable. Two-way feedbacks between social and physical processes[94], possible unintended consequences of seemingly uncontested management decisions, institutional societal changes and possible disruptive events (such as wars, pandemics, social movements, etc.) were generally not taken into account (Srinivasan et al., 2016). Thereby, the paradigm has rested on linear causalities and the assumption that system behaviour can be fully known and controlled. Uncertainties have been treated as ´knowledge gaps´ to be filled by further research. Linear monocausal thinking has contributed to the neglect of environmental and unintended effects of engineered solutions. The self-understanding of hydrological modellers has rested upon developing models to hand them over to decision makers (Srinivasan et al., 2016).

Management means: Challenges have primarily been framed as well-defined problems, for which technical engineering solutions were to be developed, notably to control ecological processes (e.g. in

[93] It seems pertinent to point out that ´top-down´ governance in Western representative democracies has been legitimised through elections and parliaments. Furthermore, scholars rarely elaborate on the existence of municipal water competences that continue to exist in certain countries (such as Luxembourg).

[94] For example, traditional hydrology has not been able to account for the ´levee effect´ in floodplains. Scientists have found that levees can actually increase flood risks and vulnerability of local communities. They argue that more people tend to move into floodplains when high levees suggest safety and reduce the frequency of flood events, because memories of past floods fade and the sense of risk weakens. As a result, when rare but violent floods occur, consequences can be disastrous and defy predictions based on historical data (Di Baldassarre et al., 2015).

flood protection)[95]. The paradigm is based on technologies and large-scale infrastructures for water supply, distribution, treatment and flood protection. Infrastructures have mainly been developed based on blueprints that delivered one-size-fits-all ´solutions´ and blueprints that could be transferred and implemented, regardless of contexts. These are specified in ´state-of-the-art´, which offers heuristics to how problems are to be tackled, and is inscribed in engineering codes, curricula, design and practices (Halbe et al., 2015). Infrastructures are built to last for decades if not centuries. Their construction, operation and maintenance necessitates largely irreversible massive public investments (Srinivasan et al., 2016). Moreover, technologies and infrastructures have concentrated on treating symptoms of pollution (´end-of-pipe solutions´), rather than to prevent or reduce pollution at source (Pahl-Wostl, 2015). Given that overall purposes hardly changed during the past century, increasingly specialised engineers have been able to concentrate on developing and optimising ever-more sophisticated and efficient technologies.

Merits: The paradigm, democratically legitimised, has been effective in achieving its purposes in Western industrialised countries. Furthermore, if water is considered a public good that should benefit society as a whole, the centralisation of some aspects of water governance and management seems suitable to "overcome the potential bias of local interests and to guarantee generally-applicable rules based on formal legislation" (Pahl-Wostl, 2015). For example, it could be argued that it makes sense to introduce standards for water quality from "a higher level rather than being subject to negotiations at local scale" (ibid.).

Limitations: The paradigm allows for low degree of flexibility and adaptive capacity as management ´solutions´ have rarely been tailored to context and "due to high levels of sunk costs in infrastructure and often inflexible legal regulations" (Pahl-Wostl, 2015). *End-of-pipe solutions* have displaced pollution and risks in space and time, making them largely invisible to water users who could increase their levels of consumption seemingly limitlessly (Henriquez & van Timmeren, 2017). The ´information deficit model´ to increase awareness and encourage behaviour changes has proven ineffective (Maggs & Robinson, 2016). Normative issues and policy decisions surrounding water use and pollution (including possible trade-offs) have generally not been subject to public debates, and cross-sectoral coordination (e.g. with agriculture) has been limited. Hierarchical power relations have favoured governmental actors and specialised ´experts´, while engagement with local and professional communities and their knowledge has been secondary. The paradigm has rested on top-down governance that has not sought to engage stakeholder concerns and "to imagine new, transformative solutions that have never been attempted before" (Srinivasan et al., 2016). Furthermore, unintended effects of management practices and infrastructures have been neglected and have sometimes contributed to – or even caused - environmental hazards (such as floods) (Pahl-Wostl, 2015). In general, predictive hydrological models are increasingly inadequate to take into account uncertainties and nonlinear developments, e.g. due but not limited to climate change[96]. Considering the dire state of aquatic ecosystems, the ´output legitimacy´ in terms of *environmental* impacts has not been good.

[95] The German term "Massivwasserbau" describes water management practices that primarily use concrete, steel, stone fillings, and similar means to seal or consolidate riverbeds, to build large infrastructures, etc. (Parodi, 2008)

[96] Hydrology increasingly addresses some of these limitations, and challenges relating to sustainable development, moving e.g. towards models that represent catchments as complex systems, including feedbacks (Sivapalan & Blöschl, 2017). Socio-hydrology and socio-hydrological models seek to take into account adaptive responses of actors and unexpected, emergent behaviour, partly based on "unconventional data" such as from stakeholder engagement (Di Baldassarre et al., 2015; Srinivasan et al., 2016). Engineering curricula are increasingly complemented by education in ecology, stakeholder participation or ethics (incl. for "sustainable engineering", Halbe et al., 2015).

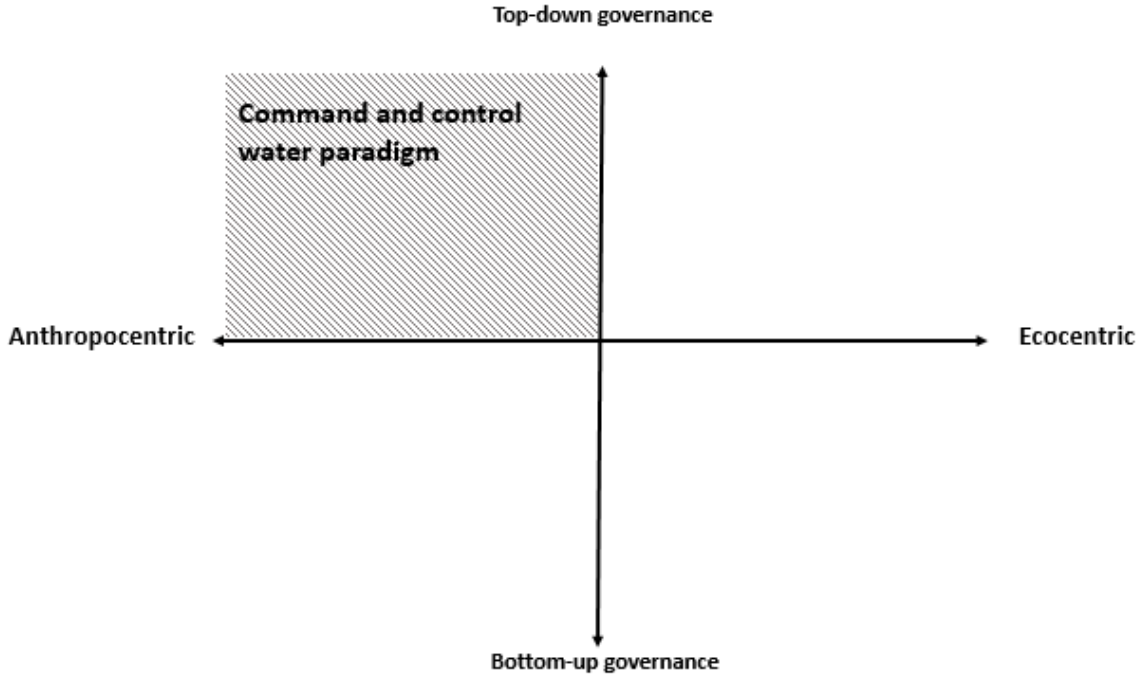

Figure 4.2 – Analytical grid: Positioning the 20th century ´command-and-control´ paradigm

4.2.2 Agriculture: Productionist

The productionist paradigm combines narrow anthropocentric purposes with a mix of market-based and hierarchical governance modes (see table 4. 3 and figure 4. 3). The term "productionist paradigm" denotes a set of beliefs and practices, in which productivity of agricultural commodities is the main criteria by which to judge agriculture (Thompson, 1994). Food production aims to raise outputs through high-energy inputs, producing commodities in high quantities, achieving lower prices per unit, but requiring farmers to produce ever-more to achieve equivalent farming incomes (Dyball & Newell, 2015). Aided by industrial technologies, it became dominant following the Second World War (Thompson, 1994). The term has become part of established discourses in scholarship on sustainable agriculture (Wolf, 2019). Thus, as in the case of water command-and-control-paradigm, terms and concepts elaborated on have been derived from critical perspectives. The productionist paradigm is closely related to the paradigms of "limitless growth" and "environments in the service of remote consumers" (Dyball & Newell, 2015) and the "sustained yield paradigm" (Cortner & Moote, 1994) outlined above. Furthermore, it describes assumptions and approaches associated with "conventional" or "intensive" agriculture that are particularly characteristic of the 1970s and 1980s, but continue to exist until today (Dendoncker & Crouzat, 2018).

Analytical grid for investigating paradigms	Productionist paradigm in agriculture and food systems
Why: overarching purposes	Narrow anthropocentric purposes: provisioning ecosystem services (national, European and global food security) supporting demographic and economic growth, competitiveness of farmers
	Narratives, discourses – farmers contributing to "feeding the world"
Who: main actors involved	Farmers, farm advisors, agricultural scientists, governmental actors, and agro-chemical suppliers (consumers as beneficiaries)
How: main mechanism of social coordination	Mixture of hierarchical top-down governance (formal regulation and public subsidies), markets and self-organisation of farmers
What: scope and factors considered	Agricultural land, demand and supply
How: main means of material management and engagement (physical interventions)	Technical innovation, efficiency and competitiveness, optimisation of variants
	View of nature: nature as domesticated and controlled, product of agricultural practices (van Woerkum & Aarts, 1998)

Table 4. 3 – Main elements of the modern productionist paradigm in agriculture

Purposes: The overall aim in the productionist paradigm is to secure food security via continuous growth of agricultural productivity to match growing demand of populations, within Europe and globally, and to ensure affordable prices for consumers (Davila & Dyball, 2018; Dyball & Newell, 2015; Pretty, 1998). Purposes rest on positivist and instrumental assumptions that "more is more" (P. B. Thompson, 1994). Farm productivity, efficiency, profitability and competitiveness are key and dominate narratives, based on intensification and technologies (Amel et al., 2017; Dendoncker et al., 2018; Ingram, 2018). Agriculture serves to sustain demographic and economic growth (Cortner & Moote, 1994).

Main actors: The main actors are governmental and intergovernmental actors, agricultural scientists, agro-chemical suppliers, retailers and other private businesses, banks, farmers, agricultural chambers and farmers´ associations and unions, farm advisors and consultants (including extension officials), and occupational training institutions such as schools and colleges (Gerber & Hoffmann, 1998; Ingram, 2018; Röling & Jiggins, 1998). They are part of "powerful actor networks" of the agri-food regime that builds on an agricultural knowledge system (Ingram, 2018). Consumers are the main beneficiaries.

Social coordination mechanisms: Social coordination relies on a mix of market-based mechanisms (i.e. under the aegis of the World Trade Organisation) and hierarchical multi-level governance of EU and national policies. Following the Second World War, and driven by the US Marshall Plan for reconstruction in Europe and the 1962 European Common Agricultural Policy (CAP), measures to increase productivity and competitiveness were based on the idea that scientific and technological information needed to be transferred to farmers, e.g. via extension/advisory services and agricultural schools (Ingram, 2008; Ingram & Morris, 2007; Koutsouris & Papadopoulos, 1998; van Weperen et al.,

1998). “Modern agricultural development has begun with the notion that there are technologies that work, and it is just a matter of inducing or persuading farmers to adopt them” (Pretty, 1998). The combination of formal regulation, financial incentives, profit-based market mechanisms and scientific/technical information is thus at the basis of the underlying theory of action and behavioural change (´rational choice´).

Scope and factors: Focusing on provisioning ecosystem services in relation to specific single resources, agriculture is seen from the twin-perspective of markets (economic stocks and flows) and land characterised by a focus on linear causality and specialisation. When soils cannot provide sufficient nutrients for plant and livestock growth (typically consumed elsewhere), artificial nitrogen and phosphorus – extracted from non-renewable sources - are added via chemical fertilisers (Dendoncker et al., 2018; Dyball & Newell, 2015; Pretty, 1998; B. Scott et al., 2016). Plant and livestock systems tend to be regarded separately. Livestock feed has increasingly been imported from elsewhere, just as food is exported globally (Dyball & Newell, 2015). Through pesticides, synthetic fertilisers, and machineries, modern industrial agriculture was to become more independent of local biophysical conditions (incl. soil and weather). Overall, strategies and perspectives are thus characterised by de-contextualisation and specialised sectoral perspectives.

Management means: Modern industrial agriculture relies on mechanisation and motorisation, the development of highly productive plant and livestock varieties (e.g. to boost muscle mass and growth rates) and high anthropogenic input of chemical and synthetic substances, pursuing ever-growing efficiency and effectiveness through technological innovation, scientific knowledge and specialisation (Dendoncker & Crouzat, 2018; Ingram, 2008; Pretty, 1998; Röling & Wagemakers, 1998). Characteristic features of European agriculture in, particularly, the 1970s and 80s included continuous arable cropping, winter cereals, ploughing, minimal rotation (incl. between crops and livestock), monocultures, and intensive grazing (Ingram, 2008, 2018). At the same time, “sustainable intensification” has been used as a concept to reduce environmental damage (Ingram, 2018). In contrast to extensification (relying on expanding cultivated areas), intensification relies on high anthropogenic inputs to increase yields from the same piece of land (Dendoncker & Crouzat, 2018).

Merits: The productionist paradigm has reached its main purpose in Western industrialised countries, where health conditions and life expectancy have continuously increased, partly thanks to the abundant availability of affordable food (Röling & Jiggins, 1998). ´Marginal´ areas that were hardly fit to produce food before (e.g. because of low-nutrient soils), have been made arable, increasing the amount of ´productive´ lands. Furthermore, given continuous world population growth, there have been arguments that intensification has made it possible – and is the very precondition for being able to - “spare land” for nature and to protect habitats elsewhere (Kremen, 2015; Pretty, 1998; Windt & Swart, 2018).

Limitations: The productionist paradigm has had severe social and environmental impacts. High-investment requirements, machines and fierce global competition have driven small farmers and rural workers out of business across the world, changing the social fabric of rural communities (Davila & Dyball, 2018; Pretty, 1998). EU farmers who have remained ´in business´ face high administrative and technical requirements. International food security discourses and large-scale agricultural policies have benefited large specialised producers and corporations, and have increased dependencies of communities on food and animal feed imports from elsewhere on the globe (Davila & Dyball, 2018; Dyball & Newell, 2015). In the 1980s, EU policies produced huge overproduction (Massot, 2019). Due to the low degree of diversification and autonomy (or ´food sovereignty´), scholars diagnose a lack of resilience and adaptive capacities: If one link breaks, the whole system risks to fail (Davila & Dyball, 2018; Dendoncker & Crouzat, 2018). Given high technological and financial investment requirements

to remain competitive, the regime has produced considerable path dependencies and lock-ins (Ingram, 2018).

Furthermore, Western industrialised and developing countries have seen dietary shifts, leading to growing obesity, type-II diabetes, hypertension and cardiovascular diseases, while hunger continuous to be rampant in many places (Davila & Dyball, 2018; Dendoncker & Crouzat, 2018; Dyball & Newell, 2015). Finally, the prices of agricultural commodities do not reflect their social and environmental costs that are carried by societies and taxpayers. Agricultural policies and market mechanisms have been inadequate to address the external costs incurred, for example, by the pollution of drinking water sources (Pretty, 1998; Röling & Jiggins, 1998). As regards environmental effects, modern industrial agriculture has been one of the main drivers in the loss of habitats and biodiversity, eutrophication and pollution of water bodies, and soil degradation due to over-exploitation, the use of chemical substances and broken nutrient cycles that have impaired regeneration capacities (Dyball & Newell, 2015; Ingram & Morris, 2007; Pretty, 1998). By relying on high levels of non-renewable inputs, the productionist paradigm is unsustainable.

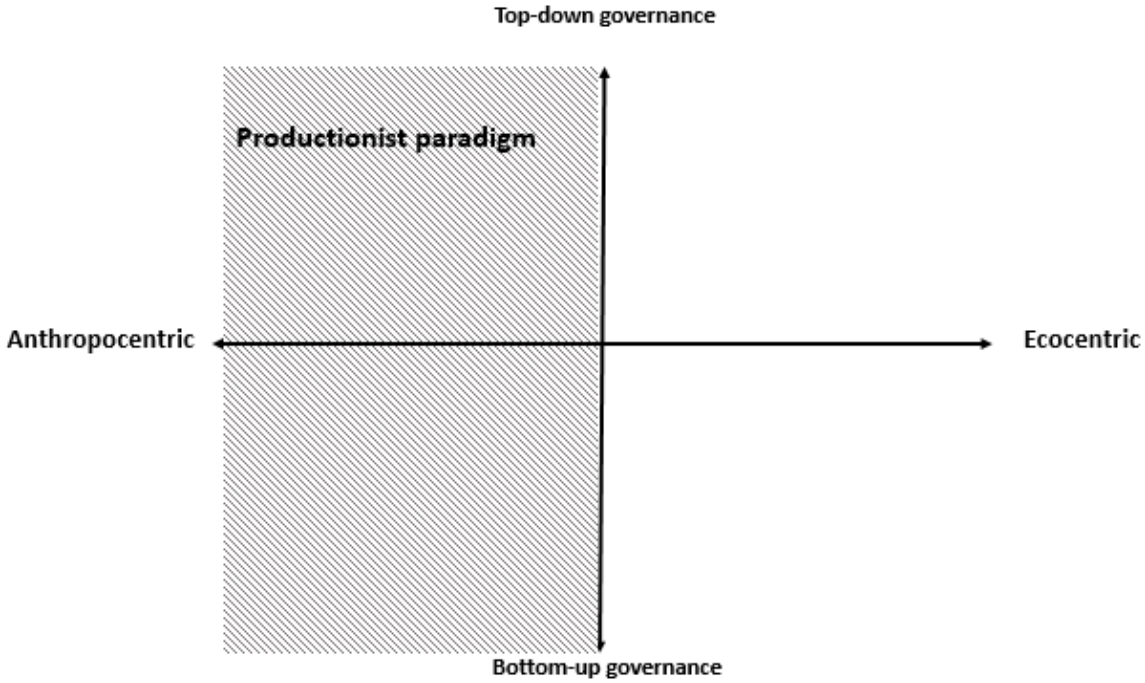

Figure 4.3 - Analytical grid: Positioning the productionist paradigm in agriculture and food systems of the 20th century

4.2.3 Modernisation phases from the 19th to the 20th century

The "modernisation of water" until today can be divided into three phases (Henriquez & van Timmeren, 2017). Attempting a nexus perspective that departs from confines of disciplinary perspectives, the below account combines them with developments in agriculture outlined above (Dendoncker & Crouzat, 2018; Dyball & Newell, 2015).

Phase 1

The industrial revolution in agriculture of the 19th century made possible the industrial revolution *per se* (Dendoncker & Crouzat, 2018). Better ploughs and weed control, ´artificial grassland´, and legumes that replaced fallow land and were used as livestock fodder or green manure significantly increased

production, supporting growing populations that also resulted in the availability of more manpower in agriculture, and further productivity hikes. In parallel, the second half of the mid-19th century saw scientific ´discoveries´ that linked the spread of diseases to poor sanitation and hygiene contributed the construction of first piping networks for potable water supply and sewerage systems in European cities through combined municipalisation and first government investments. With industrialisation and the emergence of nation-states, water supply projects became a matter of national and economic interests (Huitema & Meijerink, 2017).

Phase 2

Following the First World War a "Public Works" era began (lasting well into the second half of the 20th century), with massive government investments and urban planning efforts relating to water, electricity and telecommunication infrastructures (Henriquez & van Timmeren, 2017). They included the expansion of piping networks and sewers, canals, dams and other river regulation efforts. They served to make countries more integrated by facilitating transport and communication (e.g. via regulated and ´shippable´ rivers, bridges, etc.). As projects serving nation-building and the demonstration of engineering skills, they often were objects of national pride (see also "sociotechnical imaginaries" above). In some countries, water management was put in the hands of national administrations, replacing municipal and private organisation (Huitema & Meijerink, 2017).

Thanks to public administrations and engineering, access to abundant and safe water started to be taken for taken for granted across Western industrialised countries. It rendered the technical and financial efforts required to construct, maintain and upgrade water infrastructures – as well as drinking water sources and recipient water bodies of wastewater and effluents - largely invisible to the public (Henriquez & van Timmeren, 2017). Modern science and technology effectively de-contextualised water [97].

Following the Second World War, agriculture experienced a "scientific-technical revolution" that brought fossil-fuel driven machinery, artificial fertilisers (nitrogen) and pesticides, and selection of highly productive (but fragile) crops and animal species produced ever-higher yields. Improved transport systems that connected rural areas and towns contributed to the intensification and specialisation of agricultural production (e.g. separation of crops and livestock systems). Larger fields achieved through consolidation efforts, the conversion of more land into agricultural fields and irrigation systems led to widespread landscape simplifications (Dendoncker & Crouzat, 2018; Pahl-Wostl, 2015). Subsidies paid by the Common Agricultural Policy (CAP) of the European Communities (since 1962) provided massive incentives to farmers to increase food supply for a population struggling to recover from the hardships and famines of the two subsequent wars. More wetlands were converted into arable fields. Thanks to combined efforts in agriculture, water management, economic growth and other areas, life in industrialised Western countries became safer, more comfortable and prosperous. Life expectancy in industrialised countries rose significantly, consumptions levels continued to increase (Dyball & Newell, 2015; Henriquez & van Timmeren, 2017).

[97] "The modern scientific understanding of water removes it from local conditions, its cultural, social, religious and ecological significance of use, and abstracts it as a monolithic timeless and asocial chemical compound: H2O." (Henriquez & van Timmeren, 2017).

However, as of the 1960s awareness of environmental pollution caused by e.g. insufficiently treated wastewater and insecticides and herbicides in agriculture also grew[98], counter-narratives to constant progress and growth emerged put forward by new environmental movements (Gleick, 2000). Pahl-Wostl enumerates some of the following the following drivers and resulting ecological effects that marked 20th century water and land management (Pahl-Wostl, 2015, summary of selected aspects):

- Construction of dams: interruption of connectivity of river systems, disruption of fish migration, alteration of seasonal flood regimes;
- River channelization ("regulated and controlled rivers"): reduction of habitat, alteration of flood patterns;
- Large-scale irrigation and river diversions: alteration of natural flow regimes, reduction of downstream water availability and drying up of wetlands;
- Agricultural expansion: conversion of wetlands, increase in soil salinity through evaporation, off-site pollution;
- Roads and flood control infrastructure: interruption of wetland connectivity, disruption of aquatic habitat;
- Urban and industrial pollution: deterioration of water quality, negative impacts on diversity and abundance of aquatic organisms.

Phase 3

As a response to some of these problems, the 1970s saw the first wave of European water legislation aiming to reduce the discharge of harmful substances in surface and ground waters (Kallis & Nijkamp, 2000). New drinking water and wastewater treatment techniques were introduced. Some of the most harmful pesticides were forbidden. In some countries, the third phase in water management (starting in the 1970s/1980s) also saw some retreat of government via privatisations of e.g. water supply and treatment facilities (Henriquez & van Timmeren, 2017). It also saw the emergence of civil society actors in *governance*, academically bolstered by inquiries into community and self-governance promoting, for example, the idea of integrated water management at the river basin-scale (Huitema & Meijerink, 2017, see below). Furthermore, following the Maastricht Treaty of 1992 that provided its environmental policies with a firm legal basis (EC, 1997), the European Union began to take regulatory initiatives to reduce nitrate pollution from agriculture to counteract worsening water quality and eutrophication of water bodies (Kallis & Nijkamp, 2000; Moussis, 2001).

4.3 Adaptive and integrated paradigms

Since the 1990s (typically building on Holling, see conceptual positioning 2.2.1.1) scholars have coupled normative questions about the overarching purposes that water and land management (including agriculture) are to achieve with calls for paradigm shifts away from narrow anthropocentric, hierarchical and market-oriented approaches (Cortner & Moote, 1994; Gleick, 2000; Patterson & Williams, 1998; Röling & Wagemakers, 1998; Thompson, 1994). Modern-industrial paradigms are unsustainable due to the growing mismatch between human activities and limits of the carrying capacities of environmental systems. Current human uses and pollution increasingly overstretch environmental regeneration capacities, causing unforeseeable consequences and risks, such as extreme weather events that increase the vulnerability of societies, and casts doubts on societies being

[98] Rachel Carson´s ´Silent Spring´ of 1962 about harmful effects of pesticides signalled the beginning of growing environmental awareness and environmental movements in many Western countries (Henriquez & van Timmeren, 2017; B. Scott et al., 2016).

able to provide for their populations in the medium- and long-term (Jacobs et al., 2013; Pahl-Wostl, 2015; Steffen et al., 2007; Vörösmarty et al., 2010). Profound transformations are necessary.

Adaptive and integrated paradigms are examples of "broad or integrated anthropocentrism" that views ecosystem health and human well-being as interdependent, and as embedded in complex systems dynamics. They reject notions that ecosystem responses to human uses are linear, that ecological and social systems can be treated separately, that possibilities of economic growth, human control and exploitation of natural resources are limitless (Folke et al., 2002). Instead, human-environment interactions are conceptualised as coupled via complex feedback loops, often based on the concept of ecosystem services. Ecosystem services are defined as goods and services of ecosystems that benefit people directly or indirectly. They include "provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious, and other nonmaterial benefits" (MEA, 2005). The concept of ecosystem services has become widely established in international and European public policy arenas (EC, 2017; MEA, 2005; UNESCO, 2018) and increasingly serves as a boundary object that engages diverse disciplines from the natural and social sciences as well as non-scientists (Abson et al., 2014)[99].

The concept of ecosystem services can serve to conceptualise feedbacks between social and ecological systems: Human uses may enhance or diminish the ability of ecosystems to produce these services and may, moreover, reduce or contribute to hazards (Pahl-Wostl, 2015; Raymond et al., 2013). Multidirectional interactions between social and ecological systems can also be described by the help of a "closed-loop" metaphor, in which humans manage ecosystem in terms of stocks and flows, aiming to balance degrading, maintaining, enhancing and restoring ecosystem functions (Dyball & Newell, 2015; Raymond et al., 2013). One important objective of adaptive management is to close ´broken links´ in, for example, nutrient and water cycles and to enhance – and/or mimic - natural biophysical processes (Pretty, 1998). At the same time, adaptive approaches emphasise that cycles are nonlinear, going through periodic readjustments and shifts between multiple stable states (´nature resilient´) or may abruptly and unpredictably transform, not least because of human impact (´nature evolving´) (Holling et al., 2002).

Furthermore, different ecological, social and economic values of ecosystems services may stand in synergetic or conflicting relations with each other, necessitating social dialogues and negotiations (Dendoncker et al., 2018). Adaptive approaches share efforts to make water and agriculture part of adaptive and ecosystem-based or "holistic" landscape management that serves both environmental and social purposes, usually from a resilience perspective (Akamani, 2016; Dendoncker et al., 2018; Folke et al., 2002; Pahl-Wostl, 2015; Röling & Wagemakers, 1998). Landscapes are to become "multifunctional", offering diverse ecosystems services that bring together ecosystem health and human well-being (broad anthropocentrism), based on contextualised conditions (e.g. local or river basin scales) and engagement of diverse actors (Dendoncker et al., 2018; Huitema et al., 2009; Pahl-Wostl, 2006a; Schindler et al., 2014). Adaptive approaches understand management as ongoing social learning that requires flexible institutional arrangements instead of fixed rules (Dietz et al., 2003; Folke et al., 2002; Ison et al., 2004; Medema et al., 2008; Pahl-Wostl, Jeffrey, et al., 2008b; Woodhill & Röling, 1998). Ecological restoration seizes to focus exclusively on ecosystems (Schaich, 2009; Swart et al., 2018). In contrast to "land-sparing" outlined above, "land-sharing" develops integrated strategies for land use practices that rely on diverse ecosystem services, reflect and involve local and societal needs and values, giving rise to "hybrid regimes" (Swart et al., 2018; Windt & Swart, 2018). Public and

[99] Abson et al. (2014) also emphasise that, in order to avoid technocratic discourse, more attention should be devoted to normative issues and potential trade-offs between human well-being and biodiversity conservation.

stakeholder engagement in environmental management (including water and land) that builds on local, experiential and practical knowledge of practitioners becomes key (Armitage et al., 2008b; Ison et al., 2004; Pahl-Wostl, 2006a; Reed et al., 2018; Röling & Jiggins, 1998); for example, of farmers (Ingram, 2008; Kloppenburg Jr, 1991; Reid et al., 2006).

As regards water, the current thesis sets out to explore the adaptive and integrated governance and management paradigm proposed by Pahl-Wostl and other scholars. As regards agriculture, it briefly discusses approaches to "sustainable and regenerative agriculture", with a focus on agroecology.

4.3.1 Adaptive and integrated water governance and management

The adaptive and integrated water governance and management paradigm has emerged from a combination of Integrated Water Resources Management (IWRM) and adaptive management from ecology (Pahl-Wostl, 2015; Pahl-Wostl et al., 2008a) (see 2.2.1). The paradigm rests on a broad understanding of water management that also covers approaches such as adaptive co-management (including bioregionalism) that builds on community-based and network-oriented approaches to common-pool-resource governance (Pahl-Wostl et al., 2008a) (see table 4. 4 and figure 4. 4).

Put forward by the Global Water Partnership[100], IWRM seeks to integrate water management with other sectors (including agriculture, industry, transportation, environment, rural development) via cross-sectoral and cross-scale coordination, stakeholder participation and context-specific ´solutions´ that serve economic and social welfare and ecosystem sustainability (Akamani, 2016; GWP, 2000). As in adaptive governance, flexible and diverse institutional frameworks are key components. Adaptive management distinguishes itself from IWRM by highlighting uncertainties in complex adaptive systems, the need for social learning, experimentation, adaptation, and anticipation of external influences and outcomes of management actions (Akamani, 2016; Medema et al., 2008; Pahl-Wostl et al., 2008a).

Purposes: Broadly anthropocentric, the paradigm aims to enhance adaptive (and transformative) capacities of governance systems by fostering continuous social learning processes (Pahl-Wostl, 2015). Its main purposes are to ensure water security for the environment, households and the economy (see above) and a balance of ecosystem services provided by "multifunctional landscapes" (Pahl-Wostl, 2006a). In extending water security to ecosystems, a broader definition has begun to emerge (see also BMU, 2011; Pahl-Wostl et al., 2016), in which water security is defined as the "the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies" (Grey & Sadoff, 2007). The term "acceptable" highlights the normative dimension. What constitutes "acceptable risks" needs to be determined through qualitative risk dialogues between diverse stakeholders (Mostert et al., 2007; Pahl-Wostl, 2015).

The MTF offers a framework to analyse relations between environmental, household and economic water security[101]. Environmental water security is defined as the availability of "sufficient water, in

[100]The Global Water Partnership is a "network of networks" that includes governments, intergovernmental organisations, national and regional water partnerships, NGOs, academic institutions, companies and public service providers that seek to advance water governance and management for sustainable and equitable development (www.gwp.org).

[101] Definitions of household and water security: "Household water security means that the whole population (including poor and vulnerable groups) has reliable and affordable access to sufficient water, in quantity and quality, to satisfy their needs related to health (e.g. drinking water, sanitation, hygiene etc.). […] Economic water security means that the provision of water is, in quantity and quality, sufficient and reliable enough to allow an

quantity and quality as well as temporal distribution" to sustain aquatic ecosystems (Pahl-Wostl et al., 2019)[102]. Environmental water security thus relates to regulating and supporting ecosystem services[103].

Analytical grid for investigating paradigms	**Adaptive and integrated water governance and management paradigm**
Why: overarching purposes and narratives	Broad anthropocentric purposes based on provisioning, regulating, supporting and cultural ecosystem services, water security (environment, households, economies), multifunctional landscapes, adaptive and transformative capacities, resilience
Who: main actors involved	Non-governmental and governmental actors from diverse scales (including river basins) and sectors (e.g. agriculture, conservation, engineering), including researchers, diverse practitioners, citizens and user groups and local communities
How: main mechanism of social coordination	Network governance (social learning) embedded in multi-level polycentric arrangements
What: scope and factors considered	Feedbacks between societal, ecological and technological systems , across sectors and scales
How: main means of material management and engagement, and related metaphors	Adaptive management, with nature-based solutions (e.g. restorations) and green infrastructures as preferred means, prevention of pollution and overexploitation at source
	´Nature myths´ and human-environment relations: • ´nature resilient´ or ´nature evolving´ (Holling et al., 2002) • Metaphor: "closed loops" (Raymond et al., 2013)

Table 4. 4 – Overview of main elements of adaptive and integrated water governance and management

Main actors: Nongovernmental and governmental actors from diverse scales (including river basins) and sectors (e.g. agriculture, conservation, engineering), including researchers, diverse practitioners, citizens and user groups and local communities. Paradigm shifts cannot be designed and implemented in a top-down manner, but require the "active participation of citizens and organised stakeholder

adequate level of economic activities related to agriculture, energy generation, and industry" (Pahl-Wostl et al., 2019)

[102] The environmental dimension of water security - coupled with the emphasis on social learning in governance processes - makes the concept (as used within MTF) different from "food security" discourses that have been dominated by calls for increases in food production (favouring certain trade policies and corporations) and associated with "technical, positivist approaches to tackling hunger through a mix of technological advancements and providing economic access to food" (Davila & Dyball, 2018).

[103] It is also used in assessments of correlations between water security for humans and for aquatic biodiversity (Vörösmarty et al., 2010).

groups" (Pahl-Wostl, 2015). Members of diverse epistemic communities need to come together, with new emerging skills, roles, and changes in power relations (Pahl-Wostl, 2015). Boundary organisations such as river basin organisations may hold key roles in facilitating cross-sectoral and –scale exchange and cooperation (Hahn et al., 2006; Huitema & Meijerink, 2017).

Social coordination: Adaptive governance and management entails decentralisation, stakeholder engagement, and open and shared information sources to promote social learning, based on network governance (Pahl-Wostl, 2015). Network governance embedded in a polycentric governance system (see 3.2.3.1) serve to provide flexible frameworks to facilitate interplays between formal policy and informal social learning processes, and vertical and horizontal coordination. Social learning aims to enhance the capacities of actor groups for collective and context-specific action by generating knowledge, facilitating collaborative decision-making, leveraging synergies that reduce conflicts and trade-offs, while recognising unintended effects of actions, and uncertainties (ontological, epistemological, and normative) (Berkes & Folke, 2002; Pahl-Wostl, Mostert, et al., 2008b). Social networks provide informal contexts and processes for diverse actors to come together, and are characterised by their self-organising, emergent and open character deemed essential to strengthen the transformative capacity of governance systems (Pahl-Wostl, 2017)[104]. *Sustainable* water governance thus rests on the engagement and coordination of *all* actors that use, supply and treat water, and/or affect these activities and the state of ecosystems through their activities (e.g. via pollution) (Wiek & Larson, 2012). Community-based adaptive approaches favour decentralisation as a way to strengthen "locally evolved institutional arrangements" (Dietz et al., 2003). Similarly, bioregional approaches to co-management promote arrangements that engage local communities more intensely with their environments (Cook et al., 2016; McGinnis, 1999; Meijerink & Huitema, 2017).

Scope and factors: The paradigm calls for multiple perspectives on complex social-ecological systems that consider how complex system dynamics (feedback loops), uncertainties, and unintended effects between diverse sectors affect – and are affected by – the context of concern (e.g. river basins). Improving ecosystem health as a priority requires a shift of perspectives away from technical infrastructures (including for water treatment and supply) towards ecosystem-based management, biodiversity and natural habitats. (Akamani, 2016). Water management becomes part of holistic landscape management that needs to consider all sectors and multiple forms of human activities that influence aquatic ecosystems (Pahl-Wostl, 2015), including: drinking water extraction, built infrastructures (e.g. settlements, transport, hydro-power, flood protection, visitor´s centres), agriculture, fishery and syviculture, recreation and culture (Pahl-Wostl, 2006, 2015; Wiek & Larson, 2012). Land availability, property rights, and prices are among factors to be considered.

Management means: Adaptive water management aims for context-specific approaches to ecosystem-based management, rejecting blueprints (Pahl-Wostl, 2017). Management rests on iterative learning cycles that adapts strategies based on the monitoring and evaluation of outcomes of experiments and interventions, and in relation to changing environmental and socio-economic conditions (Pahl-Wostl, 2006a). Pursuing preventive and precautionary approaches, adaptive management seeks to tackle sources of pollution and overextraction rather than their effects (Pahl-Wostl, 2015). Under the umbrella of holistic landscape management, "nature-based solutions" are a

[104] The concept of social networks has partly been derived from the ´communities of practice´ (COPs) put forward by Wenger (1998). They share the following elements: being focused on a specific domain, attributing high importance to the quality of relations among members cutting across organisational boundaries and scales and a diversity of perspectives and approaches as well as to actual practice (also Snyder & Wenger in Blackmore, 2010).

preferred means to support ecosystem-based approaches. The UNESCO proposes the following definition:

> *"Nature-based solutions (NBS) are inspired and supported by nature and use, or mimic, natural processes to contribute to the improved management of water. The defining feature of an NBS is, therefore, not whether an ecosystem used is 'natural' but whether natural processes are being proactively managed to achieve a water-related objective. An NBS uses ecosystem services to contribute to a water management outcome. An NBS can involve conserving or rehabilitating natural ecosystems and/or the enhancement or creation of natural processes in modified or artificial ecosystems" (UNESCO, 2018).*

The focus on the state of entire ecosystems has made the restoration of rivers and their aquatic ecosystems a major element of adaptive and integrated water management. The main objective of ecological restoration is to "restore or rehabilitate ecosystems that have been degraded, damaged, or destroyed with respect to its health, integrity, and sustainability" (Swart et al., 2018). An example of nature-based solutions, river restoration projects typically aim for redirecting the water into its ´traditional´ riverbed and/or lifting riverbeds, removing river bank fixations and rehabilitating wetlands by introducing slopes and spaces that allow for seasonal and weather-related changes in water expansion and levels and prolong or create new water courses (Schaich, 2009, Schindler et al., 2014). Thereby, floodplains are recreated to enhance self-generation capacities and biodiversity, and to give more room to water (i.e. increase retention capacities) rather than to "fight" water through engineered dikes or dams (´grey infrastructures´). Necessitating more attention to human behaviour, measures such as these necessitate the reconciliation of various objectives and views held by different actors, e.g. farmers, conservationists, inhabitants, and water operators (Pahl-Wostl, 2006a; Swart et al., 2018).

Nature-based solutions are important elements of the concept of "green infrastructures" that denote networks of ecosystems that serve to conserve ecosystem values and functions, while also providing benefits to populations (Schindler et al., 2014).

Merits: The paradigm dissolves the dichotomy of social and ecological systems, and takes into account interrelations (two-way feedbacks), complex systems dynamics, and uncertainties across sectors and scales. It is based on the insight that there are limits to human knowledge, control, and exploitation of natural resources that are best dealt with through integrated, adaptive, participatory and context-specific approaches. Social and ecological systems can mutually benefit each other, increasing both human well-being and ecosystem health. The concepts of ecosystem services and (environmental) water security are suitable to widen the scope of water management beyond water supply for human purposes and to conceptualise trade-offs. The concept of multifunctional landscapes invites cooperation with other sectors such as agriculture and ecological restoration. Evidence suggests that the restoration of e.g. floodplains does, indeed, increase biodiversity and the multifunctionality of landscapes by enhancing the supply of provisioning, regulating, supporting, and cultural ecosystem services (Schindler et al., 2014).

Water management is regarded as requiring normative (risk) dialogues about ends, means and possible outcomes and ongoing social learning that put the "human dimension" to the fore, seeking to engage and empower a wide range of actors and citizens and their knowledge (Akamani, 2016; Armitage et al., 2008a).

Limitations: The paradigm faces various social and material limitations. Its potential success depends on the emergence of mutual understanding and social learning among diverse stakeholders belonging to different epistemic communities that need to overcome serious obstacles. The implementation of

adaptive measures requires significant commitment, time and efforts, including extensive monitoring. There are no ´recipes´ that can simply be implemented and expected to work. There are examples of participatory processes that failed (Reed et al., 2018). There may also be doubts concerning accountability and legitimacy of such processes, e.g. due to the composition of social networks, their diversity and "representativeness", or regarding the quality of processes (Lebel et al., 2010; Mostert et al., 2007; Reed et al., 2018). Furthermore, there is not yet much empirical evidence for if and how social learning has contributed to actually improving ecosystem health. In general, there are few documented adaptive and participatory management projects that were well-implemented and monitored, successful in integrating scientific and non-scientific knowledge, dissolving conflicts and producing tangible outcomes (Medema et al., 2008; Reed et al., 2018). Calls for adaptive and integrated paradigm shifts have not yet fostered action and transformative change on the ground (Pahl-Wostl, 2015). There are general doubts about the translation of science-based management concepts into practice, and they continue to be confronted with considerable institutional constraints as regards planning processes and practices (Medema et al., 2008)[105]. Skills and capacities of individual and collective actors continue to be key in overcoming technocratic legacies of the past (Pahl-Wostl, 2015; Pahl-Wostl et al., 2008c).

As regards material factors, a possible constraint may be that, compared with technical ´solutions´, green infrastructures such as river restorations require more space and may be difficult to implement in areas with settlements and existing grey infrastructures (Schindler et al., 2014).

With a view to human-environment relations, concepts such as resilience, adaptive capacity, and ecosystem services are associated with managerial approaches to sustainability (Castree, 2014). Overall, SES and adaptive governance is criticised for underappreciating the significance of sociocultural meanings and place attachment in environmental governance and management (e.g. van Koppen & Bush, 2018). Ontologically and epistemologically, the notion of ecosystems delivering services to humans upholds a separation between ecological and social systems (Barnaud & Antona, 2014; Raymond et al., 2013). Critics of the concept furthermore argue that the notion of ecosystem services disregards the intrinsic value of the natural environment and contributes to its reification and commodification, for example, via monitoring and measurement regimes, in which ecosystems are assessed in quantifiable or even monetary terms to reflect their utility for humans (Barnaud & Antona, 2014)[106]. Thereby, the concept risks to reproduce dominant political and economic views and to favour the status quo (Raymond et al., 2013). Conceptualised in instrumental terms and rooted in economic thinking, the concept is unsuitable to capture experiential, emotional and spiritual interrelations between humans and their material environments, i.e. the meaning-making dimension (Barnaud & Antona, 2014; Ives et al., 2018; Raymond et al., 2013). Ethically, it presupposes that humans are entitled to use ecosystem services, displaying an anthropocentric orientation that confirms rather than challenges predominant utilitarian assumptions of modern industrial paradigms (Barnaud & Antona, 2014; Raymond et al., 2013).

[105] Some argue that science-based approaches should themselves be viewed as "testable theories and revised or abandoned as evidence dictates" (Medema et al., 2008).

[106] Some scholars, indeed, regard quantified valuation as a precondition for ecosystem services to be taken into account, economically and politically: "Because ecosystem services are not fully 'captured' in commercial markets or adequately quantified in terms comparable with economic services and manufactured capital, they are often given too little weight in policy decisions. This neglect may ultimately compromise the sustainability of humans in the biosphere. The economies of the Earth would grind to a halt without the services of ecological life-support systems, so in one sense their total value to the economy is infinite. However, it can be instructive to estimate the 'incremental' or 'marginal' value of ecosystem services (the estimated rate of change of value compared with changes in ecosystem services from their current levels)" (Constanza et al., 1997) .

So far, few emerging ´adaptive narratives´ and imaginaries (e.g. of ´multifunctional landscapes´) have been identified and analysed empirically.

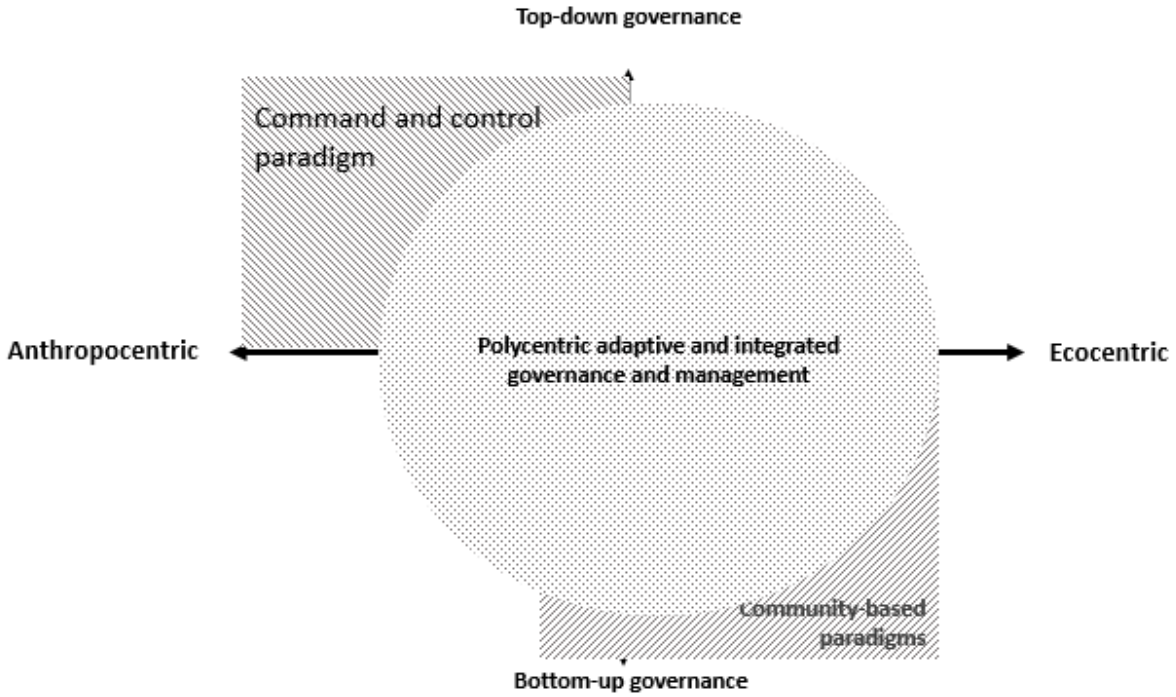

Figure 4.4 - Analytical grid: Positioning adaptive and integrated water governance as part of hybrid multi-level and polycentric arrangements

4.3.2 Regenerating agriculture and agroecology

Often based on adaptive and resilience-oriented management, different approaches have been developed for agriculture to make it more "ecologically sound" (Röling & Jiggins, 1998) or "nature-friendly" (Windt & Swart, 2018), typically based on the idea of ´extensification´. Sustainable agriculture is considered an integral element of local communities and landscapes, and more sustainable food systems (Dyball & Newell, 2015). As alternatives to conventional agriculture, the current part outlines principles of regenerative agriculture (also "regenerating agriculture" (Pretty, 1998) and agroecology (Dendoncker et al., 2018; Dendoncker & Crouzat, 2018). They include agroecological approaches to organic (or eco-)farming and permacultures (Gerber & Hoffmann, 1998; Ingram, 2018). Moreover, they are complemented by perspectives from scholars applying an "expanded concept" to nature restoration and regeneration that integrates agriculture and other forms of human land use in land-sharing approaches (Higgs, 1997; Swart et al., 2018; Windt & Swart, 2018) (see table 4. 5 and figure 4. 5).

Agroecology – as a science, a set of practices, and social movement - comes in many shades and nuances, of which only a few are covered here. In broad terms, agroecology aims for the conversion of intensive agricultural systems to "sustainable agroecosystems" that reconnect producers with their social and material environments, and rest on diverse mosaic landscapes and practices with low anthropogenic and non-renewable inputs (Dendoncker et al., 2018). If only marginally, agroecology is mentioned in the European Commission´s strategy for its post-2020 Common Agricultural Policy as offering knowledge and techniques that create both economic and environmental benefits (EC, 2019b). Regenerative agriculture (often building on agroecology) stresses the optimal use and

regeneration of locally available resources and natural processes, such as through nutrient recycling. (Röling & Wagemakers, 1998 and Pretty, 1998)

Analytical grid for investigating paradigms	**Regenerative agriculture, agroecology**
Why: overarching purposes and narratives	Broad anthropocentric purposes based on provisioning, regulating, supporting and cultural ecosystem services, aiming for autonomy (incl. food sovereignty), agrobiodiversity (as part of multifunctional landscapes), resilience
	Narratives are based on food and feed autonomy or sovereignty that reconnect farmers and local communities with their environments
Who: main actors involved	Farmers, farm advisors, farming associations and cooperatives, conservationists, local communities, scientists, governmental actors, sometimes tourists
How: main mechanism of social coordination	Network governance (social learning)
What: scope and factors considered	Feedbacks between societal, ecological and technological systems across sectors and scales
How: main means of material management and engagement (physical interventions) and related metaphors	Adaptive management using/mimicking natural processes, closing nutrient cycles, low anthropogenic and non-renewable input, diversification with nature-based solutions (e.g. restorations) and green infrastructures as preferred means, prevention of pollution and overexploitation at source
	´Nature myths´ and human-environment relations: • ´nature resilient´ or ´nature evolving´ (Holling et al., 2002) • Metaphor: e.g. “closed loops” (Raymond et al., 2013)

Table 4. 5 – Overview of main elements of adaptive agricultural management (including agroecology and regenerative agriculture)

Purposes: Food production is one purpose among several others. Agroecology aims for resilience, diversity, and autonomy, and to minimise harmful environmental impacts, with agriculture as integral element of sustainable and adaptive landscape and soil management (Dendoncker et al., 2018; Dendoncker & Crouzat, 2018; Ingram, 2008). Resilience depends on the reconnection between the farming system and its ecological and social environment. It includes the idea of autonomy (“closing cycles”) that embraces economic autonomy and rural development (or “increase in “self-reliance”, Pretty, 1998) through closer connections between producers and consumers (e.g. through local selling of products and tourism), autonomy in fertilisation (e.g. the use of organic farmyard manure) and feed autonomy in livestock farming (Dendoncker et al., 2018, Brédart & Stassart, 2017). In contrast to ´food security´, agroecology is related to discourses about “food sovereignty” that rests on the principle that

people should be able to control their own national or community-level food systems rather than being dependent on global markets and supplies (Davila & Dyball, 2018; Dyball & Newell, 2015). The diversity objective relates to the maintenance and enhancing of biodiversity via the use of synergies between different ecosystem services offered by diverse mosaic landscapes (Dendoncker et al., 2018, also referring to “agrobiodiversity”).

Main actors: Main actors are farmers, farm advisors, farming associations and cooperatives, conservationists, local communities, scientists, governmental actors, and sometimes tourists (Dendoncker et al., 2018; Ingram, 2018; Reckinger, 2018; Windt & Swart, 2018).

Social coordination: Striving for re-embedding agricultural production into local value chains and resource management, the main social mechanisms consists in a combination of market- and community-based governance, resting on (informal) self-organisation. Innovation is not driven by technologies or science, but by changes in markets, institutions (mainly informal, e.g. in growing public environmental concerns and changes in consumption patterns), social organisation and local knowledge (Ingram, 2018; Pretty, 1998; Röling & Wagemakers, 1998). Aiming for the development of context-specific approaches that are responsive to local conditions, needs and visions, sustainable and regenerative agriculture requires cooperation, negotiations and the emergence of social learning among farmers, local communities and other stakeholders (e.g. scientists), i.e. in social networks and “science-practice partnerships” (Dendoncker et al., 2018; Pretty, 1998; Woodhill & Röling, 1998). New modes of social organisation can include direct marketing by farmers, consumer/producer associations or cooperatives, and product networks of producers, processors, traders, and consumers that guarantee the supply/acquisition of certain quantities and at certain prices, or other alternative marketing chains and social initiatives (Dyball & Newell, 2015; Gerber & Hoffmann, 1998; Reckinger, 2018; Windt & Swart, 2018). They can also support rural development by diversifying to include offers for tourists (e.g. farm holidays). Best practice examples from elsewhere often serve as source of inspiration and reference. Farm advisors have a particularly important role in supporting farmers in the conversion of their farms (Gerber & Hoffmann, 1998; Ingram & Morris, 2007; Röling & Jiggins, 1998); as do journals, magazines and newsletters (e.g. by permaculture or eco-farming movements) that provide information to farmers and are part of alternative emerging knowledge systems that contribute to building communities (Gerber & Hoffmann, 1998; Ingram, 2018).

Hierarchical governance that relies on compliance with rigid regulatory frameworks and financial incentive schemes (e.g. with ´cross-compliance schemes´ that oblige farmers to adopt certain resource-conserving practices) is considered inadequate to encourage farmers´ support for a more far-reaching transformations (Pretty, 1998). They leave little room for manoeuvre and creativity and encourage instrumentalist ´strategic behaviour´ (Pretty, 1998; Wagemans & Boerma, 1998). Formal policy measures such as support of alternative research, training programmes, demonstration farms and farmers´ meetings and platforms that create space for exchange , revised farming advice, shifts of financial support from goods to non-polluting or –degrading technologies, low-interest loans or grants may be more effective (Pretty, 1998; Röling & Jiggins, 1998). The agri-environment-climate scheme of the EU Common Agricultural Policy is an example of how the ecosystem services concept can be operationalised to pay financial support to farmers who deliver specific environmental services, thereby creating a “market” for nonprovisioning ecosystem services (Payment for Environmental Services, PES) (Dendoncker et al., 2018).

Scope and factors: As adaptive and integrated approaches in general, regenerative agriculture and agroecology require extensive systems knowledge that takes into account dynamics of coupled social-ecological systems across scales and levels of social organisation. Many factors need to be considered: ecological and other material factors (such as soil, weather, technologies, stocks and flows of agricultural commodities), informal factors relating to local communities, society and culture, and formal factors such as policies (including trade policies) (Dyball & Newell, 2015; Woodhill & Röling, 1998). Overall, sustainable farming is demanding in terms of knowledge (and skills). Depending much more on locally specific conditions and natural processes and requiring a high level of responsiveness to changing ecological environments, farmers need to continuously improve their ecological knowledge (e.g. of soil, plants and animals) through intensive observation and hands-on experience. They can also benefit from specialised scientific information and advice concerning these complex processes (Ingram, 2008; Röling & Jiggins, 1998; Windt & Swart, 2018). At the same time, conditions for sustainable farming, healthy crops and animals – e.g. ecosystem diversity and health - are also dependent on wider social and material contexts, needing to be responsive to feedbacks loops from farm and societal levels. ´Sustainable´ farmers, by necessity, need to be experts in a wide range of domains (Röling & Jiggins, 1998).

Management means: Agroecological farming is seen as a crucial contributor to sustainable landscape management and biodiversity. As in the case of adaptive water management, agroecology and regenerative agriculture rely strongly on experimentation with practices and technologies. Regenerative practices imply the optimal use and regeneration of locally available renewable resources and natural processes (incl. biomimicry), and the limitation and efficient use of anthropogenic inputs (such as agro-chemicals, minerals and non-renewable energy) (Dendoncker & Crouzat, 2018; Pretty, 1998). Principles of agroecological farming include the maintenance of rotating vegetation covers as a measure to conserve soil and water (incl. via reduced tillage, mulch, cover crops[107]), the use of organic manure and fertilisation to promote soil biotic activities, pest regulation through biological control (e.g. via natural enemies or alternative pesticides) and nutrient recycling through the use of livestock systems based on nitrogen fixing legumes (Dendoncker & Crouzat, 2018; Pretty, 1998). The aim to achieve feed autonomy in livestock farming implies replacing feed imports (such as soybean meal) by protein-rich legumes such as clover grass, peas or beans produced locally, which requires a change in the entire farming and feed system, and the acceptance of lower production volumes (Brédart & Stassart, 2017). Incomparable with pre-industrial agriculture, sustainable farming often relies on sophisticated technologies to manage resources (including genetic resources), pests, and diseases (Pretty, 1998; Röling & Jiggins, 1998).

The aim to create diverse multifunctional mosaic landscapes that integrate human use and ecosystem health lead to "land-sharing" approaches, in which extensive forms of agriculture recreate semi-natural cultural and traditional landscapes. For example, river restorations can be accompanied by pasture projects that involve extensive year-round grazing with older or more robust breeds of cattle and/or the cultivation of more traditional or innovative grains that do not require pesticides and

[107] Some scholars of eco-farming, however, argue that soil structure and fertility can be negatively affected by replacing ploughing by tilling and mixing of top soil only, and lead to weed problems. They thus argue that eco-farming should have the freedom to question all established principles and adjust their practices to special conditions and new experiences, "otherwise, the system will someday die from mental sclerosis" (Gerber & Hoffmann, 1998).

fertilisers (or hardly). Whilst usually producing lower yields, they are suitable to support a wide range of other ecosystem services (Windt & Swart, 2018, Schaich, 2009).

Merits: Agriculture based on agroecological and sustainable farming practices is more resilient, because it is more diversified, autonomous, and adaptive to external influences (Dendoncker & Crouzat, 2018). It requires less anthropogenic and non-renewable input, benefits ecosystem health and diversity and, potentially, empowers and reconnects farmers, local communities and consumers with each other and their environments (including, experientially), benefitting rural development (Dyball & Newell, 2015). From synergies with environmental and ecological restoration, new "eco-agricultural regimes" can emerge that integrate and connect ecological, economic, social and cultural values, and retain nutrients closer to their origins (Dyball & Newell, 2015; Swart et al., 2018). Thereby, it would partly reverse the "paradigm of environments in the service of remote consumers" for the sake of more food sovereignty (and feed autonomy). Low-input agriculture produces higher quality nutritious food important in shifts to healthier diets (Dyball & Newell, 2015). Furthermore, it signals a shift away from human control and domination of nature to regarding humans as part of it (Röling & Jiggins, 1998). Taking these together, sustainable agriculture thus entails fewer external environmental and social costs to be carried by society.

Limitations: Sustainable agriculture is intensive in observation, knowledge, learning, technology and labour, as it relies to a much larger extent than conventional agriculture on farmers´ abilities to apply and develop locally-specific approaches (Ingram, 2008; Kremen, 2015; Röling & Wagemakers, 1998). Farmers often depend on specialist knowledge of advisors, who themselves need to develop their knowledge via continuous learning (Ingram & Morris, 2007). It also depends to a larger degree on the state of surrounding ecosystems (e.g. soil quality and biodiversity), cooperation between diverse actors, the state of local communities and society (i.e. consumers), as it typically relies on niches rather than global markets (Ingram, 2018; Kremen, 2015). As sustainable agriculture tends to produce lower yields, farmers depend on receiving higher prices for their products, e.g. via alternative marketing channels (Brédart & Stassart, 2017). Profitability and the maintenance of productivity of land remains essential (Röling & Jiggins, 1998). Thus, in general, sustainable farming is much more dependent on a wide range of context-specific factors, and takes many years to develop (Windt & Swart, 2018). Furthermore, critics argue that extensive agriculture and land-sharing approaches cannot deliver food security, both for reasons of productivity and production costs, and would necessitate the conversion of more ´wild´ habitats into agricultural land (Dyball & Newell, 2015; Kremen, 2015). Furthermore, relying more on local and seasonal food would entail more limited consumer choice (Dyball & Newell, 2015). Finally, the production of some local products may, in fact, be produced more resource-efficiently elsewhere, despite transportation (Dyball & Newell, 2015).

Institutional constraints are significant. Besides formal and financial constraints, agroecological systems require changes in narratives, identities, and aesthetic ´imaginaries´ of landscapes. Studies suggest that wetlands are less highly appreciated than other landscapes, and sometimes associated with pests (e.g. mosquitoes), as opposed to landscapes that provide open views (e.g. on open water) (Schaich, 2009; Vessel et al., 2018).

In addition to doubts about how conducive the concept of ecosystem services is, in general, to transformative change (see above), the concept of Payments for Ecosystem Services (PES) is also criticised for shifting the "polluter-pays principle" to a "beneficiary-pays principle", without addressing underlying structural factors for environmental degradation (Dendoncker et al., 2018). Furthermore,

so far there is no clear evidence to confirm that the use of the concept of ecosystem services has improved landscape management (Dendoncker & Crouzat, 2018).

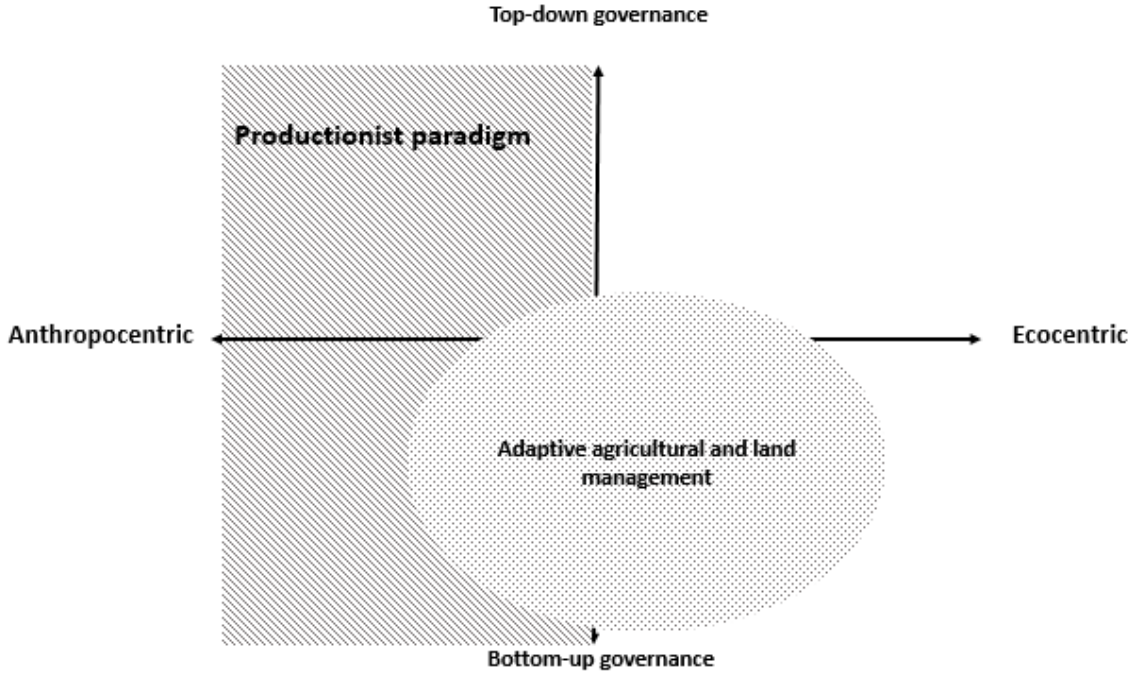

Figure 4.5 - Analytical grid: Positioning adaptive agricultural management in relation to the productionist paradigm

4.4 Ecocentric paradigms

In general, ecocentric paradigms in water and land governance receive less attention in the literature than anthropocentric paradigms, both conceptually and empirically. The EU Water Framework Directive is typically interpreted as a move towards adaptive and integrated water governance and management (see below chapter 4.5). Exploratory empirical research in Luxembourg suggests that current changes underway in Luxembourg can be conceptualised reasonably well by juxtaposing modern-industrial and adaptive and integrated paradigms. There are two reasons for why the present thesis *does* elaborate on possible emerging ecocentric paradigms. Firstly, in transformative sustainability research, ecological restoration (Higgs, 1997; Swart et al., 2018), the "environmental humanities" (Castree, 2014), and other scientific communities concerns are raised about what are perceived as technocratic managerial approaches to sustainability and ´environmental protection´ that perpetuate ways of thinking and doing that have contributed to environmental deterioration in the first place (see conceptual positioning 2.1.3). Instead, some scholars begin to explore new – and often more ecocentric - ways of conceptualising – and engaging in – human-environment interrelations[108]. After the Copernican revolution replaced geocentrism by anthropocentrism, implications of new ecocentric paradigms might be equally far-reaching (Capra, 1996; Meyer-Abich, 1996)[109]. Secondly, the

[108] The "participatory inquiry paradigm" of Heron and Reason also shares features of some of the approaches outlined under "ecocultural community", notably, the notion of "co-creative dance" between mind and "cosmos" and its emphasis on spirituality (see conceptual positioning 2.1.1.1).

[109] "As soon as we refrain from anthropocentricism, the new paradigm can be considered with the question: What is it – if not industrial destruction – that humanity is due to bring about in nature, to which it belongs, assuming that in the history of nature we are not supposed to leave the world as if we had not been here, which

EU Water Framework Directive itself can be interpreted as an example of an ecocentric and technocratic approach, if not paradigm (Ollivier, 2004, see 4.5 below). In order to facilitate the analysis of possible emerging ecocentric paradigms - and analogous to the distinction between narrow and broad anthropocentrism - the present thesis has tentatively introduced a distinction between narrow and broad ecocentrism. Both forms of ecocentricsm share an emphasis on the intrinsic value of nature, but differ fundamentally on how human-environment relations are understood (see also 3.2.3.2):

- narrow ecocentrism: nature needs to be protected from human activities as a precondition for ecosystem health on which humans depend
- broad ecocentrism: nature and humans form a community based on the intrinsic value *and inter*dependence of all living beings

The present thesis associates sectoral approaches to ecological restoration based on formal regulation, e.g. for protected areas, with narrow ecocentrism and hierarchical governance. Community-based approaches that emphasise "ecocultural regeneration" are associated with broad ecocentrism and bottom-up governance. Several emerging concepts and paradigms could be discussed here[110]. Narrow ecocentrism represents the right-end pole of the horizontal axis in the analytical grid, broad ecocentrism is located towards the middle and, hence, next to "broad anthropocentrism", and as potentially overlapping (see figure 4.6). The present thesis briefly outlines approaches and concepts from deep ecology, bioregionalism, and ecological regeneration, and relates them to each other.

4.4.1 Managerial ecological restoration

The following characterisation combines elements from diverse strands of literature that are critical of approaches to ecological restoration (or conservation) that focus almost exclusively on ecosystems. Narrow ecocentrism shares with narrow anthropocentric a sectoral approach that treats ecological systems as separate from social systems, and is mainly based on formal regulation, natural sciences, and technical management.

Purposes and narratives: ´Traditional´ approaches to environmental restoration and legislation aim to restore ecosystems to a specific state (e.g. as regards biodiversity) and to protect threatened species by minimising human interventions and use of natural resources, e.g. in protected areas (Higgs, 1997; Schaich, 2009; Swart et al., 2018). The state to be achieved is to resemble a particular reference state that typically pre-dates industrialisation, and is to come as close to "pristine nature" as possible (principle of "ecological fidelity", Higgs, 1997, Ollivier, 2004). The metaphor that comes closest is the

is not possible anyway? Perhaps this is the contemporary restatement of the Sphinx´s question" (Meyer-Abich, 1996).

[110] Alternative paradigms not discussed here include the "Paradigm of biosensitivity" of Dyball & Newell (2015), which ascribes the metaphor of "stewards of the earth" the role of humans, underlining human dependence on natural processes, and aiming to foster the "belief that maintaining the physical (clean air and water, a healthy diet, appropriate physical activity) and psychosocial health needs (including creativity, conviviality, and access to emotional support networks) lf all humans was the ultimate goal of society […] a biosensitive society would hold that a more appropriate goal lies in the ´just right´ levels of consumption […] where equitably distributed ´sufficiency´ replaces limitless growth as a material goal, with ´contentment´ rather than hedonism as its psychological counterpart" (Dyball & Newell, 2015). Another example is the "ecologically grounded worldview" equally rooted in systems thinking, based on five principles (Amel et al., 2017; Scott et al., 2016): "all life is interdependent", "small actions can cause big consequences", "life systems are circular", and "there are limits to growth".

"stewardship metaphor", which is based on the idea that humans have an ethical obligation (and the necessary powers) to assume responsibility for and ´take care´ of nature. This may also encompass the principle to pass nature on to future generations in a better state than it was before (Raymond et al., 2013)[111]. It is more difficult to relate to the "nature myths" of human ecology and cultural theory[112].

Main actors: Governmental actors, natural scientists, engineers, and consultants.

Social coordination: Hierarchical governance mode based on formal regulation and specialised scientific/technical expertise. Environmental policies establish protected areas with restrictions on social, agricultural and economic activities. They rely extensively on studies and plans by consultancies and quantified objectives and measures as regards, for example, particular species (Higgs, 1997).

Scope: Pursuing a sectoral approach, ecological systems are treated as separate from social systems. Based on natural science, numbers are determined for specific species and technical specifications developed for habitat structures that are considered determinable and fixed (Higgs, 1997), which brings the paradigm close to the linear and monocausal thinking characteristic of narrow anthropocentric hierarchical approaches.

Management means: As in adaptive and integrated paradigms, preferred means are "nature-based solutions" and "green infrastructures" to improve habitat connectivity and, thereby, biodiversity. Emphasis is placed e.g. on restoring rivers to their historical beds. Restoring and maintaining a particular target state requires extensive human and continuous human management, including seed sowing and weeding, selective plantings and thinning (Higgs, 1997). The restoration of riverbeds and wetlands is mainly based on hydraulic engineering (Parodi, 2008).

Merits: Narrow ecocentrism provides a counter-pole to narrow *anthropo*centrism, counteracting environmental deterioration caused by industrialisation, and the long neglect of environmental concerns in society and policy-making by seeking to preserve and restore biodiversity and reduce pollution.

Limitations: The paradigm perpetuates the separation of humans and nature characteristic of modern-industrial paradigms, if only with opposite implications. It assumes that nature is static, or can be "returned" to a near-equilibrium state that it once had and that can be quantified and measured, independently of social systems, and wider social- ecological feedbacks (e.g. climate change). The main paradox is that while the purposes themselves are ecocentric, the desirable states determined, and the means to achieve them are anthropocentric, i.e. social constructs. In most places in Europe, ecosystems untouched by human hands have not existed for centuries. Many species considered particularly worthy of protection today have emerged together with (agri-)cultural practices, that is, they have been co-produced along with human activities (see 4.1 above). In addition, ´records´ of what nature-before-humans looked like are necessarily incomplete, its replication probably impossible,

[111] The "stewardship metaphor" is sometimes used in the planetary boundaries approach, with humans called upon to use their controlling powers to make sure that life on earth stays safe, based on the best available scientific evidence and technological means (Rockström et al., 2009; Steffen et al., 2007).

[112] On the one hand, it might rest on the assumption that nature is "ephemeral" (or "fragile" (Verweij et al., 2006)), and that human disturbance should be avoided (Schwarz & Thompson, 1990). On the other hand, by assuming that stable states can be achieved and maintained, it also contains elements that bring it closer to "nature balanced", with environmental policies seeking to return nature to equilibrium (Holling et al., 2002), or, alternatively, to "nature perverse/tolerant" that assumes that governmental efforts can control nature to keep it within defined limits, via regulation and by curbing "the greed of global markets" (Verweij et al., 2006).

especially when considering that habitats do not exist in isolation of their surroundings and are embedded in what have increasingly become highly fragmented landscapes (and a changing global climate). Furthermore, as much as they seek to restore ´what once was´, restoration efforts also reflect the scientific knowledge, technological possibilities, ecological and aesthetic preferences of their time (Higgs, 1997). As grey infrastructures, green infrastructures and nature-based ´solutions´ also rely on technical interventions and technologies[113]. One major obstacle to the restoration and preservation of specific habitats is their maintenance. While restoration efforts in the period from the 1960s to 80s were mainly carried by social and ecological movements (and their volunteers), the "professionalization" of conservation has meant that it has proven more difficult – and costly - to mobilise the necessary labour. Farmers and local populations have often been reticent. As a result, many ´traditional´ conservation efforts have failed to reach or maintain their goals in the medium- and long-term (Higgs, 1997).

4.4.2 Ecocultural community

The term ´ecocultural community´ combines the "ecocultural community" metaphor of Raymond et al. (2013), with the concept of "community" between all living beings from Capra, and the purpose of "ecosocial regeneration" derived from the "expanded concept" of restoration of Higgs (1997), and from ´community-based´ bioregionalism (e.g. McGinnis, 1999). In the following, they are represented alongside – and in relation to – one another; they do not, however, belong – or add up to - to a single paradigm. In fact, some of the scholars cited here do not identify with ecocentrism at all (see footnote 115 on Higgs). Together, however, they do open alternative – and similar – perspectives relevant to water and land governance and management.

Purposes: The main purpose is "ecosocial" (or "ecocultural") *regeneration* that concerns both ecosystems and local communities (Higgs, 1997; McGinnis, 1999). In the "expanded concept" of restoration (Higgs, 1997; Schaich, 2009; Swart et al., 2018), regeneration is understood as a social and ecological *process* that relies on "place awareness":

> *"A better alternative, perhaps, is regeneration, which gives open recognition to the tentative, developmental quality of sensitive human engagements with ecosystems. […] I proposed that ecological restoration offers the prospect of generating healthier relationships with people and the ecosystems in which they live. Generation is a constructive process and when applied to ecosystems suggests that restorationists-as-regenerationists are thinking carefully about the future as well as the past. Regeneration involves merging what we have accomplished and practiced well, and sets this in the context of workable, creative, and faithful engagements with ecosystems" (Higgs, 1997)*

[113] "Naturnaher Wasserbau" is the German denomination for a type of "nature-oriented hydraulic engineering" that (in contrast to "Massivwasserbau") seeks to restore rivers and lakes (including wetlands) to a state, in which they can unfold natural dynamics. It is, nonetheless, a technical endeavour: "Denn Wasserbau ist immer technisch, und Naturnaher Wasserbau ist in einem weiten Technikverständnis um nichts weniger technisch als Technischer Wasserbau. Im Gegenteil, zumindest historisch […] ist Naturnaher Wasserbau ein Fortschreiten der Technik im Wasserbau. […] die Gegenüberstellung von Technischem Wasserbau und Naturnahem Wasserbau [könnte] Gefahr laufen, dahingehend missverstanden zu werden, dass Naturnaher Wasserbau mit einem Verzicht auf Technik einhergeht. Damit aber könnte wiederum einer irrationalen Naturromantik Vorschub geleistet werden" (Parodi, 2008).

The expanded concept of restoration calls for "environmental humility" (Higgs, 1997). Ecocentrism de-centres humans, human purposes, and means of engagement to become part of a community that brings self-organising humans into a more symbiotic relation with ecological processes of the "co-natural world" (Meyer-Abich, 1996, p.)[114]. This view lends itself to new metaphors. Raymond et al. (2013) have developed the metaphors "web of life" and "ecocultural community" to denote alternative understandings of human-environment relationships. The "web of life" metaphor has been derived from Capra who argues in favour of "deep ecology" as a new paradigm and holistic ecological worldview that regards all living beings as intrinsically valuable, with humans as "one particular strand in the web of life" (Capra, 1996)[115]. Vibrant and sustainable communities depend on (awareness of) interdependence and flexibility to resolve conflicts, establishing a "dynamic balance" between diversity and fragmentation, on the one hand, and cooperation and partnership on the other. One consequence for ecological restoration is that particular species and sites cannot be treated adequately in isolation from one another and from surrounding environments (Raymond et al., 2013).

The metaphor of "ecocultural community" is based on similar assumptions. Given close interconnections between spiritual, physical, and social worlds (including family and ancestors), humans engage with other living beings and aspects of their environments as part of their community. The metaphor has been derived from co-management literature on indigenous people (Raymond et al., 2013). It can also be related to certain community-oriented strands of bioregionalism (different from the bioregional and common-pool resource management approaches outlined above that focus on institutional design[116]) that stress that regeneration of local community and ecological lives are inseparable from one another (McGinnis, 1999).

Main actors: Local citizens and communities (including farmers), conservationists, possibly (but not necessarily) in cooperation with scientists, governmental actors, and other actors.

Scope: As parts ecosystems, humans are embedded in networks of communities of living systems, characterised by interconnections and cyclical processes (Capra, 1996). Referring to systems thinking, Buddhist doctrine and Gaia theory, Capra stresses that sustainability depends on "thinking in networks" (or "networking thinking"), requiring changes in consciousness and awareness. The purpose of science is to provide models that hold explanatory and evocative power, grounded in empirical studies and a deeper level of understanding (Capra, 1996).

´Community-based´ bioregionalism, on its part, builds on "unfolding relationships" between culture, specific places, and animals:

[114] Meyer-Abich argues in favour of physiocentric "philosophy of nature centered in nature, in physis rather than anthropos". When humans locate themselves in an open non-anthropocentric cosmos, the "natural world" becomes a "co-natural world" (or, in German, "Mitwelt" rather than "Umwelt") (Meyer-Abich, 1996)

[115] It is beyond the scope of the present thesis to elaborate on "deep ecology" as a philosophy and movement. The statements made here are exclusively based on Capra. Scholars also criticise deep ecology for making nonhumans the primary moral subjects. "An ecocentric perspective would argue that restoration is good insofar as it serves to enhance the lives of ecosystems from their own perspective. This is difficult for most of us to conceptualise, and it is especially challenging in restoration practice. Is restoration motivated primarily by a desire to help organisms and ecosystems realise their own ways of being, or ware we driven by a desire to absolve ourselves of guilt over past environmental transgressions?" (Higgs, 1997)

[116] In contrast to bioregionalist who define bioregions by their biophysical characteristics (e.g. hydrological flows in river basins) and focus on ecosystem-based management, this strand of bioregionalism defines bioregions both ecologically and culturally, and stresses community reinvigoration (McGinnis, 1999).

"´Inside a circle´ of animals and plants, human beings are joined by a multitude of fibers that connect them to a place. Human culture is a result of this system of primordial connections with others (both plants and animals, living and non-living)" (McGinnis, 1999).

Furthermore, some scholars have argued in favour of a "cosmopolitan bioregionalism" that recognises connections with ´the global´ as essential for the "well-being of any one place", and in which local places serve as starting-points "from which to explore the relationships between and among places"(Thomashow, 1999)[117]. The "networked meaning" of place (van Koppen & Bush, 2018) corresponds well with the conceptualisation of context (in general and local contexts, in particular) developed for the present thesis that combines scalar and non-scaler perspectives, linking spaces of flows with spaces of places.

Engagement: The choice of the term ´engagement´ (rather than management) in the quote given above (Higgs, 1997) is the expression of a reframing of human-environment interaction that entails that nature is not something separate to be *managed* by humans (be it as ´masters´, ´stewards´, or other). ´Engagement´ emphasises that humans are not only a part of nature, but that nature and man have mutually constituted each other for a long time. Regeneration efforts should be directed towards the future at least as much as being guided by the past (Higgs, 1997). Seeking to counteract the separation of society from the "natural world" caused by globalisation, bioregionalists favour bottom-up and grass-roots activities that inspire individuals and communities to "re-inhabit" places of the landscapes and regions on which they depend (McGinnis, 1999). River restorations, for example, can be community-based projects that encourage people to "develop their own understanding of their place" (Goldstein, 1999). They can reinvigorate both community life and ecosystems (McGinnis, 1999). If local communities are *not* involved in restoration, they risk to become alienated from their surroundings (Goldstein, 1999).

Merits: Ecocultural community and regeneration paradigms profoundly reframe human-environment relations, opening up opportunities for alternative narratives, imaginaries, and metaphors, i.e. for new ways of human-environment engagement that stress interconnections, human and ecological well-being as inseparably tied to one another. The "expanded concept of restoration" and community-based bioregionalism direct attention to the self-organisation of communities and consideration of social and cultural factors as an alternative to managerial approaches.

Limitations: Implications of a "post-anthropocentric ethic" are potentially profound (Castree, 2014) and require extensive societal dialogues. In general, although conducted for decades, debates about possible ecocentric and future-oriented alternatives to old and emerging new paradigms (such as those discussed above) have not (yet?) been taken up more widely in transformative sustainability research and resource governance and management, let alone been carried out in practice and studied empirically (at least in Western societies). Bioregionalism has perhaps been the most widely discussed (even if predominantly in relation to its ´ecosystem-based´ variant). Bioregionalism can be criticised for overemphasising and idealising congruencies between communities and biophysical environments, and local engagement and attachment. Bioregionalism (as other approaches putting local communities

[117] Thereby, they echo geographer Doreen Massey who argued for a "global sense of place", based on the view that "each place is the focus of a distinct mixture of wider and more local social relations" (Massey, 1991). In the same vein, Amin favours a "sense of place and place attachment that works with difference and distance, assuming no indigeneity or privileged set of claimants" (Amin, 2004). Others ´de-localise´ place by positioning it as "subject to flexible and networked meanings" (van Koppen & Bush, 2018).

to the fore) may neglect that populations are heterogeneous and that, in times of globalisation, the embeddedness of individuals in ´networked spaces of flows´ may supersede attachment to any particular place (Castells, 2000).

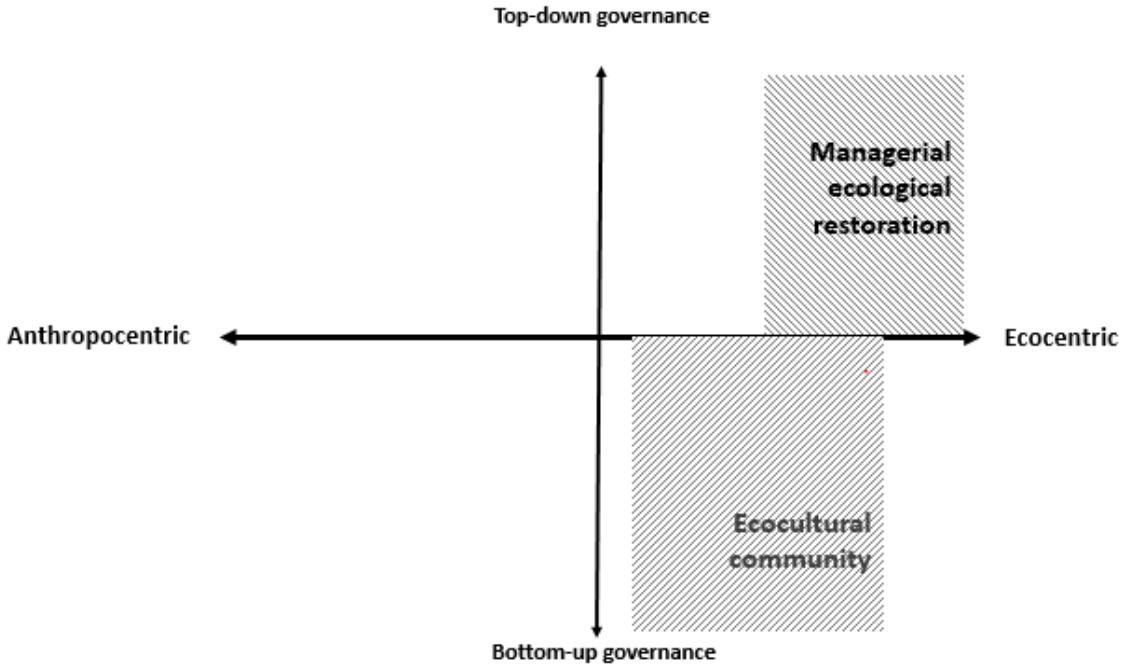

Figure 4.6 - Analytical grid: Positioning top-down and bottom-up ecocentric paradigms

4.5 The EU Water Framework Directive: A hybrid framework

This chapter analyses the EU Water Framework Directive. Although EU directives depend on how member states transpose them into national law, the analysis provides a basis for the empirical inquiry into how the EU WFD has contributed to changing water governance and management in Luxembourg (research question 2).

The EU Water Framework Directive entered into force in 2000 (EC, 2000). Based on the above, the current chapter sets out to analyse what can be characterised as paradigmatic hybridity of the directive, which is at present under-researched. As regards *water* governance, the most prominent paradigms that have shaped formal policy-making have been compared as part of the analytical and conceptual framework (see table 3.3 in chapter 3.2.3.3).

According to most scholars (and in line with expressed EU WFD objectives), the EU WFD heralds a possible paradigm shifts towards integrated water management and more network governance (Jager et al., 2016; Maganda, 2013; Pahl-Wostl, 2015). Few have interpreted it as an expression of a top-down ecocentric approach (Ollivier, 2004). The following analysis of the EU WFD suggests that the directive provides a hybrid regulatory framework that combines elements from ´command-and-control´, adaptive and integrated, and managerial ecological restoration paradigms (see table 4. 6):

- A *top-down managerial ecocentric* approach pursuing the purpose of restoring aquatic ecosystems to a “good status” (by 2027 at the latest), including via protected areas and nature-based ´solutions´ such as river restorations, based on extensive specialised scientific/technical requirements and expertise;

- An *anthropocentric* focus on securing drinking water supply and on granting exemptions from ecological requirements on grounds including overriding public interest;
- An *adaptive and integrated* approach that aims for the integration of diverse sectoral policies and pursues a network governance mode with active stakeholder involvement and public consultations at the scale of river basins, based on polluter-pays, precautionary and preventive principles and nature-based solutions.

With its new water law of 2008 (Mémorial A, 2008)[118], Luxembourg transposed not only the EU WFD, but also the EU Floods Directive (EC, 2007). For this reason, the following also includes references to the Floods Directive.

4.5.1 Purposes and scope

The overall purpose of the EU WFD can be described as ecocentric, as it aims for a "good ecological status" of all surface water and groundwater bodies (Ollivier, 2004). It is one of the most comprehensive and ambitious pieces of environmental EU legislation that significantly extends the scope of water governance and management (Kallis & Nijkamp, 2000). Member states are obliged to prevent further deterioration, to protect and improve the status of water bodies (article 1), in order to reach a ´good status´ by 2015, latest 2027 (article 4). The ´good status´ of groundwater bodies refers to quantitative and chemical criteria. In the case of surface water bodies, the ´good status´ rests on chemical criteria as regards water quality and ecological criteria that extend the objectives to aquatic ecosystems (article 2).

The shift towards aquatic ecosystems has profound implications, effectively extending the scope of water management to landscape management (notably, wetlands). The introduction of, particularly, biological and hydromorphological criteria can be regarded as a ´game changer´, as it entails that engineered ´solutions´ (e.g. wastewater treatment plants) do not suffice to improve the status of rivers (Pahl-Wostl, 2015). Rather, nature-based solutions may be necessary, such as the restoration of wetlands and rivers (Annex VI, Part B). The Floods Directive (coordinated with the EU WFD) is based on similar principles and explicitly evokes the principle of "giving rivers more space" (EC, 2007):

> *"Flood risk management plans should focus on prevention, protection and preparedness. With a view to giving rivers more space, they should consider where possible the maintenance and/or restoration of floodplains, as well as measures to prevent and reduce damage to human health, the environment, cultural heritage and economic activity." (recital 14)*

By being extended to entire aquatic environments, water management necessitates coordinated approaches across sectoral policies (Pahl-Wostl, 2015). Accordingly, the EU WFD *encourages* member states to integrate water protection in policy areas "such as energy, transport, agriculture, fisheries, regional policy and tourism" (recital 16). However, it does not explicitly mention economic policies.

Moreover, the EU WFD integrates areas within its framework that are protected under the environmental European Habitats (EEC, 1992) and Wild Birds (EEC, 1979) directives and have been classified as "sensitive" under the Nitrates Directive that aims to reduce nitrates from agriculture (EEC, 1991c, article 6 and annex IV). In addition, member states are required to protect areas intended for drinking water abstraction. Furthermore, the EU WFD builds on the pollution control standards stipulated in the EEC Wastewater Directive (EEC, 1991a). From this perspective, the EU WFD, indeed, signals a move towards an "integrated Community policy on water" (recital 8). At the same time,

[118] Loi du 19 décembre 2008 relative à l'eau. Mémorial A N° 217

member states are only *obliged* to coordinate water governance with the environmental and agricultural policies mentioned above, not with other policies. WFD interrelations with other policies and regulations, and the issue of protected areas, and drinking water supply, are object of further analysis in the case studies.

Furthermore, the EU WFD reminds member states that (in line with the EU Treaty, article 174 (EC, 1997), environmental policies should be "based on the precautionary principle and on the principles that preventive action should be taken, environmental damage should, as a priority, be rectified at source and that the polluter should pay" (recital 11). By referring to the ´polluter-pays´ principle, the EU WFD explicitly evokes one of the cornerstones of adaptive and integrated water governance and management that prioritises pollution *prevention* over technological ´fixes´ (Ollivier, 2004). Among others, it is to be taken into account by the member states when fixing water prices for industry, households and agriculture (article 9). In 2004, the ´polluter-pays´ principle was substantiated in a new directive on environmental liability (EC, 2004): It stipulated that "an operator whose activity has caused the environmental damage or the imminent threat of such damage is to be held financially liable […]" (recital 2). Environmental damage encompasses, notably, damage to protected species and natural habitats.

4.5.2 Social coordination: River basin management and public participation

Water management at the scale of river basins and the introduction of formal public consultations are the main WFD elements interpreted as part of a potential paradigm shift towards more context-specific and participatory water management.

The introduction of river basin districts is central to the idea of ecosystem management (Huitema & Meijerink, 2017; Jager et al., 2016). Member states are required to introduce river basin districts and "appropriate administrative arrangements", including "competent authorities", in order to implement EU WFD provisions in the river basin districts (article 3). In addition to being associated with ecosystem-based (and "bioregional") management, the introduction of the river basin scale also signaled that water management would become more decentralised and tailored to specific local contexts. The opening of the EU WFD (later also referring to the "principles of subsidiarity", recital 18) seems to confirm this interpretation:

> *"There are diverse conditions and needs in the Community which require different specific solutions. This diversity should be taken into account in the planning and execution of measures to ensure protection and sustainable use of water in the framework of the river basin. Decisions should be taken as close as possible to the locations where water is affected or used. Priority should be given to action within the responsibility of Member States through the drawing up of programmes of measures adjusted to regional and local conditions" (recital 13).*

At the same time, member states are to introduce river basin districts exclusively based on hydrological and administrative criteria. Social and cultural considerations are not mentioned. The EU WFD may thus well have been inspired by a bioregional ecosystem-based paradigm (´fashionable´ among policy-makers in the 1990s), but probably not by the bioregional community-based paradigm (Aberley, 1999; McGinnis, 1999). However, it has opened up for and, as the first major EU directive, prescribed stakeholder involvement (Pahl-Wostl, 2015).

The introduction of public participation is the element that has perhaps received most attention in governance and management research, notably in relation to social learning (Carr, 2015; Jager et al., 2016; Mostert, 2003b; Mostert et al., 2007; Pahl-Wostl, 2015). The introduction can be interpreted as

a partial departure of a hierarchical mode of water governance towards network governance. The EU WFD requires member states to draw up river basin management plans. Every six years, progress on meeting a good status of water bodies needs to be reported to the European Commission and plans be updated. As a minimum requirement, member states have to formally consult the public on the production, review and updating of these plans (article 14). Formal public consultation entails that member states have to "publish and make available for comments to the public" the following documents and in predefined intervals (article 14):

- At least three years before the new period: the timetable and work programme for the production of the plan
- At least two years before the new period: an interim overview of significant water management issues identified
- At least one year before the new period: draft copies of the river basin management plan

In addition to formal consultations, the directive stipulates that background documents and information used in the production of the management plans should be made available, however, not as a general rule, but "on request" (article 14).

The right to access to information was further elaborated on by the EU directive on public access to environmental information that entered into force three years after the EU WFD (EC, 2003a) transposed into Luxembourgish law in 2005 (Mémorial A, 2005). The directive refers to the ´Aarhus Convention´ of the United Nations Economic Commission for Europe (UNECE, 1998). The convention is one of the most far-reaching intergovernmental treaties on environmental rights (Mostert, 2003b). Among others, it is to guarantee access to environmental information, encourage public involvement in decision-making and gives the public the right to challenge environmental decisions (Mostert, 2003b).

The EU directive on public access stipulates that "it is necessary to ensure that any natural and legal person has a right of access to environmental information" and requires public authorities to "make available and disseminate environmental information to the public to the widest extent possible" (recital 8, 9), considering that disclosure should be "a general rule" (recital, 16) and "free of charge". Environmental information is understood as covering any information that relates to the "state of the environment, on factors, measures or activities affecting, or likely to affect the environment", including information on human health and safety (recital 10). The directive on public access thus goes further as regards right to access environmental information than the EU WFD.

In addition to the minimum requirements regarding formal consultations and access to information, the EU WFD invites member states to "encourage the active involvement of all interested parties" in all steps of the WFD management plans (article 14). The directive leaves it to the member states to define what these provisions might imply in practice. Another EU document published in 2003 adds to the understanding of possible interpretations of the WFD public consultation clauses: the WFD guidance document n°8 on public participation (EC, 2003b)[119]. It was issued to assist member states in the implementation of the provisions on ´public information and consultation´ and the « active

[119] Among the contributors to the document is Erik Mostert cited above. Although the guidance document has been published by the European Communities´ official publications office, there is a disclaimer: "the views expressed in the document do not necessarily represent the views of the European Commission". Nonetheless, some of the main points are outlined here, because the document has been made available to Luxembourg and all other member states as part of the common WFD implementation strategy that aims to ensure coherent WFD implementation across the EU.

involvement of all interested parties »[120] [121]. While only providing *recommendations* on public participation, it refers to the main principles of network governance:

> *"Water management is no longer the sole responsibility of government authorities. Network organisations are needed in which government organisations work together with NGO's, business enterprises, interest groups, and experts (universities)" (EC, 2003b)*

The document defines ´active involvement´ as the opportunity of interested parties to "participate actively in the planning process by discussing issues and contributing to their solution" (EC, 2003b). Active involvement can also extend to "shared decision-making and self-determination", for example, by stakeholders becoming "partly responsible" for water management in the framework of river basin organisations (EC, 2003b). Among its recommendations to the member states are that context factors be taken into account before processes for active involvement are launched: "there will always be a ´history´ of environmental management before the implementation of the Directive […] the context can significantly influence public participation in terms of process design, content of discussions and outputs" (EC, 2003b).

Finally, it provides some of the following recommendations on process design, stressing that "the quality of the process determines whether wider support for actions and measures is forthcoming" (EC, 2003b):

- Expectation management: "To avoid disappointing the parties involved it is very important to make clear which form of public participation is dealt with and what the role of those involved is"
- Design: early involvement of people "in setting the terms of reference" and to develop "co-ownership" and conduct regular meetings
- Evaluation: evaluation should be included from the beginning and should, iteratively, be used to (re-)formulate objectives, timetables and outcomes envisaged.
- Demonstration projects: to build trust and to learn from practical experience together
- Independent facilitation: a neutral third party who facilitates can be beneficial, particularly in situations of conflict or distrust

The document explicitly underlines the value of local knowledge and the knowledge of "those affected" by policies in decision-making:

> *"It is important to realise that expert and non-expert knowledges can contribute to a better understanding of the root causes of the problem and lead to a more informed and relevant plan of action". (EC, 2003b)*

[120] Definition provided: "Interested party can be interpreted as meaning any person, group or organisation with an interest or "stake" in an issue either because they will be affected or may have some influence on its outcome. This also includes members of the public who are not yet aware that they will be affected (in practice most individual citizens and many small NGOs and companies)." (EC, 2003b)

[121] The guidance document defines "public" as follows, based on art. 2(d) of the SEIA Directive (2001/42/EC), which is also applicable to the WFD: "One or more natural or legal persons, and, in accordance with national legislation or practice, their associations, organisations or groups". In recital 14 and 46 the Directive also uses the phrases "public, including users" and "general public" respectively without any difference in meaning.

The quote is provided here, because the guidance document n°8 seems to be the only EC document relating to the WFD that explicitly mentions other types of knowledge than scientific ´expert knowledge´.

4.5.3 Technical requirements and exemptions from the ´good status´

Notwithstanding the principle of subsidiarity and the introduction of public consultations, the EU WFD makes extensive technical prescriptions on how water management is to be carried out. A possible contradiction emerges from the question whether and how ´subsidiarity´ and ´local´ decision-making and conditions can be ´reconciled´ with compliance with technical specifications (Ollivier, 2004). Furthermore, there is an imbalance between the extent of technical requirements and the attention to public consultations (Ollivier, 2004). By introducing technical requirements, the EU WFD seeks to ensure coherence and comparability of measurements, measures, and ecological effects within and across the river basin districts:

> *"It is necessary to undertake analyses of the characteristics of a river basin and the impacts of human activity as well as an economic analysis of water use. The development in water status should be monitored by Member States on a systematic and comparable basis throughout the Community. This information is necessary in order to provide a sound basis for Member States to develop programmes of measures aimed at achieving the objectives established under this Directive" (recital 36).*

For this reason, the EU WFD contains extensive technical and methodological requirements to the designation of river basin districts. It entails a detailed characterisation of water body types (or "ecoregions") that has to take into account a large range of obligatory and optional factors (annex II) and the determination of "type-specific reference conditions" for each of the water body types identified[122]. The establishment of type-specific reference conditions shifts management away from ´one-size-fits-all solutions´ privileged by the command-and-control paradigm towards taking into account specific ecological criteria tailored to water body types. Furthermore, "anthropogenic pressures" in the districts need to be identified and assessed, including substances from urban settlements, industry, and agriculture.

The technical requirements mentioned above provide the basis for how member states are to assess the "good status" of their water bodies and for how they are to set up appropriate management plans

[122] EU WFD Annex II, "1.3. Establishment of type-specific reference conditions for surface water body types:
(i) For each surface water body type characterised in accordance with section 1.1, type-specific hydromorphological and physicochemical conditions shall be established representing the values of the hydromorphological and physicochemical quality elements specified in point 1.1 in Annex V for that surface water body type at high ecological status as defined in the relevant table in point 1.2 in Annex V. Type-specific biological reference conditions shall be established, representing the values of the biological quality elements specified in point 1.1 in Annex V for that surface water body type at high ecological status as defined in the relevant table in section 1.2 in Annex V.
(ii) In applying the procedures set out in this section to heavily modified or artificial surface water bodies references to high ecological status shall be construed as references to maximum ecological potential as defined in table 1.2.5 of Annex V. The values for maximum ecological potential for a water body shall be reviewed every six years.
(iii) Type-specific conditions for the purposes of points (i) and (ii) and type-specific biological reference conditions may be either spatially based or based on modelling, or may be derived using a combination of these methods. Where it is not possible to use these methods, Member States may use **expert judgement** [own highlight] to establish such conditions. In defining high ecological status in respect of concentrations of specific synthetic pollutants, the detection limits are those which can be achieved in accordance with the available techniques at the time when the type-specific conditions are to be established.[…]"

on how to reach the good status. The assessment of the ecological status of surface water bodies builds on a common definition and a five-step scale that member states are required to apply (high, good, moderate, poor, bad). The quality elements assessed are (WFD annexes II and V):

- **Biological quality elements**: composition and frequency of species of aquatic flora (phytoplankton) and fauna (e.g. macroinvertebrates and fish) according to water body types and the established "reference status"
- **Physico-chemical**: general quality elements (temperature, oxygen, nutrition) and specific (synthetic and non-synthetic) pollutants (e.g. pesticides)
- **Hydromorphological quality elements**: flow regime (hydrology), direction and speed of run-off, structure of riverbed (morphology: depth, width, structure and substrate), structure of riverbank

In establishing the overall ecological status (or "potential" for heavily modified surface water bodies such as the Upper Sûre dam) the *lower* values apply (WFD annex II, 1.4.2.). Reflecting an integrated approach, the so-called ´one-out-all-out´ principle means that the ecological status of a water body can only be characterised as "good", if all parameters are "good" or "very good".

There are several other provisions that require member states to carry out extensive analyses and assessments and to comply with technical specifications. They include economic analyses relating to the costs of water services (annex III), scientific risk assessment of effects of (potentially) hazardous substances (recital 44), and specifications for the elaboration of management plans and related progress reporting (article 15). These examples suggest that the EU water governance and management approach rests significantly on specialised scientific/technical studies, data and technologies that reflect a positivist understanding of scientific expertise, notwithstanding that "the ecological knowledge used is deemed controversial even by scientists participating in its implementation" (Ollivier, 2004).

Compliance with technical specifications necessitate significant administrative and financial resources. In fact, the EU WFD greatly *increases* the need for scientific research as regards the above-mentioned aspects (Mostert, 2003a), with some member status entering largely unknown territories: "Many of the research tasks from the WFD are new and often no useable methodologies exist, or useable methodologies do exist, but they differ from country to country […]" (Mostert, 2003b). Moreover, much of the research required will need to be "interdisciplinary or at least multidisciplinary, as nearly all elements of the WFD have technical, ecological, economic, legal and administrative aspects" (Mostert, 2003a). If we recall the underlying principle that adaptive water management, first and foremost, requires *flexible* frameworks, the quantity and degree of detail as regards technical prescriptions suggests that EU water governance and management may move towards managerial ecocentric and integrated water management rather than towards *adaptive* water management (Ollivier, 2004). What adds to this preliminary evaluation is the fact that, contrary to adaptive management, the EU WFD almost entirely neglects social factors (except anthropogenic pressures) and, thereby, the social contexts and complex social-ecological dynamics of which aquatic ecosystems are part (Waylen et al., 2019).

However, flexibility is granted to member states in the form of exemptions from the requirement to prevent deterioration or to reach a good status, "if the failure is a result of unforeseen or exceptional circumstances, in particular floods or droughts, or, for reasons of overriding public interest […]" (recital 32). Moreover, exemptions can be asked by member states for "heavily modified water bodies" (such as dams). Flexibility on reaching a good status was a concession to (and compromise with) the EU Council of Ministers representing the member states (Kallis & Nijkamp, 2000), and, we may add, their anthropocentric concerns.

4.5.4 Summary

The above has analysed the EU WFD as a hybrid – and potentially contradictory – framework that combines elements from various water governance and management paradigms.

Table 4.6 below offers an overview of some of the main elements identified as indicators for the presence of elements from the above-mentioned paradigms. The analysis provides the basis for the empirical analysis of formal and informal governance processes in Luxembourg, notably with a view to how WFD provisions have been transposed, implemented, and interpreted by governmental and nongovernmental actors, and related facilitating and hindering factors (e.g. tensions and synergies) for the emergence of social learning and actionable knowledge.

Main WFD features	**Top-down anthropocentric and ecocentric paradigms**	**Adaptive and integrated paradigms**
	Top-down *ecocentric* elements	
Overall purpose: Status of water bodies (WFD recital 11)	Aims for the attainment of a ´good status´ of water bodies by 2015 and the reduction and prevention of water pollution, e.g. via ´polluter-pays´ principle (WFD recitals 11, 38, 40) for both point and diffuse sources of anthropogenic pressures and pollution (WFD article 10, annex II)	Pollution prevention via polluter-pays, preventive, and precautionary principles
	Top-down *anthropocentric* elements	
Purposes	Exemptions from "good status" or "non-deterioration" possible for "heavily modified water bodies" (WFD, article 4)	Recognises "multi-purpose use" of water bodies combining e.g. flood risk management, ecology, hydropower, and providing for processes to address dif. uses and impacts, based on "ecological potential"
Exemption from purpose	Grants exemptions from the good status based on "reasons of overriding public interest" (WFD recital 32) and of timeline extensions based on technical feasibility, costs, and natural conditions (WFD article 4)	
	Top-down ecocentric elements	
Scope	Still sectoral approach to water, no *explicit* mention of economic policies as an area, with which water policies should be coordinated (WFD recital 16)	Integrates sectoral water-related and (some) environmental policies in one framework and calls for coordination and dialogue with other sectoral policies (incl. agriculture, transport, regional policy and tourism), but does not integrate all policy areas
Governance modes (article 14)	Prevailing governance modes in member states remain in place, river basin districts are defined for	Encourages active stakeholder involvement in the production, review and updating or river management

	administrative and ecological purposes	plans, but only prescribes written consultation procedures on drafts of the plan and that access to background documents shall be granted "on request"
Role of different types of knowledge	Is based on and exclusively tailored to scientific and technical data and monitoring of ecological, physical (and economic) criteria	"Non-expert" knowledge is highlighted as valuable in the guidance document no 8 on public participation (EC, 2003b)
Coordination mechanisms	Provides common principles, definitions, technical standards and prescribes extensive and detailed classifications, measurements, monitoring and reporting regimes for comparability and statistical integration (opening 36, article 20 and annexes I, III, V, guidance documents no 2, 3), while allowing for technical adaptations "adapted to scientific and technical progress" (article 20)	Refers to "principles of subsidiarity" and the need to develop measures "adjusted to regional and local conditions" (WFD openings 13, 18) and promotes social learning (EC, 2003b)
Risk assessments	Emphasises that the list of prohibited pollutants should be updated based on scientific assessments (opening 44, article 16)	Refers to the "precautionary principle" and "safety factors" (even if to be applied to and based on "available data" (WFD annex 2))
Sanctions – learning mechanisms	Obliges members states to apply penalties to breaches of national provisions (article 23)	Promotes social learning as part of stakeholder involvement and consultation (EC, 2003b)
Aquatic ecosystems	Promotes the conservation and restoration of rivers, wetlands and floodplains and protected areas such as within Natura 2000 (article 6, annex VI, guidance document no 12)	
	Prescribes the control of discharges and emissions based on "best available techniques" (article 10)	
Flood risks (EC, 2007, Floods Directive)	"[...] it is necessary to provide for the establishing of flood hazard maps and flood risk maps showing the potential adverse consequences associated with different flood scenarios, including information on potential sources of environmental pollution as a consequence of floods. In this context, Member States should assess activities that have the effect of increasing flood risks" (opening 12)	Focus on "prevention, protection and preparedness" (opening 14) and "giving rivers more space", incl. via floodplain restoration, the "promotion of sustainable land use practices, improvement of water retention and controlled flooding of certain areas"

Table 4. 6 – Comparison of main EU WFD elements in relation to top-down ecocentric/anthropocentric and to adaptive paradigms

4.6 Synthesis

The present part has conceptualised and discussed different paradigms identified in the literature to support the analysis of the EU WFD and of water and land governance in Luxembourg before and after the directive entered into force. While most of the literature juxtaposes command-and-control and adaptive paradigms, the present thesis has added an ecocentric managerial ecological restoration paradigm that is reflected in the EU WFD. It has also elaborated on top-down and bottom-up anthropocentric paradigms in agriculture. Finally, it has constructed an ´ecocultural community´ paradigm. The aim has been to widen the gaze beyond both anthropocentric and managerial ecocentric paradigms towards alternative conceptualisations of human-environment relations.

It is important to point out, however, that the present thesis is based on the assumption that no ´ideal´ paradigm, institutional arrangements, and management approaches exist to tackle complex and ´wicked´ challenges at the water-land nexus. Diagnosing paradigmatic hybridity (such as in case of the EU WFD) is not a point of criticism. Rather, the EU WFD may constitute a "clumsy solution" characteristic of the "multivocality" in democratic decision-making (Verweij et al., 2006). Such a perspective is also reminiscent of arguments in favour of polycentric and/or hybrid arrangements that combine diverse approaches emerging from context-specific negotiation and coordination processes between diverse actors (Ostrom, 2010; Pahl-Wostl, 2015). Nexus challenges require the capability to embrace the merits of different paradigms as well as their limitations and possible contradictions:

> *"Implacably unmoved by political expediencies to simplify knowledge, assert particular agendas and claim straightforward operational ´solutions, interactions between water, energy and food infrastructures, institutions and resources themselves remain as complex and intractable as ever. Rather than denying these uncomfortable realities for their inconvenience to short-term political [and, we may add, scientific] interests, then, the practical, democratic, and scientific responsibilities are to recognise and explore them" (Stirling, 2015c).*

What the thesis sets out to do is thus to analyse the multiple possible constellations of tensions and synergies between diverse approaches and paradigms that may manifest themselves in Luxembourg before and after the entering into force of the EU WFD (see figure 4.7). Empirical analysis may also identify other approaches and paradigms not mentioned in this part.

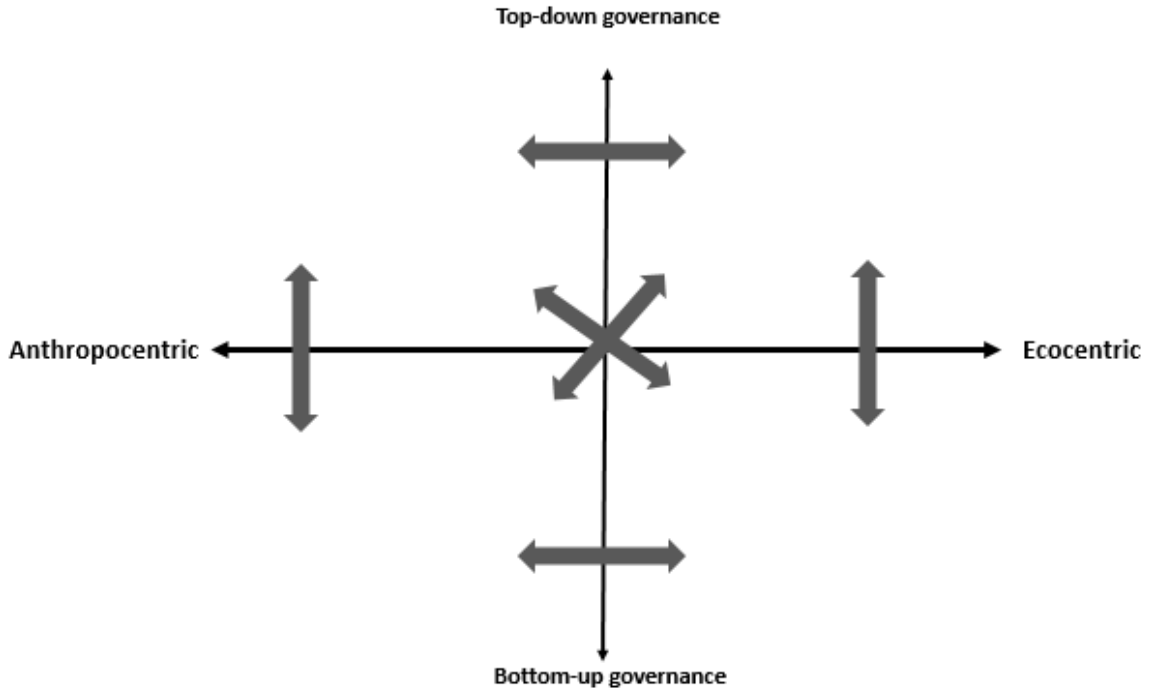

Figure 4.7 – Analytical grid: possible fields of tensions and synergies in water and land governance

METHODS

5 Research design and methods

Research design and methods shape how and what data is produced to apply and revise scientific concepts and to achieve research purposes. The following is divided into two main sub-parts:

- chapters 5.1 to 5.5 elaborates on the transdisciplinary design that has structured the research process and the methods used for collaborative workshops, interviews, observations, and document analysis;
- chapter 5.6 outlines details of how the main analytical categories of the diagnostic approach of the Management and Transition Framework and its database have been adapted for the purposes of the thesis (Pahl-Wostl et al., 2015).

A qualitative research project, the present thesis analyses human action and meaning-making in context. The understandings made explicit here have emerged from how the researcher has interpreted her engagement with others, material contexts, and diverse documents. Collaborative and participatory inquiry rests on transactional encounters shaped by mutual engagement, action, and normative orientations (Heron & Reason, 1997).

Modes of scientific engagement, methods, purposes, concepts, and data have mutually shaped each other. They have also been shaped by diverse contexts that themselves have evolved. The "biographically situated researcher" has entered the research journey with her personal knowledge and own narrative identity, purposes, and assumptions (Rallis & Rossman, 2012). She has engaged with diverse actors and interview partners, supervisors, other scholars and colleagues as well as with material sites and diverse tools. As diverse the research, as manifold the transactional contexts, all of them very hospitable: farms and fields, protected habitats and forests, rivers, sources and a lake, nature centres, municipal, government, and other buildings. Academic professional and organisational contexts contributed to structuring the present thesis through conferences and seminars, scientific publications, methods and concepts, technical infrastructures, formal procedures and requirements. Overall, contexts were wonderfully open and flexible enhancing the need for agency, responsibility, and reflexivity. Ecological, societal, and political macro contexts formed out of conversations and never-ending media streams.

The present thesis freezes some of these dynamics into a time-bound product that is open to diverse interpretations. It cannot be but tentative and preliminary – and, most of all, an invitation to further engagement.

Figure 5. 1 – The present inquiry has resulted from a combination of methods, concepts, and content

5.1 Transdisciplinary research

Transformative sustainability science is rooted in the conviction that sustainability challenges call for the engagement with multiple perspectives and types of knowledge via transdisciplinary processes (see conceptual positioning 2.1.1.1). Transdisciplinary engagement is likely to change the way the researcher herself comes to approach and understand nexus challenges:

> *"Key insights are often provided by other kinds of tacit, nonspecialist or general knowledge – as often variously held by local communities, affected people […] or many different kinds of practitioners. Of course, whilst academic disciplines remain subject to their own particular political dynamics and institutional interactions and hierarchies, disparate knowledges and perspectives from outside academia bring their own structuring and limiting conditions. But the diversity itself can also play essential roles in positively framing and refocusing how nexus-related challenges are addressed. And more generalised non-specialist perspectives can often help avoid narrow disciplinary and institutional blinkers. Indeed, these kinds of knowledge can assist academic experts and government specialists better access their own common sense" (Stirling, 2015c).*

Transdisciplinary cooperative inquiry is a mode of engaging with people (Heron & Reason, 1997). It takes place at the interface of science, policy, and practice, and seeks to contribute to reconfigure associated roles. Scientists become facilitators offering concepts, insights and methods, collaborating closely with practitioners, citizens, and policy-makers in iterative and reflexive processes (Popa et al., 2015). A pragmatic approach offers a third way´ between positivism and relativism by conceiving of knowledge production (and use) "as a social and reflexive process whereby criteria of scientific credibility and legitimacy are jointly defined within a community of inquiry" (Popa et al., 2015). This approach builds on "post-normal science" that has proposed the Extended Peer Community as a methodological approach and practice to assure quality in science (Ravetz, 2006). It extends scientific quality assurance to include practitioners and citizens who contribute with "common sense", their knowledge, and values in relation to "real-world situations", complex problems and problem-solving strategies (Funtowicz & Ravetz, 2008; Ravetz, 2006). From a complex systems perspective quality concerns the relation between complex systems and the image of reality constructed as part of the system by scientific research (which always "reveals, distorts and conceals") and the ethical

judgements made in the process (Ravetz, 2006). ´Evidence´ is not random, but an element of arguments formed in deliberative processes whose conclusions are more or less robust (Ravetz, 2006), scientifically and socially (see conceptual positioning 2.1.3).

5.1.1 Process design

The Extended Peer Community of the present thesis has encompassed the NEXUS FUTURES reference group composed of 15 nongovernmental and governmental members who meet approximately twice a year to provide input to the project. From diverse scales and sectors, the reference group includes two river partnerships, the Ministry of the Environment, the Water Management Authority (AGE), the national drinking water supplier (SEBES), the national water association (ALUSEAU), the Upper Sûre agricultural association (LAKU), other researchers, and citizens[123]. The cooperation with the Syr and Upper Sûre river partnerships has been particularly close. In addition to meetings of the reference group, interviews, and joint site visits, a total of eight meetings have been held with them to discuss the research focus, workshops (see below), and first research insights.

The design of the research project has drawn on elements from post-normal science, action research (Stringer, 2014), public participation in scientific research (Shirk et al., 2012), and from transformative, transdisciplinary and participatory sustainability research (König, 2018, Wiek et al., 2014, Lang et al., 2012, Hirsch Hadorn et al., 2007). Shirk et al. (2012) have developed a typology for public participation in research. Among “contributory”, “collaborative” and “co-created” projects, the current research design is located in-between collaborative and contributory projects. Diverse actors were engaged in an active role as regards the identification of the case study topics, provided input to research design, the selection of ´action situations´ (see below), and to some interpretations of preliminary case study findings (see annexes IV, V). At the same time, cooperation did not extend to co-ownership and did not include common problem *framings* in relation to the present thesis topics, nor joint research activities, with the exception of the two co-organised collaborative systems workshops described below. Whilst preliminary findings were shared with stakeholders at joint meetings, they were not involved in final analyses.

Lang et al. (2012) have developed design principles for ideal-typical transdisciplinary research process. In the following, the cooperation with actors in Luxembourg will be outlined in relation to the (iterative) phases developed by them.

Phase A: Problem (re-)framing and building of research team: The main topics chosen for the case studies have emerged iteratively from conversations with members of two river basin organisations, exploratory interviews, and collaborative workshops over a period of approximately one year and a half year. They related closely to the overarching theme of the NEXUS FUTURES project that deals with challenges at the water-land nexus. Moreover, they were related to the main topic pre-defined for the PhD thesis, namely, actionable knowledge. Originally, governance (incl. in relation to the EU WFD) and social learning had not been anticipated as focal research areas, nor inquiries into historical contexts, paradigms, and narratives.

In the Syr basin, a collaborative workshop and follow-up meetings were organised in February and May 2018, co-organised with the Syr River Partnerhip. From these meetings, river restorations emerged as one of two main possible ´action fields´ for the river basin discussed by participants (see below). The other concerned establishing closer relations between local farmers and consumers. In the Upper Sûre

[123] For an overview of NEXUS FUTURES reference group members, see website sustainabilityscience.uni.lu/nexus-futures_/projektorganisation/rgsab/

valley, meetings with the regional River Contract and exploratory interviews with local actors suggested that the elaboration of new drinking water protection zones was a major preoccupation of local actors.

Phase B: Research and knowledge co-creation: One collaborative systems workshop was organised in each of the two river basins (see workshops below), at which between 20 and 35 governmental and nongovernmental from national and local scales and diverse sectors participated (see workshops below). The Upper Sûre workshop has also been included as an ´action situation´ in the case study (see 9.13).

Furthermore, throughout the project, the reference group meetings provided a ´safe space´ for the actors to exchange information and to discuss critical issues in relation to the processes analysed in the case studies, and other developments, both in the river basins and nationally. Occasionally, they also included controversies that also cast light on divergent views and tensions between individual members. The selection and characterisation of "action situations" of the formal and informal governance processes chosen for the Upper Sûre and Syr river basins was done in cooperation with NEXUS FUTURES reference groups members, and discussed at meetings (NEXUS FUTURES, 2019b). Furthermore, following the meeting, several members provided further input to the selection based on a document that explained objectives of the case studies and summarised preliminary action situations identified (see annex IV). Reference group members and actors interviewed also provided the researcher with numerous organisational and formal policy documents, studies, and press articles (some of them from their archives). Finally, first insights from the case study were discussed at the reference group (NEXUS FUTURES, 2019c), following several individual meetings with key actors concerned who provided further feedback (see annex V). Except for these workshops and meetings, research was conducted individually.

Furthermore, the author of the present thesis was invited to moderate a plenary discussion at the annual colloquium of the six river partnerships of Luxembourg organised by the Syr River Partnership on the occasion of World Water Day 2019[124]. It was dedicated to the issue of ecosystem-based flood protection. The author also participated in a subsequent debriefing with the six river partnerships. The colloquium is analysed as an action situation in the Syr case study (see 10.6.3).

Phase C: (Re-)integration and applying co-created knowledge: Collaboration has so far not extended to actively exploring the ´action fields´ identified at the collaborative workshops, for reasons of time and lack of resources (PhD research limited to 4 years). However, they may be pursued further in the framework of NEXUS FUTURES follow-up projects, including a possible ´real-world lab´, for which a funding application is pending.

Results of the PhD research will be made publicly available, sent to all interview partners, presented to the NEXUS FUTURES reference group, at personal and public meetings of the river partnerships Syr and Upper Sûre (for example, at their river committees), and to all other interested actors. Furthermore, summaries and articles of the results will be published in German (one of the official languages of Luxembourg) in manner that should be accessible and engaging.

[124] Topic: „Weltwassertag 2019: Starkregen - dezentrale, ökologische Überflutungsvorsorge", presentations available online at www.partenariatsyr.lu

5.1.2 Collaborative conceptual systems workshops

Transformative sustainability science and adaptive governance and management have developed diverse participatory approaches, methods, and design criteria to enhance knowledge co-creation through collaborative processes. The aim is to enhance capacity-building, systems knowledge, and action among societal actors (e.g. Caniglia et al., 2017; Checkland & Scholes, 1990; Drenth et al., 2018; Dyball & Newell, 2015; Halbe et al., 2013; König et al., 2016; Lang et al., 2012; Medema et al., 2014; Newell & Proust, 2018; Pahl-Wostl, 2015; Pohl & Hirsch Hadorn, 2007; Scholz et al., 2014). They typically involve collaborative workshops.

In the framework of the NEXUS FUTURES project, the author of the present thesis organised two one-day collaborative conceptual systems workshops in the Syr and Upper Sûre river basins, in close collaboration with the respective river partnerships. Among others, participants discussed some of the main research topics of the present thesis at the workshops (see chapter 6.1.1). The workshops were dedicated to:

- Syr (March 2018): perspectives on systemic interconnections, problem and action fields at the water-nature-land nexus, venue: Municipality of Niederanven (see annexes I, II)
- Upper Sûre (February 2019): perspectives on systemic interconnections, possible and desirable futures, and action fields at the water-soil-nature nexus, venue: Municipality of Boulaide (see annex III and case study chapter 9.13)

The workshops were mainly based on the method of Collaborative Conceptual Systems Mapping (CCM, Newell & Proust, 2018, Dyball & Newell, 2015) and the Material Engagement Template (MET) developed by Ariane König. The CCM method seeks to support transdisciplinary engagement and social learning by engaging members in dialogues about feedbacks that drive sustainability challenges and how they may be tackled (Dyball & Newell, 2015; Newell & Proust, 2018).

The method is rooted in human ecology, building on the ´cultural adaptation template - CAT´. The CAT template supports inquiries into the complexity of social-ecological systems by considering feedbacks between the ´state of human wellbeing´, the ´state of ecosystems´ (e.g. pollution levels), the ´state of community´ and its institutions (e.g. relating to consumption behaviour and legally binding political and economic arrangements), and the ´state of discourses´ (Davila & Dyball, 2018), respectively, the ´state of cultural paradigms´ (Dyball & Newell, 2015). An example of the latter is how the framing of challenges in food systems as either in terms of ´food security´ or ´food sovereignty´ reflects different discourses, narratives, and paradigms that affect what are regarded suitable options for change, for example, through the industrialisation of food production or, alternatively, through closer connections between food producers and consumers (Davila & Dyball, 2018).

The Material Engagement Template (König, 2020, *manuscript in preparation*) develops the cultural adaptation template further by adding personal spheres of meaning-making and by expanding the category relating to the state of ecosystems to wider material spheres that include technologies and infrastructures. The state of community, institutions, and discourses (including related paradigms and narratives) are included under social and cultural spheres. Together, these spheres shape social and material engagement of actors and cognitive processes.

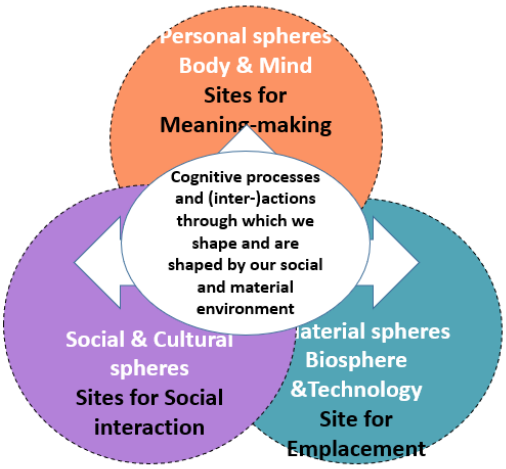

Figure 5. 2 - Material Engagement Template (König, 2020, manuscript in preparation)

The templates encourage participants in collaborative conceptual mapping exercises to consider a wide variety of factors and feedbacks. Through dialogues in small groups, actors collaboratively draw influence diagrams of feedbacks between factors that they select, in order to construct shared visual representations of problem spaces that bring together their diverse perspectives, and develop common terms. In order for participants to enter a "creative dialogic space" (Wegerif and Mercer, 2004), they are encouraged to articulate and question own and others´ assumptions. Thereby, conceptual maps may contribute to challenging assumptions and to foster a broader view of sustainability challenges – across individual actors and sectoral views - and emergent phenomena and patterns of organisation in complex systems that arise from dynamic interactions (König, 2018; Newell & Proust, 2018). The members are guided through several activities and steps through which they share their views on key challenges, identify a central variable, discuss main drivers and effects and collaboratively explore possible action fields that could change future system behaviour.

The idea is to switch from looking at individual factors in great detail to exploring dynamics and interdependent changes between factors, to explore uncertainties, and opportunities for change ("action fields") (see figure 5.1). Furthermore, groups are usually composed of stakeholders with diverse backgrounds and remixed several times (blended), entailing a fusion of perspectives and diagrams, in order to encourage perspective switches and a further broadening of ´horizons´.

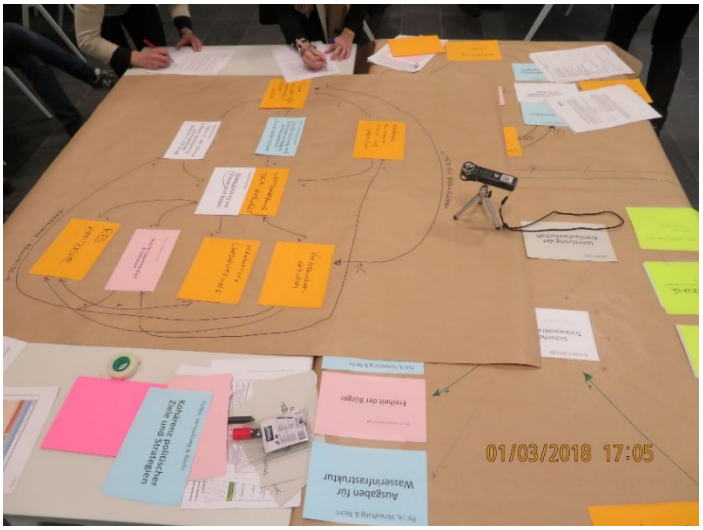

Figure 5.1 - Collaborative elaboration of systems diagrams at the Syr workshop

In the framework of the two NEXUS FUTURES workshops, between 20 and 35 diverse actors participated from both local and national levels and from different sectors. Invitations were sent out via dissemination lists of the NEXUS FUTURES project and the river partnerships, in addition to personal invitations, in order to ensure the participation of a diversity of participants from different sectors and levels. Some of the most significant conceptual and methodological innovations in workshop and process design introduced to Newell & Proust (2018), Dyball & Newell (2015), Davila & Dyball (2018), and König are based on the conceptualisation of contexts developed in the conceptual and analytical framework. With the exception of the introduction of the personal sphere by König, the collaborative workshop methods of the aforementioned authors do not explicitly distinguish between different contexts, scales or levels of actor engagement. In contrast, elements of the collaborative design developed for the two NEXUS workshops have built on the distinction between "internal" and "external contexts" (Medema et al., 2014), "transactional and contextual environments" (Drenth et al., 2018), "personal, interpersonal and contextual spheres" (Wals & Schwarzin, 2012).

Thus, as regards the early Syr workshop (at the time of which the conceptual framework had not yet fully matured), the author of the present thesis, in cooperation with the Syr River Partnership and based on interviews and document analysis, had developed factor cards that participants could *optionally* choose from – or be inspired by – when constructing their conceptual maps. In line with the CCM method and MET template, the 90 factor cards that were presented to participants on tables included ecological and technical factors (material spheres) and social factors (cultural and social spheres) (see figure 5.2).

Figure 5.2 – Factor cards at collaborative stakeholder workshop in the Syr valley

Most of the factors concerned macro factors such as ecological and chemical water quality, security of drinking water supply, the EU Water Framework Directive, and the degree of ´nature attachment´ in general. Based on the distinction between formal and informal factors introduced in the conceptual framework, formal regulative institutions were highlighted by a different colour. More importantly, however, the factors included 21 cards that explicitly belonged to *local* transactional and organisational contexts (see annex I, the personal sphere had not yet been explicitly taken into account:

- *Material spheres*: local ecological factors (e.g. biodiversity of particular fish species in the Syr river, chemical state of local drinking water sources), local technological and infrastructural factors (e.g. wastewater treatment capacities and amount of effluents);

- *Social and cultural spheres*: state of implementation of formal management plans concerning local nature reserves and drinking water protection zones, local water and land use rights (e.g. of property and mill owners, farmers, and fishermen), and water use and outflows of organisations active in the Syr river basin, and the degree of their cooperation.

Despite the local factors proposed, however, the conceptual maps elaborated mostly remained at a rather general (societal) level, with few concrete local feedbacks and action fields considered (see introduction to case studies 6.1). At debriefings with the Syr River Partnership and the NEXUS project team, the large number of (general) factor cards and the composition of participants (many of whom were national governmental actors) were discussed as possible reasons. It was also considered to limit cards to local factors at possible future workshops.

At the later Upper Sûre workshop, the author of the present thesis decided to leave the elaboration of factors entirely up to participants. Instead of factor cards, the author had developed timelines that encompassed factors, ´action situations´ (see below) and events (material, formal, informal) related to challenges until the year 2019 that had been derived from interviews and documents. The idea for constructing timelines was based on the idea of ´action situations´ as building-blocks of governance processes (see below). The Leverage Points 2019 international conference held at the University of Leuphana where conference participants co-produced a timeline on sustainability transformations provided further last-minute inspiration. The Upper Sûre workshop also included a *prospective* timeline until 2050. Upper Sûre workshop participants were thus encouraged to discuss and supplement collaborative timelines (see annex III), both for their own region (see figure 5.3) and national (and global) scales (see figure 5.4):

- *Personal factors* relating to daily private and professional life and well-being of actors;
- *Local material factors*: local ecological factors (e.g. drought periods, pesticides accident, eutrophication caused by blue algae blooms), technological factors (e.g. construction of Upper Sûre dam, experimentation with farming techniques);
- *Local informal factors* (social, cultural) relating to specific actors and their activities (e.g. Upper Sûre Nature Park and River Contract).

Some of these factors, action situations and events are taken up in the introduction to the case studies.

Figure 5.3 - Collaborative timeline of factors in the Upper Sûre region until today

Related macro contexts (national, EU, global):

- *Formal factors* (e.g. concerning sanitary protection zones, WFD management plan, milk quota)
- *Informal factors* (e.g. public debates on/awareness of topics such as drinking water and farming)
- *Material factors*: Climate change, technological innovation

Furthermore, the second part of the workshop was dedicated to the elaboration of conceptual maps concerning possible futures of the Upper Sûre region. The background was that three scenarios had been elaborated as part of the national work strand of the NEXUS FUTURES project to explore plausible alternative futures for Luxembourg, related uncertainties, and possible transformation paths (Drenth et al., 2018; König, 2018). The workshop provided an opportunity to interlink possible regional and national futures. Two ´anticipatory´ timelines (structured as those above) were thus proposed to workshop participants that were to encompass anticipated factors and events in the region from 2019 to 2045 (see figure 5.4).

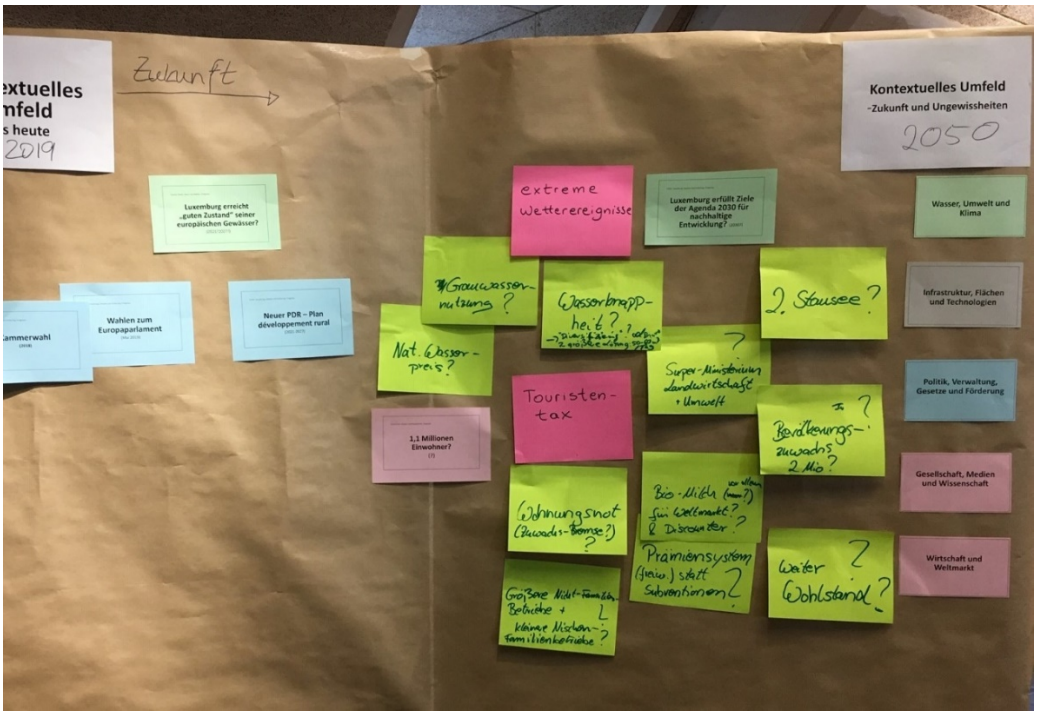

Figure 5.4 - Collaborative anticipatory timeline until 2050

The scenarios and timelines provided input to workshop discussions and conceptual maps on ´the Upper Sûre region in 2050´. Possible future factors and events were added to the timelines based on the conceptual maps and plenary debates. Due to their focus on specific actors and how their relations, roles, and activities may evolve in the future, the conceptual Upper Sûre workshop maps were untypical of collaborative systems maps usually structured along specific in- and decreasing variables (see above). The Upper Sûre conceptual maps are further discussed as part of the case studies.

Further innovations experimented with at the Syr and Upper Sûre workshops included:

- Group composition: open and mixed as regards sectors and levels (Syr), predefined, first ´homogeneous´ (grouping e.g. farmers and public administrators in different groups), then mixed following ´pair blending´ (Upper Sûre);
- Providing detailed oral and written instructions to participants (Syr) or supplementing oral instructions with a CCM example instead of instructions (Upper Sûre);
- Follow-up meeting with participants to discuss possible action fields in more detail (Syr);
- Feedback questionnaires filled in by participants following workshops (see annexes I and III).

The methods thus became objects of experimentation in the two workshops.

5.2 Case studies

The main overarching scientific method chosen for the present study is the one of comparative case studies. A case study analyses a particular unit (individual or collective actors, events, or activities) in relation to its context, often with a focus on how it evolves over time (Creswell, 2014; Flyvbjerg, 2011; Rallis & Rossman, 2012). The case studies of the present thesis analyses and interweaves complex constellations and dynamics of multiple factors (formal, informal, material) concerning water and land challenges and related governance processes along three dimensions:

- across places: Syr and Upper Sûre (sub-)basins
- across scales: formal and informal governance across local, river basin, national, and EU scales
- across time: from the 19th century to today, with a focus on the period from 2000 to 2019

The selection of cases can be based on different forms of sampling. While research issues have emerged from transdisciplinary engagement, the choice of the two Syr and Upper Sûre river basins (of six existing in Luxembourg) rested on a concern for *variation*[125]. One of them a comparatively large cross-border river basin situated in a rural area (Upper Sûre), the other small, entirely national, and increasingly densely populated (Syr); the Upper Sûre basin of national interest serving the country´s drinking water supply and of regional interest through e.g. tourism (Upper Sûre), the Syr river basin of comparatively minor social and economic concern. Thereby, the case studies are expected to cast light on similarities and differences in challenges relating to the fostering of social learning in governance processes.

The case studies have three main aims that correspond to some of the main objectives attributed to case studies. They help the researcher develop her skills, they enhance understanding of context-specific phenomena and challenges, and contribute to theory-building, notably via comparison (Flyvbjerg, 2011; Krohn, 2008, 2010). They also reflect the transformative and Pragmatist research stance of the present thesis. It builds on MTF that serves to facilitate cross-case comparison, both between the two cases chosen, and with the host of other cases that have used the related database(s).

Research skills: Case studies are a method of learning that allow the researcher to develop issue sensitivity, to gain intimate knowledge of concrete cases and experience in judging what is typical or specific in a case, which is at the basis of scientific expertise (Flyvbjerg, 2011; Krohn, 2008). Learning takes place between ideographic and nomothetic features of knowledge (rather than between inductive and deductive learning) that are interdependent (Krohn, 2010). The first describes knowledge of particularities, the latter of generals. The present thesis seeks to strike a balance between the two, rooted as it is in the Pragmatist stance that actions can best be understood by considering both their actor- and context-specificities *and* collectively shared assumptions that shape personal meaning-making and habits (Gross, 2009).

Fostering understanding of particular actions, processes, and challenges: Research that seeks to help actor groups or society to address ´real-world problems´ via socially robust knowledge in specific contexts typically privileges ideographic features of scientific knowledge production (e.g. transdisciplinary and transformative research) (Krohn, 2008). Societal actors who seek to tackle specific problems are usually less interested in general solutions (Krohn, 2008) or "universalistic" knowledge (Flyvbjerg, 2011). The first objective, therefore, of the case studies is to enhance

[125] Flyvbjerg distinguishes between random and strategic information-oriented selection. While the former serves to avoid systematic biases aiming for generalisation, the latter seeks information based on a small sample of cases. Information-oriented selection can be done on the basis of unusual (extreme/deviant) cases, critical cases of strategic importance in relation to a problem (allowing for logical deductions about general applicability or nonapplicability of selected elements), paradigmatic cases that seek to establish a school for a particular domain that concerns societal characteristics, or "maximum variation cases". Although the present thesis deals prominently with the concept of paradigms, cases and topics have not been selected based on the expectation that they will necessarily reveal particular paradigms. This was left to empirical analysis. Variation cases analyse various circumstances for processes and outcomes of cases that may differ in terms of, for example, in size, form of organisation, location, budget, etc. (Flyvbjerg, 2011). Studying two river basins, the present comparative case study is below the typical number of three to four cases. The scope of the case studies did not allow for a greater number considering PhD and NEXUS project time constraints. On the other hand, as regards Luxembourg they cover two of the six existing river basins with river basin organisations.

understanding of actors (i.e. the meaning frames that guide them), factors, and processes in their contexts, based, notably, on an analysis of narratives and the identification of possible metaphors, imaginaries, and other narrative expressions that may cast light on underlying assumptions and identities.

As outlined in the conceptual framework, narratives may be more suitable to guide actions than general rules or scientific knowledge that aims for general applicability. For this reason, and highlighting the "narrative qualities" of case studies, qualitative researchers argue in favour of an analysis and representation of case studies that encourages readers to make their own interpretations. A case study should "tell the story in its diversity, allowing the story to unfold from the many-sided, complex, and sometimes conflicting stories that the actors in the case have told researchers", rather than to reduce them to general conclusions (Flyvbjerg, 2011). Such case studies, therefore, will highlight contingency and heterogeneity (e.g. of actors) rather than causal mechanisms (Krohn, 2008). This is discussed in more detail below.

There is another reason for why transformative researchers favour open emergent research processes and why qualitative researchers argue in favour of rich (or 'thick") descriptions of actors, actions, and cases typical of ethnographic approaches (Denzin & Lincoln, 2011; Flyvbjerg, 2011; Geertz, 1973). By immersing in contexts to enhance understandings, it becomes more likely that actors and objects studied "talk back" to the researcher who, as a consequences, may become less guided by own assumptions and "selection bias" (Flyvbjerg, 2011). This is in line with the Pragmatist and interactional stance outlined above, and in contrast to assumptions of ´normal science´ that regard de-contextualisation and distance between researcher and research objects as a basis for ´objective knowledge´. Indeed, in the present thesis, the research subjects and objects have emerged in close interaction with actors and their contexts, taking a number of unexpected conceptual and empirical turns.

Contributing to theory-building: At the same time, science in general and transdisciplinary research in particular, seek to identify general (i.e. nomothetic) features of cases, for example, via comparative case studies and by using mixed methods (Creswell, 2014; Flyvbjerg, 2011; Krohn, 2008). The term ´general´ does not denote universal applicability, but the idea that they enable researchers and practitioners alike to be able to discriminate between what is different in their case and contexts, and what might be "transferable" to become elements in, for instance, learning processes elsewhere (Flyvbjerg, 2011). Cases may also seek to highlight "more general characteristics of the societies in question", including particular paradigms (Flyvbjerg, 2011, see also footnote above). For theory-building, therefore, narratives and narrative expressions are analysed with a view to identifying common elements used by several actors that may suggest the existence of shared (epistemic) cultures and practices, e.g. collectively held assumptions, paradigms, and narrative identities.

Theory-building centres on nomothetic features emerging from causal analysis (Krohn, 2008). Causal analysis links causes and outcomes in particular processes, seeking to identify causal mechanisms, including by examining historical contexts (Flyvbjerg, 2011). Some of the concepts and analytical schemes developed as part of the analytical framework, serve this purpose. Using a "pragmatist theory of social mechanisms" (Gross, 2009), social causality is understood as resting on habits of action and meaning-making in which actors draw on their personal experiences and culturally shared assumptions (see conceptual framework 3.1). It is "social" also in relation to engagement with the material environment, because all meanings and experiences involve interpretation (Gross, 2009). Qualitative research, ethnographic, interview-based, and historical, then aims "to identify the main social mechanisms by which cause and effect relationships in the social world that are of moral, political, or intellectual importance come about. This entails breaking complex social phenomena into their

component parts to see how aggregations or chains of actors employing habits to resolve problem situations bring about systematic effects" (Gross, 2009). To analyse causal mechanisms is to inquire into collective assumptions, how they shape subjective meanings and habits in specific situations, and when and why they are suspended: "How and why did new practices come into being?" (Gross, 2009). This question is at the heart of the case studies. Concepts rooted in systems theory focus on how complex causalities manifest themselves as *patterns* of social and material behaviour (Bateson, 2000; Capra, 1996; Macy, 1991; Meadows, 1999).

At the same time, given the limited selection of only two cases (Flyvbjerg, 2011), research conclusions may overstate or understate the role played by particular factors in facilitating or hindering social learning in governance processes in Luxembourg and beyond[126].

5.2.1 Triangulation of data and mapping of synergies and tensions

The conceptual and analytical framework has outlined diverse concepts that provide different perspectives on and methods for analysing governance and social learning, partly rooted in different assumptions and paradigms. Each concept and each method of inquiry "makes the world visible in a different way" (Denzin & Lincoln) and shapes and *creates* the world in different ways (Jackson & Mazzei, 2012). The emphasis here is on how different methods and sets of data will be related to one another in the case studies in a *pragmatic* and *reflexive* manner that combines scientific considerations pertaining to relations between data, methods, and research results with perspectives of practice partners (see figure 5.5). Reflexivity concerns axiological, ontological, and epistemological assumptions that shape methods, data, and their interpretation. Reflexivity is a regulative idea that does not imply rigid methodological and normative standards, but serves as a constant reminder to reflect on these interrelations as part of an ongoing and social deliberative process and under conditions of uncertainty, plurality of values, and perspectives (Popa et al., 2015).

Post-structuralist theory underlines how "plugging in" *different* theories into the same text changes relations between the researcher and the text (incl. data) creating "new ways of thinking about both theory and data". In this sense, they mutually constitute each other (Jackson & Mazzei, 2012). Triangulation provides an alternative to ´validity´ and ´validation´ (in the narrow sense of the terms), building on diverse methods and data (Creswell, 2014; Denzin & Lincoln, 2011). By juxtaposing data produced by diverse methods, it adds "rigor, breadth, complexity, richness, and depth" to understandings that reflect competing perspectives and visions, uncertainties, contradictions, and tensions instead of "the truth" (Denzin & Lincoln, 2011). Triangulation displays "multiple, refracted realities simultaneously", offering – and opening up for - diverse perspectives (Denzin & Lincoln, 2011).

Data sampling in methods grounded in practice rest on the notion of diversity and saturation (Charmaz, 2006; Elliott, 2005), which aims for constructing data that allows the researcher to gain a comprehensive insight into the cases studied (actors, contexts, processes) and that provides a robust basis for theory-building, including via insights into variations and deviations. Sampling is emergent, going hand-in-hand with the construction of problems, of tentative categories, their relations, and

[126] The author, however, has also contributed to a validation study of Claudia Pahl-Wostl and the team of the project STEER ("Increasing Good Governance for Achieving the Objectives of Integrated Water Resources Management") of the University of Osnabrück. It investigates how coordination and cooperation between the water and sectors such as agriculture can be improved, with a view to achieving the Sustainable Development Goals. The framework has been applied to five regional in-depth cases. The validation study serves to compare findings with 20 other cases. In the framework of the present thesis (and in cooperation with the Upper Sûre River Contract), data, and insights concerning the Upper Sûre river basin have been integrated in the project via a survey and dialogues. See also www.steer.uni-osnabrueck.de

possible variations, ideas, hunches, and ambiguities further explored (Charmaz, 2006). Allowing data to generate propositions in interplays with methods and concepts prevents a conceptual framework to become a "container in which the data must be poured" (Creswell, 2014). In the present thesis, triangulation has mainly been applied to qualitative interpretations of data sampled from:

- qualitative interviews,
- collaborative conceptual systems workshops,
- document analysis of policy, legal, organisational, and press documents,
- site visits and observations.

Quantitative and statistical data used mainly concerned Luxembourgish macro contexts of the water and land systems (incl. on water quality and consumptions, biodiversity, agriculture, and socioeconomic developments).

Figure 5.5 – Triangulation of data from diverse methods

All of these methods open up different modes of engagement and, hence, produce different data and data interpretations. Based on the conceptual and analytical framework, the present thesis maps synergies and tensions between different actors, policies, and approaches based on the analytical paradigms grid to identify possible facilitating and hindering factors for social learning, and how they evolve over time:

- *Synergies*: perspectives on challenges and related factors, purposes, and preferred ways of tackling them are similar facilitating the possibility of a shared sense of purpose,
- *Tensions*: perspectives on challenges and related factors, purposes, and preferred ways of tackling them are divergent, may seem opposed and mutually exclusive (**contradictions**), making communication and cooperation difficult, increasing the possibility of polarisation

In relation to the grid, synergies and tensions may arise within and between any of the four quadrants, always depending on overarching actor perspectives and contexts[127].

[127] Much of the literature discussed in the conceptual and analytical framework focuses on tensions between top-down anthropocentric versus bottom-up ecocentric approaches, with adaptive and integrated approaches seeking to bring together the two sides. The analytical grid allows for more complex constellations of tensions and synergies and, thereby, serves to contribute to more differentiated analyses. Indeed, it would seem that one of the challenges facing adaptive and integrated approaches – and, perhaps, water and land governance and management in general – is how to foster cooperation and social learning among actors from these diverse approaches (and possible respective paradigms).

For example (see figure 5. 6):

- *Tensions between top-down and bottom-up approaches:* when tensions are predominantly defined along the vertical human-human governance axis they may be accompanied by synergies between anthropocentric and ecocentric *bottom-up* approaches, on the one hand, and anthropocentric and ecocentric *top-down* approaches on the other;
- *Tensions between anthropocentric and bottom-up approaches:* when tensions are predominantly defined along the normative human-environment axis they may be accompanied by synergies between, on the one hand, top-down and bottom-up *anthropocentric* purposes and, on the other hand, bottom-up and top-down *ecocentric* approaches.

Triangulation has been of particular relevance as regards the mapping of policies and actors, and how their knowledge (incl. purposes and interpretations of institutions), relations, and actions have evolved in the course of governance and learning processes.

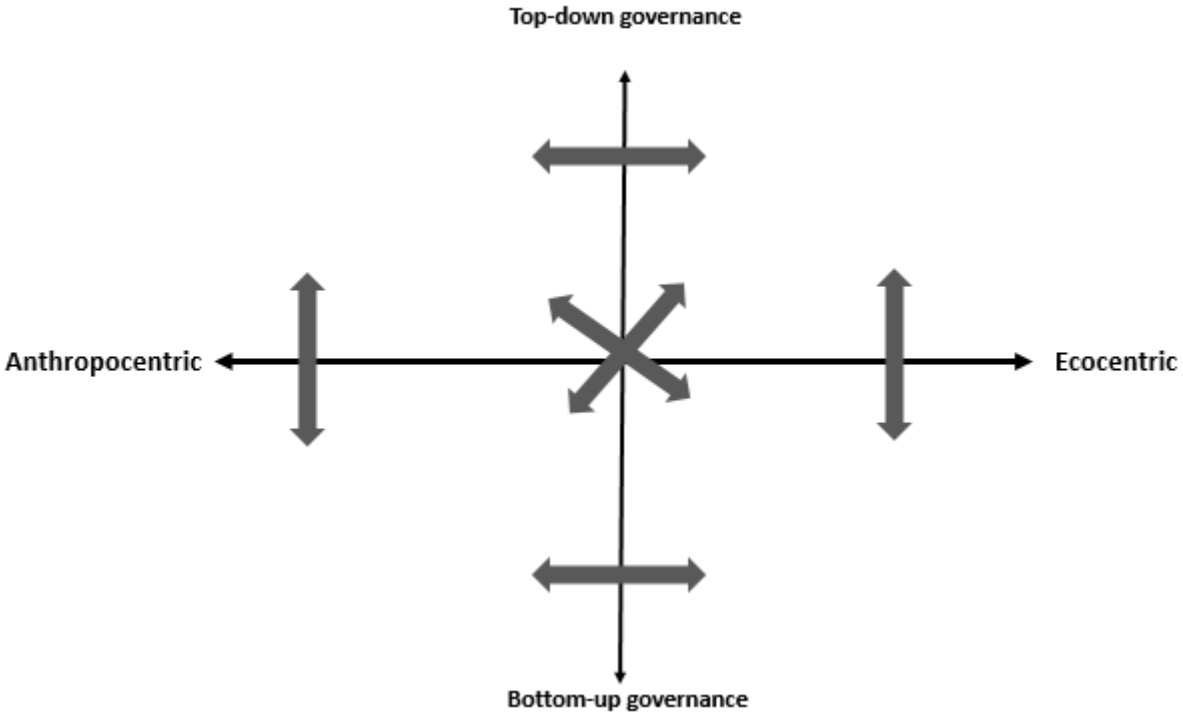

Figure 5.6 - Analytical grid facilitates identification and analysis of synergies and tensions

For example, the case studies suggest that several actors have moved from narrow anthropocentric and top-down approaches towards more integrated and ecocentric and network-based approaches. Conversely, there are also example of actors moving from narrow anthropocentric or ecocentric bottom-up approaches towards more network-based approaches and integrated purposes.

Therefore, one of the crucial methodological questions is on what basis such a mapping and corresponding analysis can be done without boxing, in particular, actors in an undifferentiated manner, taking into account possible internal ambiguities, contradictions, conflicts, and dynamics.

This requires a careful consideration and interpretation of diverse data:

- *Formal institutions*: document analysis (e.g. legally-binding policies, legal frameworks, formal organisational documents such as statutes);
- *Informal, but documented institutions*: documentary analysis (e.g. non-binding policies, organisational documents);
- *Actor perspectives*: diverse methods (interviews, meetings, workshops, site visits, observation studies) to inquire into knowledge (incl. interpretations of informal and formal institutions, meaning frames, and narratives), interpersonal and -organisational relations, actions of diverse actors;
- *Material factors*: site visits and observations of actors and landscapes.

The mapping of policies and actors has thus emerged from an interpretive process that has considered documented formal and informal institutions and, most importantly, perspectives of diverse actors on formal and institutions, purposes, and preferred ways of tackling them (in terms of social coordination and material practices). Importantly, this has included actor perspectives on themselves, their organisations and on *other* organisations and individual actors. *Self*-perceptions (as revealed in interviews) and perceptions of others partly diverged significantly. Furthermore, there were significant discrepancies even as regards formal institutions and requirements (e.g. national and EU regulation), with divergent interpretations of if they were compatible or contradictory. The diversity of perspectives has revealed a number of interesting differences in data produced by different methods that have informed analysis, notably:

- *Qualitative interviews:* particularly suitable to inquire into personal and shared knowledge, practices, and narratives, differences in interpretations of challenges and institutions, social relations and mutual perceptions (including how they have evolved over time);
- *Site visits*: particularly suitable to ´develop a feel´ for landscapes and for relations between actors, landscapes, and animals, at the sites of their professional (and recreational) activities (e.g. farms, nature reserves), incl. place attachment;
- *Documentary analyses*: particularly suitable to inquire into formal and informal (but documented) purposes and other institutions (incl. possible constraints and possibilities), and explicit organisational knowledge (legal bases, activity reports, studies);
- *Observation studies*: particularly suitable to analyse the quality of social relations and communication, and how actors frame challenges and purposes in ´real-world situations´;
- *Collaborative systems workshops*: particularly suitable to elicit systems, normative, and transformation knowledge, and to analyse how new ideas and visions, and shared understandings can emerge from creative dialogues (i.e. social learning in action).

The analysis of diverse data thus provided insights that were partly similar (congruent) and complementary, but partly also ambiguous (inconsistent), contradictory or inconclusive. For example:

- *Interview data compared with documentary data*: differences between formal and informal institutions and knowledge/information *´on paper´* and their interpretations and application *in practice* (e.g. purposes conveyed may be different – and have evolved from - formal organisational purposes);
- *Interview data compared with site visits and observation studies*: differences between perspectives and self-perceptions conveyed in interviews and behaviour and views displayed *in practice* (e.g. statements in interviews may be more reflective and seeking to reveal a certain image to which site visits and observation data may add certain nuances, e.g. by revealing apparent contradictions; or mutual relations might be represented in a

more stereotypical manner in interviews than observations of interaction would suggest, or vice versa);

- *Interview data compared with collaborative workshops*: although both semi-structured longer interviews and collaborative workshops potentially provide reflective and ´creative spaces´, more new and creative ideas (including regarding possible actions) have overall emerged from workshops, perhaps because of the collaborative methods and their dialogic nature.

Any of the methods and respective data on their own thus only reveals very partial pictures, partly concealing possible contradictions and ambiguities, providing ample arguments for triangulation.

5.3 Qualitative narrative interviewing

Qualitative interviewing is a method, in which the researcher asks engages in interactions with those interviewed by eliciting detailed responses to specific questions (Creswell, 2014; Rallis & Rossman, 2012). All interviews conducted in the framework of the present study have been face-to-face interviews. Narrative interviewing has been chosen as main interview method. It builds on the humanist tradition characterised by an acute interest in understanding people´s lives, behaviour and experiences from their own perspective, notably based on how they order experiences and events in society in relation to their selves into meaningful sequences and wholes (i.e. plots). (Chase, 2011; Elliott, 2005). Narrative interviewing can also have an "empowering" dimension by giving participants the opportunity to contribute to issues taken up in research (Elliott, 2005), as has been the case for the present thesis.

Based on constructivist and interactional stances, narratives are not ready-made stories and forms of knowing that provide "unmediated access to people´s thoughts and feelings´" and which the interviewer can simply tap into (Elliott, 2005). Rather, telling stories is a narrative act (Elliott, 2005) that cannot be separated from how interviewer and interview partner engage with each other (e.g. mutual trust and expectations) in the specific place and (transactional) context (Creswell, 2014). In the course of ´telling´, the interviewee may construct new meanings and knowledge rather than to simply transmit pre-established ones. The situation might also be coloured by external events and contexts. For example, participants might use the ´safe space´ provided by the interview to "let off steam" about factors s/he feels frustrated about (Elliott, 2005).

Therefore, interviews themselves do not necessarily reflect how actors act and think in "natural settings" and in other moments in time, providing arguments for juxtaposing them with other methods and data (Creswell, 2014). Indeed, as outlined above, observation studies sometimes provided "a different picture" than the one conveyed in interviews. Moreover, several actors were interviewed several times over the duration of two years during which some of their interpretations, perceptions, and expectations had changed, reflecting both how processes had evolved and, occasionally, different emotional states (e.g. as regards the level of frustration). Somewhat ´disturbingly´ for the interviewer and despite the open character of how interviews were conducted (see below), several interview partners politely asked after the interview (or workshops) if the researcher "had obtained what she needed" or whether what they had said had been "useful". In one isolated case, the interviewer had an acute sense that the interview partner had carefully prepared for the interview by reading online NEXUS project descriptions, repeating some of the specialised project terms, and voicing ideas that corresponded closely to project concepts. Due to this suspicion, she decided to discard statements that fitted ´too neatly´.

Corresponding to the above distinction between nomothetic and ideographic features of case studies (and keeping the above qualifications in mind), narrative interviewing aims, firstly, to enhance understanding of causal interrelations between individuals and the contexts, in which they are embedded. Narrative interviewing analyses how interviewees interpret events and contexts as a basis for analysing how interrelations have changed over time. It rests on the assumption that identity, knowledge, and relations are constantly "in the making" (Elliott, 2005). Based on the conceptual and analytical framework, the analysis also seeks to identify certain narrative expressions (metaphors, imaginaries) that may help to cast light on underlying assumptions, both personal and shared, that shape the individual meaning-making and actors´ engagement with water and land, and related governance processes.

Secondly, narratives of interview partners are interpreted with a view to the societal context (Elliott, 2005). The present thesis places the focus on *organisational* and societal contexts, and related possible epistemic cultures and practices (reflecting shared paradigms), and shared narratives. By comparing diverse interviews and via triangulation with diverse data, the present thesis seeks to identify recurrent and divergent elements in actor interpretations and argumentations that, together, may enhance understandings of possible "social mechanisms" and patterns in interrelations between collectivities, individuals, and their contexts. On this basis, the resulting case studies offer a "second-order narrative" that reflects how the author has interpreted the perspectives, experiences and narratives shared in interviews and other data, and that may be recognised by actors as a "collective story" (Elliott, 2005).

5.3.1 Sampling and statistics

The selection of interview partners has been made in an iterative manner in relation to the emerging research questions, case studies chosen, governance processes analysed and respective action situations. The identification of interview partners was based on purposeful sampling through which actors are selected for interviewing who have a stake in a particular issue or process and/or can (or should be able to) influence it, e.g. as regards water management in river basins (Collins et al., 2004; Reed et al., 2009; Stringer, 2014). Stakeholder analysis serves to identify those actors. Furthermore, normative approaches in natural resource management (in contrast to instrumental approaches), transformative and action research aim for including a diversity of actors and perspectives, in order to enhance the (input) legitimacy of processes and empower participants who may otherwise not be "heard" (Reed et al., 2009; Stringer, 2014). Of the diverse methods typically employed to sample stakeholders and interview partners the present thesis has chosen a combination of brainstorming with practice partners (notably the river partnerships and other members of the NEXUS FUTURES reference group), semi-structured interviews, and snowball sampling, in order to ensure that no relevant stakeholder would be omitted. The NEXUS FUTURES reference group thus served as a first "focus group" suggesting actors to be interviewed for a first round of exploratory interviews. In their turn, the first actors interviewed suggested further stakeholders, thus beginning "snow-ball sampling" of new actors successively interviewed (Reed et al., 2009). As there were initially only fuzzy boundaries to determine ´who´s in and who´s out´ (due to evolving framing of research questions, of which interviews were an element), snowball-sampling resulted in wide concentric circles.

The main criteria and categories emerging iteratively reflected the objective of diversity and the systemic conceptualisation of water and land systems:

- governmental actors: national decision-makers and public administrations in charge of water and land governance and management (notably, the Ministry of the Environment and the Ministry of Agriculture, and their respective administrations),
- intermunicipal and national ´syndicates´ in charge of public drinking water supply and wastewater treatment,
- the river partnerships of the Syr and Upper Sûre basins and their parent organisations (Upper Sûre Nature Park, respectively, natur&ëmwelt & Fondation Hëllef fir d´Natur),
- municipal actors of the Syr and Upper Sûre river basins (members of the river partnerships),
- farmers and farm advisors active in the river basins and nation-wide,
- consultancies and research institutes involved in water- and land-related projects in the river basins.

In addition to relevant organisations and actor groups, the preliminary stakeholder analysis also included the identification of key people formally in charge of the issues studied, particularly active in the processes identified (e.g. as pioneers, leaders, including opinion leaders), or characterised as either ´typical´ or ´untypical´ (i.e. deviant) members of a certain group affected by or involved in the arena of concern, e.g. in agriculture (Stringer, 2014). Investigating the relations between stakeholders (including their ´mapping´) was the object of the case studies themselves rather than of preliminary research.

The 55 interviews used for empirical analysis thus reflect the endeavour to strike a balance between (see figures 5.7 to 5.9):

- national, river basin-scale, and local actors,
- actors actively involved in processes in the Upper Sûre, respectively, Syr river basin,
- diverse sectors (water, environment, agriculture),
- actors in favour of stricter environmental requirements and those sceptical of further environmental policies and/or related projects.

As regards actors sceptical of certain initiatives and processes, particular efforts were made to contact and recruit them for interviews (and invite them to workshops). Efforts were successful in the Upper Sûre basin, but less successful in the Syr basin, partly because there were no overarching processes or social networks to bring together a wide range of actors with divergent views.

Furthermore, as the research questions and focus matured and the governance processes studied evolved, some key actors were interviewed up to three times (see table 5.1). A majority of interviews was conducted as one-to-one interviews. Others involved two or three interview partners. In most cases, the reason was that interview partners wished to involve colleagues or superiors working on the same topics or projects. Furthermore, some of the first exploratory interviews were conducted together with one or several NEXUS FUTURES team members, some of them also involving several interview partners. Nearly all of them were followed by one-to-one interviews conducted by the author of the present thesis alone. Finally, the author received permission to use transcripts of two interviews conducted by the NEXUS FUTURES project leader.

As regards languages, the large majority of interviews was conducted in German, with the exception of six team interviews partly held in English, two one-to-one interviews held entirely in French, and one partly in Luxembourgish (translated to and quoted in German in the case studies). The interviews lasted between 40 minutes and four hours. The longest interviews were ´walking interviews´ that

included guided walks (see below). As regards gender, 46 interview participants were male, 12 female, largely reflecting gender representation in, particularly, agriculture and water management.

Total number of interviews used for research	**55**
- number of one-to-one interviews	30
- number of one-to-two/-three interviews	11
- number of interviews involving several interviewers (e.g. two-to-one interviews)	12
- number of interviews used conducted by team colleague (excl. author)	2
Total number of actors interviewed	**58**
- actors interviewed once	48
- actors interviewed twice	8
- actors interviewed thrice	2

Table 5.1 – Statistics on number of interviews used for research and number of actors interviewed

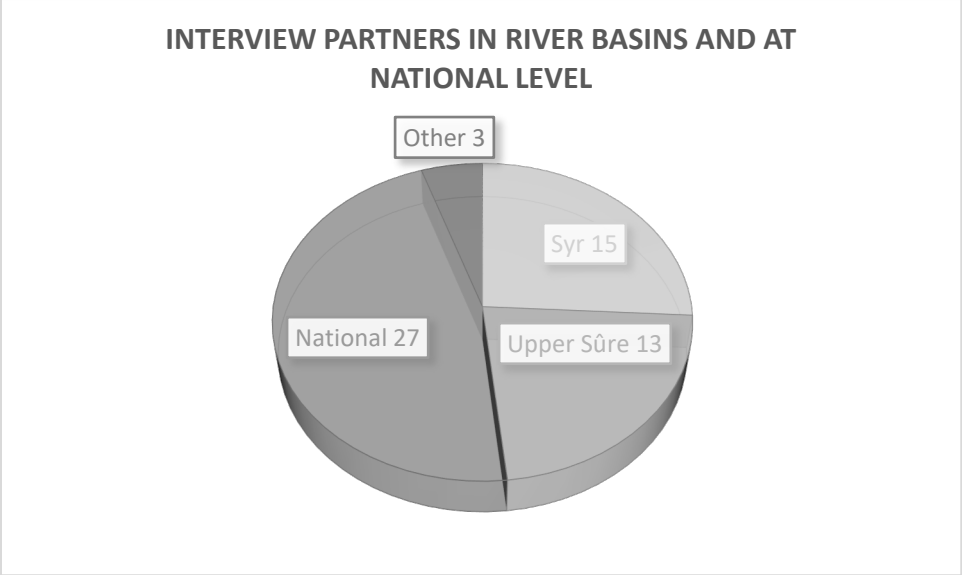

Figure 5.7 - Number of interview partners per level/spatial scale of activity (total: 58)

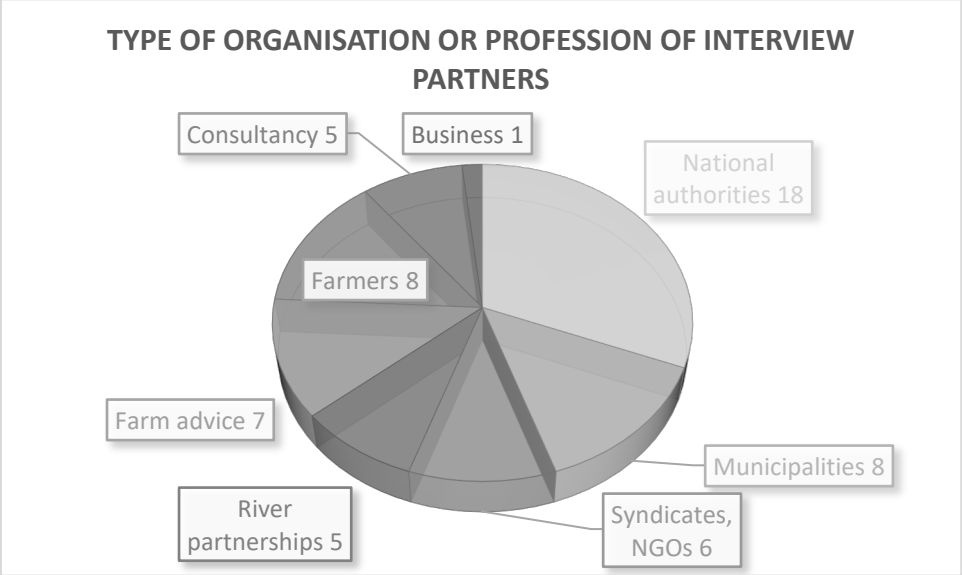

Figure 5.8 - Number of interview partners per organisation or profession (total: 58)

Both the Syr and Upper Sûre river partnerships are part of the organisational structures of the environmental NGO natur&ëmwelt Fondation Hëllef fir d´Natur, respectively, the syndicate Upper Sûre Nature Park, but they are listed separately for present purposes.

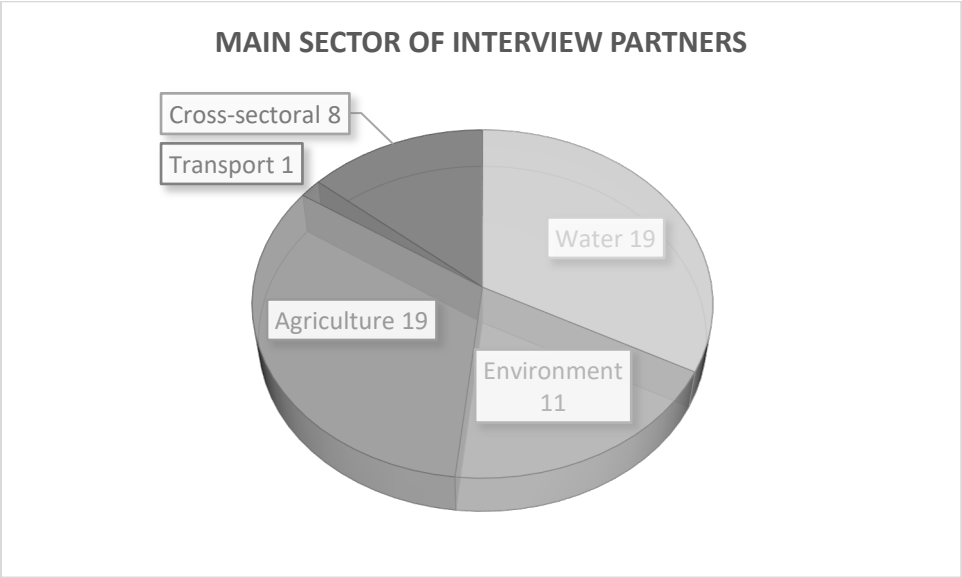

Figure 5.9 - Number of interview partners per main sector of activity (total: 58)

The sector "environment" comprises interview partners active in either environmental protection in general (including water bodies) or nature protection in particular without a focus on water bodies. Accordingly, the sector "water" includes all actors working predominantly on water bodies and aquatic ecosystems. Municipal interview partners have been active across all sectors.

5.3.2 Questioning structure and techniques

The author has adopted a "naturalist" approach to narrative interviewing that has aimed for depth in substantive content. The researcher has sought to develop an "art of interviewing" that invited interview partners to elaborate and reflect on their experiences in an accurate and "truthful" manner without unilaterally imposing a structure and research agenda, and seeking to avoid academic concepts and jargon (Elliott, 2005). For example, after having experienced on a number of occasions that questions concerning what "knowledge" actors used in specific situations resulted in puzzled reactions, the researcher erased the term from the tentative questionnaire, instead exploring more indirect ways of getting interview partners to elaborate on experiences and sources of expertise.

An attention for narratives implies in-depth interviewing, in which the interviewer encourages interviewees to develop their stories and explore their memories in their own terms by showing understanding and empathy without, however, confirming their views (Chase, 2011). This also implies avoiding questions tainted by the researchers´ own perspectives (´leading questions´) (Elliott, 2005; Stringer, 2014). Following a first round of meetings with partners, exploratory interviews, and the first collaborative workshops, a number of potential ´action situations´ and related formal, informal, and material factors began to emerge that were included in subsequent interviews by specifically asking participants about certain events, depending on their professional capacities and sectors.

The researcher applied a semi-structured questioning procedure that was based on a tentative questionnaire with possible questions adapted to each participant, as part of the preparations for each interview (Stringer, 2014) (see table 5.2):

- *Introduction:* brief presentation of the researcher, the case studies, and the NEXUS FUTURES project, including funding bodies and composition of reference group, ethical principles (see below), and checking time availability for the interview;
- *´General grand tour´ questions* about the interview participants professional activities and background, capacities in organisational context, organisational/professional/educational background;
- *´Typical grand tour´ questions* concerning challenges in everyday activities, particularly in relation to water and land (incl. agriculture, if applicable), including from an organisational perspective (i.e. professional and/or local, e.g. municipal);
- *´Specific grand tour´ questions* concerning the participant´s involvement in specific governance processes and action situations relating to the case studies, the role of specific informal factors (inter-organisational and inter-personal relations), formal factors (water, environment, and agricultural policies), and material factors (ecological, technical, economic/financial), including external events, and how processes have evolved, and why – identifying milestones, surprises, eye-opening events, turning-points, etc.
- *Personal, past- and future-oriented questions* (personal context): values and attachments, past achievements, ´lessons learned´, sense of self-efficacy, anticipated futures ("Luxembourg 2045"), related concerns, wishes, and plans (these kind of questions are not covered by Stringer, 2014);
- *Concluding questions*, remarks (from the interview partner) and explanation of follow-up by researchers.

Seven interviews were held in conjunction with a guided tour at the interviewee´s farms, nature reserves or water infrastructures (see below). Guided tours are often used in interviews to give the interviewee the opportunity to show the researcher the premises of his/her work and/or life and explain related activities, allowing the interviewer to familiarise herself with the immediate context (Stringer, 2014). The tour component of five of the interviews were not recorded, being an ´add-on´ to the actual interview. Two of interviews, however, were conducted almost entirely during walks and drives (the walks themselves lasting nearly three hours), and were recorded almost entirely. Visiting agricultural fields situated in a nature and drinking water protection area with small streams and a number of sources had been the very ´condition´ of one particular interviewee for agreeing to the interview.

Walking interviews have emerged as a distinct qualitative research method (Kinney, 2017). Among others, they serve to explore relations between people, place, and environments (Jones et al., 2008; Kinney, 2017). All interviews and conversations done ´on tour´ have confirmed the assumption that "talking becomes easier when walking" (Kinney, 2017). In the participatory walking method, the participant chooses the route around locations related to the topic of research. In all cases, they were sites of the interviewees´ professional (and hobby) activities most of them with ongoing projects relating to agriculture, habitats, and water infrastructures, which interviewees elaborated on during the interview and conversations. Participants being "expert guides", walking interviews have the advantage to change power relations between interviewer and those interviewed, taking the interviewer out of what might be a more fixed and controllable and, hence, ´safe´ environment (P. Jones et al., 2008). In the case of both walking interviews, a strong attachment between places and the interviewees, their natural environments, and animals could be felt. This in itself was not surprising. The very reason why the walking interview method had been chosen was that the interviewer suspected this to be the case, as both were outdoor practitioners. Doing the long walks and drives gave the interviewer the chance to ´prove´ her genuine interest in the practitioners´ activities and the challenges they face, which was of utmost importance for the quality of relations.

The researcher had the acute impression that one of the interviewees seemed to ´test´ her commitment by choosing a challenging route under adverse conditions (thus further ´balancing-out´ power relations).

The interviewer is convinced that interviewing the two participants inside (even if in their private homes) would by far not have produced the same richness of content. Notably, visiting specific places strongly enhanced the *narrative* quality of the interviewing process, as many sites immediately awoke memories of past experiences and, indeed, emotions that interview partners shared in the form of anecdotes. Generally, interview partners seemed to talk more openly and less controlled being outside. This made relations between interviewer and interviewee closer, making the challenge of showing empathy while ´keeping a distance´ even greater. It might also have made interviewees more vulnerable, because they ´opened up´ more, entailing an even greater responsibility for the researcher. After some of the walking interviews and guided tours, the interviewer wondered if participants had perhaps shared certain experiences or presented certain issues in manner that they felt uncomfortable about afterwards. While the interviewer will probably never find out, this makes the follow-up seem even more important (i.e. the sharing of research results).

In general, some of the most valuable insights into narrative identities, relations with others and their social and material contexts, problems encountered by practitioners, and their assumptions, were thus made during walks, recorded and unrecorded. Furthermore, and equally significant, was that doing the walks allowed the interviewer herself to develop a "sense of place", altering her own ways of perceiving and experiencing the landscapes she studied, notably, by extending them to include local and professional knowledge shared by the participants (including their ´stories´ and emotions). Experientially, the walking interviews and guided tours have left some of the strongest impressions of the whole research process.

As regards the recording of the two walking interviews, however, much of what was said was lost due to background noise (from wind, streams, cars/tractors, and the walking through snow). Moreover, the interviewer decided to interrupt recording on a number of occasions, either because the participants explicitly asked for that or because she felt it was inappropriate and made interview partners feel uncomfortable. These reflections correspond to some of the merits and limitations of the walking interview methods highlighted in the literature (Jones et al., 2008; Kinney, 2017).

Experiments with interviews were also done in another manner. In five interviews of the final interview round (mainly with municipal and public officials) when major action situations (see below) had been identified based on previous interviews and documentary analysis, the interviewer experimented with putting cards on the table during the ´specific grand tour questions´. Each card (shown one-by-one, based on the judgement of the interviewer and depending on the flow of the conversation) mentioned a particular action situation or event, in order to elicit the interviewee´s perspectives and interpretations (in addition to asking him/her *first* about situations considered particularly important). They were introduced by explaining that these were situations and events that several other interview partners had mentioned. When a particular action situation (e.g. a public consultation, set-up of a particular organisation, or entering into force of a law) or event (e.g. "metazachlor accident", "blue algae bloom", or municipal or national elections) did not prompt any particular associations or was deemed insignificant the card was immediately removed from the table.

The technique risked being perceived as imposing and would not have been adequate for earlier interviews and, moreover, for interviews with some of the practitioners. When applied, it rendered interesting insights. By guiding the participant´s thoughts back to a particular situation or event in a game-like and narrative manner (interviewees tended to look at the cards rather than the researcher), reflections seemed to be both more focused *and* to flow more freely. The interviewer had the

impression that some of the situations and events may otherwise not have been mentioned by the interviewee (especially those that seemed to be associated with ambiguous sentiments or that did not ´fit in´ with the plot of the narratives conveyed during the interview). More experimentation would be required to evaluate merits and limitations more systematically.

Rough interview structure and overview of *possible* questions (adapted to each interview partner):

1) ´General grand tour´ opening question concerning professional capacities/activities:
   - Please describe your current position, main tasks (role) and for how long you have been active here.
   - What are the main objectives and tasks of your organisation (if applicable)? Who are important partners?
   - Please provide some of typical recurrent issues that you work on.
2) ´Typical grand tour´ questions (transactional and organisational contexts): Water and land issues and challenges in the river basins:
   - How have you been involved in – or affected by - issues and activities in relation to water and land (incl. agriculture and ecological restoration)?
   - Please describe some of the activities (meetings, situations etc.) and experiences, in which you were involved.
   - In your view, what are the main challenges and issues at stake? How are they related to other issues?
   - Please provide examples.
3) ´Specific grand tour´ questions concerning formal and informal governance and management processes that are objects of the case studies (transactional and organisational contexts):
   - How have you been involved in water quality/drinking water protection/river restoration processes?
   - What do you regard as main challenges?
   - What would be important to you in terms of how they are ´solved´?
   - Please describe your relations with other actors involved in the processes and how they have evolved (how you have organised yourselves), please provide examples.
   - Please describe relations between the actors in general and how they have evolved, please provide examples and possible reasons: What has been the quality of relations and communication (incl. frequency), and how have they evolved?
   - Have there been bridging organisation, facilitators or mediators in case of conflict? How do you perceive the role of the river partnership (also: Nature Park, LAKU)?
   - Which actors have been passive or missing in the processes?
   - In your view, how have the specific factors shaped processes (which role have they played):
     - Specific policies (e.g. EU WFD, CAP, specific national laws) or other political factors
     - Administrative procedures
     - ´Expert´ studies and consultancies
     - Informal contacts and relations between people involved (across scales)
     - Roles of specific organisations or individuals
     - Participation of local and professional actors
     - Economic-financial factors
     - …other important factors?
   - Have there been any ´phases´, ´milestones´ or ´turning-points´?

- Overall, how do you think activities and processes could have evolved differently? Have there been any surprises or ´eye-openers´?

4) Macro context [optional ´general grand tour questions´, depending on participant, time availability, and flow of conversation]:
   - Luxembourg: role of land-use, population and economic growth
   - Role of public (environmental) awareness, debates and media
   - Role of technologies – what role now, which in the future?
   - In which way have any of alternative/innovative approaches – and debates about them – played a role in your everyday activities:
     - Extensive or organic farming, community-supported agriculture
     - Polluter-pays principle
     - Ecosystem services, multifunctionality of landscapes, ´green infrastructures´
     - …
5) Personal sphere and future:
   - Today: how would you describe your relation with your region, nature, animals, etc.?
   - Looking back: Lessons learned: Is there something that you do differently today than in the past? What memories are you particular fond of? What achievements/successes are you particularly proud of?
   - Which doubts or concerns do you have?
   - Today: in your life: How do you judge your possibility to influence and change things?
   - Looking into the future: as regards your personal life, nature in the river basin, the development of the region/river basin and society/economy in Luxembourg: how do you think they will develop until 2045, your main concerns or hopes?
   - What will be major challenges?
   - What will life of yourself, your children or successors look like?
   - If you had a crystal bowl: what would you ask?
   - If you had three wishes: what would you wish?
   - …anything important to you that we have forgotten?

Table 5. 2 – Typical interview structure and questions posed by the researchers

5.3.3 Ethics

The following elaborates on informed consent, ensuring the well-being of participants, and of confidentiality and anonymity, as the main ethical principles to be concerned about in interviews and collaborative research (Rallis & Rossman, 2012; Stringer, 2014).

Informed consent: All interview partners have signed a consent form, which the interviewer went through with participants before starting the interview. It was typically sent to participants ahead of the interview and brought along in hard copies. It included drawing the attention of participants to the fact that they had the right to interrupt recording at any time and to review and revise the transcript. Interviewees were specifically asked if they agreed to the use of direct quotes, even if interviews were anonymised. The interviewer explicitly underlined that she did not do ´contract research´ for the Ministry of the Environment. Signed consent forms were emailed to the participants after the interview. None of the actors interviewed were physically or mentally impaired, and the project did not include any vulnerable groups.

Well-being: The responsibility entailed in doing interviews goes far beyond informed consent. Interview situations are always asymmetrical, as the researcher is the one asking questions while giving little of her own thoughts (Elliott, 2005; Rallis & Rossman, 2012). As suggested above, story-telling is a

way of empowering people. At the same time, the more respondents ´open up´, the more vulnerable they may become. The more informal the settings (e.g. in their private homes or during walking interviews), the greater the trust and the ´need to talk´ (which could be clearly felt among some participants), the greater the risk of later regret, doubts or distress, e.g. due to unexpected – and not consciously intended – turns of the conversation (Elliott, 2005). Narrative interviews touch upon issues of personal identity, even if – as in this case - they mainly concerned the professional life of actors. The interviewer sought to make sure she was neither acting as "psychotherapist" nor as "investigative journalist". She, therefore, sought to avoid:

- too personal questions (although questions such as "do you expect your son/daughter will one day take over the farm?" could be slightly emotionally stressful),
- to inquire into matters that seemed to have taken place in legal grey zones.

Confidentiality and anonymity: In a very small country like Luxembourg confidentiality and anonymity are sensitive issues. There are few actors active in specific domains and organisations relating to water and land. Moreover, most of them know each other (well). It is even more of an issue in partly polarised situations, in which many actors might be eager to find out what someone else ´really´ thinks. This awareness grew after a NEXUS FUTURES reference group meeting, in which anonymised quotes were displayed on a slide to show first insights into contradictions. Following the meeting, some of the quotes were *wrongly* attributed to specific actors who were confronted at their work about what they had allegedly said, giving rise to rumours and mutual accusations. Fortunately, the person concerned addressed the author of the thesis who could clarify that none of the concerned interview partners´ quotes had been used at the meeting. As a consequence, it was decided in the framework of the NEXUS FUTURES project to no longer use direct quotes in stakeholder meetings (especially those that might be perceived as offensive by some), and to only use direct quotes in publications after explicit consent of interview partners to their use, knowing that complete anonymity is probably impossible. Even when all organisational affiliations and geographical locations are erased, the context of the processes itself narrows possible actors down to very few. The risk remains that quotes are wrongly attributed to someone or that research results are instrumentalised in any other way *un*intended by the author.

Data management: The interviews have been audiotaped and transcribed either by an external transcription company or the researcher herself. All audio files and interview transcripts are exclusively saved on a UL password-protected server (until 2033).

Expectation management and follow-up: Participation in interviews comes with expectations on part of the participants, especially in transdisciplinary and action-oriented processes (Stringer, 2014). The researcher has committed to making results public, informing participants about them, and has offered meetings to discuss them. Beyond that, however, it has been underlined that participants would have no direct benefits from the project and their participation. However, without a doubt, some interview partners used the occasion of the interview ´to set things right´. They *did* hope that the thesis might contribute to revealing a more ´true picture´ of ´how things really were´, addressing what some have perceived as unjustified and unfair. Other may also have hoped that the thesis would provide concrete (policy) recommendations that would be in their favour. Seeking to be as ´objective´ as possible by reflecting diverse perspectives has therefore been a significant responsibility.

5.3.4 Recording, transcription, coding

With the exception of one interview, all interview partners agreed to recording. The interview not recorded was, nonetheless, a valuable background conversation (not counted in the interview statistics above). A few participants asked the researcher to pause recording to share what they considered sensitive. In general, many significant statements were made in ´unrecorded situations´ (see above), after the recording was stopped and after the interview had ´officially´ ended. Trying to learn from this experience, the interviewer sometimes left the recording running after having said "thank you" (instead of stopping it immediately). However, indeed, many interview partners shared final thoughts only after the interviewer had explicitly confirmed she had stopped the device and put it away, and while accompanying her out. One interviewee passed a written note to the interviewer during ongoing recording to share a comment s/he did not want to be recorded. Based on these experiences, the interviewer has concluded that recording *always* places a barrier between interviewer and interviewee (affecting power relations), alters the situation of the interview and what is being said and how, as pointed out in the literature (Elliott, 2005). While being able to transcribe, reflect on and analyse interviews based on recordings is of great importance (generating scientific evidence), having a mix of recorded and unrecorded conversations greatly enhances insights into subject matters and interpersonal relations. It has greatly informed case study analysis (including concepts), even if some insights could not be substantiated by direct quotes.

During the interviews, the interviewer took unstructured notes (except during interruptions and during walks and tours). All recorded interviews were transcribed. Of the 55 interviews, the researcher transcribed 21 herself; the others were done by a transcription company for reasons of time. As the interviews were not used for discourse or conversation analysis (and to enhance anonymity), they were "clean transcripts" that focused on spoken words and readability, removing repetitions, false starts, etc. (Elliott, 2005).

Most of the interviews were coded using MAXQDA. Coding interviews allows the researcher to begin constructing an analytical frame by developing a set of categories and themes that should reflect the experience of participants rather than the researcher´s own assumptions (Charmaz, 2006; Stringer, 2014). Some researchers argue in favour of detailed (e.g. line-by-line) coding, in order for the researcher to delve deeply into each spoken word suspending own assumptions (Charmaz, 2006); others however are sceptical of coding viewing it as a "mechanistic" and "simplistic" exercise that reduces data to particular themes bound into a coherent narrative or pattern. Coding may preclude a more multi-layered and complex treatment of data that allows for contradictions and conflicts (Jackson & Mazzei, 2012). The present thesis has chosen a middle-way that went through three phases. During initial phases when research questions had not yet fully matured and when the researcher still familiarised herself with actors and contexts, detailed coding for diverse themes was done with two main objectives in mind:

- Inquiring into personal meaning-making of actors: their personal knowledge and self-understanding, personal narratives of past, present, futures (including key events and experiences), perspectives on human-environment relations, and related challenges and alternative pathways (with broad codes);
- Systems knowledge: Understanding diverse factors that drive the water and land systems in Luxembourg (drivers of change) (with ´narrow´/specific codes on different factors).

The researcher attributed many segments to several codes and allowed for significant overlaps. The first phase of coding also served the preparation of the 1st collaborative conceptual systems workshop with stakeholders that was dedicated to identifying ´action fields´ of particular relevance in the Syr basin (incl. river restorations). In the meantime, the new drinking water protection zones emerged as

a key topic for the Upper Sûre basin. For both river basins, the roles of formal regulation (e.g. the EU WFD), organisations, local and professional communities (and their knowledge and narrative identities) had emerged from preliminary interview analysis as more significant than originally anticipated. Furthermore, the MTF scheme was chosen for the analysis of social learning processes in water and land-related governance processes, as it seemed suitable to analyse some of the factors and processes selected for further analysis and the development of an analytical framework. Therefore, the second coding phase entailed an entirely new coding scheme (and recoding of interviews) that reflected the MTF categories and had a stronger focus on:

- *local* and *professional* knowledge and related narrative identities, organisations, and their interrelations, including historical backgrounds and ´milestones´ or ´turning-points´,
- the governance processes chosen for the case studies, related action situations, and key events, and personal experiences hereof.

Again, coding was done with significant double- and triple-codings and overlaps, and continued to evolve until mid-2019. As the number of potential action situations increased with *diverse* narratives (temporarily up to 25), the question on which ones to select, and why, became increasingly difficult. The final selection only emerged late in the process, based on exchanges in the NEXUS FUTURES reference group (see annex IV), and during the writing-up of the case studies themselves (i.e. along with the construction of the ´second-order´ narrative).

Finally, a third phase of *selective* coding was applied to the final round of interviews (mostly with actors who had already been interviewed once or twice) when the author sought to gain insights into more overarching interpretations of how and why relations and processes had evolved as they had (including ´lessons learned´), and to seek more perspectives on specific puzzling, contradictory, and inconclusive elements. Coding thus evolved together with the interpretation of interviews, the degree of the emergence and refinement of the research questions, and the main methods and tools chosen.

At the same time, interview analysis built only partly on the coded segments. Independently of MAXQDA, the interviewer printed all interviews and repeatedly read them on paper highlighting what seemed particularly interesting passages.

5.3.5 Analysis

There is no established narrative method of analysis (Elliott, 2005). Three different foci in the analysis of interviews can however be distinguished, which the present thesis seeks to combine (Chase, 2011; Elliott, 2005):

- *Content* of narratives: chronological sequences of events, and how they are evaluated by the narrator as part of personal meaning-making (“what has happened and why”) (Elliott, 2005), focusing on themes and voices *within* rather than across narratives (Chase, 2011);
- *Structure* of narratives: including (but, normally, by far not limited to) the identification and choice of metaphors and other images evoked (i.e. of “affective narrative expressions”, see above) (Elliott, 2005);
- *Performance* and *social dimension* of narratives: the interactional and institutional dimension of narratives in their *contexts or* “narrative environments” (Chase, 2011) (i.e. how narratives shape action, and vice versa).

While the first two are centrally placed in hermeneutic traditions (focusing on evaluative and subjective dimensions), the latter has been taken up more recently by social scientists and other scholars. Coding has been particularly helpful to identify various factors that drive the water and land

system in Luxembourg as well as to establish chronologies of events, and identifying certain metaphors and imaginaries. Personal meaning-making, however, and a deeper understanding of contexts (including paradigms), their interrelations, and contradictions, was more based on reading and re-reading interviews on paper. In this sense, the methods have been complementary and iteratively shaping each other. The ´second-order narratives´ that have emerged in the form of the sequences of action situations are not meant to cohere into narratives with a certain resolution or moral at the end. In the Syr basin, no coherent sequence could be established in the first place, suggesting that water and land governance here are fragmented. As regards the Upper Sûre basin, it was possible to establish a sequence as regards drinking water protection zones and, yet, diverse possible interpretations of what actually happened, why, and what were the most significant factors remain, including many open questions and ambiguities.

5.4 Observations and site visits

Site visits and participant observation are established methods in qualitative research. They are rooted in anthropological fieldwork and ethnographic observation (Jones et al., 2008; Rallis & Rossman, 2012; Stringer, 2014). Observation enables the researcher to become acquainted with the lifeworld of actors and to develop an understanding of their behaviour, actions, and relations with other people and material contexts, and might also reveal certain patterns (Rallis & Rossman, 2012; Stringer, 2014). In the present study, observations have been carried out during guided site visits and at meetings. During some of the guided walks, the researcher took photographs, although she felt that this put a distance between her, the organisers and participants, and distracted from fully immersing in the activities (see figure 5.10). At meetings, she took notes. In general, note-taking has been unstructured rather systematic (Rallis & Rossman, 2012; Stringer, 2014).

Figure 5.10 - Walk through the Mensder Brill in the Syr valley on a grey summer day in 2019

During walks and meetings she devoted particular attention to observing interactions between actors (including their sentiments), how subject matters and challenges were framed (including possible narratives, metaphors, imaginaries evoked), and actions and measures discussed. As discussed under ´triangulation´ above, this occasionally revealed discrepancies between what interviewees had told the researcher and what she observed. Part of the explanation for these discrepancies is probably that some of the processes analysed were characterised by dynamic ´ups´ and ´downs´ in interpersonal and inter-organisational relations, and were influenced by specific contextual circumstances. In fact, unable to participate in all relevant meetings, the researcher did miss some occasions that had lasting

effects on subsequent processes. This, however, the researcher could only (re-)construct from interviews and meeting minutes. Furthermore, the researcher also suspects that, indeed, what people *say* in an interview does not always correspond to what they actually *do* in ´real-life´ and ´how things really are´ (i.e. how they are perceived by others). Not only may actors choose to act differently in a given situation for strategic or other reasons, but during the interview they may also have sought to create, for example, a more favourable or unfavourable impression of their relations with others. Observations have therefore provided an indispensable supplement to interviews, despite many ambiguities.

The meetings were also the main occasions to observe concerns of, in particular, citizens, farmers, and municipal representatives *not* interviewed. Participating in meetings and public guided walks allowed the researcher to broaden her understanding of the concerns and sentiments of some citizens and other local actors in relation to water, environment, and land. Although public meetings and guided tours often tend to attract ´usual suspects´ not necessarily representative of communities and populations as a whole, they did contribute to developing a feel for both local and wider societal debates, and contexts. Furthermore, networking at events enabled the researcher to ´recruit´ several interviewees.

During the PhD research, 17 site visits were undertaken. They included:

- **2 ´walking interviews´** (recorded) in nature reserve areas (1 Syr, 1 Upper Sûre, see above);
- **8 ´private´ guided tours** (non-recorded) at the professional/private premises of interview partners preceding or following recorded interviewing (incl. two conventional and two organic farms, two nature reserve areas, one drinking water and one wastewater treatment plant, see above);
- **7 public guided tours** (non-recorded) organised by Syr River Partnership, intermunicipal syndicates and/or municipalities for citizens in nature reserves and/or drinking water protection areas with groundwater sources located mainly in the Syr river basin (municipality of Schuttrange) or areas with surface water bodies in the Upper Sûre river basin (lake).

In addition, the researcher participated in a number of non-NEXUS meetings, mainly as observer (but also with occasional short formal or informal presentations about the NEXUS FUTURES project and her research). The included (15 in total):

- **Syr river basin (5):** 3 public meetings of the river committee of the Syr River Partnership (including presentations of NEXUS FUTURES project and research), 1 meeting of a municipal environmental citizens´ committee (municipality of Niederanven), 1 meeting on river restoration planning (municipality of Betzdorf);
- **Upper Sûre river basin (7):** 4 working group meetings on the future drinking water protection zones (agriculture, syviculture, municipal development, tourism), 2 public meetings on the future drinking water protection zones, 1 public lecture on blue algae bloom;
- **River basins – national (2):** Annual colloquia of all river partnerships in Luxembourg on the occasion of World Water Day: Progress on EU WFD implementation, Extreme weather events and nature-based flood protection (with researcher as moderator of plenary debate);
- **Ministerial stakeholder meeting (1)**: Event on agricultural labels;
- **Agricultural seminar (**1): Seminar for farmers on soil quality organised by national institute for organic agriculture (Ibla) and a regional water supplier.

Finally, the researcher is well aware that she was more than an observer; even at meetings in which she did not actively participate (most of them), her presence rarely went unnoticed, especially as her research topics became more widely known. Direct evidence for this impression were meetings (characterised by controversial issues and debates) after which several – and, fortunately, very different - actors (whom the researcher had interviewed) sought to convey – and sometimes "justify" - their perspectives to the researcher (incl. "did you notice that…..?!", "You have to include this in your thesis!", etc.). This happened especially at informal evening receptions following public meetings. The researcher stayed reserved and kept a distance. At the same time, it made her very conscious of the *political* dimension of the present thesis, and how difficult it is to stay ´objective´. Moreover, the researcher may sometimes also have served as a ´neutral conversation partner´ with whom it was ´safer´ to talk than with others. On the other hand, some actors may also have tried to find out what she ´was really thinking´ and what direction her thesis would take. Furthermore, the author has sought to make sure that she was seen as conversing with actors from ´all sides´. Overall, therefore, observing and participating in meetings has been a complex matter, particularly in polarised situations and processes, the intricacies of which would merit more reflection.

A note on language: The majority of the meetings observed were held in Luxembourgish. As a German native speaker who took Luxembourgish language classes before and during the 1st year of the thesis (level B1-1) and was familiar with most topics discussed, passive understanding of Luxembourgish has overall been sufficient. Nonetheless, she cannot be sure that she understood everything correctly. The more informal interventions and discussions were, the more difficult it became to follow and catch nuances. The researcher herself generally spoke German during events, exceptionally French (both official languages of Luxembourg).

5.5 Document analysis

A final element of triangulation, the present thesis builds on a wide range of documents. In document analysis, the researcher collects and interprets documents and records of research interest (Rallis & Rossman, 2012; Stringer, 2014). For present purposes (and based on the MTF database, see below), they included three categories of documents: 1) formal regulative and organisational documents, 2) informal policy and organisational documents that are not legally-binding, but have a certain defined status, 3) other documents.

Formal regulative and organisational documents, incl.:

- EU and national legislation, national management plans, ´expert studies´ commissioned by national ministries or administrations as part of formal management plans,
- organisational documents such as statutes, internal rules of procedures, formally signed charters or mission statements.

Informal documents containing non-binding informal institutions, information and studies, incl.:

- EU and national policy documents, reports, statistics, etc.,
- organisational documents such as action plans, studies, annual and anniversary reports, newsletters, minutes, etc.,
- scientific studies and ´expert reports´, incl. from specialised Luxembourgish journals.

Other documents, including press and historical articles.

In addition to providing the legal bases of some of the processes analysed, the documents have been invaluable to cross-check and supplement information provided by interviewees and partners, whose statements provided the main point of departure for most documentary research, including into

historical contexts. Proceeding in this manner, documents have often provided an additional layer and depth to the analysis of, in particular, organisations.

Most documents were collected via European and national inventories and online research. In addition, the river partnerships, other members of the NEXUS FUTURES reference group and actors interviewed were extremely helpful in providing the researcher with various documents, including access to organisational archives, historical editions of national journals, and press article collections. Thanks to them, the present thesis has been able to build on a rich and diverse documentary basis going as far back as the 19th century. The documents were in French (national legal language), German, and a few in Luxembourgish.

A Luxembourgish student assistant helped with the search and management of documents, and checked translations.

5.6 The Management and Transition Framework (MTF): Adaptation and application

Some of the data described above has been integrated into the database of the Management and Transition Framework (MTF). The database serves the ´diagnostic approach´ tailored to multifactorial analyses of Claudia Pahl-Wostl and associated researchers (Knieper et al., 2010; Pahl-Wostl et al., 2015). The diagnostic approaches pursues two-fold objectives: improving the "scientific understanding of water governance" and to contributing to "actionable knowledge for transformative change" (Pahl-Wostl, 2015) with a view to support the development of context-specific approaches in water management (Pahl-Wostl et al., 2015). MTF has been chosen, because it offers a flexible interdisciplinary framework that helps to structure the analysis of diverse data. Notably, it takes into account multiple factors and feedbacks between social and ecological systems (see conceptual positioning and framework 3.2.1). It has been developed and revised over several years, and in the course of several national, EU and international projects on water governance in river basins (Bouwen & Taillieu, 2004; Craps, 2003; Halbe et al., 2013; Knieper et al., 2010; Knüppe & Knieper, 2016; Mostert et al., 2007; Pahl-Wostl et al., 2010, 2015, 2019; Scholz et al., 2014). The MTF approach is tailored to the analysis (and visualisation) of specific cases within water governance systems with a view to determining if and how social learning emerges from governance processes.

While the conceptual framework has concentrated on MTF concepts and analytical categories, the following elaborates on how they have been modified and applied to data generation and analysis. In direct dialogue and cooperation with, notably, Claudia Pahl-Wostl and Christian Knieper (University of Osnabrück) the database has been adapted to the purposes of the present thesis. It has thereby contributed to reflections on and the further development of the MTF. The following description of its main elements, and how they have been adapted and applied for present purposes, is based on the MTF database manual (version 11c) unless indicated otherwise (Pahl-Wostl et al., 2015).

5.6.1 Action situations and their selection

The purpose of the MTF database is to analyse and visualise formal and informal governance processes (incl. interplays) composed of sequences of so-called action situations. The thesis has used the database to structure the case studies.

Definition: As main building blocks of governance processes, action situations are defined as "structured social interaction context". The MTF has elaborated on the concept based on Ostrom (see conceptual positioning 2.2.1.2). Action situations can be micro-situations such as individual meetings. They can also be a particular governance phase that aggregates several activities and meetings, for instance, the elaboration of an action plan. Action situations are connected via "identifiable outcomes" (e.g. in terms of institutions, knowledge and/or operational outcomes) that influence subsequent action situations and, thereby, the overall process. In the MTF database, action situations have the following main attributes (some of which have been elaborated in the conceptual framework 3.2.2):

- **Action situations**: their dominant **governance mode** (hierarchy, market or network),
- **Governance phase** (see below), and **administrative level** (or spatial unit): *What has happened when and in relation to what context?*
- **Actors** involved, their **role(s)** and **personal knowledge** (originally, ´situated knowledge´): *Who has been involved and how?*
- **Institutions**: *What formal and informal institutions have played a role?*
- **Knowledge**: *What knowledge, information, and data have been involved?*
- **Operational ´inputs´, outcomes, and effects** not captured by the above, e.g. as regards the quality of relations between actors and diverse contextual factors (incl. events): *What other factors have influenced a situation*? *What outcomes and effects have been produced?*

The database categories "situated knowledge", "knowledge" and "operational outcomes" have been adapted and refined to suit the objectives of the case study. Based on the analytical framework and the above, a scheme has been developed to capture all input and outcome factors of diverse contexts in relation to a specific action situation.

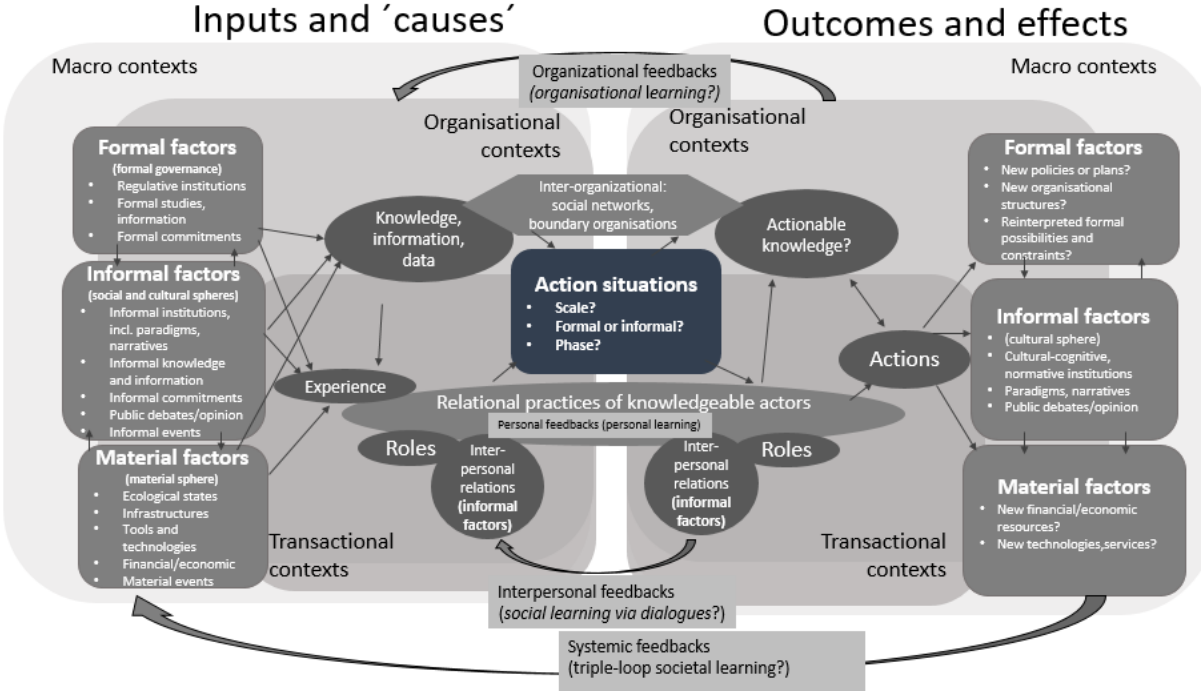

Figure 5. 1 - Schematic representation of action situations as adapted from the MTF for present research purposes

Methods and criteria used for selecting and analysing action situations for the Upper Sûre and Syr case studies: Action situations are the main structuring elements of the case studies of the present thesis. The selection of action situations (13-14 for each river basin) and their characterisation was done based on an iterative and collaborative process encompassing:

- qualitative interviews,
- conversations with and input of the river partnerships and other members of the NEXUS FUTURES reference group (see annex IV),
- documentary research (diverse legal, policy, and organisational documents, press articles),
- dialogues with and feedback by the MTF team of the University of Osnabrück.

The main criteria for the selection of an action situation were:

- meaningfulness: having been attributed a certain significance in statements and narratives of actors,
- saliency: having had a discernible outcome/significant impact in terms of actors, institutions, knowledge and information or operational outcomes on the processes analysed (formal, informal, material).

In addition, a stakeholder workshop organised by the author in the framework of the NEXUS FUTURES project in the Upper Sûre region has been added as an action situations, as it provided interesting insights into perspectives on futures and future roles of organisations in the region from diverse perspectives (see 9.13). The selection does not, therefore, lay claim to objectivity. It reflects the research purposes, concepts, and methods of the thesis. However, it does integrate the perspectives of diverse governmental and nongovernmental actors from different scales who were directly involved in the processes analysed. Action situations not selected (e.g. because they did not add much to the analysis and understanding of governance processes as a whole and/or because they were only mentioned by a few partners) have been taken into account as informal, formal or material ´input´ factors.

5.6.2 Actors and roles

For each action situation, it has been specified who was involved (governmental or non-governmental, individual, collective, collaborative or aggregated actors), in which role (lead, active, passive), and with what knowledge. Four actor categories were considered:

- **Collective actors**: organised as one entity or legal body (such as national water administrations or environmental organisations)
- **Collaborative actors**: a group of loosely organised collective and/or individual actors (e.g. the river partnerships)
- **Aggregated actors**: Non-organised actor groups such as ´citizens´ or (sometimes) ´farmers´
- **Individual actors** (hardly considered in the database for present purposes).

For each action situation, the case studies analyse in which role each actor has participated: as lead, active or passive actor (see conceptual framework 3.2.5). The attribution of a role has usually been based on a “shared understanding of their meaning and function” (Pahl-Wostl,2015) rather than on formal considerations.

Personal knowledge (revised from ´situated knowledge´): In the MTF database, ´situated knowledge´ is broadly defined as "context related knowledge", or "personal information used by an actor in an action situation" (Pahl-Wostl et al., 2015) or "situation-specific interpretation of available knowledge" (PahlWostl, 2015). It is an open ´field´ without pre-defined values. Based on the conceptual framework outlined above and on empirical insights from the interviews, the MTF database has been adapted to contain specific knowledge types to be selected (see below). Moreover, based on the conceptual framework and in dialogue with the MTF team, the category has been renamed to "personal knowledge" that an actor brings into – and acquires from – an action situation. The main reason is that the present thesis considers all knowledge situated (see conceptual positioning 2.3.1).

5.6.3 Institutions: Formal and informal

Broadly understood as rule sets in need of interpretation, institutions – as applied in the MTF database - have different degrees of formality:

- **formal institutions** are legally binding regulative rules such as EU directives, national laws, and formal national management plans (such as relating to the EU WFD) that can also be outcomes action situations in formal governance processes
- I**nformal, but documented institutions** are real written documents with confirmed – but legally non-binding – status, e.g. action plans of nongovernmental organisations
- **informal – and undocumented – institutions** are shared unwritten rules that, for present purposes, encompass paradigms, narratives, and imaginaries, in addition to societal values. In order to be considered an ´institution´, they need to have been shared over a longer period of time.

While formal and informal institutions can influence action situations (via the knowledgeability of actors), informal institutions as such cannot be outcomes of single action situations. However, it is conceivable that actors in a specific situation explicitly agree on a specific (re-)interpretation or even re-framing. Institutions will be attributed to action situations based on documentary analysis (e.g. which laws are explicitly cited?), interviews, and observation studies (for those situations, in which the researcher herself was present). While the MTF database uses institutions as separate ´input´ and ´outcome´ category, the present thesis treats them as closely intertwined with "knowledge" (see conceptual framework 3.1.2).

5.6.4 Knowledge and information

In the MTF scheme, knowledge is defined as "meaningful information and experience which can be externalized and made publicly accessible" (Pahl-Wostl et al., 2015). It may be available in an ´action situation´ to all or only to some actors (Pahl-Wostl, 2016). The definition is sufficiently broad to be compatible with the understanding of knowledge developed in the present thesis. In the database, it is an open field with no predefined sub-categories. In the case studies, knowledge and information attributed to action situations have been deduced from written documents (e.g. content of academic publications, reports, data, minutes, system diagrams) and from actor interviews, and used for collectively shared (i.e. community-based) knowledge, both implicit and explicit.

In a later MTF database version (Pahl-Wostl et al., 2019), a distinction is introduced between "expert/scientific" and "local/experiential" knowledge, which reflects the binary conceptualisation of knowledge prevalent in the adaptive governance literature (see conceptual positioning 2.2.1.3).

In dialogue with the MTF team and based on the analytical multi-contextual framework, the following community-based knowledge types have been added to the database:

- Local
- Professional
- Organisational
- Specialised scientific/technical
- Other

For each action situation, these will be used to characterise any specific knowledge and information (attributed to one or several knowledge types) that is directly related to an action situation (as ´input´ or ´outcome´). The knowledge attributes can, in principle, be attributed to action situations as "knowledge and information" and/or as "personal knowledge" of a specific actor. At the same time, for the case studies the "personal knowledge" database category has not been used to structure analysis into "personal knowledge" of individual actors. In addition, the following "meta-knowledge types for sustainability" (or dimensions of actionable knowledge) have been introduced in the database:

- Systems knowledge
- Normative knowledge
- Futures and pasts knowledge
- Transformation/action knowledge
- Other

Except systems knowledge, these additional knowledge types have been mainly used to describe and analyse the knowledge input and outcomes of NEXUS project workshops. Explicit knowledge input and outputs can be further specified in terms of their public accessibility (´publicly available´ or ´not publicly available´).

5.6.5 Operational input and outcome factors

Operational outcomes are outcomes of (and inputs to) action situations, which are not captured by "institutions" or "knowledge". In the newer STEER version of the MTF database, operational outcomes are defined as "all kinds of material […] or immaterial […] factors that can be directly attributed to a social process" (Pahl-Wostl et al., 2019). For the present purposes, ´operational outcomes´ will include ***all*** material outcomes and *some* informal outcomes. Based on the conceptual framework, the following pre-defined values to "operational outcomes" have been *tentatively* integrated in the database, of which several can be attributed to action situations (examples in brackets):

Material factors:

- Ecological (e.g. river restoration)
- Technical (e.g. new infrastructure, technology or other physical ´products´ or services)
- Business/financial (e.g. funds raised/gained/applied for)
- Professional (e.g. physical experiments launched)

Informal factors:

- Relational (interpersonal outcomes, such as network effects, quality of interpersonal relations, organisational commitment)
- Organisational (e.g. new staff, organisational activities and events)

- Political (e.g. election campaigns)
- Societal (societal "needs", public debates, incl. press)
- Other

Importantly, "operational inputs and outcomes" can also be used for specific material and social events, e.g. hazard events, elections, etc.

Furthermore, the following attribute can be added to each outcome to explicitly take into account unintended and undesirable consequences:

- intentionality (intended/unintended)

5.6.6 Phases in governance processes

The MTF applies different denominations to specific phases of formal policy and informal learning cycles. For the sake of simplification and comparison, the present thesis introduces common denominations and adds an evaluation phase (see table 5. 3). They are described in more detail in the conceptual and analytical framework (see conceptual framework 3.2.4).

MTF Formal policy cycle (detailed version)	**MTF formal policy cycle (simplified version)**	**MTF informal learning cycle**	***Adaptation for thesis***
Strategic goal setting Assessing current state Policy formation	Strategic Goal Setting & Policy Formulation	Problem restructuring & reframing	*Purposes*
Developing operational goals Developing measures	Developing Operational goals & measures	Developing action plans and mobilising additional support	*Plans*
Implementation Monitoring	Implementation & Monitoring	Implementing and evaluating pilots/experiments	*Actions*
-	-	-	*Evaluations*

Table 5. 3 – Introduction of common denominations for phases of formal and informal governance cycles

Furthermore, the present thesis develops a scheme that serves to facilitate the identification and analysis of interplays between formal and informal governance processes and learning loops (see conceptual framework 3.2.4, figure 5.10).

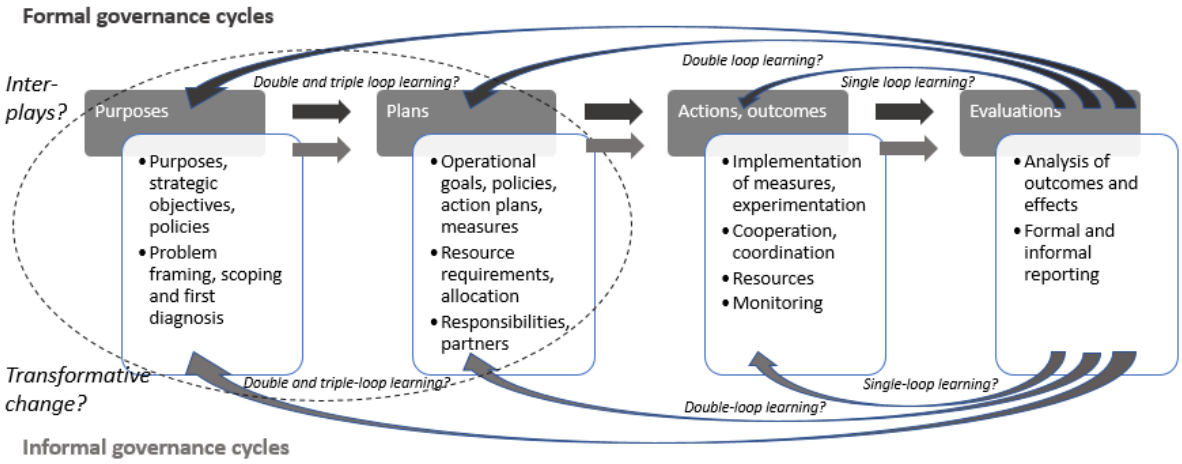

Figure 5. 10 - Ideal-typical representation of possible social learning feedbacks in formal and informal governance cycles

CASE STUDIES

6 INTRODUCTION TO CASE STUDIES: Governance and social learning in the Syr and Upper Sûre basins

Figure 6.1 - The Upper Sûre lake (source: Naturpark Öewersauer, photo: Caroline Martin)

Figure 6.2 – Upper course of the Syr river (source: Flusspartnerschaft Syr)

Based on the concepts and methods elaborated on in the previous parts, the case studies investigate how water and land governance and management in the Syr and Upper Sûre basins Luxembourg have changed following the entering into force of the EU Water Framework Directive in 2000. Special attention is devoted to the question if they have become more conducive to the emergence of social learning and actionable knowledge among diverse nongovernmental and governmental actors fostering collective action for sustainability. The case studies inquire into the following research questions:

1. *How can a kind of knowledge be conceptualised that fosters collective action for sustainability?*
2. *How has the EU Water Framework Directive changed water and land governance and management in Luxembourg?*
3. *What factors have facilitated or hindered the emergence of social learning and actionable knowledge for sustainability?*

Particular attention is devoted to how actors in Luxembourg have engaged in informal and formal governance processes. The comparative analysis is conducted across multiple dimensions investigating interplays between agency, governance processes, ecosystems, and infrastructures:

- across places: Syr and Upper Sûre (sub-)basins,
- across scales: formal and informal governance across local, river basin, national, and EU scales,
- across time: from the 19th century to today, with a focus on the period from 2000 to 2019.

In both river basins, the main issue examined concerns water quality. In the Syr valley, processes concerning water quality relate to efforts to improve aquatic ecosystem health through river restorations and the reduction of pollution caused by wastewater. The Upper Sûre case examines processes concerning the elaboration of new drinking water protection zones that aim to reduce the impact of agriculture and other local activities on water quality in the national drinking water reservoir.

Based on the scheme developed in the conceptual and analytical framework (see figure 6.3), the analysis elaborates on contexts, processes along with their outcomes and effects, followed by a comparative analysis:

- **PART I: Historical and contemporary governance contexts**
- **PART II: Governance processes** relating to the national implementation of the EU Water Framework Directive and the creation of the Upper Sûre and Syr river partnerships (2000-2012)
- **PART III: Governance processes in the Upper Sûre sub-basin** relating to the elaboration of new drinking water protection zones (2012-2019)
- **PART IV: Governance processes in the Syr river basin** relating to water quality and river restorations (2012-2019)
- **PART V: Comparative analysis** of governance processes in the two river basins

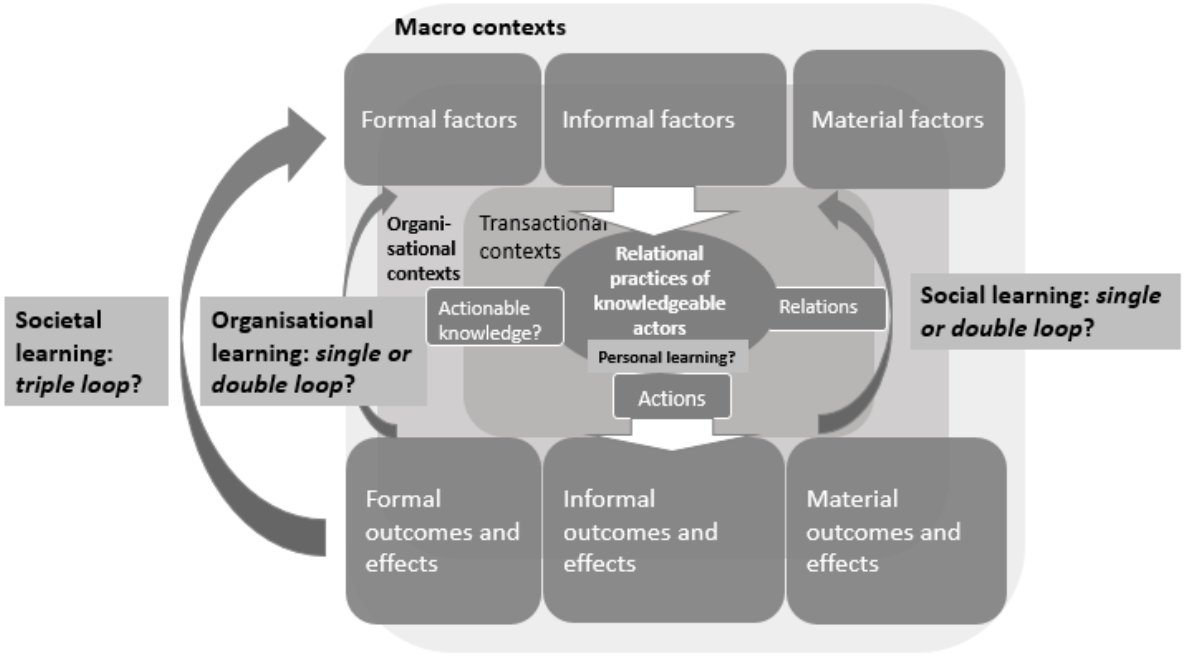

Figure 6.3 - Actor-centred scheme developed for the empirical analysis of social learning processes (elaborated from MTF)

The analysis of contexts encompasses, firstly, 19th and 20th centuries historical macro and organisational contexts of formal policies, organisations, infrastructures, and landscapes in Luxembourg. The analysis focuses on interconnections between local, regional/river basins, national, EU, and international levels. Secondly, it elaborates on contemporary formal national and EU governance contexts, with a focus on water, environmental, and agricultural policies. The analysis of processes starts out be elaborating on how the EU WFD has changed formal requirements and organisational contexts in water governance in Luxembourg, with a focus on new governmental actors (the Water Management Authority) and the river partnerships of the Upper Sûre and Syr river basins (part II). These processes lay the foundation for the subsequent separate processes analysed in the two river basins (parts III and IV). They are compared in part V.

The conceptual and analytical framework has associated transformative change with the emergence of adaptive approaches that foster social networks and aim to strengthen ecological regeneration capacities by integrating water and agriculture into environmental and landscape management. It has elaborated on the role that epistemic cultures and practices of diverse organisations and communities play in governance and management. In order for social learning and new approaches to emerge, local, professional and organisational cultures and practices may need to be transformed. Transformation may spring from changes in agency and meaning-making of individual actors. The analysis, therefore, deals with interrelations between how actors understand and seek to tackle particular challenges and assumptions, paradigms, and narratives shared and institutionalised in organisations and communities. Furthermore, the case studies consider how particular approaches and paradigms are materialised in infrastructures and landscapes. Aspects of particular concern are preferred social coordination mechanisms in human-human relations (top-down, cross-scale network governance, or bottom-up community approaches) and purposes attributed to human-environment relations (anthropocentric, integrated, ecocentric) that shape objectives, scopes, and means applied to water and land management.

The case studies focus on factors that have facilitated or hindered river partnerships of the Upper Sûre and the Syr basins in supporting the emergence of social networks and of new governance and management approaches among diverse actors. Formal factors relating to the EU WFD and other

policies and the status of scientific/technical expertise and data receive particular attention in this regard. Actors include governmental actors, municipalities and their intermunicipal water and environmental structures (´syndicates´), environmental organisations, farmers, and farm advisors. The analytical grid on paradigms serves to map and analyse synergies and tensions between diverse policies and actors (see figure 6.4).

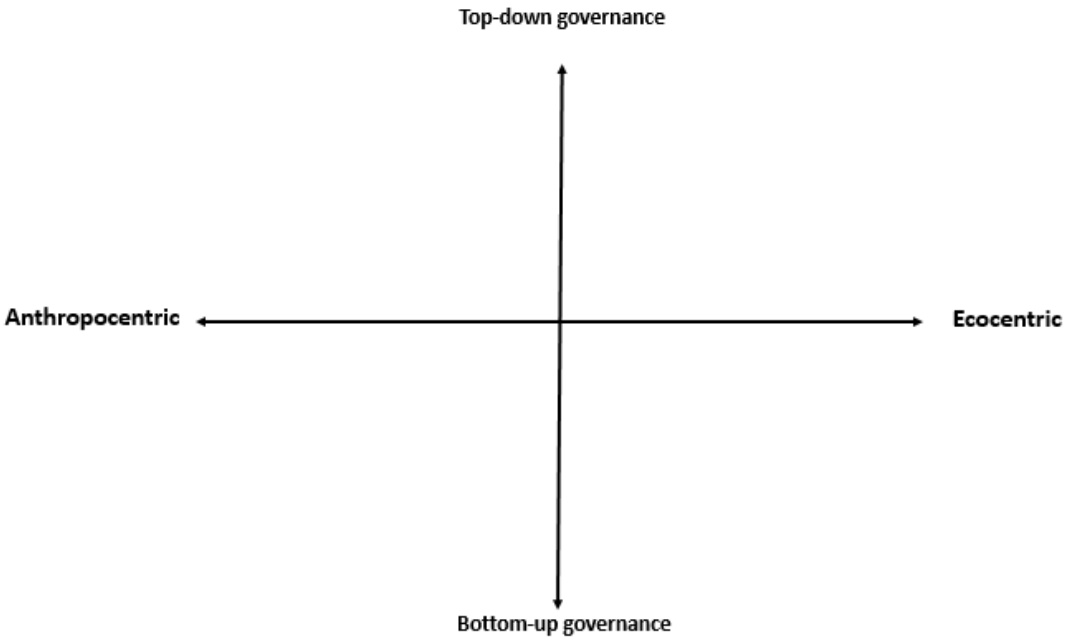

Figure 6.4 - Analytical grid to map and analyse policies and organisations in water and land governance and management

Building on the Management and Transition Framework (MTF), the case studies are structured along sequences of ´action situations´ that are building blocks of governance processes. The selection of action situations has emerged from interpretative iterative and collaborative processes that have involved data from five main sources (see methods 5.2, 5.6.1):

- **Project meetings:** exchanges with and input from members of the NEXUS FUTURES reference group (see also annexes IV, V);
- **Qualitative interviews;**
- **Documents:** formal legal and governmental policy documents (incl. laws, management plans, public presentations, etc.), consultancy and scientific studies, organisational documents (incl. minutes, annual and project reports), press articles;
- **Collaborative systems workshops** with stakeholders organised by the author in the framework of the NEXUS FUTURES project;
- **Site visits and observations**: observations at meetings, site visits, guided tours.

6.1 A systems perspective on nexus challenges

The present thesis adopts a systemic perspective on water and land systems as complex social-ecological systems that encompass social systems with their institutions and actors, ecosystems, the built environment and technologies, and (Pahl-Wostl et al., 2015; Wiek & Larson, 2012). The case studies investigate interplays between them, with a focus on actor engagement and its interrelations with material, informal, and formal factors that make up personal, transactional, organisational, and macro-contexts (see figure 6.5). Furthermore, based on STS concepts of co-production, sociotechnical

imaginaries and epistemic communities, it sets out to analyse how formal governance, societal and organisational cultures, paradigms and narratives, infrastructures and technologies co-evolve, shaping actor engagement with each other and their material environments. The role played by different types of knowledge, including scientific/technical expertise, receives particular attention.

To set the scene, some of the main challenges examined in the case studies are introduced based on summaries of the collaborative workshops and against the background of contextual characteristics of the Upper Sûre and Syr river basins.

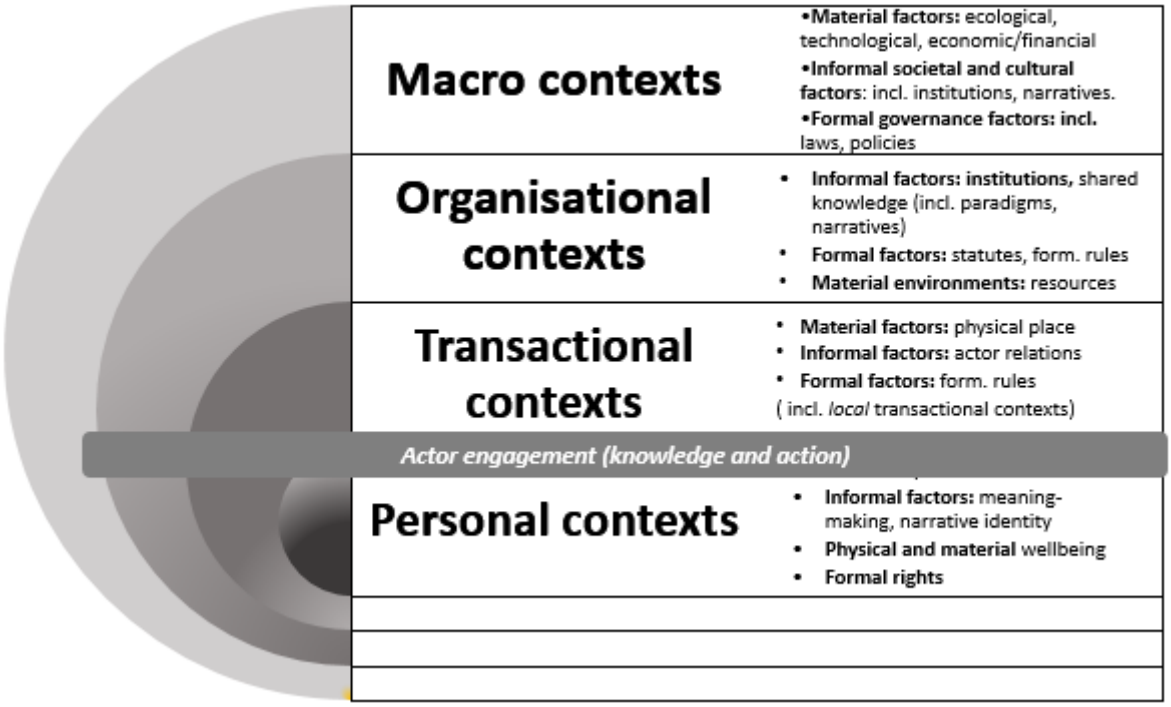

Figure 6.5 - A multifactorial framework to analyse actor engagement in relation to diverse systemic contexts

6.1.1 Multiple purposes and challenges

The EU WFD is at the centre of attention of the comparative case study. It obliges the member states to reach a ´good ecological status´ of their surface water bodies (above 10 km2) via river basin-based management that protects aquatic ecosystems and prevents further deterioration (see WFD analysis 4.5). Heavily modified water bodies such as the Upper Sûre lake have to reach a ´good ecological potential´ (EC, 2000).

At the same time, sustainability and nexus challenges are inherently diverse. Indeed, the overarching WFD objectives are only two among several purposes that governmental and nongovernmental actors pursue in relation to water and land in the Upper Sûre and Syr river basins. They also include environmental objectives relating to the EU Birds and Habitats Directives. Parts of the Upper Sûre and Syr river basins are protected under the European Natura 2000 network and in the form of national nature reserves (AGE, 2009a). In addition, the Upper Sûre basin is a transboundary wetland of international importance recognised under the Ramsar convention[128]. Additionally, water and environmental concerns are confronted with various local and national anthropocentric social, economic, and agricultural objectives pursued by diverse actors in the river basins. How actors deal

[128] www.ramsar.org/wetland/luxembourg

with divergent purposes and related approaches and paradigms is one of the core concerns of the case studies.

As potential boundary organisations, the Syr and Upper Sûre river basin organisations (the Upper Sûre River Contract and the Syr River Partnership) receive particular attention (see figure 6. 6). The Syr River Partnership is part of the national environmental NGO natur&ëmwelt Fondation Hëllef fir d´Natur (Fondation HfN) that owns land in the Syr valley situated in the South-East of Luxembourg. The case study focuses on informal governance processes aiming to improve the state of aquatic ecosystems, incl. via river restorations. They involve the Syr River Partnership, municipalities, environmental and wastewater syndicates (SIAS and SIDEST)[129], public administrations for water (AGE), nature and forests (ANF), and agriculture (ASTA), Fondation HfN, and farmers. The case studies focus on three consecutive river sections (between Munsbach and Betzdorf) that are partly situated within a Natura 2000 bird protection area and national wetland reserve.

The Upper Sûre River Contract is part of the Upper Sûre Nature Park located in the North-West of the country (see figure 6. 6). The River Contract has sought to organise stakeholder involvement in the elaboration of the future new drinking water protection zones since 2012. Informal governance processes have included local farmers, municipalities, the national water syndicate SEBES operating the Upper Sûre drinking water treatment plant and national governmental actors of the Ministry of the Environment, its Water Management Authority (AGE), and the Ministry of Agriculture. Emerging from a working group of the River Contract, the Nature Park, SEBES, and local farmers founded a regional agricultural cooperation (LAKU).

Figure 6.6 - Map of location of the Syr and Upper Sûre river basins in Luxembourg (source: Luxembourg.public.lu)

[129] ´Syndicates´ in Luxembourg (such as the Upper Sûre Nature Park, SIAS, SIDEST, and SEBES) are structures set up by municipalities (sometimes together with the government) to carry out tasks such as drinking water supply, wastewater treatment or environmental protection. They are not to be confused with trade unions.

6.1.1.1 In the Syr basin

The main challenges examined in the case study of part IV emerged from a collaborative workshop that took place in the framework of the NEXUS FUTURES project in March 2018 with more than 20 stakeholders (see figure 6.7) and from follow-up meetings with the Syr River Partnership, local and governmental actors (see annexes I, II).

Figure 6.7 - Collaborative group work at Syr systems workshop in the municipality of Niederanven

Workshop participants elaborated on systemic interconnections of water quality and ecosystem health with various other challenges and factors. The systems maps drawn collaboratively in groups outline from diverse perspectives how water quality and multiple factors relating to farming practices, consumer behaviour, awareness and life quality, demographic and economic growth, wastewater (incl. from the airport), etc. are mutually interrelated. Corresponding to EU WFD objectives, water quality of the Syr river was the challenge most frequently put to the fore (see figures 6.8, 6.9). In addition, security of drinking water supply and public awareness-raising for the value of water were considered core challenges (NEXUS FUTURES, 2018).

Water quality and ecosystems of the Syr river have been seriously affected by wastewater from the international airport that has frequently exceeded the capacities of an intermunicipal wastewater treatment plant in winter months, with insufficiently treated effluents flowing into the Syr as a consequence. This has been an object of complaints of local residents and municipalities who have also seen strong population growth, adding to the overstretch of the capacities of the treatment plant. Airport activities have intensified due to economic growth, but are considered of overriding public interest. Furthermore, reaching a good ecological status of aquatic ecosystems is seriously impeded by the fact that the hydromorphological structures of the Syr are poor, the river being channelized and interrupted by diverse barriers that prevent natural flow dynamics. Furthermore, water quality is affected by agriculture. Workshop participants proposed the topics of water quality and river restorations based on their diagnosis that there was little progress on these challenges. The lack of progress is also reflected in national EU WFD and Natura 2000 management plans that have declared river restorations and water quality improvements a priority. Furthermore, several participants expressed the wish that local inhabitants and actors were involved more actively (see figure 6.8.)

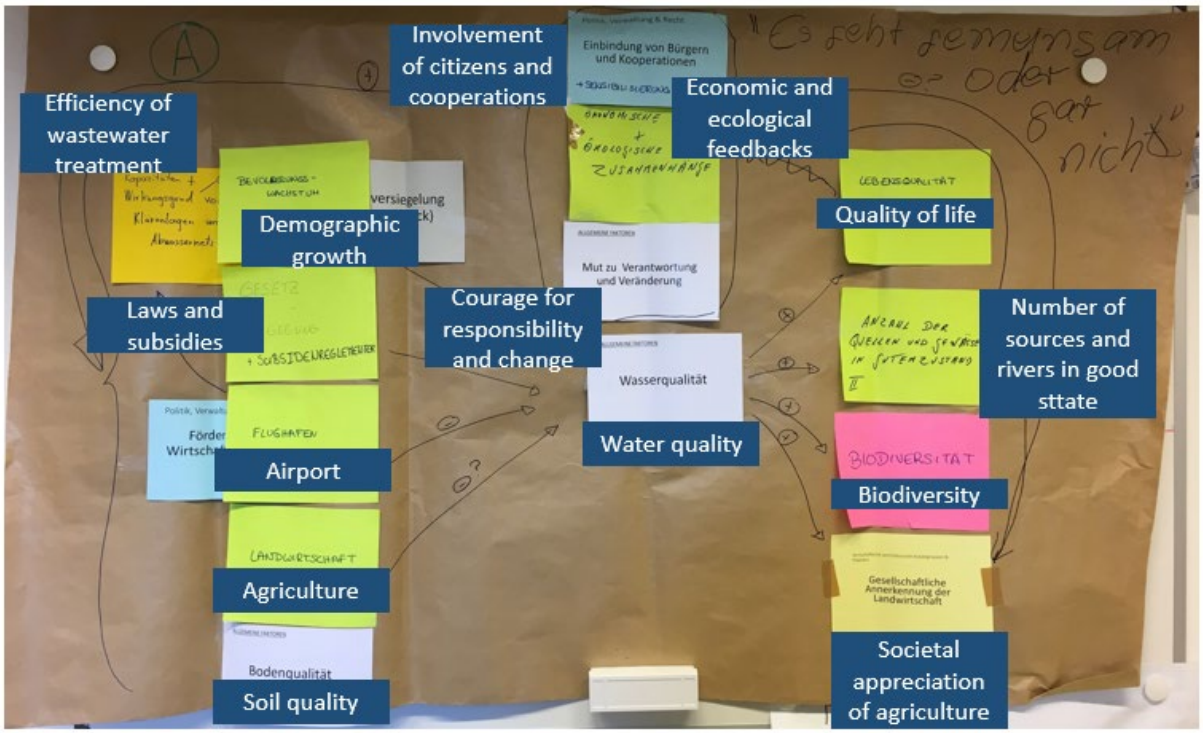

Figure 6.8 - Collaborative systems diagram focusing on water quality as main challenge

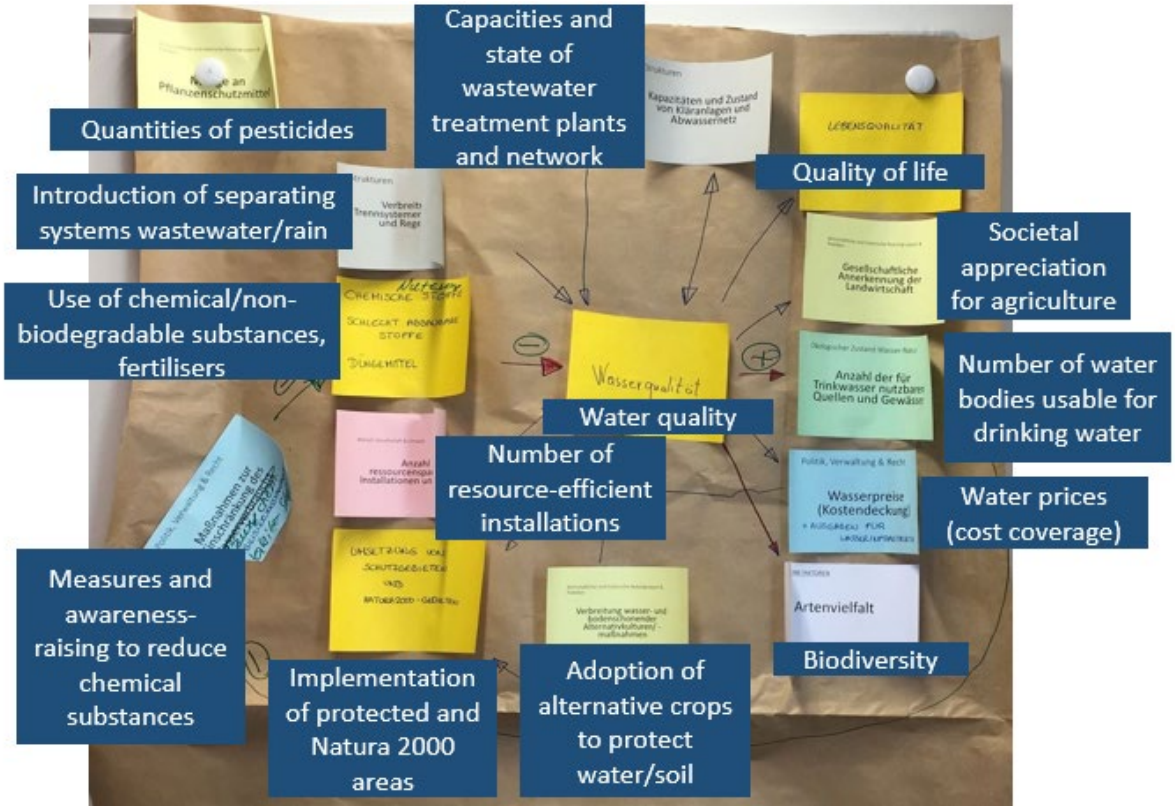

Figure 6.9 - Collaborative systems diagram focusing on water quality as main challenge

Furthermore, one workshop group focused on the challenge of security of drinking water supply. More local efforts were needed to restore local drinking water sources (many of which have too high nutrient and pesticide content) to a good state (incl. via restrictions on agriculture in groundwater protection zones) and to reduce tap water consumption in households to be less dependent on national supply

from the Upper Sûre lake (see below). In line with circular economy principles, it would be preferable that inhabitants used more rainwater, used less chemical substances and voluntarily reduced consumption rather than municipalities and state having to invest more heavily in water infrastructures – or that the "freedom of citizens" would have to be limited via restrictions on water use in peak times (e.g. summer months).

Finally, participants devoted particular attention to interrelations between agriculture, environmental awareness, and appreciation of clean water among consumers. In order to foster more extensive agricultural practices in the Syr valley and open new economic perspectives for farmers, alternative marketing chains for regional products were promoted as a way forward. Rather than farmers relying mainly on public subsidies, consumers needed to reconsider their behaviour and be prepared to pay higher prices. Consumer preferences for "quality instead of quantity" based on more awareness of interconnections between consumer choices, farming practices, water quality and the environment were considered key. Currently, however, there were only few niche initiatives in this regard. The topic will be touched upon in relation to an extensive pasture project in a restored river section in the Syr valley and in the Upper Sûre case study.

As focal topics for the present thesis, however, the last two above-mentioned challenges were deemed out of scope for the present thesis[130].

6.1.1.2 In the Upper Sûre basin

In the Luxembourgish Upper Sûre sub-basin, the present study examines relations between water quality and drinking water protection as prescribed by the EU WFD, on the one hand, and agricultural productivity and regional strives for more self-determination on issues affecting regional development on the other. Since the entering into force of the EU WFD in 2000 and its transposition into national law in 2008, Luxembourg has been obliged to introduce new drinking water protection zones around its national drinking water reservoir, the state-owned Upper Sûre dam.

Meetings, interviews, and a NEXUS FUTURES workshop with 33 stakeholders held in the period 2017-2019 suggested that the drinking water protection zones have been a major preoccupation of local farmers and municipalities who are concerned about effects of expected new restrictions on local agriculture and economic activities such as tourism. The rural Upper Sûre region is dominated by agriculture. In addition to drinking water supply, the lake has served electricity generation, flood protection, and tourism (ChD, 1951; Oeko-Fonds, 1990). It is also the largest bathing water body in Luxembourg. Sanitary protection zones have been in place since 1961 (Mémorial A, 1961). Nonetheless, high nutrient levels (phosphates, nitrogen) ascribed to household wastewater and agriculture have regularly contributed to eutrophication of the Upper Sûre lake affecting both drinking water supply and bathing tourism (AGE, 2011). In addition, pesticides have posed challenges to national drinking water supply (Karier et al., 2017). The sanitary protection zones have limited municipal and regional development via restrictions on the expansion of settlements and business parks (Oeko-Fonds, 1990). Municipalities and other local actors have long been dissatisfied with the fact that drinking water in the urban South of Luxembourg could be offered at cheaper prices to households than by the Upper Sûre municipalities who have higher infrastructural costs due a significantly lower population density, while they had to accept restrictions (NEXUS FUTURES, 2019a).

[130] Furthermore, there are a number of projects at the University of Luxembourg dedicated to the analysis of food practices and systems in Luxembourg and the surrounding Greater Region (website: food.uni.lu)

Local efforts to boost self-determination and regional development led to the creation of the Upper Sûre Nature Park in 1999, in cooperation with the government.

Figure 6.10 - Collaborative Upper Sûre workshop in the municipality of Boulaide

During the NEXUS FUTURES workshop in 2019, workshop participants elaborated systems maps that illustrated their perspectives on how water quality in the Upper Sûre lake, the ecological status of water bodies, land use (incl. by agriculture), drinking water treatment and protection (zones) are interwoven with complex systems dynamics (NEXUS FUTURES, 2019a) (see figure 6.10 and annex III). Interrelations with other factors included demographic developments and water consumption in Luxembourg, ecological factors (e.g. climate change, biodiversity), wastewater treatment technologies, various national and EU policies (incl. the EU CAP and environmental policies), regional development, appreciation of water, life quality and education (see figures 6.11, 6.12). As at the Syr, workshop participants pointed to the importance of environmental awareness (in particular, the appreciation of water) and behaviour of inhabitants of the Upper Sûre region and beyond. A number of groups regarded the ecological status of water bodies as main challenge in the Ramsar wetland and Natura 2000 area. While deemed beyond the scope of the Upper Sûre case study, similar challenges are treated in the Syr case study of part IV. Others focused on drinking water supply, emphasising (as at the Syr workshop) that municipalities across the country should become more independent of supply from the lake by protecting and using more local sources. Several participants also raised doubts about drinking water security in the long-term (e.g. in the year 2045) considering strong population growth.

Finally, and similar to the Syr workshop, Upper Sûre participants stressed the need for perspectives for farmers. If only consumers in Luxembourg were willing to pay higher prices for regional and organic products, it would be easier for local farmers to produce in a less intensive manner. They hoped that existing regional products ("vum Séi", the best-known regional brand in Luxembourg) and tourism to the area could be boosted as part of regional marketing. Finally, farmers and farm advisors also emphasised that they wished to be involved in political processes such as the drinking water protection zones and that this would increase their acceptance of new restrictions. This is one of the main topics of the Upper Sûre case study.

Figure 6.11 - Collaborative systems map with the ecological status of water bodies in the Upper Sûre basin as central challenge

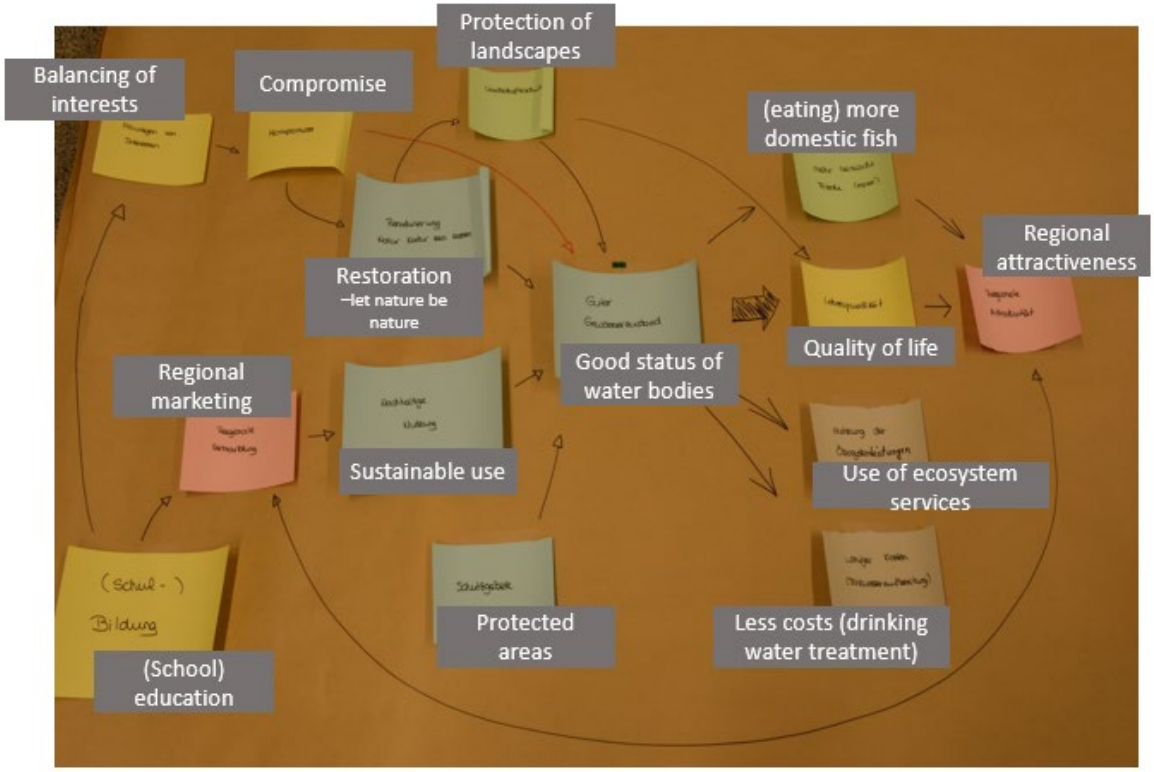

Figure 6.12 - Collaborative systems map with the status of water bodies in the Upper Sûre basin as central challenge

6.1.2 Basin characteristics

The below briefly presents selected data and information pertaining to the water and land use system in the Syr and Upper Sûre basins, comparing material factors that play a role in the governance processes analysed in the case studies. The selection of data has been done based on the Management and Transition Framework (MTF) (Pahl-Wostl et al., 2015) and a systems framework for analysing water governance regimes (Wiek & Larson, 2012).

6.1.2.1 Hydrological

The Syr and Upper Sûre basins are two of the six river basins defined in the framework of the EU WFD management plan for Luxembourg. Their main rivers, the Sûre and the Syr, flow into the Mosel and are part of the international Rhine watershed that brings ´Luxembourgish´ water – along with the water of nine other countries – to the Northern Sea (AGE, 2009a). A transboundary river basin, roughly two thirds of the catchment area of the Upper Sûre lake are situated in Belgium (see figure 6. 13). In contrast, the Syr is the only purely ´national´ basin in Luxembourg (see figure 6. 14). The Upper Sûre basin is significantly larger than the Syr basin (see table 6. 1).

Hydrological characteristics	**Upper Sûre basin** (CRHS Interreg, 2008)	**Syr basin** (FP Syr, 2014b)
International watershed	Rhine	Rhine
Basin area	428 km2 (total), 155 km2 (L) (of Upper Sûre lake)	207 km2
Length of hydrographic network	868 km	234 km
Dimensions of main water bodies	Length of main river: 135 km (Sûre, the longest river in Luxembourg) Size of Upper Sûre lake: 3,8 km2, with 60 mio m3 of volume[131]	Length of main river: 33 km (Syr, the only purely national river)
River source	Blanchipont (B)	Syren (L)
River entry	The Mosel at Wasserbillig (L)	The Mosel at Mertert (L)

Table 6.1 – Comparison of hydrological characteristics of the Upper Sûre and Syr basins

[131] Source: www.sebes.lu

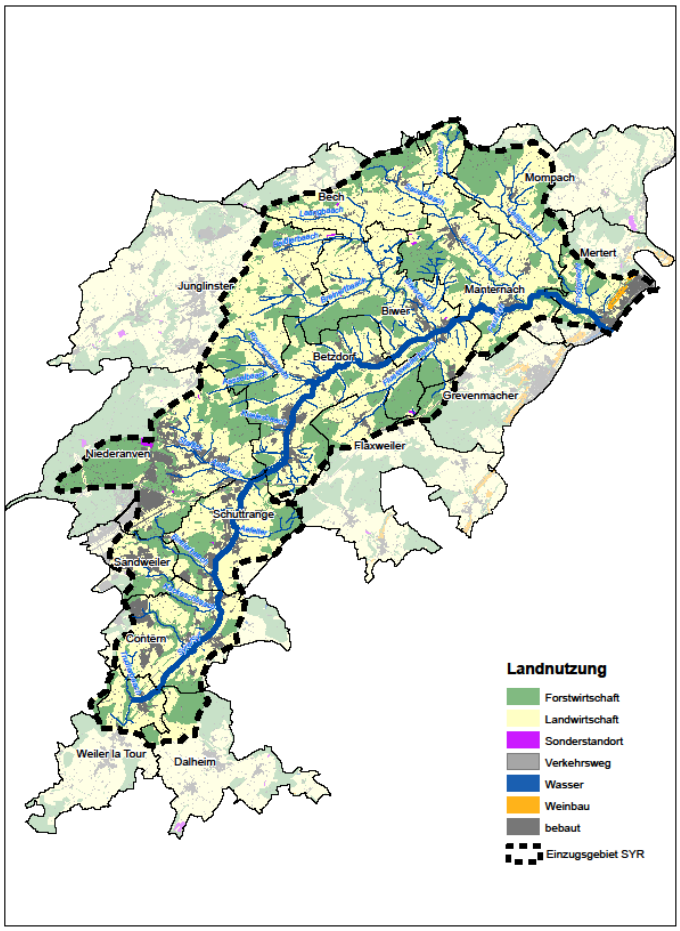

Figure 6.13 - – The Syr basin is dominated by agriculture (yellow) and forestry (green) (source: Flusspartnerschaft Syr)

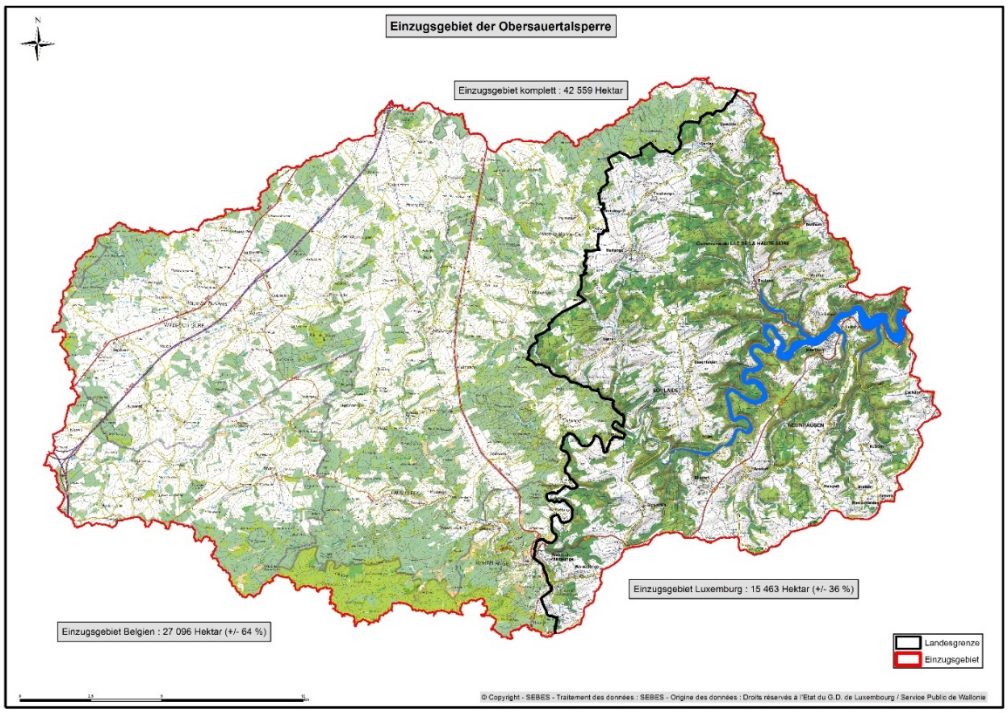

Figure 6.14 - Transboundary catchment area of the Upper Sûre dam (in blue) (source: SEBES)

6.1.2.2 Populations and land use

In 2018, Luxembourg had a total population of 600 000, with most inhabitants living in Luxembourg City and the South of the country. In the period 1970 to 2018, Luxembourg has experienced a demographic hike of nearly 80 %, the highest in the EU. Nearly half of the population holds one of the 170 nationalities present in Luxembourg (STATEC, 2019). Although predominantly rural with agriculture and forestry covering more than 70 % of their territories (see table 2), the municipalities in both the Syr and Upper Sûre river basins also saw significant demographic growth. The number of inhabitants in the Luxembourgish municipalities of the Upper Sûre basin (between 1000 and 3000) is the result of an increase of between 55 % and 140 % in the period 1981 and 2018. In the same period, the population of the peri-urban Syr municipalities of Schuttrange and of Betzdorf (each with more than 4 000 inhabitants) more than doubled due to their proximity to Luxembourg City (STATEC, 2019). None of the river basins has significant industry. The table below compares the number of municipalities and inhabitants in the two river basins.

Population and land use	**Upper Sûre basin** (CRHS Interreg, 2008; CRHS & LAKU, 2019)	**Syr basin** (FP Syr, 2014b)
Number of municipalities	7 municipalities (L), 5 municipalities (B) (all members of the River Contract)	15 municipalities located entirely or partly in the river basin (13 are members of the Syr River Partnership)
Number of inhabitants	Nearly 20 900 in the eight Luxembourgish member municipalities of the River Contract (including Wiltz that is not part of the hydrological river basin)	35 000
Population density	Between 27 and 46,8 inhabitants/km2 in the Luxembourgish municipalities	Between less than 25 inhabitants/km2 and more than 500 inhabitants/km2
Land use	90 % agriculture and forestry	74 % agriculture and forestry

Table 6.2 – Figures on population and land use in the Upper Sûre and Syr basins

6.1.2.3 Technical infrastructures

The case studies focus on the national drinking water treatment plant SEBES in the Upper Sûre basin and the Uebersyren wastewater treatment plant that receives wastewater of four municipalities and the international airport Findel in the Syr basin (see table 6.3). The infrastructures bear witness to demographic and economic developments in Luxembourg.

Constructed in mid-20th century, the main contemporary purpose of the SEBES plant is to supply Luxembourg´s growing population and economy with drinking water, supplementing local groundwater sources. The water facility operator SEBES is national syndicate with 50 % government and 50 % municipal participation. The fact that the share of SEBES water of nation-wide drinking water supply has increased from one third in 2013 to 50 % in 2019 testifies to the growing importance of the Upper Sûre lake for national drinking water security (AGE, 2013; MECDD, 2019a). It will be replaced by a new treatment plant by 2021 with significantly increased capacities[132].

Located in the Syr valley, the Uebersyren wastewater treatment plant of 1979 treats wastewater of four municipalities and of the international airport Findel. It is managed by an intermunicipal syndicate

[132] Information on the new SEBES treatment plant in Eschdorf: sebes.lu/fr/actualite/nouvelle-station/

(SIDEST). As a result of population and airport growth, the treatment plant will be expanded in the decade to come.

Main technical water infrastructures examined	**Upper Sûre basin**	**Syr basin**
Water infrastructures	Drinking water treatment plant (SEBES) (MECDD, 2019d): - Treatment of 70 000 m3 of drinking water / day (to be expanded to 110.000 m3/day) - Supply of roughly 50 % of drinking water in Luxembourg, reaching 70 % of all households	Uebersyren wastewater treatment plant (SIDEST) (Conseil d'Etat, 2018) - Capacity of 35 000 inhabitant-equivalents (to be expanded to 122.000 by 2028) - Municipal wastewater of four municipalities - Wastewater of international airport Findel
Transport infrastructure		International airport Findel[133]: - 4.4 million passengers / year (2019)

Table 6.3 – The main engineered water and transport infrastructures covered by the case studies

[133] Source: www.lux-airport.lu/corporate/the-company/our-story/

7 CASE STUDIES (PART I): Historical and contemporary governance contexts

This part analyses historical and contemporary contexts of water and land governance and management in Luxembourg and the Upper Sûre and Syr valleys. Based on the concepts of co-production, sociotechnical imaginaries, and epistemic communities (see conceptual framework 3.1.2.4), it sets out to analyse how governance, organisations, approaches and paradigms, infrastructures, and landscapes have co-evolved during the past centuries. The role played by scientific expertise in governance processes receives particular attention.

The original intention of the author was to begin the case studies somewhere before the entering into force of the EU WFD. However, various statements made during exploratory interviews and conversations suggested that historical contexts would significantly add to the understanding of some of the challenges and factors that have shaped governance processes since the entering into force of the EU Water Framework Directive. As regards the Upper Sûre basin statements included:

> *"[…] die Bestrebung, hier einen Naturpark zu machen - auch gerade wegen dem ganzen Schutz um den Stausee: Die Region fand sich da ein bisschen in die Enge gedrängt. Und das ist genau das Gleiche, was sich quasi jetzt wiederholt hat mit dem Schutzzonenkonzept, wo sie auch das Gefühl haben, so ein Déjà-vu: das hatten wir doch schon!" (interview n°34)*

> *"Wir müssen wieder mehr in die Pionierzeit zurückkehren" (interview n°33)*

As regards the Syr basin:

> *"Also, Risiken oder Herausforderungen? Neben dem Trinkwasserthema, ganz klar das Abwasser, Bevölkerungswachstum, Intensivierung in allen Richtungen, Versiegelungen. Es wird gebaut, es kommen jeden Tag ja hunderttausend Pendler ins Land; der Flughafen, der immer größer wird, speziell wenn man jetzt auch auf unser Gebiet hier schaut, der immer mehr expandiert; und Infrastrukturen, die nicht nachkommen, und Kläranlagen, die teilweise monatelang ausfallen, weil die das nicht packen. Das sind riesige Herausforderungen. Das spitzt sich zu, die Situation". (interview n°13)*

> *"Und dann haben wir peu-à-peu den Maßnahmenkatalog abgearbeitet. Leider hauptsächlich die Problemchen, und nicht die Probleme". (interview n°9)*

The main criteria, methods and data used to delineate the scope of historical contexts analysed have been:

- **Actor perspectives and narratives** on significant factors influencing contemporary water and land governance challenges, relations and approaches of actors (*main methods and data used: qualitative interviews, collaborative NEXUS project workshops*);
- **Historical background of formal governmental and nongovernmental organisations** (incl. local and professional communities) active in the governance processes analysed (*main methods and data used: qualitative interviews, document analysis*);
- **Formal policies** that have significantly influenced water and land governance and management in the river basins (*main methods and data used: qualitative interviews, document analysis*);

- **Historical background of landscapes and of infrastructures** affecting ecosystems in the basins today (*main methods and data used: qualitative interviews, document analysis, site visits).*

In addition, history books have been consulted sporadically, mainly concerning wider socioeconomic developments in Luxembourg. The triangulation of different sets of data has thus served to draw up a multifaceted analysis that suggests that diverse approaches and paradigms – partly conflicting and partly synergetic - have co-existed historically and shaped water and land governance in Luxembourg. They include different constellations of *anthropocentric* top-down *and* bottom-up approaches as well as early science-based *ecocentric* approaches encompassing elements of both bottom-up *and* top-down approaches.

This part elaborates, first, on historical backgrounds of organisations, policies, landscapes, and infrastructures in Luxembourg, relating them to approaches and paradigms outlined in part 4 and highlighting interconnections between local, national, EU, and international governance dynamics, both formal and informal. Historical contexts have been divided into three rough and overlapping periods:

- **19th to early 20th century:** Luxembourg´s pre-war transition from an agrarian society to an industrial centralised and democratic nation-state
- **1950s to 1970s:** The post-war period with its massive public investments in water and transport infrastructures, European integration and the intensification of agriculture,
- **1970s to 1990s:** Emerging environmental grassroots and bottom-up organisations and environmental EU and national legislation

These periods largely correspond to typical phases in the ´modernisation´ of water infrastructures and agriculture and the emergence of environmental awareness and movements identified across Western industrialised countries (see chapter 4.2.3). This suggests that, indeed, the Grand Duchy has been firmly embedded in macro contexts that have included international and European policy-making, scientific communities, technological advances, environmental movements, and cultures. The analysis below touches upon some of them.

7.1 From pre-industrial to modern-industrial paradigms

The present chapter outlines Luxembourg´s transition from an agrarian to an industrial centralised nation-state, with a focus on actors, paradigms, and landscapes in the Syr and Upper Sûre valleys. It provides an account of how material, organisational and formal governance contexts were profoundly altered by industrialisation and the emergence of Luxembourg as an independent state. Not only have material changes left their imprint on landscapes, preindustrial times have also remained an important point of reference for diverse actors and policies until today.

7.1.1 Pre-industrial heritage: “diverse” or “primitive”?

Similar to how diverse *scientific* communities today interpret the past differently (see paradigms 4.1), narratives of agricultural and environmental actors in Luxembourg as regards the preindustrial era also diverge significantly. What appears “primitive” to some is considered rich and “diverse” by others. This will be an important theme throughout the thesis.

Historically, Luxembourg has been an agrarian society. The Syr and Upper Sûre valleys were predominantly rural areas and continue to be so until today. Traditional agriculture and forestry,

military and pre-industrial economic activities, however, have left their marks on Luxembourgish landscapes. Reminiscent of the ´traditional approach´ to ecological restoration (see 4.4.1), consultants and public administrations often take the so-called "Ferraris maps" of 1771-1777 as a basis when seeking to establish what pre-industrial landscapes in Luxembourg looked like, for example when planning river restorations (ANF, 2008; Min.Env. & Min.Interior, 2007; Schaich, 2009). Produced for military purposes, the maps contain details on settlements, roads, important buildings and infrastructures of the 18th century (incl. mills). They also show how some wetlands were drained to facilitate troop advancements, and how locking systems were constructed to be able to flood canals as protective barriers against enemies (Helfer, 2009)[134].

Developments in the Syr valley are symptomatic for how rural areas in Luxembourg have evolved. The Ferraris maps and other historical documents suggest that the Syr valley back then was characterised by deforested floodplains with open wetlands and marshes that were partly used for livestock grazing (Schaich, 2009). In addition to agriculture and military purposes, rivers and streams since the 17th century have served hydro-electricity generation, and (already since the Middle Ages) as canalisation. In the beginning of the 19th century significant river regulation efforts and other land improvement measures were undertaken to drain wetlands and to serve more water mills. In the end, there were a total of 22 historical mills along the Syr alone, some of whose owners still own land, have weirs, and water use rights there today (FP Syr, 2017a; Gemeinde Betzdorf, 2019).

Figure 7.1 - Information panel with mills of the 19th century in the Syr valley (Municipality of Betzdorf)

In the North of Luxembourg (the so-called *Ösling* or, in Luxembourgish, *Éislek*, in which the Upper Sûre region is located), landscapes are hilly, covered by large forests (where traditional beech was often replaced by special oaks that were used for firing and leather tanning), penetrated by a dense net of small streams and rivers and is dominated by semi-dry grasslands and nutrient-poor meadows (Krippel et al., 2019). In the 19th century, permanent fields only existed in close vicinity of villages, with rotating crops. More remote areas served sheep grazing and were only cleared every couple of dozens of years to allow for a three-year consecutive cultivation of rotating crops (rye, buckwheat and oats). In some of the deep valleys, grasslands (so-called "Rieselwiesen") were regularly flooded by a special technique ("Fléizen" in Luxembourgish) that involved watergates and ditches. They served not only to irrigate

[134] The Ferraris map covers Luxembourg and Wallonia. They were produced by Joseph Johann von Ferraris (1726-1814) of the Austrian Netherlands. (Helfer, 2009)

fields, but also to fertilise them with sediments carried by stream water (Krippel et al., 2019). Throughout the country, there has also been a textile and leather manufacturing tradition that goes back to the 16th century. Today´s seat of the Upper Sûre Nature Park and river partnership, the 19th century textile factory located at the Upper Sûre river, bears witness to this tradition[135].

Figure 7.2 - The renovated 19th century textile factory at the Sûre (source: Naturpark Öewersauer, photo: Guy Krier)

Pre-industrial times continue to be a reference point in narratives and approaches today, with significant differences between agricultural and of environmental actors. Not only are historical maps used by administrations and consultancies in Luxembourg today when planning river restorations, the mid-19th century also serves as a baseline for biodiversity, as noted by one of the authors of the national red list of vascular plants:

> *"The Red List is based on the changes in Luxembourg´s flora during the past 175 years, as the necessary information for this estimation of threat levels exists only for this period. The starting point of my evaluation is not a ´natural´ landscape in the sense of wilderness existing before human beings settled in our region, but the landscape of the mid-19th century shaped by our ancestors during centuries of activities ("Kulturlandschaft"). At that moment, agriculture mainly depended on soil characteristics and the use of chemicals and artificial fertilisers was unknown. Also the melioration of marginal areas like bogs and marshes was still in its beginnings and land consolidation did not occur. The human activities had created a very diverse landscape with a huge number of different ecosystems like ploughed fields, grasslands, heaths, mires, swamps, tall-herb fens, woodlands and coppices. The were the habitats of a large number of plant species. It is probable that like elsewhere in Europe, the diversity of plant species reached a maximum in Luxembourg midway of the last century as a result of landuse practices" (Colling, 2005)*.

The preservation or restoration of these diverse mosaic landscapes, therefore, typically require agricultural practices that are not too different from pre-industrial agriculture. This includes extensive pasturing and/or (rare, but regular) mowing and no use of fertilisers and pesticides, in order to prevent

[135] See also www.naturpark-sure.lu/nps-tax-offer-category/cloth-factory/

open grasslands from gradually transforming into woods and to preserve a vegetation that needs nutrient-poor soils (Krippel et al., 2019).

Many agricultural actors, however, regard pre-industrial agriculture as "primitive" and "unproductive". A publication of the later Administration of Agricultural Technical Services (ASTA) characterises 19th century agriculture as follows:

> *"Gegen Mitte des 19. Jahrhunderts war Luxemburg noch ein reines Agrarland mit primitivem Ackerbau und unproduktiver Viehhaltung. Ödland, Brachen und „Driesch"weiden nahmen noch einen großen Teil der Flure ein. […] Hinzu kam eine ziemlich bedeutende Schafhaltung und ein schwacher Rindviehbestand mit anspruchslosen Landrassen, die mehr als Zugtiere als für die Milch- und Fleischerzeugung genutzt wurden" (ASTA, 1983).*

Not only was agriculture hardly able to feed families and local populations (see further below), the lack of river regulation and maintenance is assumed to have caused the spread of malaria-like swamp fever:

> *"Die Versumpfung der in den Tälern befindlichen Wasserläufe hatte aber auch schwerwiegende gesundheitliche Schäden zur Folge. In vielen Ortschaften des Landes lag die durch das Sumpffieber bedingte Sterblichkeit bei 20 % und man kann daher annehmen, dass bis zu 50 % der Einwohner vom Fieber befallen waren" (ASTA, 1983).*

Despite documentary research done in the NEXUS project team, the author of the present thesis has not been able to find much supporting evidence of direct relations between river regulation and the extent of swamp fever, and the general state of public health in Luxembourg in mid-19th century. The only exception is an article that refers to accounts of a priest who lived and worked close to the Syr valley who also established causal links between the state of rivers, insects (mosquitoes), poor sanitary conditions, and the spread of swamp fever[136]. The case study on river restorations in the Syr valley suggests that many actors and citizens continue to perceive wetlands as potential public health threats today. The case study will also suggest that different views on 19th century landscapes and agriculture continue to make dialogues between diverse actors difficult.

[136] Accounts of the priest Jean-Michel Kleyr (who lived in the municipality of Junglinster from 1803-1866) of the state of the river Ernz and local health in Imbringen and Eisenborn (Schmit, 1979): "Das Säubern und Einbetten der Weißen Ernz geschehe übrigens sehr unregelmäßig, nie im Interesse der Gesundheit und Hygiene […] So sei es auch nicht verwunderlich, dass hier Schilf und Schlammpflanzen aller Art den Fluss in einen stockenden Tümpel verwandelten […] Zu diesen Voraussetzungen kam schließlich noch der verwahrloste Zustand der hier lebenden Bevölkerung, der sicherlich einer Erkrankung nicht entgegenwirkte […] Hier lebten unterernährte und schlechtgekleidete Menschen, Bettler und Vagabunden […] Die armen und verwahrlosen Mieter aber lebten in einem heillosen Durcheinander zwischen Abfällen, Abwässern und Misthaufen, und der Morast reichte ihnen des Öfteren bis an die Haustür. Die häufigen Überschwemmungen brachten schließlich verwesende Überreste in die stets verbleibenden Sumpflöcher, um die unzählige Insekten, hauptsächlich Stechmücken, herumschwirrten. So tauchte dann auch prompt das Sumpffieber in diesen Siedlungen auf. Von 1857-1859 gab es in Imbringen auf diese Weise 65 Fiebererkrankungen bei 110 Einwohnern und in Eisenborn zur gleichen Zeit 72 bei 169 Einwohnern. […] So blieb nur die teure Lösung übrig, die der Trockenlegung und Umwandlung der Sumpfgebiete in Weideplätze. […] Aber erst später, durch ein Gesetz vom 28. Dezember 1883, das die Ausführung der Arbeiten anordnete, wurde die Weiße Ernz eingebettet, und die darauf folgende Entwässerung brachte das Ende der Überschwemmungen, der Sümpfe, der Stechmücken und schließlich des Sumpffiebers"

7.1.2 The emergence of modern-industrial paradigms

The current chapter analyses the emergence of the modern-industrial ´command-and-control´ and ´productionist´ paradigms in Luxembourg, focusing on the ´first phase´ of their "modernisation" accompanying the industrial revolution. It suggests that ´command-and-control´ paradigm emerged from a combination of technical water management serving municipal drinking water supply and river regulations carried out by agricultural actors. As suggested in the literature, the below analysis confirms that in Luxembourg, as in many other countries, the emergence of modern-industrial ´command-and-control´ and ´productionist´ paradigms was made possible by modern science and technologies. However, rather than being exclusively top-down-driven, it will be argued that ´command-and-control´ management emerged from combined efforts of local actors (municipalities, farmers) and the government.

As in most other countries, the industrial revolution coincided with the rise of Luxembourg as an independent and increasingly democratic nation-state, which saw the creation of the first public administrations. After having been subject to various shifting empires, dynasties and territories, Luxembourg emerged within its current borders in 1839[137]. One of the first national administrations, the precursor of today´s Nature and Forest Agency, was put in charge of matters relating to forestry, hunting, and fisheries serving anthropocentric provisioning services in 1840 (ANF, 2015; Mémorial, 1840).[138] Nearly 140 years later, ANF would be charged with environmental protection and 160 years later, it initiated the first river restorations in Luxembourg.

The industrial revolution began with the discovery of iron ore in the 1840s. Gradually, the iron and steel industry in the South of the country became a major economic factor. It had several implications. In addition to engineers and workers from abroad, the industry attracted farmers from the North of the country, which reduced the number of farmers there. At the same time, due to demographic growth and the emergence of larger towns, the need for food and (healthy) drinking water greatly increased (Thewes, 2017). Therefore, industrialisation efforts necessitated better transport infrastructures to overcome geographical isolation and to be able to transport food across the country. Food production and distribution had been mainly local before; rudimentary roads and transport systems did not allow for the transportation of products with low durability over longer distances (such as milk, butter and meat). Thus, one of the first centralised state initiatives was the construction of national railways, the first line being inaugurated in 1859 (Luxembourg-France), followed by the 1861 opening of the Luxembourg-Trier/Germany train connection that has been running along the Syr river ever since (Thewes, 2017) (see figure 7.3). Efforts to improve transport connectivity were accompanied by river regulation, efforts to boost agricultural productivity, and improve the supply and quality of drinking water. These are outlined in the following.

[137] In 1839, Luxembourg´s territory was split up into a ´province of Luxembourg´ that became part of Belgium and a territory that continued to be attached to the Dutch dynasty of Orange-Nassau that, however, granted (the remaining territory of) Luxembourg the possibility to set up its own autonomous state structures. In the period between 1848 and 1868, three consecutive national constitutions were to pave the way for Luxembourg to move towards representative democracy (culminating in 1919 with the introduction of universal suffrage) and a constitutional monarchy (since 1890 with its own dynasty of Nassau-Weilburg, Thewes, 2017). State-making was also accompanied by significant nation-building efforts, centred on Luxembourgish culture and language (Pauly, 2011). These will, however, not be examined within the scope of the present thesis.

[138] Ordonnance royale grand-ducale du 1er juin 1840 concernant l´organisation de la partie forestière

Figure 7.3 – Today´s train embankment along the Syr river where the first train ran to Germany in 1861

7.1.2.1 River regulation brings together the ´agricultural service´ and farmers

Already before the demographic hikes accompanying industrialisation, agricultural productivity had been too low to feed Luxembourg´s population. In 1871, 60 % of the population worked in agriculture (Pauly, 2011). In many cases, traditional small-scale farms were hardly able to produce enough food for their own subsistence. Thus, emigration waves had begun in the 18th century and peaked in the 19th century, with 72 000 Luxembourgers (of a total of 212 800 inhabitants) venturing overseas in the period between 1841 and 1891 (Thewes, 2017). Agricultural intensification and the associated emerging productionist paradigm was a response to this situation.

Documents and interviews suggest that there were two sets of concerns that directly related agriculture to river regulation. They live on in narratives today. One concern was to increase agricultural productivity and food supply, the other to improve public health by reducing water-borne diseases. In the following, they will be elaborated on from the perspective of agricultural actors interviewed and organisational documents consulted, which have, however, been ´cross-checked´ with accounts of historians (Pauly, 2011, Thewes, 2017). The reason for this somewhat one-sided representation is that some of the descriptions and explanations cited below were echoed in different variations in several interviews and conversations with diverse agricultural actors. They highlighted the interdependence between agricultural intensification, river regulation, and drainage systems:

> *"Für unsere auf Viehwirtschaft ausgerichtete Landwirtschaft war die Verbesserung des Wiesenlands von lebenswichtiger Bedeutung, und eine zusammenhänge Wasserregulierung war eine Grundbedingung für eine wirksame Intensivierung unserer Landwirtschaft". (ASTA, 1983).*

There had been no coordinated national efforts to manage rivers and agricultural activities before 1883. In 1880, municipalities had been encouraged by royal decree to clean and regulate rivers and restructure meadows, as water flows were blocked in many of them due to debris in the riverbeds (Mémorial, 1880).[139] It is assumed that municipalities had however been slow in implementing measures due to lack of resources and of ´experts´ who possessed the necessary technical know-how (Frisch, 2006). Therefore, in 1883, an agricultural service, ´*service agricole*´ (predecessor of today´s

[139] Loi du 23 juin 1880, concernant le curage, l'entretïen et l'amélioration des cours d'eau. Mémorial n°42

ASTA) (Mémorial, 1883a)[140], was created to implement centralised efforts to drain land and straighten rivers. The later ASTA would keep its competences on river maintenance and regulation until they were transferred to the Water Management Authority (AGE) in 2004 in the course of national WFD transposition.

Drainage systems and trenches were put in place to dry up the marshes, including in the Syr valley. A commission had visited the Syr valley in 1884 and approved a credit of 100 000 Belgian Francs for river regulation measures (Frisch, 2006). The drier - but very fertile - land could thus be mowed and used for more intensive farming and settlements (Falsetti, 2012).

In addition to centralised efforts, another 1883 law allowed landowners and farmers to set up own syndicates to carry out river regulation work and related tasks (Mémorial, 1883b) (own translation of selected passages)[141]:

- [flood] protection around navigable and non-navigable rivers,
- the deepening, straightening and regulation of non-navigable river and irrigation and drainage canals,
- draining of swamps,
- improvement of wet and "unhealthy" areas,[142]
- irrigation and filling systems,
- drainage systems,
- field paths und any other culture improvements of public utility and interest.

The fact that these two laws followed closely upon one another suggests that centralised state initiatives and the self-organisation of farmers were regarded as complementary. According to agricultural actors, there was a direct causal link between concerted river regulation and the improvement of public health:

> *"Im Zeitraum von 1881 bis 1893 wurden insgesamt 269.504 Meter Wasserläufe reguliert und saniert, wofür 916.528 Fr. investiert wurden. Das Sumpffieber war in diesen Gegenden binnen wenigen Jahren besiegt" (Frisch, 2006).*[143]

At the same time, river regulation alone was not sufficient to increase agricultural productivity. As outlined above, many farmers had left their lands. Plummeting land prices attracted farmers from abroad, especially, Lorraine and Belgium. They brought with them new livestock breeds and modern engineered equipment that proved to be more productive and efficient than traditional techniques (ASTA, 1983). Moreover, thanks to improved infrastructures, fertilisers, and fodder could now be transported over longer distances.

Furthermore, following government requirements, the iron and steel industry sold phosphorus-rich slags as affordable artificial fertilisers to farmers (the so-called "Thomas-Mehl"). As a result, nutrient-poor soils such as those in the North and Upper Sûre region could now be cultivated and became more

[140] Interestingly, the agricultural school of Ettelbruck was set up at the same time.

[141] Loi du 28 décembre 1883 concernant les associations syndicales pour l´execution de travaux de drainage, d´irrigation, etc. Mémorial N°63

[142] "terres humides et insalubres"/"sumpfiger und ungesunder Ländereien" (section 1, article 1.4.)

[143] The author of this thesis has not been able to verify possible causal links between river regulation and the disappearance of malaria-like infections in Luxembourg. However, considering the significance of the argument in contemporary controversies, it would be well worthwhile a research project. The passages have been chosen as an expression of certain narratives that could be discerned in many statements.

productive (Pauly, 2011). Increasing quantities of dairy products and meat were now produced and transported across the lands to satisfy the needs of growing (urban) populations. Some agronomists regard the turn of the century as perhaps the "happiest period" in agriculture (ASTA, 1983). The "paradigm of food production in the service of remote consumers" (see chapter 4.1) had now also arrived in Luxembourg. The number of people working in agriculture had dropped to less than 36 % of the population by 1907 (Luxemburger Wort, 1909).

The country beginning to prosper, some Luxembourgers also returned to their home country from abroad, including to the Syr valley where a former emigrant opened the "Café de l´Amérique" in 1900 (Gemeinde Betzdorf, 2019). Today, it is part of a small local heritage and recreation project that includes a recently restored river section of the Syr (see case study part IV).

Efforts of the agricultural administration and farmers to regulate rivers and drain wetlands continued well into the second half of the 20th century - in the Syr valley as in other places in the country (Schaich, 2009). During that period, a new informal institution emerged: the imaginary of rivers as "trenches" that should be straight and deep to carry away water as ´efficiently´ as possible.

> *"Die Situation ist ja heute so, dass wir, ja, Gewässer haben, wo es darum geht, dass das Wasser möglichst schnell abfließt damit man keinen Ärger mit Starkregen, mit Hochwasser hat, damit man möglichst nahe bis ans Gewässer die Flächen nutzen kann, bebauen kann, landwirtschaftlich nutzen kann." (interview n°37)*

As suggested above, this imaginary was also fed by fears of open standing waters, swamps, and marshes as breeding-grounds for infectious diseases. None of the agricultural actors and conventional and organic farmers interviewed were nostalgic about the traditional pre-industrial farming paradigm. In conversations, some of them jokingly referred to traditional agriculture as "Heidi agriculture" (interviews n°19, 44). A sense of pride and notion of progress could be discerned in statements about how farmers were able to provide food for a growing population and to contribute to improving public health in Luxembourg (interview n°42, 51). From an environmental perspective, however, industrialisation entailed a growing loss of wetlands and biodiversity (see chapter 4.2 and Syr case study part IV).

7.1.2.2 Water supply brings together municipalities and the state

Industrialisation also increased the need for water. Since the end of the 18th century, municipalities in Luxembourg have been in charge of securing local drinking water supply. Until the end of the 19th century, they relied predominantly on local wells or cisterns, from which inhabitants drew their (more or less drinkable) water (AGE, 2013; SEBES, 1973). Following the turn of the century, municipal water management in Luxembourg became increasingly technical, beginning to transport drinking water to more distant inhabitants via engineered pipeline infrastructures. The development is analogous to how agriculture began to provide food for increasingly remote consumers. Moreover, it constitutes the first phase of the ´modernisation´ of water management carried out through *combined* efforts of municipal and governmental actors, gradually giving rise to a ´command-and-control´ paradigm. The following accounts are mainly based on documents of the Water Management Authority (AGE), the national drinking water supplier SEBES, and the National Roads Administration (P&Ch) (AGE, 2013; SEBES, 1973), juxtaposed with legal documents and interviews with governmental and municipal actors.

The first groundwater wells (around 50 m deep) had been drilled at the initiative of the Austrian Habsburg empress Marie-Thérèse back in the 18th century, but the water from the wells was deemed unsafe more than once (SEBES, 1968). Luxembourg City thus built the first drinking water facility of the

country in 1866 as an alternative to wells (AGE, 2013). More municipalities followed, also putting into place water pipes and distribution systems from local sources. International water congresses on hygiene in 1887 (Vienna) and 1889 (Paris) had encouraged public authorities and municipalities to attribute more importance to the supply of healthy and abundant drinking water, partly based on new scientific insights concerning pathogenic microorganisms causing illnesses (SEBES, 1968).

Indeed, not all municipalities were able to supply abundant and safe drinking water to local inhabitants, either because of the absence of adequate local sources, technical expertise or for financial reasons. In 1900, a law made it possible for municipalities to set up common intermunicipal structures (´syndicates´) (Mémorial, 1900).[144] The first were drinking water syndicates in the South (SES) and the North (DEA – covering the Upper Sûre region) (AGE, 2013). They began to make heavy investments in distribution systems, supported by national co-financing and P&Ch that had been in charge of carrying out works for the municipalities that improved sanitary conditions and public hygiene since 1874 (SEBES, 1973).

> *„Man muss auch sehen, es hat einen ersten gewaltigen Investitionsschub in Luxemburg Anfang des 20. Jahrhunderts gegeben. Da ist man ja von der Brunnenversorgung zu einer kollektiven kommunalen Trinkwasserversorgung hingegangen. Wenn man die Geschichte der Zweckverbände in Luxemburg sich anschaut, dann waren es vor allem Trinkwasserzweckverbände, die sich gegründet haben, ganz einfach mit der Industrialisierung" (interview n° 60)*

Until 1930, some water infrastructure projects were implemented conjointly between the intermunicipal syndicates and the agricultural service mentioned above, including in the Upper Sûre region (SEBES, 1973)[145]. The syndicates founded during that period continue to be in charge of municipal water supply and treatment today. Some of the pipelines put into place in the beginning of the 20th century were only replaced 80 to 100 years later (a few might even still exist today).

Thus, drinking water supply underwent a change from being a purely local and then municipal concern to relying increasingly on more remote sources. This was the result of increasing intermunicipal cooperation and coordination with – and financial support of – national administrations and their technical services. Together, they made possible the construction of pipelines and, hence, the distribution of growing quantities of water across larger distances, thereby enhancing water security of households and the economy in Luxembourg (SEBES, 1968). In this sense, as in the case of river regulations, the expansion of water supply infrastructures suggests that municipal autonomy and organisation, on the one hand, and state initiatives and support, on the other hand, complemented and perhaps even necessitated each other.

Some interview partners argued that municipalities (and their syndicates) continued to be the main players in water politics until the Water Management Authority (AGE) was set up in the 21st century following the entering into force of the EU WFD (interviews n°60 and 61). As in the case of river regulation and the agricultural syndicates mentioned above, the notion that top-down and bottom-up approaches have been complementary provides a more nuanced view of water and land governance and management in Luxembourg than some of the literature about the "modernisation" of water and agriculture suggests (see chapter 4.2).

[144] Loi du 14 février 1900 concernant les syndicats des communes. Mémorial N°10

[145] In those days (1918-1929), DEA also cooperated closely with the ´service agricole´: dea.lu/presentation/#historique

7.1.3 An emerging science-based ecocentric paradigm

The previous sub-chapters have contrasted emerging industrial and anthropocentric paradigms that focused on food and water supply with pre-industrial approaches to agriculture and water supply. But the 19th century also saw the emergence of what will be referred to as a science-based ecocentric paradigm. It will be argued that what began as a bottom-up paradigm would gradually also give birth to a top-down managerial approach to ecological restoration.

While wetlands gave increasingly way to agriculture, settlements, and transport infrastructures, a counter-paradigm and -movement arose in the beginning of the 19th century. Equally inspired by modern science, formally educated scientists and lay people with a keen interest in flora and fauna began floristic, vegetation, and ornithological research in Luxembourg´s cultural landscapes (Melchior & Lorgé, 2015; Schneider et al., 2019). As in the sub-chapters above, the historical account of how environmentalist movements and organisations emerged in Luxembourg is mainly based on interviews with and publications of affiliated actors, including from natur&ëmwelt Fondation HfN (the parent organisation of the Syr River Partnership), the Luxembourg Nature and Bird Protection League (LNVL), and the Luxembourg Naturalist Society (SNL)[146].

Around the mid-19th century, a number of organisations were set up that continue to contribute to scientific expertise about the ´natural´ environment until today. They included a society of natural sciences (today´s *Institut Grand-Ducal – Section des Sciences*). As an early version of citizen science, it appealed to the public to contribute objects of interest to the Luxembourg National Museum of Natural History that opened in 1854[147]. The appeal was echoed by the botanical society (1872) that stressed that the study of natural sciences – "in the century of lights and progress" - was no longer a privilege reserved to a few savants, but was becoming accessible to everyone[148]. While deploring the environmental impact of industrialisation, the emerging paradigm is pronouncedly *modern* by inscribing itself in the Enlightenment tradition that gave rise to modern science and nowadays´ "technoscientific culture" (Ezrahi, 2004; Jasanoff, 2006, see chapter 4.2). In 1890, the botanical society was followed by the Luxembourg Naturalist Society (SNL). They would later merge and continue to exist today, with some of its members working for today´s Upper Sûre Nature Park and other environmental organisations in Luxembourg (both nongovernmental and governmental). Since the end of the 19th century, naturalists in Luxembourg have studied and monitored ecosystems, organised seminars, and published scientific articles and journals as fora for scientific exchange between diverse nongovernmental and governmental actors.

In 1920, ornithologists founded a society, which would become the Luxembourg Nature and Birds Protection League (LNVL). With its currently more than 13 000 members, the league is the largest environmental grass-roots organisation in Luxembourg (Fondation HfN, 2008). Together, and in cooperation with other environmental groups, the LNVL and SNL were later to set up the Fondation Hëllef fir d´Natur, which has participated in many restoration projects in Luxembourg (incl. the Syr valley). In 1928, the onithologists contributed to the drafting of a first law on bird protection that included the idea of protecting particular species and natural reserves, under the aegis of the administration for waters and forests, today´s ANF (ANF, 2015; Mémorial, 1928). However, it did not

[146] See also SNL, today 350 members (www.snl.lu), and natur&ëmwelt (www.naturemwelt.lu), of which the Luxembourg Nature and Bird Protection League is a member

[147] See also www.igdss.lu and www.mnhn.lu

[148] Own translation from : "Le dix-neuvième siècle qui est, dit-on, le siècle des lumières et du progrès, inaugura toute une révolution sous ce rapport. L'étude des sciences naturelles ne resta plus l´apanage de quelques savants; elle deviant accessible à tous" (La Société Botanique, 1877). In 1876, the society had 58 members.

pass the legislature (Melchior & Lorgé, 2015).[149] The regulatory initiative can be interpreted as a first example of how bottom-up environmental organisations and governmental actors (notably, the administration for waters and forests) have sought to cooperate for nearly 100 years.

Without the above-mentioned nongovernmental organisations, their members and volunteers, there would hardly have been such a large body of scientific publications and data about Luxembourg´s landscapes, flora and fauna as exists today (Colling, 2005; Fondation HfN, 2008).

7.1.4 Summary on actors and paradigms until early 20th century

As in many other countries in Europe, the 19th and early 20th centuries in Luxembourg saw the birth of technoscientific cultures. State-making, industrialisation, and scientific and technological advances profoundly changed the Grand-Duchy. Widespread river regulations, drainage systems, transport and water infrastructure projects greatly increased the supply of water and food supporting a growing population and economy. If *de*creasing emigration and *in*creasing immigration can serve as indicators, quality of life in Luxembourg improved significantly. Many organisations and formal structures were set up that continue to be active – and have formal roles - in water and land governance today. They include municipalities, intermunicipal syndicates, some of the environmental organisations mentioned above, the Administration of Agricultural Technical Services (ASTA, former ´service agricole´), today´s Nature and Forest Agency (ANF, former administration for waters and forests) and the National Roads Administration (P&Ch) (see figure 7.4).

In the literature, technoscientific cultures and yield-oriented paradigms are primarily associated with top-down governance and markets. However, what is particularly interesting about Luxembourgish history is that some top-down and bottom-up structures emerged simultaneously and often complemented each other. Indeed, 19th century state-making followed a narrow anthropocentric top-down paradigm, resting on formal policies, public administrations, and massive public investments in infrastructures that served industrialisation, but also public health. At the same time, however, intermunicipal and farmers´ syndicates were set up to implement infrastructure projects in cooperation with state administrations. Food production itself rested predominantly on farmers and markets, but it would seem somewhat simplistic to reduce food provision to economic interests alone considering that existential food needs could not be met in 19th century Luxembourg. Thus, it would seem that the massive projects and changes of the ´industrial revolution´of the 19th and 20th century rested on a wide range of actors joining forces that served diverse anthropocentric purposes, starting with the satisfaction of basic health needs. While interviews also suggest that there have been tensions between the diverse actors from early days onwards, it is difficult to imagine how the ´modernisation´ of infrastructures, economic and agricultural production would have been possible without widespread cross-scale and cross-sectoral cooperation and coordination.

Furthermore, the emergence of botanists, ornithologists, and naturalists pursuing research in the name of both emancipatory ideals of the Enlightenment and the protection of flora and fauna is noteworthy. As discussed in the concepts chapters, modern science rests on ideals of objectivity that erect a barrier between the scientific observer and what is being studied. For this reason, the Enlightenment is associated with separations of mind-body and nature-culture dualities (see chapter 4.2). At the same time, early environmentalism suggests that the separation of humans and nature

[149] Loi du 24 février 1928 concernant la protection des oiseaux (Mémorial, 1928, N°10). Interestingly, during these early days and assumedly on “external pressure” exerted by public opinion, farmers, and hunters, the envisaged protection of certain bird species concentrated on those birds “useful” for humans, either because they were edible or considered of benefit in farming (Melchior & Lorgé, 2015).

does not necessarily have to be associated with efforts to *exploit* nature for narrow anthropocentric purposes. The “emancipation” of humans was thought of as going hand in hand with not only the study – but also the *conservation* – of nature. Furthermore, the ambigious character of the Enlightenment project itself (see chapter 4.2) is also reflected in these early environmental organisations. On the one hand, early bottom-up environmentalists self-organised and encouraged amateurs to participate in the study of nature. On the other hand, the scientific orientation – and firm belief in progress associated with scientific knowledge – and the objective to protect nature from human activities also came with a certain affinity to top-down regulatory approaches as the 1928 legislative initiative on bird protection suggests. These thoughts will be explored further as the case studies progress.

At any rate, and to sum up, the 19th century in Luxembourg saw the emergence of anthropocentric paradigms that pursued narrow anthropocentric purposes via a mix of top-down *and* bottom-up governance that served societal ´progress´. Furthermore, the 19th century also gave rise to an emerging ecocentric and science-based paradigm carried by self-organised scientists and amateurs whose organisations began to collect data on biodiversity in Luxembourg and hold significant roles in environmental governance and management in Luxembourg today.

Finally, pre-industrial times are associated with two radically different narratives and imaginaries. While agricultural narratives focus on progress in productivity and public health thanks to hard labour and technological advances, conservationists deplore the loss of unregulated rivers, diverse landscapes and their biodiversity that was caused by industrialisation, agricultural intensification, and the draining of wetlands. Indeed, it seems that the *imaginaries* of diverse pre-industrial cultural mosaic landscapes (scientifically studied since mid-19th century) guide some of today´s nature conservation efforts (Colling, 2005). The imaginaries are in stark contrast to views of the 19h century that focus on human hardship as caused by agricultural “backwardness”, swampy rivers and floodplains. The author of the present thesis has not met a single farmer or agricultural actor who regretted the waning of pre-industrial farming. Health concerns associated with wetlands are still alive – as are memories of times when Luxembourgish farmers were hardly able to feed themselves and their families, let alone Luxembourg´s population as a whole.

In one aspect, however, these seemingly opposing narratives meet: in the notion that landscapes need to be actively managed and controlled by humans to restore or maintain a state deemed desirable, be it for anthropocentric or ecocentric purposes.

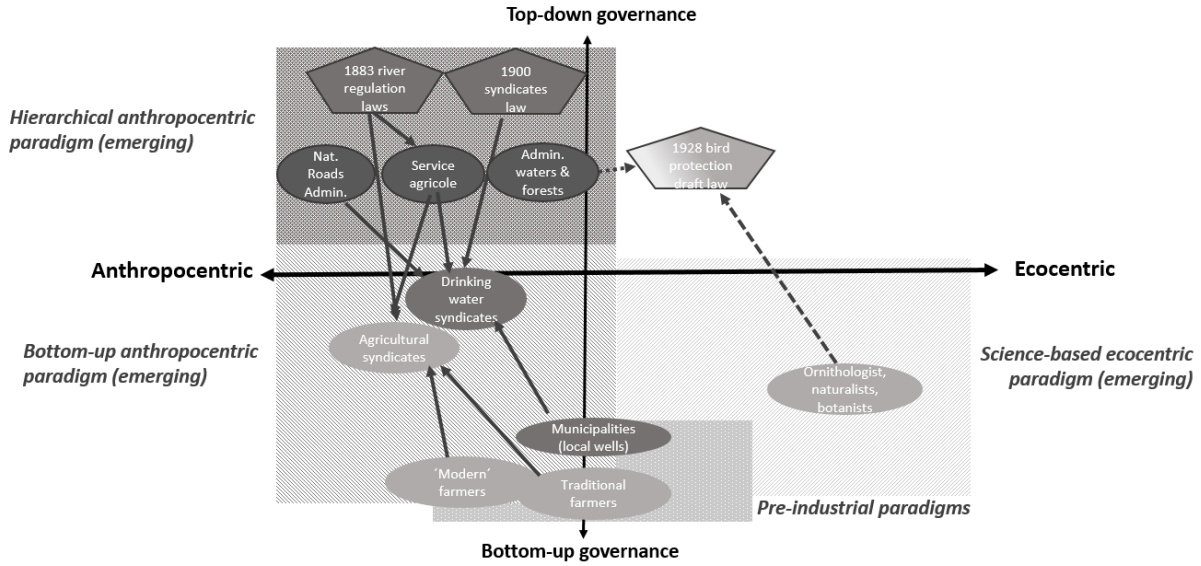

Figure 7.4 – Analytical grid: Mapping of selected laws and actors around the turn of the 19th century

7.2 Post-war Luxembourg: Anthropocentric supply-oriented paradigms

Allowing itself to skip dark war times, this chapter elaborates on how the anthropocentric supply-oriented command-and-control and productionist paradigms in water and agricultural management consolidated in post-war 20th century Luxembourg, notably in the framework of nascent European integration. The period corresponds to what has been referred to as a "public works era" characteristic of the post-war period in Western industrialised countries that also saw a "scientific-technical revolution" in agriculture (see chapter 4.2.3). This chapter analyses how the national government initiated the massive construction of the national Upper Sûre dam in the 1950s and how agricultural productivity was boosted via the Common Agricultural Policy (CAP) of 1962 of the European Communities, of which Luxembourg became one of the capitals. Along with these technology-driven and supply-oriented projects, new actor groups emerged, among them new national administrations and a national water syndicate. Scientific and professional engineering knowledge continued to gain in importance, as did technical skills in the professional knowledge of farmers.

Following the devastations of the Second World War, the population and economy of Luxembourg were in dire need of not only food, but also of safe, abundant and easy-to-access drinking water and electricity. An interview participant recalled war times of his parents:

> *"Meine Eltern, die mussten noch vielleicht an den Brunnen damals gehen. Dann war es gefroren, haben sich die Finger gefroren, wenn sie den Eimer rausgezogen haben. […] Die waren aus dem Krieg […]. Da war die Trinkwasserversorgung zum Teil abgestellt." (interview n°11)*

In continuity of pre-war infrastructural works, the government passed a law in parliament to ensure that all municipalities and households would be connected to public drinking water supply (Mémorial A, 1950).[150] While drinking water supply was nationalised in many other countries (Henriquez & van Timmeren, 2017), Luxembourgish municipalities have continued to be in charge of urban water infrastructures, but (and as in pre-war times) with significant co-funding and technical support of the state. Conjointly, the state (especially via its National Roads Administration), municipalities, and their

[150] Loi du 8 juillet 1950 ayant pour objet le parachèvement des distributions d´eau du pays. Mémorial A n° 40 de 1950

syndicates expanded water infrastructures. The focus entirely on drinking water supply and transport infrastructures, wastewater treatment had not yet become an issue.

> *"In den 1950iger Jahren gab es einen Schub... an Trinkwasser-, an Bau von Trinkwasserstrukturen. Der ganze Norden wurde vernetzt. Da waren schon embryonale Teile vor dem Krieg da, da war dann aber auf einem Schlag alles kaputt." (interview, n°61)*

Thanks to massive investments and infrastructural projects, Luxembourg would develop a prospering economy in the decades to come. While it initially relied almost exclusively on iron and steel production in the South and on agriculture in the rest of the country, its industry would gradually be replaced by international finance (Thewes, 2017).

7.2.1 The Upper Sûre dam and national water supply

In the framework of the US Marshall recovery plan for Europe, the Ministry of the Interior in 1948 relaunched a project in the Upper Sûre region that aimed to produce hydroelectricity and drinking water that aimed to reduce dependence on water from the Luxembourgish sandstone aquifer and to secure long-term human and economic water security[151]. The construction of the Upper Sûre dam in the period from 1953-1958 as national drinking water reservoir provides evidence that water management became increasingly state-driven. It was the most important national project to secure nation-wide access to high-quality drinking water. If the creation of intermunicipal syndicates and water infrastructures had already increased the distance between water sources and consumers, it was further extended by the project.

The construction of the artificial Upper Sûre dam was led by a French engineer and executed by the National Roads Administration, together with a Luxembourgish concrete company (Heinerscheid, 1973). Landscape changes were significant, but in the sparsely populated area of the Upper Sûre only a few buildings and mills had to make way for the massive project (see figure 7.5).

[151] In 1958, a geologist had warned against consequences of what he considered a too excessive reliance on one layer of the sandstone aquifer. He feared that too little water would run into sources and streams, to the detriment of agriculture and sylviculture, and recommended the closure of some groundwater wells (SEBES, 1968).

Figure 7.5 – The main wall of the Upper Sûre dam (renovated in 1991)

The following quote suggests that the dam was the expression of an emerging national narrative centred on the notion of progress and technoscientific imaginaries (see chapter 3.1.2.4). Water was no longer a "gift from heaven", but instead became a resource to be exploited for societal and economic ends. The Upper Sûre dam was a sign that Luxembourg began to rise to the level of other "great industrial nations":

> *"Jusqu´à nos jour l´eau était souvent considérée comme un don du ciel, créé pour le plus grand bien des êtres vivants qui peuple notre planète. Or depuis les derniers vingt ans, dans les grandes nations industrielles du monde, se manifeste un important accroissement de la demande d´eau pour faire face aux exigences incessantes du niveau de vie, des besoins énormes de la sidérurgie, des industries chimiques et de bien d´autres installations industrielles. Comme dans tous les pays, chez nous également, le problème poignant de la pénurie, comme celui de la pollution de l´eau, réclame sans tarder une solution efficace. Il est indéniable que par la construction du barrage d´Esch/Sûre et l´utilisation de son eau à des fins d´approvisionnement de la population, les autorités de l´Etat et des communes ont posé un acte politique d´une grande valeur. Il les met en état de réaliser une politique nationale de l´eau tout en permettant à long terme une planification de ces ressources […]" (interior minister Schaus in SEBES, 1973).*

The first (and only) national drinking water syndicate SEBES was set up to operate the new drinking water facility, to treat, and distribute water from the lake (Mémorial A, 1962).[152] The lake and dam itself are owned by the state. The syndicate has a 50/50 composition split between the government and the existing intermunicipal water syndicates (incl. the DEA syndicate representing the Northern municipalities). In 1969, SEBES became operational and began to supply municipalities all over the country with water. Today, SEBES delivers drinking-water to 70 % of all households in Luxembourg

[152] Loi du 31 juillet 1962 ayant pour objet le renforcement de l'alimentation en eau potable du Grand-Duché de Luxembourg à partir du réservoir d'Esch-sur-Sûre. Mémorial A N° 47

from the Upper Sûre lake[153]. Some hydroelectricity is also still produced there today[154]. SEBES has had to pay no extraction fee to withdraw water from the Upper Sûre lake (Mémorial A, 1962) and sells drinking water to municipalities, respectively, their regional water syndicates, including the DEA syndicate. Municipalities themselves decide upon, which prices to charge to local water users. Today, DEA municipalities buy approximately 50 % of their drinking water from SEBES, the other 50 % are extracted from local groundwater sources[155].

In addition to drinking water, the ´presentation of motives´ for the Upper Sûre project specified that the dam would contribute to meeting agricultural needs of irrigation water (ChD, 1951).[156] Furthermore, the project served flood protection and the development of tourism in the area.

> *„Man hat auch dann den Stausee gebaut mit im Prinzip vier Hauptaufgaben in einer Prioritätenreihenfolge, steht nur im ´Exposé des motifs´ vom Gesetz: Stromproduktion, Trinkwasserproduktion, Hochwasserschutz, Tourismus. " (interview, n°61)*

In 1961, two ´sanitary protection zones´ were set up around the dam, entailing restrictions on agriculture, local economy and municipalities, completely forbidden in protection zone 1 (see figure 7.6) that roughly forms a 100 m belt around the lake (Mémorial A, 1961).[157] The sanitary protection zones continue to be in place today, but are expected to be replaced by stricter drinking water safeguard zones by 2020, based on the EU Water Framework Directive. They are the object of the Upper Sûre case study of part III.

Figure 7.6 – Information panel on the sanitary protection zone 1 at the Upper Sûre dam

[153] www.sebes.lu
[154] 13 megawatt meter/year, see www.seo.lu
[155] www.dea.lu
[156] Projet de loi autorisant le Gouvernement à réaliser l´aménagement hydro-électrique de la Haute-Sûre en amont d´Esch-sur-Sûre. Dépêche au Conseil d´État. N°368. Session ordinaire de 1950-1951. Exposé des motifs.
[157] Règlement grand-ducal du 16 août 1961, tendant à assurer la protection sanitaire du barrage d'Esch-sur-Sûre. Mémorial A N°36

It is noteworthy that government plans for the Upper Sûre reservoir had included the possibility of creating a national (or nature) park. In the following, this plan would bring together governmental actors with members of some of the environmental organisations elaborated on above, inspired by international environmental and science-oriented initiatives. In 1954, a group of natural scientists had addressed a letter to the minister of the interior. They envisaged the opportunity of creating a national reserve area around the lake (Obertin et al., 1954). The group was composed of the director of the administration of waters and forests and representatives of the bird protection league LNVL, the naturalists of SNL, and of the Luxembourg National Museum of Natural History. They had been inspired by the 1952 general assembly of the International Union for the Protection of Nature (today´s IUCN), of which Luxembourg has been a member (IUPN, 1952). The IUPN had adopted several resolutions to draw attention of governments to the environmental destructions caused by hydro-electrical dams, the need for scientific assessments, and to mimimise ecological harm:

> *"Resolution 3: Whereas the construction of dams for hydroelectric or other projects is often achieved without appropriate scientific study of effects of such works on other natural resources, and*
>
> *Whereas it is generally recognized that the management of one natural resource of any kind often seriously affects other resources of equal or superior value,*
>
> *Therefore the Assembly recommends: That the IUPN should make an insistent appeal that for all new proposed construction careful studies of all the resources should be made […]*
>
> *Resolution 4: The Assembly expresses the hope that all countries undertaking large scale public works capable of compromising the natural balance should establish a consulting commission, if such does not already exist, composed of experts, particularly pedologists, ecologists, systematicians, phyto-sociologists, and hydrologists […]" (IUPN, 1952)*

In line with the recommendation, the Ministry of the Interior charged IUPN experts, mainly composed of French natural scientists (led by R. Furon), with the elaboration of a report and recommendations. Following a site visit in 1955, their report concluded that the landscapes of the Upper Sûre were aesthetically beautiful, but that no *natural* environment existed in the strict sense of the term:

> *"D´une manière générale les pentes de la vallée de la Sure sont boisés et d´un bel aspect, mais il n´existe nulle part de paysage naturel […] Il n´existe aucune curiosité naturelle à protéger : pas de gisement fossilifère, pas de grottes, pas de stations de plantes rares, peu ou pas d´animaux rares" (Furon, 1975).*

Nonetheless, the members considered flora and fauna of the valley as worthy of protection. Their recommendation was to create a National Park that, in their view, was to be managed by an expert group:

> *"Le Parc National serait géré par un Comité spécial uniquement compose de techniciens, de spécialistes: Forestiers, Naturalistes, Urbanistes, qui, seuls, sont en possession des connaissances nécessaires à l´aménagement d´un domaine protégé" (Furon, 1975).*

The expert group recognised that it would not be possible to create an ´integral´ national park as the area was inhabited by people. The solution they envisaged was two-fold: within one area there should be two smaller fenced reserves with no forms of human activity. In the second populated area, there should be restrictions on human activities (including the complete interdiction of hunting). Private

land-owners should be forbidden to change anything on their land without permission of the forest administration, as the sole authority on all spatial planning matters.

The present thesis argues that the creation of the expert group and its plans are first signs of the emergence of a managerial ecological restoration paradigm building on affinities between bottom-up and top-down environmentalist actors and approaches. Plans such as those for the creation of a national park were expressions of science- and expert-driven imaginaries of landscapes that reflected ecological restoration objectives but hardly encompassed local communities. The plans also suggests that, as far back as the 1950s, top-down governance may not necessarily have been limited exclusively to anthropocentric purposes, but may at times also have considered environmental concerns.

The advice of the environmentalist expert group, however, was not pursued further. Instead, several additional expert studies and reports were commissioned and prepared in the decades to come. In the 80s, they culminated in a ´global plan´ for what in intergovernmental negotiations had become the idea of setting up a crossborder ´nature park´ extending to the Belgian part of the river basin. The plan had been elaborated by the Ministry for Spatial Planning, in close cooperation with Swiss experts.[158] The preparation of these consecutive plans seems symptomatic of how specialised scientific/technical expert studies grew in importance in formal governance throughout the 20th century. However, 30 years of studies and negotiations did not produce concrete decisions. Instead, plans would take an unexpected turn (see below).

Wildlife and aquatic ecosystems in the Upper Sûre basin had been profoundly changed by the dam. Under the EU Water Framework Directive today, the Upper Sûre dam is listed as the only "heavily modified water body" of Luxembourg (AGE, 2015). At the same time, flora and fauna began to adapt to the new conditions. New plant and animal species began to settle in and around the lake, profiting from the large water surface and its variable levels (Krippel et al., 2019).

Despite its major importance as national drinking-water reservoir, wastewater treatment in the transboundary Upper Sûre basin continued to be neglected. Well into the 21st century, the majority of wastewater treatment plants in the Upper Sûre region was purely mechanical, and not all households were connected to them. At least up to 1990, not a single biological treatment plant existed in the Belgian sub-basin that makes up 2/3 of the catchment area (Oeko-Fonds, 1990). In the Luxembourgish sub-basin, there were four. Adding nutrients from agriculture, eutrophication and blue algae bloom caused by cyanobacteria occurred regularly. As they sometimes clogged drinking-water extraction (and thereby posed a risk to societal and economic water security) SEBES in 1991 invested in the installation of a technological device (PROVAR) to extract water from deeper levels less affected by algae[159]. Blue algae blooms have also resulted in declines of tourism during the bathing season.

7.2.2 European integration and agricultural productivity

In parallel to domestic constructions, Luxembourgish governments had been busy contributing to an institutional framework that would finally guarantee peace and stability in Europe. In 1951, Luxembourg was one of the founding countries of the European Coal and Steel Community, in 1957, of the European Economic Community (precursors of the European Union) (Thewes, 2017). In 1958, it also co-founded the Benelux economic union with Belgium and the Netherlands.

[158] Parc Naturel de la Haute-Sure. Plan Global - Rapport de Présentation (Service de l'Aménagement du Territoire, 1986)

[159] SEBES: https://sebes.lu/fr/syndicat-eaux-barrage-desch-sure/historique/

Since the Second World War, the political system in Luxembourg had been characterised by continuity and dominated by the conservative party (CSV) until 2013. Until the late 1980s there had been a series of five conservative prime ministers, with a liberal intermezzo in the mid-70s (Thewes, 2017). Policy-making was democratic, but hierarchically structured and dominated by top-down and sometimes intransparent decision-making. Luxembourg has no tradition of formal participatory governance and public access to information (Arendt, 2018a). At the same time, Luxembourg being a very small country, informal networks, relations, and contacts have often played a prominent role.

In addition to peace, food was high up on the agenda of European policy-makers. The main objective of the Common Agricultural Policy (CAP), introduced by the European Economic Community in 1962, was to increase agricultural productivity to ensure no one in their countries would ever have to go hungry again (EC, 2012). Since then, agricultural policies have been negotiated and decided upon within the European Community. It would lead to significant structural changes in Luxembourgish agriculture. One interview partner recalled:

> *"Nämlich, direkt nach dem Zweiten Weltkrieg hatte Europa ein Riesenproblem. Die hatten Schwierigkeiten, die Leute zu füttern. Nicht genug zu handelnde Nahrungsmittel zu bekommen, weil die Landwirtschaft nicht ordentlich strukturiert war. Es waren hunderttausende von kleinen Bauernbetrieben, die an sich zuerst mal für sich produziert haben und dann das, was noch übrigblieb, haben sie verkauft. Nur halt in der Zwischenzeit gab es aber so viel Prozent jetzt Nichtlandleute, die also in der Stadt wohnen und die müssen natürlich auch etwas bekommen! Ja, die müssen auch essen […] Das Wort, was für uns das Wichtigste ist, ist Produktivität". (interview n°42)*

As outlined above, agricultural intensification had begun back in the 19th century. Following the wars, it was further boosted by the Marshall plan and the Common Agricultural Policy of the European Communities, with agricultural subsidies – paid for *quantities* produced – having represented the single biggest European budget item for most of its history (EC, 2012). Steep productivity hikes were the result of new machines and technologies, the increasing use of synthetic fertilisers and pesticides and subsidies that rewarded high productivity.

From narratives of interviewees, juxtaposed with documentary research, a ´third stage´ of agriculture, dominated by a productivity and technology-driven paradigm, can thus be identified. In 1964, the National Land Consolidation Office (ONR) was created within the Ministry of Agriculture, charged with restructuring property and farmland (Mémorial A, 1964).[160] Among others, consolidation efforts aimed to create bigger fields more suitable for bigger machines. Figures from the national statistical office STATEC cast light on the profound changes that agriculture has undergone since. Since 1962, the number of farmers in Luxembourg decreased from 10 250 to 2 200 farmers in 2009, with an increase of the land used from an average of 13,4 ha per farm in 1962 to nearly 60 ha in the same period (STATEC, 2012a). In the 1960s, many farmers across Europe had still milked their cows by hand and mowed hay with scythes (EC, 2012). In the period between 1962 and 1985, the number of milk cows in Luxembourg increased from nearly 59 000 to more than 68 000 thanks to milking technologies. Furthermore, annual average of milk produced increasing by more than 100 000 tons to 300 000 tons, cows producing increasing amounts of milk (STATEC, 2012a, 2012b).

In most municipalities of the Upper Sûre region, the number of farms halved between 1978 and 2005 (PNHS, 2007). The constant decrease in farmers and people employed in agriculture have led to far-reaching changes in the social fabric of rural communities.

[160] Loi du 25 mai 1964 concernant le remembrement des biens ruraux. Mémorial A N°46

The increase of land cultivated and cows held was made possible by a corresponding increase in number of tractors and other machineries (peaking in the 1980s). Agriculture in Luxembourg also saw a sharp increase in the use of nitrogeneous fertilisers that, overall, more than tripled between 1962 and 1990 (STATEC, 2012a). Artificial fertilisers and pesticides made farmers less dependent on weather and soil conditions. Mechanic weeding techniques were now used much less than before. Accordingly, less professional knowledge of soil, weeds, and plant health was required. At the same time, farmers needed to develop more professional knowledge of artificial fertilisers and chemicals as well as of (other) technologies and machineries. Farmers also became dependent on public subsidies and European and international markets that drove them to making ever-bigger investments in their farms and becoming larger and more technology-intensive. As a result, Luxembourg – as all other members of the European Communities - saw a strong boost in food production. Dutch farmers began to come to Luxembourg, land still being cheaper in the Grand Duchy than in their home country.

This need for technological know-how was also reflected in the formal professional education of farmers – offered, among others, by the technical lyceum of Ettelbruck – that began to be strongly oriented towards the use of machines. One farmer recalled:

> *"Entwicklung von luxemburgischer Landwirtschaft geprägt von viel Promotion für Marshall-Plan, dass man Wirtschaft und Landwirtschaft mit Subventionen ankurbelt für Produktionstechniken. Als ich zur [Ackerbau-]Schule ging, da war es hier so Mode: viele Maschinen, große Maschinen, waren spezialisiert, jeder kannte die Maschinen […]"(n°18)*

Productivity hikes and intensification in agriculture, however, came at the expense of ecosystems and water quality in rivers, lakes, and groundwater. Adding to the manure from an increasing number of cattle, there was a strong uptake in the use of chemical products (pesticides) and mineral fertilisers. Until the 70s, synthetic and chemical substances were used that were later forbidden, due to severe health and environmental impacts. Another actor interviewed recalled:

> *"ich weiß zum Beispiel, […] dass in den 60er, 70er Jahren, als das losging, Mittel eingesetzt wurden, die wirklich katastrophal gefährlich waren. Die dann aber auch nach 10 Jahren vom Markt genommen wurden. Aber, wie zum Beispiel, eines von den Mitteln...ich komme jetzt nicht auf den Namen...findet man jetzt noch in Waldflächen wieder […] Das wurde teilweise in der Kriegsführung eingesetzt, um Leute umzubringen. Und das wurde dann auch in der Landwirtschaft teilweise mit rein vermischt, da es hocheffektiv gegen Unkraut XY war" (n°5)*

Not only technologies, fertilisers, and pesticides profoundly changed agriculture. While manual labour was greatly facilitated by technologies, the administrative burden on farmers grew steadily with their dependence on subsidies. Thus, in addition to acquiring technical skills, farmers increasingly needed to acquire administrative knowledge relating to the reception of subsidies and compliance with corresponding administrative requirements.

Consumers, on the other hand, benefited from affordable products. While there had been too little food only a few decades earlier, infamous "food mountains" began to pile up in the 1970s, because dairy and meat production by far exceeded demand. The European Community reacted by introducing milk quota in 1984 (EC, 2012). As a result, the number of milk cows began to fall again in Luxembourg (as elsewhere).

7.2.3 Summary of landscapes, actors, and paradigms until the 1970s

The present chapter has outlined the emergence and consolidation of sociotechnical cultures and technoscientific imaginaries in Luxembourg, focusing on water and agriculture. In the decades following the Second World War, anthropocentric provisioning paradigms consolidated, with the Common Agricultural Policy (CAP) strengthening the productionist paradigm in agriculture, and the Upper Sûre dam as materialization of a supply-oriented ´command-and-control´ paradigm in water. They secured abundant food and drinking water supply to a population that had struggled to satisfy its basic needs less than two decades ago. If landscapes had already been ´cultural´ in the 19th century, they were now increasingly heavily modified by infrastructural, industrial, and agricultural interventions. Eutrophication of water bodies and blue algae blooms in the Upper Sûre basin were visible signs of agricultural intensification and the neglect of wastewater treatment. The various formal studies and plans that were drawn up for the Upper Sûre region by external consultants and ministries to enhance drinking water protection beyond the sanitary protection zones bear witness to what appears to be a growing institutionalisation of ´expert systems´. In the beginning, it encompassed an ecocentric expert group that focused on conserving ´nature´. With the drinking water treatment facility, SEBES emerged as a new major actor in water governance and management in Luxembourg who receives considerable attention in the Upper Sûre case study of part III.

At the same time, municipalities and their syndicates continued to be in charge of urban water supply and pricing, although depending on national funds. They, too, focused on anthropocentric needs. Likewise, the productionist paradigm in agriculture was not only carried by EU and national governmental actors, but also became engrained in practices of farmers and the formal education they received in technical schools. The consolidating anthropocentric regimes thus encompassed both governmental and nongovernmental actors across scales and sectors (see figure 7.7).

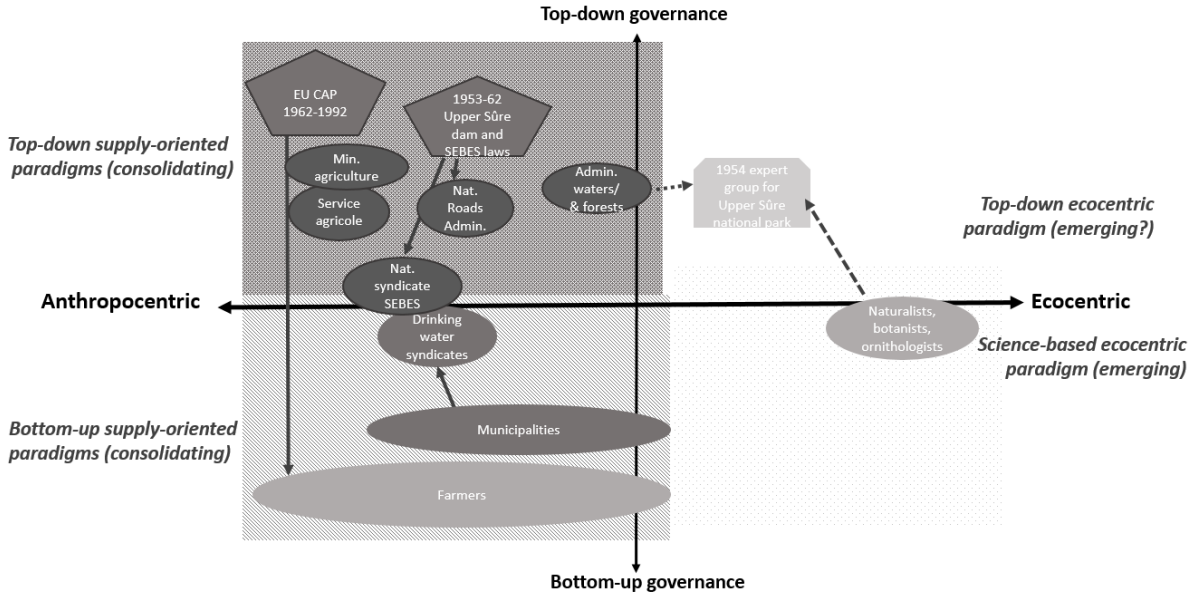

Figure 7.7 - Analytical grid: Mapping selected actors and policies until the 1960s

7.3 Bottom-up self-organisation from the 1970s to 1990s

The third historical chapter analyses how two different bottom-up paradigms emerged in the Upper Sûre and Syr valleys. The period coincides with the "third phase" scholars have identified in water and land governance across Western industrialised countries (see chapter 4.2.3). Starting in the 1960s, countries saw the emergence of counter-narratives to social and economic ´progress´ promoted by emerging social and environmental movements (Gleick, 2000; Scott et al., 2016). Unlike many other countries that began to privatise water infrastructures in the 1970s (Henriquez & van Timmeren, 2017), Luxembourg left water management in the hands of municipalities and syndicates, with the Upper Sûre dam as one of the few major state-owned water facilities.

In the context of countercultural youth movements of the late 1960s, diverse actors and communities in Luxembourg, too, began to question some of the developments described in the previous chapters. Building on organisations and paradigms of past centuries, they challenged state-centred command-and-control approaches and, respectively, industrial growth and productivity paradigms. Strives for more autonomy in the Upper Sûre region can be associated with municipal autonomy that had existed in matters such as water supply since the 18th century and the increase in intermunicipal cooperation that had begun in 1900 with the possibility to set up intermunicipal syndicates to manage water infrastructures (see above). The below analyses how municipalities, farmers, and other actors self-organised in the 1980s and 1990s to rally against governmental plans that aimed for the creation of a national – or nature – park around the Upper Sûre lake. They began to develop own visions, projects and products to strengthen their region. At the end of the 20th century they, together with the government, created the Nature Park Upper Sûre that would later initiate their regional river partnership: the Upper Sûre River Contract.

In the case of the Syr valley, amateur ornithologists from the Luxembourg Nature and Bird Protection League initiated grassroots activities to protect and restore wetlands, and scientifically monitor wild birds in the late 1960s. Together with other environmental organisations, they set up the Fondation Hëllef fir d´Natur that would later launch the Syr river partnership project. The activities inscribed themselves in the tradition of 19th century environmentally-minded scientists and amateurs (see above). At the same time, they also went hand-in-hand with the deep cultural and social changes of the 1960s. Environmental movements such as in the Syr valley are an expression of growing environmental awareness in Western industrialised countries and opposition to economic growth paradigms (Grober, 2013; Higgs, 1997; Scott, 2015).

As suggested above, birds and wetlands have played a prominent – and perhaps pioneering – role in early environmental protection initiatives, both locally and internationally. The history of environmental protection in the Syr and Upper Sûre valleys are closely related to international and European contexts. Internationally, wild birds and wetlands were at the heart of one of the first intergovernmental environmental conventions, signed under the aegis of UNESCO in 1971 in Iranian Ramsar (UNESCO, 1971). The contracting parties recognised the "interdependence of Man and his environment" and the ecological functions of wetlands as "regulators of water regimes and as habitats" (especially for waterfowl and their seasonal migrations). In addition to their ecological functions, the convention stressed that wetlands "constitute a resource of great economic, cultural, scientific, and recreational value, the loss of which would be irreparable" (UNESCO, 1971). Thus pre-announcing the notion of ecosystem services, it also reflects the scientific dimension that has been so prominent in environmental protection efforts since the 19th century. More than 25 years following its signature, the Ramsar convention would be ratified in Luxembourg, with the cross-border Upper Sûre basin designated one of the two Ramsar sites in Luxembourg. Also in 2004, both the Upper Sûre valley

and parts of the Syr valley would become two of Luxembourg´s twelve bird protection areas, based on the national nature protection law transposing the EU Birds Directive (Mémorial A, 2004a)[161].

Formal governmental initiatives on environmental protection are elaborated on further below. As informal bottom-up self-organisation in the two river basins *preceded* formal environmental policies, they are discussed first.

7.3.1 Environmental self-organisation in the Syr valley and the creation of the Fondation HfN

As outlined above, the Luxembourg Nature and Bird Protection League (LVNL) is one of the earliest environmental organisations of Luxembourg, dating back to 1920. The activities of members of the bird protection league in the Schlammwiss area could be said to have laid the foundation of conservation and restoration efforts in the Syr valley. Their narratives and activities cast light on informal factors that can inspire and motivate actors to self-organise and rally around a common environmental cause. Of particular interest in this regard are the types of learning and knowledge that were involved.

As early as 1954, bird enthusiasts had begun to buy first chunks of land in Luxembourg to protect wild birds (Fondation HfN, 2008). In 1969, amateur ornithologists set up the first birdringing station in Luxembourg in Schlammwiss (close to Uebersyren), where a small reed area around the channelised Syr had been left untouched by encroaching settlements, agriculture, and transport infrastructures. What were the origins of the birdringing station? Narratives derived from interviews and conversations suggest that self-organisation in the area was driven by a teenage spirit of rebellion, freedom, and an acute interest in birds.

> *"[…] wir sind hier auf das Schilfgebiet gestoßen, haben wir gesagt, wir müssen schützen. Dann haben wir losgelegt. Also primär war es immer der Gedanke Schutz. Helfen". (interview n°49)*

Asked why bird protection, historically, has had such a prominent place in environmental protection, the interview hints at both ecocentric and anthropocentric motives:

> *"Ich glaube, das ist so, wenn man das sozial guckt oder soziologisch, ist das so ein Herz für Tiere, weil die Vögel einfach mehr ansprechen. […] Man hört sie singen. Sie sind anschaubar. Verschiedene sind schön. […] Andere nicht so schön. Verschiedene konnte man auch mal essen. Das war dann ja auch dann ein Problem, dass man gesagt hat, „jetzt musst du aufhören, die zu schießen oder zu essen". Schlingen, Fallen". (interview n°49)*

Inscribing itself in the amateur tradition, ornithology for the members of the bird protection league was first of all a matter of learning-by-doing. The teenagers involved had no scientific knowledge of birds, but sought to gain experience in birdringing from a French project and by consulting a book on ornithology:

> *"Also angefangen hat es einfach mit Vogelkunde. Wir sind als Kollegen mit dem Fahrrad herumgefahren. Wir sind neunzig Kilometer gefahren nach Frankreich auf eine Beringungsstation. Da hatten wir, ich glaube, keinen Führerschein. Wir waren 16. Dann haben wir da alleine beringt. […] Die Dame, die da beringt hat, hatte vom Beringen so viel Ahnung wie wir. Wir hatten ein kleines Buch und wir haben uns da durchgeschlagen." (interview n°49)*

[161] Loi du 19 janvier 2004 concernant la protection de la nature et des ressources naturelles. Mémorial A N°10

When seeking to protect the leftover reed area, the self-made ornithologists were up against agriculture. More precisely, they sought to "defend" the area against the ´agricultural service´ of the Ministry of Agriculture and against farmers who conjointly renewed drainage systems in the area. The law did not stop the young ornithologists from making sure that machines and existing drainage systems would not be able to perform their functions. With support from inside the administration for waters and forests, the amateur ornithologists managed to ´save´ the small reed area of Schlammwiss (little more than one hectare at the time) and set up a makeshift birdringing station that celebrated its 50th anniversary in 2019[162]. It encompasses various installations, including lookouts and nets, that serve to monitor, catch, and register birds (see figure 7.8).

Figure 7.8 - Nets in the Schlammwiss reed area serving to catch birds

In 1965, Luxembourg had passed its first law on the protection of nature (Mémorial A, 1965)[163], extending the competences of the administration of waters and forests of the Ministry of the Interior to include the protection of flora and fauna. We can only speculate that this new mission of the administration may have contributed to the support of the birdringing station. Incidents surrounding the Schlammwiss area and its drainage systems can be interpreted as a ´clash´ of paradigms. On the one hand, there was an emerging ecocentric paradigm that inspired actions of self-made ornithologists. On the other hand, there were the agricultural service and farmers who pursued an anthropocentric productionist paradigm that had just received a boost by the introduction of the European Common Agricultural Policy (CAP) in 1962 (Moussis, 2001). They were in direct conflict as regards the purposes and the means of their activities: environmental protection centred on birds and self-organisation versus technical interventions in wetlands to enhance agricultural production. This opposition will continue to play a role in the subsequent parts of the case studies.

In the decades that followed, Schlammwiss and the birdringing station became a meeting place for environmentally-minded and science-oriented youth and other environmental activists, many of whom would continue to be active in environmental organisations until today, some also becoming civil servants in the Nature and Forest Agency and, later, the Green-led Ministry of the Environment.

In 1982, the bird protection league LVNL, the naturalist society SNL, and two other environmental organisations (NATURA and AAT) joined forces to set up a common organisation that would later host

[162] see www.birdringingstation-schlammwiss.com

[163] Loi du 29 juillet 1965 concernant la conservation de la nature et des ressources naturelles. Mémorial A N°50

the Syr River Partnership: the Fondation Hëllef fir d´Natur. Building on first land purchase activities of the nature and bird protection league, their purpose was to raise funds and protect natural habitats and biodiversity via the acquisition of land (Fondation HfN, 2008).

> *"Das war auch so ein Challenge, so eine verrückte Idee. Wir haben gesagt, wir machen eine Stiftung und kaufen mal Land ein. […] Zum Naturschutz. […] Ich würde es noch mal machen. Das bringt doch Leben in die Bude" (interview n°49)*

The Fondation HfN became the largest foundation for the preservation of natural habitats in Luxembourg. In addition to land purchase, its mission was to raise environmental awareness and carry out scientific studies with a view to protect flora and fauna in Luxembourg[164]. Shortly after, the state accorded them – as the first environmental organisation in Luxembourg - the status of ´foundation of public utility´, which meant that private donations became tax-deductible. Supported by the state in their endeavour and equipped with first donations, they began more systematically to buy land from farmers and other inhabitants across the Grand Duchy (Fondation HfN, 2008).

One of the first areas, in which the foundation bought land was Schlammwiss in the Syr valley, where it acquired six hectares of land from farmers. But there were not only farmers and hunters in the area. Other threats to flora and fauna included wastewater and expanding transport infrastructure. Since times immemorial, the Syr had served as dump for untreated sewage of riverine municipalities and inhabitants. In 1974, four of the municipalities (Contern, Niederanven, Sandweiler and Schuttrange) got together to set up the intermunicipal syndicate SIAS for wastewater treatment in the Syr river basin[165]. Only five years later, the Uebersyren plant (including biological wastewater treatment) took up operations, neighbouring the birdringing station.

> *„[Der Minister] hat gesagt, "jetzt bauen wir" und dann wurde gebaut, so sind die meisten Kläranlagen gebaut worden, vor 40 Jahren". (interview n°11)*

Moreover, in addition to the railroad of the 19th century running along the Syr, a national highway (A1) was built right across the river Syr to connect Luxembourg City with Trier/Germany. Planned since the 60s, it was built across the Syr valley in 1981 and divides it into two sections (see figure 7.9) : the part North of the highway, ´Mensder Brill´, and the Southern section, ´Schlammwiss´, with its birdringing station and new wastewater treatment plant (Heidt, 1991).

[164] www.naturemwelt.lu/de/ueber-uns/fondation-hellef-fir-dnatur/ueber-uns/
[165] www.sias.lu

Figure 7.9 - Highway A1 between Schlammwiss and Mensder Brill in the Syr valley

The ornithologists convinced the minister of the newly created Ministry of the Environment (created in 1977, Thewes, 2011) and the roads administration P&Ch to support compensatory measures in return for the highway bridge. Their plan was to create ponds to attract more wild birds (see figure 7.10). The ornithologists themselves made some drawings and instructed a construction company to dig out ponds. The process took no longer than a few weeks; no specialised scientific studies were commissioned. All the initiators knew was that the ponds had to be shallow, the rest was improvisation and experimentation.

> *"Wir haben eine Zeichnung gemacht und dann zur Baggerfirma gesagt: „Jetzt machst du das so. […] Ja, so, so mit dem Bulldozer rein und fertig. Ja, also wir hatten schon ein bisschen eine Idee, die sollten flach sein". (interview n° 49)*

Figure 7.10 - Pond in the Schlammwiss area in the Syr valley

In contrast to today, the short time-span and the fact that no formal studies or authorisations were needed is striking. All the ornithologists had was the informal consent of the Ministry of Interior, P&Ch, and of a local forest ranger (employed by administration for waters and forests).

"Mit dem Förster: „Ja, ja", sagt er, „das ist in Ordnung", fertig! Heute brauchst du hundertdreißig Gutachten, sechs Genehmigungen und kommst nicht weiter". (interview n° 49)

There is an interesting contrast between the above descriptions of how the Uebersyren wastewater treatment plant was constructed and how the nearby ponds were dug. The statements suggest that while hierarchical governance was dominant in engineered water infrastructures (despite municipal competences), there was also some flexibility as regards self-organised and experimental bottom-up activities, with good interpersonal relations between individuals as a key element (and perhaps precondition). The statements thus seem to underscore the argument that top-down paradigms have co-existed along with bottom-up paradigms. What is more, in this case a top-down anthropocentric paradigm was able to accommodate bottom-up ecocentric initiatives.

Asked whether the ornithologists would have done anything differently in hindsight, the interviewee admitted:

"Wir haben vielleicht ein bisschen in der Spontanität gesündigt". (interview n° 49)

The interview partner explained that if they had taken more time to plan and reflect, they would have connected two of the smaller ponds. Nonetheless, within a short period the ponds, indeed, became magnets for more birds and other wetland species (Heidt, 1991).

An important aspect of the narratives of local activists is that without their strategy to buy and protect land, many areas, which would later be protected, would have ceased to exist. This idea is taken up again in parts IV and V of the case studies.

In the meantime, in the vicinity of the Syr valley, the small pre-war airport Findel, home of the national "Luxembourg Airline" (´Luxair´ since 1962), had been further extended in the 1970s and 1980s to support national economic aspirations and development. In the course of a few decades, the cargo company Cargolux took off, a new terminal was built, a national airport administration was set up and a runway was extended[166]. In the beginning, the airport had its own wastewater treatment plant. However, due to the growth of the airport, capacities were too small. In the 1990s, the treatment plant was connected to the intermunicipal Uebersyren plant. Since then, the plant has treated an increasing amount of airport wastewater, including from chemical toilets and its runways (personal communication, n°1). In 1995, just meters away from the new ponds, the capacities of the wastewater treatment plant Uebersyren were almost tripled from 12 000 to 35 000 inhabitant-equivalents.

One year earlier, Luxembourg had passed a new law on the long-neglected treatment of urban wastewater (Mémorial A, 1994).[167] SIAS, the intermunicipal syndicate in charge of the plant, had changed its statutes back in 1989 to carry out various activities for the protection of nature, in cooperation with its member municipalities (Contern, Niederanven, Sandweiler, Schuttrange, Mémorial B, 1989)[168]. Since 2007, the specialised intermunicipal syndicate SIDEST[169] has operated the Uebersyren treatment plant (Mémorial A, 2007a)[170].

[166] www.lux-airport.lu

[167] Règlement grand-ducal du 13 mai 1994 relatif au traitement des eaux urbaines résiduaires. Mémorial A N°48

[168] Arrêté grand-ducal du 19 août 1989 portant modification des statuts du syndicat intercommunal pour l'assainissement du bassin hydrographique de la Syre- S.I.A.S. Mémorial B N°49

[169] www.sidest.lu

[170] Arrêté grand-ducal du 6 septembre 2007 autorisant la création du syndicat intercommunal de dépollution des eaux résiduaires de l'est, en abrégé «SIDEST». Mémorial A 186

Thus, by the end of the 1990s the Schlammwiss area in the Syr valley looked very differently from before. A highway and a wastewater treatment plant had been built, and enlarged. Up on the hills from the Syr valley, the airport had opened a new cargocenter (1996). At the same time, a new habitat for waterfowl had been created that would become a national nature reserve in 2018 (see part IV). New organisations were active in the area: the Fondation Hëllef fir d´Natur, today´s Nature and Forest Agency, SIAS, and SIDEST, in addition to the municipalities, the National Roads Administration, and the Administration of Agricultural Technical Services (ASTA).

The Syr river continued to run straight, quick and turbid through its valley, trains rattling to its left, industrious agricultural and economic activities on all sides, and noisy cars and planes above, sometimes drowning the singing of birds (see figure 7.11).

Figure 7.11 - Plane over the area Mensder Brill in the Syr valley

A new home for environmental organisations in Luxembourg had also emerged. In 1994, the Fondation HfN, along with its members (including the Nature and Bird Protection League and the Naturalist Society) and other environmental organisations, had obtained a building close to Luxembourg City. The new "House of Nature" became a site for joint environmental education and networking activities. Luxembourg had its first centre for environmental protection that was further enlarged in the decades to come (Fondation HfN, 2008).

7.3.2 Local self-organisation in the Upper Sûre basin and the creation of the Nature Park

Mobilisation and self-organisation were also underway in the North of Luxembourg, where governmental plans for the creation of an Upper Sûre Nature Park had matured. Here, however, the heart of the matter was not environmental protection as in the Syr valley, but local self-determination vis-à-vis central government. The ´global plan´ for the Nature Park Upper Sûre of 1986 (see above) contained plans for various restrictions on agriculture, on the expansion of settlements and industry. Explicitly distancing itself from earlier studies that had intended to create a national park (see above), the document stressed:

> *"Il ne s´agit donc pas de créer une réserve naturelle, un territoire vide d´habitants, mais d´organiser un espace vital pour la population autochtone en tenant compte des conditions de base naturelles". (Service de l'Aménagement du Territoire, 1986)*

This assurance, however, was not enough to appease local communities. Ever since the dam had been built, the local population had felt sidelined and somehow ´cheated´. Many local inhabitants haft felt that SEBES was withdrawing water from their region to supply, first and foremost, the City of Luxembourg and Southern municipalities, while inhabitants of the Upper Sûre valley had few benefits (although they have received 50 % of their drinking water from SEBES[171]). The fact that local communities were charged higher water prices than people in the South (which is explained by the fact that water infrastructures incur higher infrastructural costs per capita due to a lower population density) has long contributed to public dismay (d'Lëtzebuerger Land, 1993).

Except via their DEA syndicate, there were few contacts between the Upper Sûre municipalities and SEBES. Despite the geographical proximity of the water supplier, SEBES was perceived as a distant actor serving the interests of the government, Luxembourg City and Southern municipalities:

> *"Die SEBES betrachte ich für uns als Burgherren, […] ohne [uns] etwas zu zahlen…Weil, wenn SEBES den Wasserpreis einen Zehntel höher macht, dann schreien die aus dem Süden. […] SEBES gehört nicht zu uns. Das ist die Stadt Luxemburg und die anderen Gemeinden aus dem Süden, die uns dort etwas auferlegen, was wir nicht gut finden" (Interview n°33).*

The statement refers to previous unsuccessful local demands that SEBES should tax Southern municipalities a ´water fee´ ("Wasserfranken") that was to benefit the Northern municipalities – or, alternatively, that the state would contribute to water expenditures in the Upper Sûre municipalities, so that they could charge consumers lower prices (d'Lëtzebuerger Land, 1993)[172]. When the ´global plan´ was presented to the municipalities in 1987, it met with harsh criticism and protest. A newspaper analysed local reactions to the 1987 plan as follows:

> *"Da treten in der Tat Ressentiments aus jener Zeit wieder offen zutage, als der Staudamm geschaffen, das Sauertal überflutet und die Lebens ermöglichen Sinn zu stiften Projekte und Maßnahmen zu entwickeln, die für sie „Sinn machen"aeiten der umliegenden Dörfer grundlegend verändert wurden: Eine alte Wunde wurde wieder aufgerissen" (d´Lëtzebuerger Land, 1987).*

Local suspicions that an "indian reserve" was to be created (d'Lëtzebuerger Land, 1989b), in which the local population were allegedly to entertain well-off city dwellers in need of recreation at the lake, re-surfaced. The suspicion has also been expressed in interviews:

> *"Aber die Vorstellung hatte ich auch oft hier im Naturpark: den Eindruck auf Ministerien, dass man hier gerne ein Erholungsgebiet haben will […] Und hier, da meint man, müsste man noch die Klompen [Holzschuhe] anziehen und die Kappe auf, dass die Touristen animiert werden" (interview n° 18)*

Municipalities, local inhabitants, and the farmers feared economic losses and existential threats due to the planned restrictions. Spatial planning practices of the government were perceived as leaving no room for public participation (d' Lëtzebuerger Land, 1989a). More than 200 farmers thus got together to found an association, ´Bauereninitiativ´, that was mobilizing against the nature park, along with the farmers´ national syndicate, the "Centrale paysanne". Furthermore, nine municipalities got together to set up a joint syndicate, SYCOPAN, to take the future in their own hands and "defend" their interests. The objectives of the syndicate was to act as interlocutor of the whole region towards the spatial

[171] See DEA - Distribution d'Eau des Ardennes: dea.lu

[172] Articles from d´Lëtzebuerger Land are cited here, because the newspaper has followed regional developments closely and reflects perspectives and views that have been recurrent in interviews conducted with local actors.

planning authorities, to voice the regional interests concerning agriculture, industry and tourism, and to contribute to finding solutions to reconcile national and regional interests (Mémorial B, 1988)[173].

The municipalities commissioned their own expert study. Under the heading "*Naturpark Uewersauer – eng Chance fir d´Regioun. Wat kann e Naturpark de Gemengen an de Leit brengen*?", the Luxembourgish foundation Oeko-Fonds worked out a report that contained recommendations and visions for the future of the region (1990). In its opening statement, the study took stock of the past and local sentiments:

> *"Als der Stausee Ende der fünfziger Jahre errichtet wurde […] wurden der Region damit auch neue Entwicklungschancen in Aussicht gestellt. Zieht man nun nach 30 Jahren Bilanz, so kann man feststellen, dass den Gemeinden um den Stausee selbst vielleicht mehr Nachteile als Vorteile entstanden sind (Wochenend-Massentourismus, Überhandnehmen der Wochenendhäuser, Baustopp, Einschränkungen für die Landwirte, Verkehrsbelastung u.a.m.). Die weiter entfernt liegenden Gemeinden haben nicht einmal vom Tourismus profitieren können.*
>
> *Die staatliche Idee zur Schaffung eines Naturparkes in der Region änderte kaum etwas an dieser Situation. Der Begriff „Naturpark" wurde in der Tat noch immer mit einem „Naturschutzreservat" in Verbindung gebracht. Schuld an dieser negativen Einschätzung dürften nicht zuletzt staatliche Stellen sein, die 1986 ohne Mitsprache der Gemeinden und der Bevölkerung einen Globalplan ´Obersauer´ erstellten. Dieser Plan sah viele Einschränkungen vor, zeigte aber keine Zukunftsperspektiven für die Region auf" (Oeko-Fonds, 1990).*

Referring to the French model of Nature Parks, the report stressed that a future nature park should serve regional development, compatible with ecological objectives, and driven by the municipalities themselves. The renovation of the building of an old textile factory could serve as a common home for the administration of the nature park, combined with a tourist office and a museum. Municipalities and farmers should also receive financial compensation for restrictions imposed that could, so it was proposed, be financed by charging a "drinking water tax" on ´lake water´ to outside communities. (Oeko-Fonds, 1990)

In the following, SYCOPAN members and ministerial representatives *did* get together to work out a *common* plan for the future Nature Park Upper Sûre. Previous plans for a cross-border park were off the table. The fact that municipalities were to play a more prominent role in the future nature park and that there were now visions for the future for the region seems to have contributed to public acceptance, according to local municipal representatives interviewed:

> *"Mit Naturschutz hatten viele Leute anfangs weniger am Hut, da wir am Anfang gesagt haben, wir wollen keinen Nationalpark, wir wollen einen Park nach französischem Muster. Einerseits Motor für regionale Entwicklung, und für regionale, ökonomische und soziologische Entwicklung und kulturell. Auf der anderen Seite aber auch Natur und Wasserschutz, vor allem Wasserschutz. Das war immer schon ein Thema. Aber ich glaube, die Akzeptanz, welche wir erreicht haben für den Naturpark hat eigentlich nur funktioniert, weil wir das […] französische Modell erreicht haben" (interview n°32).*

Inspired by some of the visions and projects proposed in the Oeko-Fonds study, the region entered into the 1990s with a dynamic spark of activities. Somewhat nostalgically, some local interview partners characterised the years that followed as marked by a pioneering and entrepreneurial spirit

[173] Arrêté grand-ducal du 2 septembre 1988 autorisant la création du syndicat intercommunal du Parc Naturel de la Haute-Sûre (SYCOPAN). Mémorial B N°40

("Aufbruchsstimmung"), in which the region grew together. In the framework of European LEADER projects for rural development and other local initiatives, a large range of different projects were launched, many of them coordinated by SYCOPAN and in cooperation with governmental actors. Local actors interviewed recalled the spirit and atmosphere of the time as follows:

> *"Aber damals waren da ganz viele motivierte Leute […] Gemeinden, die dann wirklich auch den Naturpark wollten. Ich glaube, die ganzen LEADER-Projekte, die damals anliefen, wie der ´Téi vum Séi´ und so weiter, da waren die Leute wirklich engagiert und die haben sich zusammengetan, ´Spelz vum Séi´, glaube ich, damals auch schon […] was ja aus Wasserschutzgründen auf die Beine gestellt wurde. […] Und dann die ganzen Feste, Festivals, die damals waren, wo die Leute dann zusammenkamen. In dem ganzen Dorf waren dann alle Akteure und Produzenten zusammen. Das war so ein richtiges Dorffest: […] wir haben unsere regionalen Produkte, die damals ja noch viel stärker [waren]. Dann waren die ganzen kulturellen Sachen, wie Skulpturenweg." (interview n°34)*

The projects launched in the 1990s included (LEADER, 2000; Roder, 1999):

- The creation of a herbal garden and cooperative for spices, medicinal plants and tea - ´Téi vum Séi´ (LEADER 1 project leader: Kräutergenossenschaft Naturpark Obersauer)
- A feasibility study on the creation of a regional tourism agency (LEADER II project leader: SYCOPAN)
- ´Véi vum Séi´: Marketing of local and regional agricultural products, especially meat (LEADER II project leader: Bauereninitiativ Naturpark Uewersauer)
- The reintroduction of threatened traditional breeds of sheep and poultry by a new local cooperative (LEADER II project leader: ´Véi vum Séi´ - Genossenschaft)
- Creation of marketing structures for spelt products, including the first Luxembourgish spelt beer (LEADER I and II project leader: Spelzgenossenschaft Naturpark Obersauer)
- ´Bléi vum Séi´: soaps (´Naturpark-Seef´) and aroma essences
- ´Gourmet vum Séi´: restaurants and their chefs use regional products, based on traditional recipes and menus
- ´Duch vum Séi´: traditional textiles made in the old textile factory
- The opening of a shop for local products ("Buttik vum Séi")
- The launch of a solar boat for environmental and educative excursions on the lake
- Cultural events, incl. theatre on the lake ("Seebühne"), sculpture paths, monthly market and music evenings ("Maart a Musik") and a flower festival ("De Séi an der Bléi")

Some of these activities and products have continued until today, including the solar boat (see figure 7.12) and a shop with regional products of the (later) Nature Park: ´Véi vum Séi´, ´Bléi vum Séi´, ´Duch vum Séi´, and ´Téi vum Séi´[174]. The ´vum Séi´ products would become one of the most known regional product brands in Luxembourg. For various reasons other projects, however, have seized to exist. Many actors particularly regret the fact that the spelt beer project did not take off and that many cultural activities did not continue (see Upper Sûre case study of part III).

[174]Regional products: www.naturpark-sure.lu/projects/vum-sei-produkte

Figure 7.12 - Solar boat trip on the Upper Sûre lake (source: Naturpark Öewersauer, photo: Caroline Martin)

Following years of negotiations between the municipalities and ministries, the Nature Park Upper Sûre was formally created in 1999. Before the creation of the Nature Park, SYCOPAN had renovated the textile factory building (“*Tuchfabrik”)* to make it a place for visitors to gain an insight into industrial history and to offer environmental pedagogical activities. It now became the seat of the successor organisation: the Nature Park Upper Sûre[175].

The Nature Park Upper Sûre was born as an intermunicipal structure (´syndicate´) between seven municipalities[176] for a renewable period of 10 years (Mémorial A, 1999)[177]. It was the first nature park in Luxembourg. The executive bureau and board of the Nature Park are composed of municipal and ministerial representatives, incl. from the Ministry of the Environment, the Ministry of Agriculture and nowadays also the Water Management Authority. The Nature Park receives 50 % co-funding from the state. In addition, the Nature Park has an advisory board composed of citizens (incl. farmers) and representatives of local organisations. The Nature Park was structured into three main units: an administration, a department for ´tourism, enterprises and the ´human dimension´ and one department for environment, agriculture and forestry. For the latter, an agricultural advisor was recruited to advise farmers on more ´environmentally-friendly practices´ and to support the development of regional agricultural projects and products. The water supplier SEBES was not represented in any of the statutory bodies of the Nature Park. Its formal mission was exclusively directed towards the provision of water-related services.

The formal mission of the Nature Park has been to contribute to the conservation, restoration and promotion of the natural and cultural heritage of the area, including the “purity of air and waters and the quality of soils”, to promote economic and social-cultural development, tourism and recreational activities (Mémorial A, 1993b, own translation). [178]

[175] Two municipalities (Rambrouch, Wahl), however, did not become members; apparently, for financial reasons.

[176] The municipalities were: Boulaide, Ell, Esch-sur-Sûre, Heiderscheid, Lac de la Haute-Sûre, Neunhausen and Winseler. Following municipal restructuring in 2012, they became: Boulaide, Esch-sur-Sûre, Commune du Lac and Winseler. In 2016, the municipality of Wiltz also joined.

[177] Règlement grand-ducal du 6 avril 1999 portant déclaration du Parc Naturel de la Haute-Sûre. Mémorial A N°44

[178] Loi du 10 août 1993 relative aux parcs naturels. Mémorial A N°67

Indeed, the protection of water was thus just one objective among others, while tourism was considered particularly important for the rural region:

> *"La protection de ce lac n'est qu'un but du Parc Naturel de la Haute-Sûre. Il s'agit également de sauvegarder les ressources naturelles et culturelles de la région et de les promouvoir en douceur. Le Parc Naturel soutient ainsi la création d'un environnement attrayant pour les hommes qui vivent et travaillent sur son territoire. Dans le cadre du développement de perspectives d'avenir pour la région et ses habitants, la promotion d'un tourisme en conformité avec la nature et l'environnement est un autre objectif essentiel du Parc Naturel" (PNHS, 2008).*

The denomination "Nature Park" was thus also used for regional branding and marketing purposes (PNHS, 2008). Municipalities and local communities of the Upper Sûre now had a common structure and networking platform, which has continued to engage in projects for regional development. The Upper Sûre River Contract would in the following decade be one of its projects. The Upper Sûre Nature Park has thus provided a space for cross-scale and cross-sectoral exchange between local and national actors from various sectors who have sought to achieve multiple purposes and objectives at once.

Indeed, in terms of its formal structure, the Nature Park Upper Sûre could be regarded as a first example of a formal organisation in Luxembourg that comes closest to an integrated approach to water and land governance (see chapter 4.3). Its history also suggests that its municipal members have had a strong bottom-up orientation. Within the Nature Park itself, there have been divergent perspectives and tensions on how strong the environmental orientation should be. The protection of water bodies, indeed, seems to have played a comparatively minor role during the first ten years of its existence.

Interviews and conversations also suggest that the Upper Sûre Nature Park is regarded with some scepticism among some national actors who perceive the nature park as having primarily been used as a vehicle by its member municipalities to defend local interests and gain more weight and visibility vis-à-vis national decision-makers. The case study of part III analyses these aspects in more detail.

7.3.3 Comparative analysis: Actionable knowledge in the river basins (research question 1)

The subsequent decades analysed in parts II-IV of the case studies would not see the same level of self-organised activities compared with the activities of the bird protection league and Fondation HfN in the Syr valley from the 1960s to 1980s and those of the Nature Park Upper Sûre in the 1980s and 1990s. Furthermore, they would become an important reference periods in later regional and environmental initiatives and narratives analysed. For this reason, it seems well worthwhile to analyse and compare factors that fostered self-organisation and action along the lines of the tentative analytical framework developed on actionable knowledge (see 3.1.1.2)

The conceptual framework outlined several dimensions of the co-creation and emergence of actionable knowledge (see figure 7.9) that were conceptualized as bringing together different knowledge types. Based on these dimensions, it will be compared in the following how diverse factors facilitated that actors launched environmental and bird protection activities in one basin (Syr), and regional projects and products in the other (Upper Sûre).

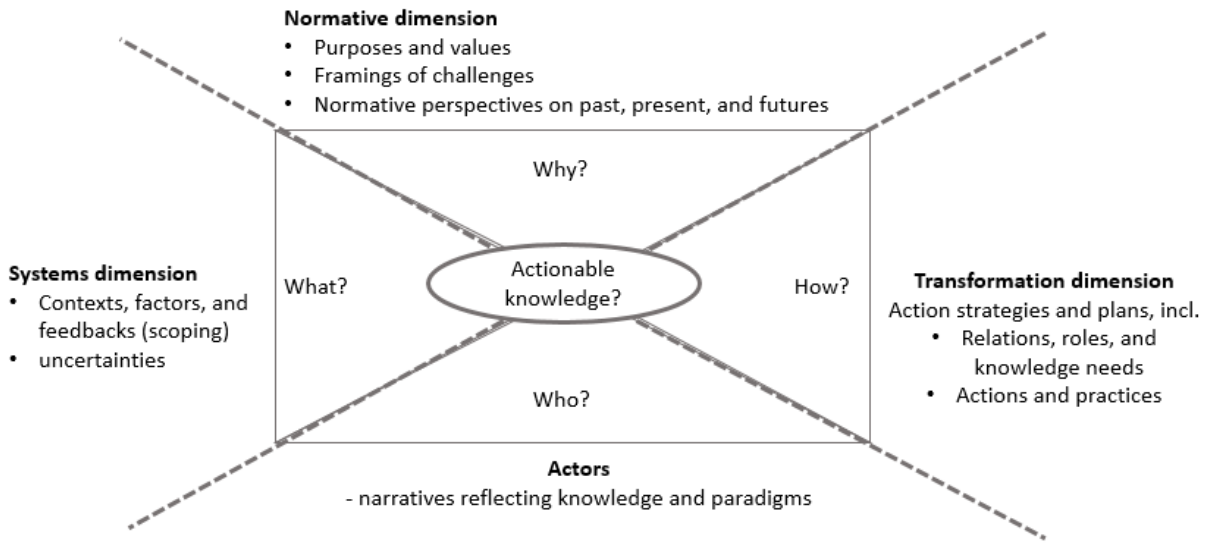

Figure 7.13 - Dimensions of actionable knowledge developed by the thesis

7.3.3.1 Who: Actors and social relations

In both cases, there were existing communities of actors who knew each other well and who trusted each other sufficiently to launch joint actions. In the Syr valley, the community was composed mainly of environmentally-minded youth with a keen interest in birds. The community was not only local, but composed of a country-wide network of like-minded environmentalists (and beyond).

In the Upper Sûre region, the community was local and bringing together both individual citizens and diverse professional, notably, municipal officials and farmers. We can suspect that the experience of the construction of the Upper Sûre dam had contributed to bringing them together. Certainly, interviews suggest that there was a sense of interdependence and of ´being stronger together´ rather than on their own.

While there was a significant degree of distrust in governmental actors, members of each of these communities also sought close relations with and allies among governmental actors.

From the Nature Park Upper Sûre and the Foundation HfN very different networks and focal activities have emerged, on which the river partnerships analysed could later build. The Upper Sûre network is mainly regional, composed of, among others, municipalities and farmers, but also includes national public representatives. The foundation network, on its part, spans the whole country (and beyond) and is composed of environmentally-minded activists, stakeholders, and citizens.

Against this background, it is important to point out that many of the individual actors involved in the governance processes analysed in the case studies have been personally engaged in the above-mentioned organisations and communities before the entering into force of the EU WFD in 2000. Furthermore, several of them began their careers in some of the nongovernmental organisations or municipalities mentioned above, and became later employed by ministries or public administrations. Many actors have known each other well for a long time, some of them for decades. Some relations build on long-standing cooperation and even friendship, others have been characterised by ´ups and downs´, tensions, and rivalry.

7.3.3.2 Why: Purposes and problem framing

An awareness of problems, perceived threats, an attitude of protest and ´resistance´ gave actors an acute sense of urgency of action. The narratives of some of the actors involved have two sides: one negative, the other positive.

In the Syr valley, an ecocentric narrative of "saving nature" from encroaching infrastructures and agriculture emerged, including by the help of science (bird monitoring). They tell stories of how economic growth and agriculture have contributed to environmental deterioration and how, in the future, there would be no ´natural´ habitats left, unless they took action to buy and protect land. Their ´counter-vision´ was based on the preservation and restoration of ecologically rich habitats and cultural-natural landscapes. None of the actors spoken with, however, believed that ecosystems could be restored to being ´intact´ and achieving a ´natural balance´. Rather, indeed, their overall purpose and actions were found to be closely linked to pre-industrial cultural mosaic landscapes and the preservation of species related to those landscapes.

In the Upper Sûre valley, local actors sought to defend what they saw as their right to self-determination and economic interests and prospects against top-down governmental plans for their region. The artificial dam and SEBES drinking water plant have been perceived as visible signs of government intervention. Central to their narratives of "local self-determination" are how the Upper Sûre dam has been imposed on them, perceived as serving mainly national interests and those of the city of Luxembourg and Southern municipalities. They feared that the future of their region would have been bleak, economically, socially and culturally, if governmental plans and further restrictions had been implemented.

This is in contrast to the Syr valley, where formal policies at the time seem to have played no role at all for the ornithologists. In both cases, a strong sense of attachment with local places could be discerned: in the case of the Syr valley, the Schlammwiss area played an important role, as did ´nature´, in general, as the basis for personal and shared ´environmentalist identity´ (see comparative case study, part V).

In the case of the Upper Sûre, the point of reference was often the entire region. A strong regional identity, indeed, seems to have contributed to self-organisation. Furthermore, as regards farmers, there seems to have been a strong professional identity and attachment to land, with a strong local and personal dimension. In the Upper Sûre region, the narratives of many interview partners also referred to how the parents and grandparents (from whom they inherited their farms) had lived and worked in the region. A sense of pride could be discerned in being food producers, based on hard labour and sacrifices as regards, for example, family life. Economic constraints and ´imperatives´ also played a significant role, with many farmers having invested heavily in their farms and paying off bank loans, or seeing the necessity to do so in the future. In conversations, many farmers (both conventional and organic) underlined that they did not wish to continue to expand, but did not see any alternatives.

In addition to economic ´needs´, the inquiry thus seems to confirm that how challenges are understood and framed is closely related to personal and collective identities, specific places and narratives, i.e. to knowledge of pasts (memories), present and anticipated and/or desirable futures (fears and hopes).

Furthermore, interviews have suggested that ´best practice´ examples from abroad have played a significant role: in the one case, the birdringing station in France, in the other the French nature park model. Furthermore, in the Upper Sûre region, the Oeko-fonds study (commissioned by the municipalities) seems to have had a significant impact in launching debates about visions for the region and possible projects. All projects launched in the 1990s sought to boost regional development, economically (agriculture, tourism), culturally and socially.

At the same time, in the Upper Sûre case, overall, environmental and water protection seems to have played a secondary role after regional development. At the same time, the spelt project, among others, was an attempt to create more perspectives for ´water-friendler´ agriculture. In case of the environmentalists, economic and social concerns played minor roles.

7.3.3.3 What: Scope and factors

In both the Upper Sûre and Syr valleys, the scope of the challenge defined has thus had strong territorial and place-based dimensions that consisted in being able to determine what should happen on the (or "their") land. Thematically, systems knowledge has played a role in both cases. As regards the environmentalists, ecological systems knowledge has encompassed, particularly, interrelations and interdependencies between wetlands, specific plant and animal species and human interventions (both negative and positive). Awareness of harmful effects of agriculture, transport, and economic development on the state of the environment was acute.

In the Upper Sûre region, systems knowledge concerned, particularly, economic interdependencies between local economic well-being, national and EU policies and global (food) markets. The development of regional marketing, products and branding have been considered essential for more self-determination and material prosperity. Importantly, it was also set in direct relation with the cultural and social activities that aimed at bringing local inhabitants together – and launching cultural activities that would also make the region attractive for outsiders beyond short bathing holidays. Thus, the projects launched bear witness to a recognition of interdependencies between economic, cultural and social life and wellbeing.

At the same time, it could be argued that the recognition of interdependencies with ecosystems was weak (beyond eutrophication) – and, moreover, that sources and causes of problems such as eutrophication have been highly contested by farmers and other local actors (e.g. what is the ´share´ of agriculture in causing eutrophication vs. wastewater and ´natural´ factors?). Partly for this reason, the Nature Park recruited a farm advisor. We will return to this aspect in the case studies.

7.3.3.4 How: Actions

Action strategies in both cases have built on informal self-organisation and learning-by-doing, with the objective of getting started on specific projects as soon as possible. Through experimentation, professional knowledge was enhanced, e.g. ornithological or farming knowledge. The examples from abroad inspired their activities, but they were not simply copied or ´transferred´.

In case of the bird protection league and Fondation HfN, the action strategy was centred on the idea to buy land and scientifically monitor birds to protect habitats. Buying land was considered the main (and perhaps only) ´solution´ to prevent the disappearance of wetlands and other habitats – and, thus, to counteract economic and agricultural developments. The main obstacles were to raise funds and convincing landowners of selling their land. The main challenge has then been to manage the land. Indeed, one land management aspect in the Schlammwiss area was to prevent the emergence of a floodplain *forest*, which would imply the disappearance of species that need open waters and reed areas (further discussed in part IV).

In case of the Upper Sûre actors, the action strategies built on the idea to develop own projects and products to demonstrate to policy-makers that they could take the fate of their region in their own hands and carry out projects bringing together economic and environmental objectives. The main

obstacles seem to have been funding, but municipalities themselves were willing to invest in projects and the LEADER programme providing most of the funds.

In both cases, building and leveraging relations with governmental and national actors and finding ´allies´ have been important action strategies. As suggested above, despite initial oppositions to central government policies, both the Nature Park Upper Sûre and the Foundation Help for Nature ended up benefiting from national support and funding. Both organisations can thus be regarded as fostering network-based informal governance that relied on cross-scale relations bringing together nongovernmental and governmental actors (see concepts chapter 3.2.3.1). In the Upper Sûre case, network-based integrated governance sought to bring together anthropocentric and ecocentric objectives present in the region. In the case of the Fondation HfN, the network was ecocentric, bringing environmentalists of the whole country together and like-minded governmental actors.

Finally, both communities pursued formal institutionalisation. Both needed formal organisational ´vehicles´ through which they could manage finances, recruit staff and be able to become partners in projects and conclude contracts. The organisational structures also provided external visibility (which, in case of the Upper Sûre, was an important branding aspect, in the case of the Fondation HfN a means to attract donations).

Finally, their organisations needed official seats. In the Syr valley, the makeshift birdringing station has been a hub of self-organised activities. At the same time, the foundation also needed a ´real´ building to team up with like-minded actors, and to carry out environmental and educational activities: the House of Nature. Similarly, in the Upper Sûre region, the textile factory became not only an administrative seat and office, but a place of local cultural-industrial heritage, tourism, networking, and environmental education.

7.4 Contemporary national and EU governance contexts

Starting in the late 1970s, environmental objectives began to make their entry in formal policy-making, both at European and national levels, with the European Communities as major driving force. This corresponds to the “third phase” identified in the “modernisation of water and agriculture” (see chapter 4.2.3). European directives on nitrates and wastewater aimed to tackle water pollution. The below analysis suggests that water and environmental governance in Luxembourg was slow to fulfil EU requirements and that, moreover, water continued to be tackled in a sectoral manner, with competences dispersed among several ministries and little coordination with environmental and agricultural policies. This only began to change with the EU Water Framework Directive of 2000 and a CAP reform of 2003. In formal governance, narrow anthropocentric paradigms aiming primarily for drinking water supply and food production were gradually supplemented by more integrated and ecocentric policies.

7.4.1 National and European water and environmental policies from the 1970s to 2000

As outlined above, Luxembourg had passed its first modest environmental law in 1965 and set up its first Ministry of Environment in 1977. The administration of waters and forests had been charged with classifying rare and threatened plant and animal species. In 1979, the European Economic Community had passed its first environmental piece of legislation, the directive on the conservation of wild birds (EEC, 1979).[179]

[179] Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds. EEC

Notwithstanding these initiatives, environmental policies in Luxembourg only began to enter the political stage timidly in the 1980s, under consecutive conservative-led governments. In 1981, Luxembourg passed a ´declaration of general intention´(DIG)[180] that defined priority zones for environmental protection, in line with the EEC Birds Directive. In its recital, the declaration explicitly referred to environmental deterioration caused by economic development, increasing environmental concerns among the public and the need to safeguard the natural environment, in order not to compromise human existence:

> *"Il est évident que la poursuite effrénée d´objectifs économiques quantitatifs a repoussée dans l´ombre d´autres valeurs, celles-là qualitatives, telle que la protection de l´environnement. Mais depuis quelques années un changement s´est fait dans l´opinion publique et désormais la prise en considération de l´élément écologique imprime sa marque essentielle à la réflexion et à l´action des hommes. La détérioration croissante de l´environnement, où l´homme vit et travaille, est devenue une préoccupation dominante pour la société. Si nous ne voulons pas compromettre notre existence, il faut, aujourd´hui et à l´avenir et plus que par le passé, faire des efforts en vue de maintenir un milieu naturel de qualité et de garantir partout l´équilibre qui doit exister entre l´homme et son milieu » (Mémorial B, 1981).*

Along with many other sites, the territories of the (planned future transboundary) Upper Sûre Nature Park and the Schlammwiss wetlands in the Syr valley were "to be protected as a matter of priority" (own translation). In 1987 (the first European Year of Environment), the Ministry of the Environment charged the young Fondation Hëllef fir d´Natur to carry out a nation-wide mapping of biotopes and the classification of (prospective) nature reserves. Thanks to financial aid from the state, a first staff member could be employed to carry out the work lasting well into the following decade (Fondation HfN, 2008).

The example seems to substantiate the above argument that formal environmental governance and informal self-organised initiatives of environmental nongovernmental actors began slowly to come together under the overarching purpose of environmental protection, notably, around scientific mapping and monitoring programmes, in which the state relied on the professional-scientific knowledge and data of environmental organisations.

In 1993, a new national water law passed (Mémorial A, 1993a).[181] For the first time in Luxembourgish history, surface water *and* groundwater bodies were united in one law (Arendt, 2018b). Their water quality was to be evaluated in the framework of a new national ´water quality inventory´. The law also provided for the demarcation of protected areas around drinking water sources. Finally, it included the setup of an inter-ministerial committee to coordinate water management between the various ministries holding water competences, including the ministries for environment, interior, transport and public works, spatial planning and agriculture (Maganda, 2013). Competences, however, continued to be dispersed between a total of seven ministries and administrations until 2004, when the Water Management Authority was set up (interview n°61, see case studies part II).

At the same time, however, national policies began to seriously lag behind European environmental legislation, as these three examples from the beginning of the 1990s suggest: the directives on urban wastewater treatment, on nitrates from agriculture, and on natural habitats.

[180] Décision du 24 avril 1981 relative au plan d´aménagement partiel concernant l´environnement naturel et ayant trait à sa 1ère partie intitulée ´Déclaration d´intention générale´. Mémorial B

[181] Loi du 29 juillet 1993 concernant la protection et la gestion de l'eau. Mémorial A N°70

The first two directives can be attributed to growing awareness of and scientific studies on increasing water pollution: the urban wastewater treatment directive (EEC, 1991a) and the directive against water pollution caused by nitrates from agriculture (EEC, 1991c). Insufficiently treated wastewater, an "excessive use of nitrogen-containing fertilisers" and discharge of livestock effluents in agriculture were held responsible for increasing (risks of) eutrophication in European water bodies caused by nutrients (especially compounds of nitrogen and/or phosphorus) that produce accelerated algae growth. In particular, the nitrates directive warns against increasing nitrate content in water bodies intended for the abstraction of drinking water. It also explicitly recognises a direct causal link between water pollution from agriculture and the European Common Agricultural Policy (CAP).

The two directives were followed by the European Economic Community´s second major piece of legislation on environmental protection (following the 1979 Birds Directive that had been voted by unanimity concerning an area for which the Treaty of Rome had not provided powers): the directive on the conservation of natural habitats (EU Habitats Directive) that set out to create a community-wide ecological network of protected areas: Natura 2000 (EEC, 1992). Shortly before, the Maastricht Treaty had provided the European Union with a solid legal basis for common environmental policies. Earlier policies had been based on the Single European Act of 1987 that had endowed the Community with some - but less far-reaching - competences (Moussis, 2001).

Luxembourgish transposition was difficult. The wastewater directive was transposed into Luxembourgish law in 1994 (Mémorial A, 1994)[182], the Nitrates Directive in 2000 (Mémorial A, 2000)[183]. However, in both cases, the European Commission would take Luxembourg to the European Court of Justice for insufficient compliance/implementation. As regards the wastewater directive, Luxembourg was condemned twice, because several wastewater treatment plants did not fulfil EU requirements (2006 and 2013). The first judgement also concerned the Uebersyren wastewater treatment plant in the Syr valley. In the end, Luxembourg, in the period from 2013 to 2018 had to pay a fine of two million euros and an additional 2 800 EUR for every day that the four remaining wastewater treatment plants did not live up to standards (EuGH, 2013). Municipalities and administrations had dragged their feet in pushing for and investing in their wastewater infrastructures. In the case of the Nitrates Directive, Luxembourg was condemned in 2010 for not having transposed the directive correctly (EC, 2010). The revised national law would only pass in 2014 (Mémorial A, 2014).[184]

Finally, as regards the Habitats Directive, it would only be transposed into Luxembourgish law twelve years later (Mémorial A, 2004a)[185], when Luxembourg was again threatened with EU fines (Conzemius, 2012). The nature protection law aims to protect natural habitats and resources. Among others, it prescribed that environmental impact studies should be carried out for all projects that could potentially have affect the environment. It established a network of protected areas comprising Natura 2000 and national reserve areas. The Upper Sûre and Syr valleys were to become two of the twelve areas in Luxembourg protected under Natura 2000 for their diversity of birds. The new law also included an update of the environment protection fund. The fund had existed since 1999, primarily to

[182] Règlement grand-ducal du 13 mai 1994 relatif au traitement des eaux urbaines résiduaires. Mémorial A N°48

[183] Règlement grand-ducal du 24 novembre 2000 concernant l'utilisation de fertilisants azotés dans l'agriculture. Mémorial A N°124

[184] Règlement grand-ducal du 28 février 2014 modifiant le règlement grand-ducal modifié du 24 novembre 2000 concernant l'utilisation de fertilisants azotés dans l'agriculture. Mémorial A

[185] Loi du 19 janvier 2004 concernant la protection de la nature et des ressources naturelles; modifiant la loi modifiée du 12 juin 1937 concernant l'aménagement des villes et autres agglomérations importantes; complétant la loi modifiée du 31 mai 1999 portant institution d'un fonds pour la protection de l'environnement. Mémorial A

help finance the modernisation and building of technical infrastructure such as wastewater treatment plants by the municipalities. It now contained specific funding opportunities for municipalities and environmental organisations for measures to improve biodiversity in – and beyond – protected areas. The law will be further discussed in part IV of the case studies.

In addition, Luxembourg transposed a European directive giving the public the right to access environmental information in 2005 (Mémorial A, 2005).[186]

Despite growing environmental awareness in Luxembourgish society and the activities of several environmental organisation in the second quarter of the 20th century, Luxembourg lagged behind in terms of promoting environmental governance and in adequately transposing European environmental and water-related legislation.[187] The examples chosen suggest that Luxembourg entered the 21st century with serious backlogs as regards wastewater treatment, the reduction of nitrates from agriculture, and the protection of natural habitats – and in policy coherence and coordination between the various ministries and administrations. In all of the cases mentioned, implementation and compliance took between one to nearly three decades. This had direct effects on the water quality and state of ecosystems in the Upper Sûre and Syr valleys.

Without the EU and threats of legal proceedings, many actors interviewed were convinced, environmental issues and water protection would have been much slower in making their appearance in formal governance in Luxembourg (Conzemius, 2012). At the same time, as suggested by the Declaration on General Intent (DIG) of 1981 and several interviewees, there was also growing environmental awareness in society at large and, particularly, among environmental grassroots organisations such as the Fondation HfN that stepped up their activities in the 1980s and 1990s.

In general, however, at both EU and national levels, water policies remained purely sectoral and fragmented dealing with “problems one by one in isolation” (Pahl-Wostl, 2015). The above analysis suggests that this diagnosis also applies to Luxembourg.

7.4.2 CAP reform: National programmes and environmental criteria in agriculture

Despite a first reform in 1992, environmental criteria would only be introduced in the EU´s Common Agricultural Policy (CAP) in the following millennium. In 2003, a long-awaited agreement was reached on the reform of the EU Common Agricultural Policy (CAP). It introduced a Single Payment Scheme for direct subsidy payments, which were paid to farmers per hectare and was de-coupled from the production and quantities of specific crops. It also introduced the principle of ´Cross-Compliance´, which contained minimum standards for crop production, animal welfare and the environment. Moreover, a second pillar was created for rural development, containing programmes such as LEADER, which member states could also use to set up sub-programmes for young farmers, climate mitigation and adaptation, biodiversity and agricultural restructuring (Massot, 2019).

Following the entering into force of the CAP reform, the agri-environment-climate measures scheme was introduced in Luxembourg. Farmers have since been able to receive financial aid for voluntary measures that contribute to the protection of landscapes and biodiversity, the climate and of natural resources such as water, soil and air. They can also be paid for the restructuring of entire farms, for example, to organic production. The scheme also includes the reduction of pesticides and fertilizers,

[186] Loi du 25 novembre 2005 concernant l'accès du public à l'information en matière d'environnement. Mémorial A N°204

[187] Studies suggest that Luxembourg has above-average infringement rates compared to other EU member states (Maganda, 2013).

grazing of cattle and the creation/preservation of field margins, flower strips and hedges and the cultivation of follow-up and catch crops. Some of these measures are particularly tailored to agricultural land in protected areas, such as Natura 2000, Ramsar, national natural reserves and drinking water protection zones (ASTA, 2014). The Ministry of Agriculture manages the scheme. In 2009, the ministry also launched a first action programme for the promotion of organic agriculture, which, at the time, made up roughly 4 % of the total of agricultural land (and would increase to 5,5 % by 2014, i.e. from 88 to 119 organic farms) (MAVDR, 2014).

In addition, a specific biodiversity programme for ´sensitive´ areas (incl. special habitats and biotopes outside the protected areas) was introduced in 2002 (Mémorial A, 2002a)[188]. It is managed by the Nature and Forest Agency (part of the Ministry of the Environment) via so-called biological stations, whilst the funds themselves stem from the Ministry of Agriculture and its CAP schemes. The biological stations (most of them created in 2003) are in charge of direct contacts with farmers and conclude biodiversity contracts with them. In the Upper Sûre region, the biological station is attached to the Nature Park. In the Syr basin, it is the intermunicipal syndicate SIAS that negotiates biodiversity contracts with farmers. The biological stations are also in charge of the scientific monitoring of biodiversity, including specific species, in their areas.

Farmers can thus receive subsidies either via the agri-environment-climate or the biodiversity programme. It is often the farm advisors who recommend one scheme or the other to farmers. Since 2007, there have been four organisations for farm advice in Luxembourg: the Chamber of Agriculture (since 1924), a cooperative for animal production (CONVIS, since 1923), an institute for organic agriculture (IBLA, since 2007) and the farm advisors of the Upper Sûre Nature Park (since 2000).

In addition to providing advice to farmers, the Chamber of Agriculture is the official professional representation of the interests of farmers. It formally needs to be asked for its opinion on each legal initiative concerning agriculture[189]. CONVIS is a breeding cooperative that had been founded by farmers and smaller cooperatives to increase milk productivity and robustness of domestic cattle breeds. Later activities also included beef cattle, pigs and other livestock. It is specialised on advice on animal production and related farming activities[190]. The institute for organic agriculture, Ibla, carries out research and advises farmers on organic farming. It has been founded by two organic farming associations, a Swiss research institute for organic farming and organic farmers[191].

[188] Règlement grand-ducal du 22 mars 2002 instituant un ensemble de régimes d'aides pour la sauvegarde de la diversité biologique. Mémorial A N°36

[189] Landwirtschaftskammer, www.lwk.lu, created by the ´Loi du 4 avril 1924 portant création de chambres professionnelles à base élective´: legilux.public.lu/eli/etat/leg/loi/1924/04/04/n1/jo

[190] Personal communication n°3, including excerpts from articles of Majerus & Wagner published in the organisation´s ´lëtzebuerger ziichter´ and from STATEC, SER, ´Bauerekalenner´ 1995, 2005, 2006, 2007. CONVIS has developed programmes and methods to assess the resource efficiency and environmental impact of agricultural animal and plant production (´Nachhaltigkeitsmonitoring´), see also www.convis.lu

[191] www.ibla.lu, founding organisations included the bio-LABEL Lëtzebuerg and the Demeterbond Lëtzebuerg and the Swiss Forschungsinstitut für biologischen Landbau (FiBL)

7.5 Summary of changing contexts until the 2000s

Based on the concepts´ chapters and empirical analysis, the first part of the case studies has outlined historical contexts of water and environmental governance in Luxembourg of the 19th and 20th centuries. It has done so by analyzing multiple formal, informal, and material factors across various dimensions (places, scales and time) and across contexts of knowledge-making and action: macro-contexts, organisational contexts, and transactional contexts that have emerged in interplays between formal and informal institutions, actions of actors within formal organisations and informal communities and material factors, with technologies and infrastructures playing major roles. With a focus on informal and material contexts, this summary underscores the argument that paradigms, actors, and biophysical environments have co-evolved, highlighting the increasingly significant role played by specialised scientific and technical expertise, but also the role played by the agency of particular actor groups. Dynamics have been complex. Self-organised purposeful actions of, especially, environmentalists, local communities, and farmers in the Upper Sûre and Syr valleys were not foreseeable and challenged the prevailing hierarchical paradigm.

It was suggested that formal water and land governance and management until the 21st century was dominated by a hierarchical anthropocentric paradigm and imaginaries, the most visible expression of which were large-scale infrastructures such as the Upper Sûre dam. At the same time, this notion was relativized in three ways. Firstly, by reference to the continuous existence of another paradigm: an anthropocentric bottom-up paradigm of municipalities and farmers. Since the 18th century, technical water management and water pricing have continued to be in the hands of the municipalities. Moreover, farmers have continued to self-organise. Secondly, it was argued that since the late 1960s, a bottom-up ecocentric paradigm has emerged, carried by environmentalist groups such as ornithologists and the later Fondation HfN. Despite hierarchical governance, they created room for manoeuvre to set up a birdringing station and to carry out various activities that changed the Schlammwiss area in the Syr valley and made it more attractive for birds. Thirdly, it has been argued that various formal and informal arrangements have been found that brought to the fore synergies between hierarchical and bottom-up governance as well as between anthropocentric and ecocentric management approaches.

Therefore, the following summary starts out be highlight paradigmatic tensions and conflicts, followed by a focus on synergies and mutual arrangements. Finally, it elaborates on what may have constituted actionable knowledge in the Syr and Upper Sûre basins in the 1980s and 1990s.

There were first environmental laws, the intention to establish protected areas, with the mapping of biotopes as a precondition for the future demarcation of protected areas – and growing environmental awareness in Luxembourg. There were emerging actors and paradigms that can be associated with bottom-up and network governance and more integrated management of water, nature and land. They challenged the ´incumbent´ hierarchical and technical paradigm, leading to tensions. The Nature Park Upper Sûre can be interpreted as a nascent expression of network governance and integrated management, as it was born out of a cooperation between local and national actors and followed the two-fold purpose of combining regional development with environmental protection.

As regards environmental protection, the Fondation HfN gave birth to the idea to buy land to protect flora and fauna in Luxembourg, including as compensation for habitat destruction caused by infrastructure developments. Environmental organisations reinforced scientific monitoring of Luxembourg´s flora and fauna. Their activities have been associated with a bottom-up ecocentric paradigm.

7.5.1 Tensions and synergies between paradigms and actors from the 1980s to 2000

Figure 7.14 illustrates some of the tensions that were identified between these actors and their respective paradigms. In the 1970s and 1980s (roughly), three lines of tensions came to the fore.

Firstly, there were tensions between hierarchical anthropocentric governance and the bottom-up ecocentric activities pursued by the ornithologists that sought to protect bird habitats against drainage systems and encroaching infrastructures, such as in the Syr Schlammwiss area. But they were not only at odds with governmental projects.

They were also in direct opposition to local farmers whose agricultural practices depended on draining systems put into place by their ancestors. One of the ´solutions´ found by the ornithologists to this conflict was to ´re-claim´ the land by buying as much as they could from mainly farmers. Mostly, they seem to have pursued a ´land-sparing´ approach (see 4.3.2) that was based less on cooperation, and more on the separation of agricultural production and bird protection.

Thirdly, in the Upper Sûre area the main line of tension and conflict was between anthropocentric top-down and bottom-up paradigms, i.e. between governmental actors who pursued national interests in relation to the Upper Sûre dam and between municipalities (SYCOPAN), farmers, and other local actors who were concerned about their economic futures.

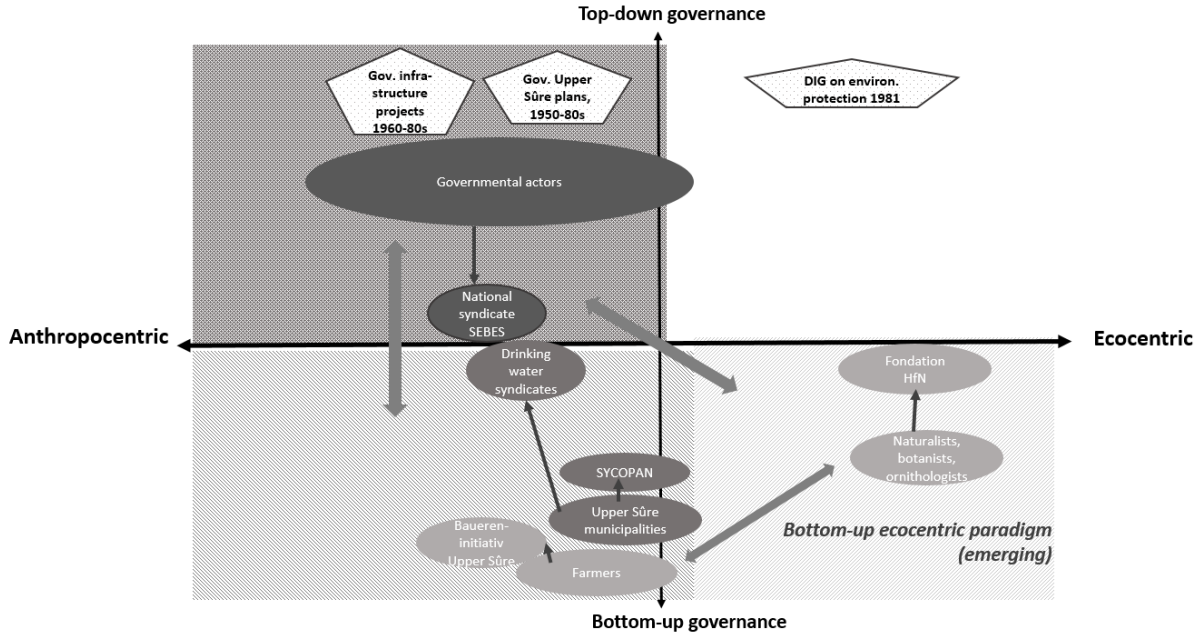

Figure 7.14 - Analytical grid: Selected policies and actors in the 1980s

However, various arrangements were found to overcome or accommodate conflicts.

In the Syr valley, the ornithologists gained governmental support for the digging of ponds to compensate for the new highway. Furthermore, the newly founded nation-wide Fondation HfN was endowed with the right to receive private donations that were tax-deductible. It also received a public contract to carry out the mapping of biotopes in the country. Finally, the foundation – along with other environmental organisations – received governmental support to be able to renovate a building that became their “House of Nature” in the 1990s.

In the Upper Sûre valley, the municipalities, other local and governmental actors began to cooperate (among others in the framework of LEADER projects) and, in the end, to set up the Upper Sûre Nature Park, which was co-financed by the state and included governmental representatives in its statutory bodies. As regards paradigms, the Nature Park is a particularly interesting example, as it not only brings together local and national actors (including from different sectors), but also aims to ´integrate´ regional development and agriculture with environmental and water protection objectives.

In the Syr valley, there is no similar example. However, the objectives of the intermunicipal SIAS syndicate changed from being exlusively directed towards the operation of the Uebersyren wastewater treatment plant to becoming a multi-purpose structure that was charged by its member municipalities with carrying out a wide range of different environmental services, including environmental protection. It would cooperate not only with municipalities and local actors (including foundation members), but also with the government on a variety of tasks, including biodiversity programmes and monitoring.

Based on these examples, the present thesis argues that dynamics in the 1990s could be interpreted as first signs of an emerging polycentric and integrated paradigm that includes elements of network governance and of adaptive environmental management (see figure 7.15). This assumption will be further examined in the following case studies.

The above also serves to suggest that paradigmatic tensions and contradictions did not only produce conflicts – but also unleashed creativity and a boost in new approaches, visions and self-organised activities, and perhaps even new emerging paradigms.

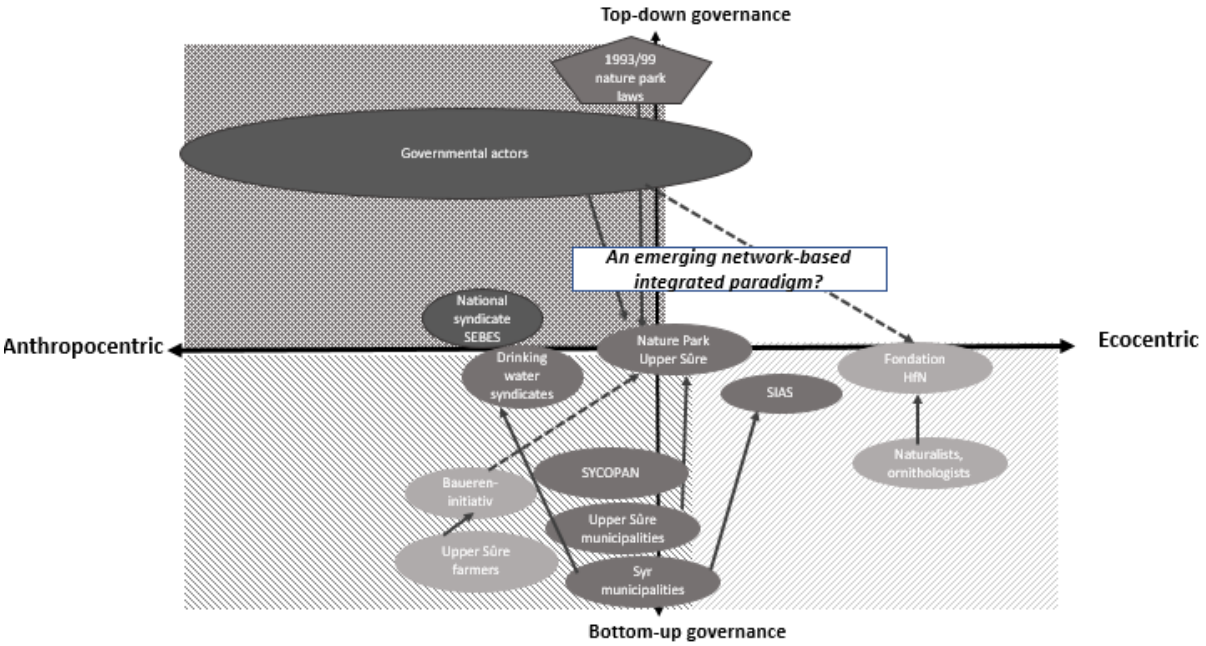

Figure 7.15 – Analytical grid: Selected laws and actors of the end of the 1990s

7.5.2 National macro-contexts: material factors

Not only actors, relations, policies, and paradigms have undergone profound changes since the 19th century. Material, economic, and demographic changes have been significant, too. In the following, a few ´facts and figures´ have been selected from governmental sources as a background for the following case studies.

As regards demographic developments, the population of Luxembourg has more than doubled since 1875, growing to nearly 450 000 in 2001 (STATEC, 2003, see figure 7.16).

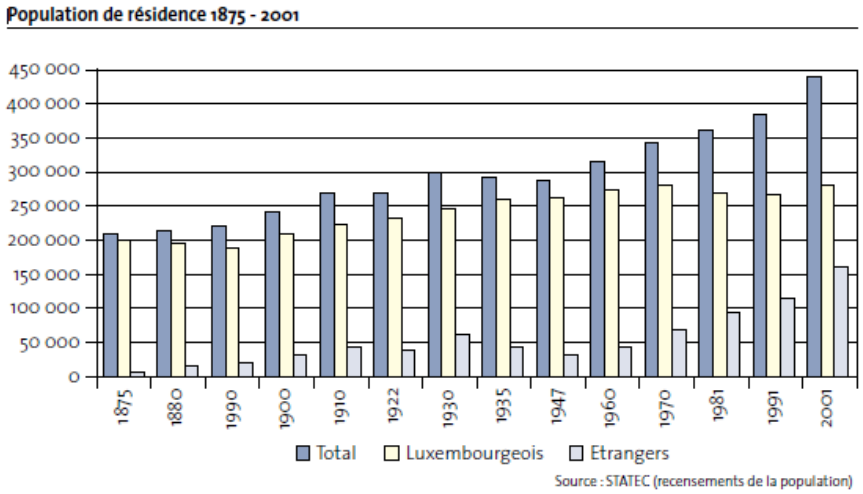

Figure 7.16 – Increase in Luxembourgish and foreign residents ("étrangers") from 1875-2001 (source: STATEC, 2003)

Furthermore, in the period from 1985 to 2001, Luxembourg has on average experienced economic growth of more than 5,5 % of its gross domestic product (STATEC, 2003, see figure 7.17).

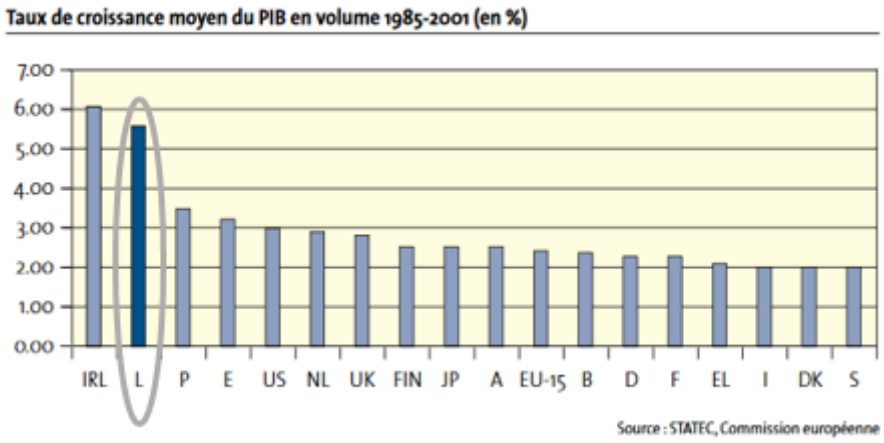

Figure 7.17 - Average increase in gross domestic product from 1985-2001 compared with other EU countries (source: STATEC, 2003)

In the same period, the share of agriculture of the gross value added decreased to 0,6 % (STATEC, 2003, see figure 7.18). From 1870 to 2000, the share of residents working in agriculture fell from 60% to less than 2 % (STATEC, 2012c). In 2000, there were 2.728 farms in Luxembourg, 23 of them organic (SER, 2016). The revenue of farming families[192] were approximately been at the same level as the minimum

[192] The figures refer to agricultural revenues per family unit work (UTAn, SER, 2016)

salary of Luxembourg (and has since fallen below the minimum salary for non-qualified workers that, in 2015, was at 1.920 EUR/month[193], SER, 2016).

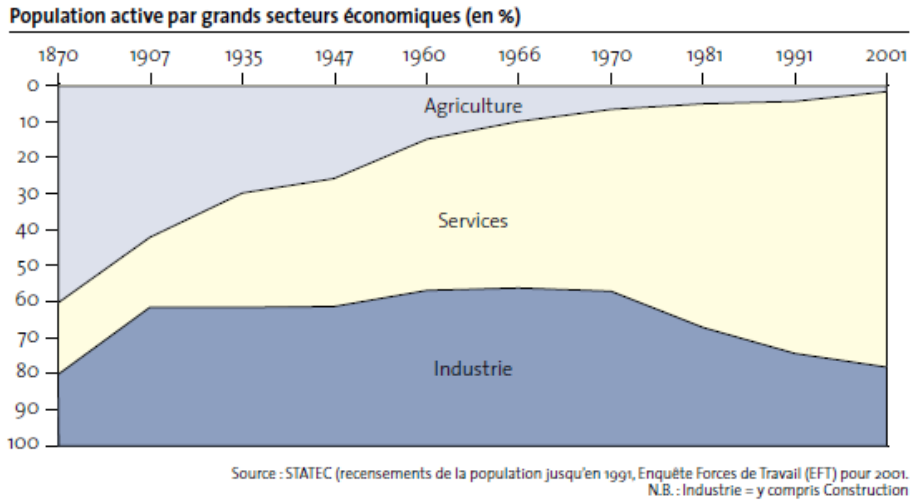

Figure 7.18 – Number of residents active in agriculture and other sectors from 1870-2001 (source: STATEC, 2013)

At the same time, farmers manage approximately half of Luxembourg´s territory, with agriculture being the dominant form of land use (SER, 2016, see figure 7.19).

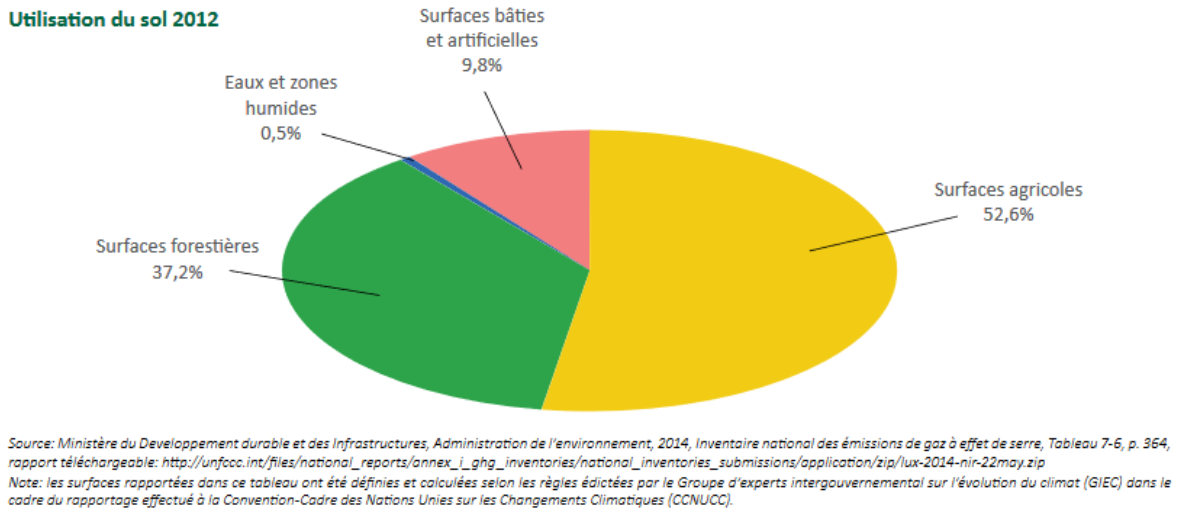

Figure 7.19 – The surface of Luxembourg by land use: agriculture (52,6%), forests (37,2 %), built environment (9,8%), and water and wetlands (0,5 %) (source: MDDI cited by the Ministry of Agriculture/SER, 2016)

Between 1990 and 2000, it is estimates that Luxembourg lost on average 900 hectares of non-built land a year due to economic and demographic growth (MDDI, 2017b)[194]. In 2002, it was the second-

[193]For minimum salary development see:
ttps://statistiques.public.lu/stat/TableViewer/tableViewHTML.aspx?ReportId=12960&IF_Language=fra&MainTheme=3&FldrName=1&RFPath=30

[194] Le Plan National concernant la Protection de la Nature : E Plang fir eis Liewensqualitéit. 100 million d'euros investis pour notre qualité de vie (MDDI, 2017b) : « La croissance économique et en parallèle la croissance démographique des dernières décennies ont eu des répercussions importantes sur l'organisation de l'espace et l'utilisation des sols au Luxembourg. Au début de la croissance économique, la consommation foncière s'est

most fragmented member state of the European Union after Belgium; by 2009, it would be the most fragmented country (MDDI, 2009; MECDD, 2020, see figure 7.20).

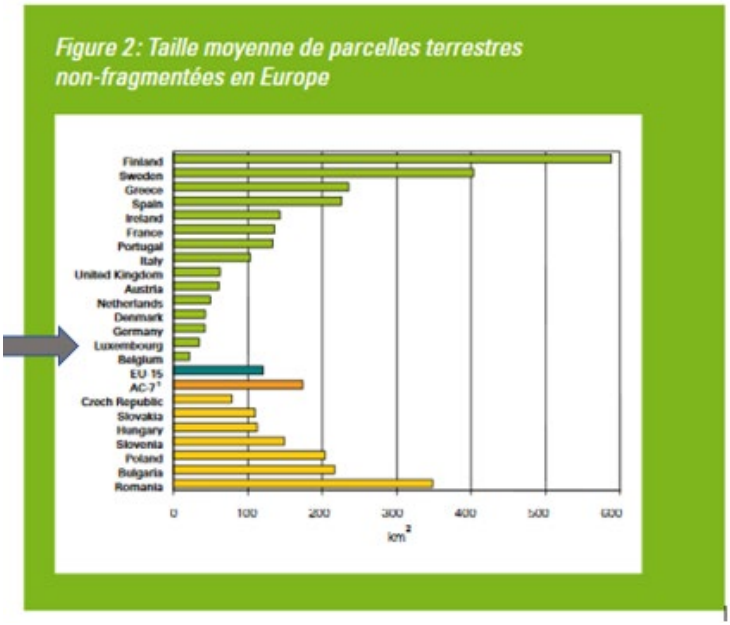

Figure 7.20 - Fragmentation of Luxembourg´s landscape in 2002 in comparison with other countries based on non-fragmented land parcel size (in km3) (MDDI, 2009)

Demographic and economic growth, the expansion of transport infrastructures, industry, and settlements as well as the intensification of agriculture have profoundly altered water bodies, ecosystems and landscapes in Luxembourg. According to the Ministry of Sustainable Development, biodiversity in Luxembourg has decreased significantly from 1962 to 1999 (MDDI, 2009):

- 82 % less wetlands
- 58 % less orchards
- 55 % less solitary trees
- 35 % less grass and heath lands
- 28 % less groves

The ministry attributes the loss to the following factors: the expansion of settlements (urban areas), commercial and industrial areas and transport, the intensification of agricultural practices, and the draining and transformation of wetlands (MDDI, 2009). The ministry was particularly concerned about the degree of the fragmentation of landscapes (mainly due to transport infrastructures). It stresses that the lack of connections between habitats has severely affected ecosystem dynamics and fauna (MDDI, 2009).

If we look at these figures, the following case studies, indeed, seem symptomatic. The Upper Sûre case studies concerns relations between the supply of drinking water to a growing population (and economy) and agriculture. The Syr case study directly concerns landscape fragmentation and the deterioration of aquatic ecosystems, partly due to expansions of transport infrastructures (railways, highway, airport) and the growth of local populations, with which the wastewater infrastructures have not been able to keep pace.

brutalement élevée. Toutefois, le rythme de la consommation foncière s'est ralenti ces dernières années par rapport aux années 1990 (900ha/an entre 1990 et 2000 à 200ha/an actuellement) »

8 CASE STUDIES (PART II): Governance processes relating to national WFD implementation and creation of river partnerships (2000-2012)

Focusing on outcomes and effects of the EU WFD and related directives in Luxembourg, the second part of the comparative case study inquires into research question 2, as a basis for more detailed investigations in parts III and IV:

Research question 2: How has the EU WFD changed water and land governance and management in Luxembourg?

As regards formal processes, the part analyses the creation of the new national Water Management Authority (AGE), the new national water law, and the national WFD management plans for the periods 2009-2015 and 2015-2021. As regards informal processes, the case study investigates how the river partnerships of the Syr and Upper Sûre basins emerged from self-organised bottom-up activities of the Nature Park Upper Sûre and, respectively, natur&ëmwelt/Fondation Hëllef fir d´Natur (Fondation HfN) that *preceded* national WFD transposition. Both river partnerships have pursued a network governance approach by seeking to bring together actors from various scales and sectors.

It will be argued that the overarching ecocentric purposes of improving water quality pursued by the river partnerships and the new Water Management Authority (AGE) have been largely identical, the EU WFD providing a common normative basis. At the same time, first tensions and possible contradictions can be discerned between diverse actors and their approaches. These can partly be attributed to the paradigmatic WFD hybridity itself (see chapter 4.5), notably as regards the status of specialised scientific/technical expertise vis-à-vis non-scientific knowledge. Furthermore, first possible tensions will be explained by reference to different organisational contexts and histories. Finally, the fact that Luxembourg had significant catching up to do as regards its wastewater infrastructures (see previous part I) continued to shape management priorities.

Empirical analysis into formal and informal governance processes is structured along seven action situations (see table and figure 8.1) that have been identified based on stakeholder interviews and workshops and document analysis (see methods chapter 5.6.1).

Informal action situations selected (ASI)	**Formal action situations selected (ASF)**
	ASF 1: EU WFD enters into force and provides a new hybrid framework for national water governance and management (2000)
	ASF 2: The Water Management Authority is created, unites water competences within the Ministry of the Interior (2004)
ASI 1: Interreg projects initiate river partnerships in the Upper Sûre and Syr basins (2005-2008)	ASF 3: The Water Management Authority elaborates the 1st national WFD management plan (2004-2009)
	ASF 4: Stakeholder involvement is conducted on the 1st WFD management plan (2007-2009)
	ASF 5: The national water law enters into force creating legal basis for river partnerships (2008)

ASI 2: The Syr and Upper Sûre river partnerships are formally institutionalised (2011-2012)	
	ASF 6: The Water Management Authority elaborates the 2nd national WFD management plan, assesses possible non-attainment of objectives

Table 8.1 – Action situations selected for the period 2000 to 2012

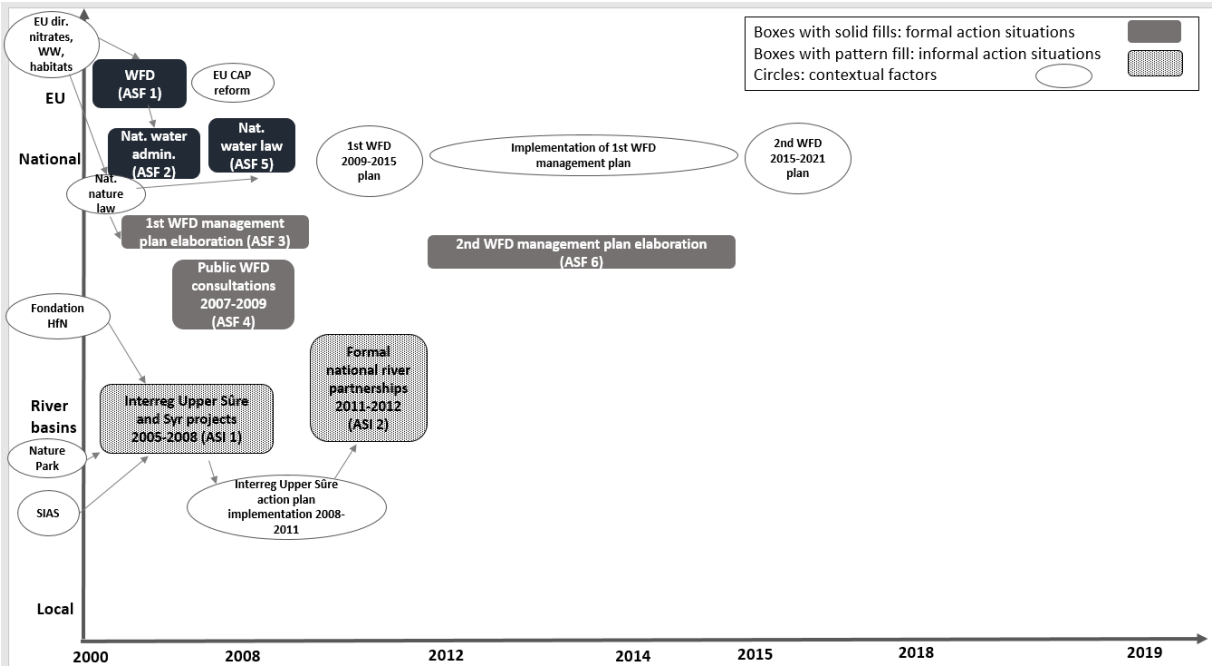

Figure 8.1 - Graphic representation of the selected action situations and related contextual factors

8.1 ASF 1: EU WFD enters into force, provides new and hybrid framework

Providing a new integrated but also hybrid framework for water governance and management, the EU Water Framework Directive confronted Luxembourg with significant requirements that entailed institutional, organisational, epistemic, and material challenges. Building on the analysis of the EU WFD (see chapter 4.5), the requirements can be summarised as follows:

Formal obligations:

- to achieve a "good ecological status" of its water bodies by 2015, notably via nature-based solutions such as river restorations,
- to introduce river basin districts, elaborate management plans and define competent authorities,
- to introduce formal public consultations on national management plans,
- to introduce drinking water protection zones and to coordinate management plans for areas, protected under the EU Birds and Habitats directives (incl. Natura 2000) with water policies.

In order to fulfil the requirements, Luxembourg had to meet various new technical epistemic and material requirements that were intensive in terms of the specialised scientific/technical expertise they required. They including:

- the determination of water body types in Luxembourg and respective type-specific reference conditions for biological, physico-chemical and hydromorphological quality elements,
- analysis of anthropogenic pressures in the river basins, risk assessments of effects of potentially hazardous substances, economic analyses of costs of water services,
- the putting into place of extensive measurement and monitoring equipment and procedures.

Furthermore, the EU WFD encompassed informal non-binding recommendations to integrate water policies with other sectoral policies beyond the environment (including agriculture), and to actively involve stakeholders and consider non-scientific knowledge to foster social learning (EC, 2003b).

8.2 ASF 2: Water Management Authority is created, unites water competences

Summary	In order to be able to transpose the EU WFD, the Water Management Authority (AGE) was set up in 2004, resulting in a redistribution of competences between ministries and administrations. For the first time in Luxembourgish history, water competences were united in a single administration. Meeting WFD requirements and principles of integrated water management required extensive professional and organisational learning within the administration.			
Synergies and tensions	Tensions between the ministries of the interior and sustainable development and between the Water Management Authority (AGE), the administration for waters and forests (ANF), and the administration for agricultural technical services (ASTA)			
Action situation	Documents	Main interviews	Observations and meetings	Workshop content
ASF 2: The Water Management Authority is created, unites water competences	National law creating the Water Management Authority (2004)	N° 31, 60, 61	-	-

EU member states were required to transpose the directive by the end of 2003. As in the cases of the EU Habitats, Nitrates, and Wastewater Directives, Luxembourg was only able to transpose the EU WFD in 2008 due to political and administrative difficulties, under the shadow of legal actions and judgements by the European Court of Justice for legal non-compliance (Arendt, 2018b; Maganda, 2013)[195]. One of the challenges was organisational. The extensive scope and detailed technical specifications of the WFD necessitated the uniting of water competences dispersed among several ministries in one national administration.

Following political arguments and legal difficulties (Arendt, 2018b), the conservative-liberal government under Jean-Claude Juncker decided to set up the new Water Management Authority (AGE) within the Ministry of the Interior (Mémorial A, 2004b)[196] rather than within the Ministry of Sustainable Development where the administration of waters and forests (today´s ANF) was located. Considering the strong environmental objectives of the WFD, the allocation of the Water Management

[195] According to Maganda (2013), only few EU member states met the deadline for transposition. The European Court of Justice launched a total of eleven infringement cases against EU member states, including Luxembourg.
[196] Loi du 28 mai 2004 portant création d'une Administration de la gestion de l'eau. Mémorial A, n°92

Authority outside the Ministry of Sustainable Development suggests that water management continued to be treated mainly as a technical and supply-oriented management issue. Several interview partners shared the view that the creation of the AGE within the Ministry of the Interior meant that environmental objectives in water management continued not to receive sufficient priority.

> *"Ich glaube, es gab jahrzehntelang ein Strukturproblem, weil die Zuständigkeiten im Wasser, Abwasser, Flussbereich wirklich auf x Verwaltungen verteilt waren und das hat dann dazu geführt, dass eigentlich für vieles niemand sich so richtig zuständig gefühlt hat. Und es war sicherlich eine ganz richtige Entscheidung, irgendwann dann alles zusammenzulegen, Wasserwirtschaftsamt zu gründen […] aber gleichzeitig hat man eine ganz falsche Entscheidung getroffen und das ans Innenministerium angesiedelt. Und das ist halt ein Ministerium, das mit Umwelt recht wenig am Hut hat" (interview n°60)*

The formal overall purpose of AGE is to pursue "an integrated and sustainable management of water resources and aquatic ecosystems and to ensure efficient protection" (Mémorial A, 2004b, article 2, own translation). AGE was put in charge of all matters relating to water management (without prejudice to those held by the municipalities, see also ASF 5), including management plans and measures to improve the qualitative and quantitative status of water bodies and flood protection. Furthermore, it was formally ascribed the task to "inform the public and encourage all initiatives relating to a sustainable management of water" (own translation, article 2 (12)).

After its creation, the young authority was charged with drafting the water law that would transpose the EU WFD into national law. In parallel, it had to prepare the first national WFD management plan that had to be finalised by 2009. AGE staff was predominantly composed of hydrologists, engineers, and natural scientists who had previously worked for the ´water unit´ of the Ministry of the Interior, experienced in technical infrastructure management. Some older civil servants were not eager to appropriate WFD requirements, including principles of integrated and ecosystem-based water management. As in many other countries (Mostert, 2003b), the WFD approach and requirements were new and demanding. It would take many years, a generational change, and significant learning for civil servants to appropriate WFD principles and requirements (interview n°31).

Of particular relevance for the present case studies is the fact that AGE was endowed with competences that had previously been held by the *administration des eaux et des forêts* (re-created and –named as Nature and Forest Agency in 2009, ANF) and by the Administration of Agricultural Technical Services (ASTA, see also part I).

ANF had been in charge of the management and protection of aquatic ecosystems, including wetlands, since 1965 and continued to be in charge of natural habitats. In the previous part of the case studies, the administration has been described as closest to a new emerging ecocentric paradigm. Around the millennial turn (and thus preceding national WFD transposition) the administration had begun to carry out river restorations, including in the Syr valley (see part IV). Attempts were made to recruit some of its staff members for AGE, but especially high-ranking members decided not to move. The fact that the two administrations belonged to different ministries and that ANF civil servants did not join AGE affected the portfolio of competences of staff members and produced both interorganisational and interpersonal tensions.

> *"Da ist wieder der persönliche Moment, wo dann der Weg halt eventuell nicht ganzheitlich angeschlagen wurde. Das war kleinpolitischer Krieg auch und dann hängt das Ganze. Das ganze System hängt dann ein bisschen, hat so ein Klotz am Bein." (interview n°31)*

Although AGE had formally become in charge of aquatic habitats, the area *de facto* remained largely within the Ministry of Sustainable Development. Following a governmental change in 2013, AGE was moved to the Ministry of Sustainable Development that has been headed by the Green Party since. However, until today there are overlapping competences between AGE and ANF as regards aquatic ecosystems. Furthermore, the fact that the civil servants of the two administration have, historically, belonged to different ministries continues to influence relations (interviews n°31, 61).

> *"Und sie haben immer gesagt, aquatisch ist Wasserverwaltung. Das war aber nicht so, weil wir nicht die Kompetenz hatten. Und die Zusammenarbeit war schwierig, auch weil wir ministeriell getrennt sind [waren] und ist immer noch schwierig irgendwie […] Regierung und Ministerium, das prägt einen schon." (interview n°31)*

> *"Und dann ist die Naturverwaltung auch noch zuständig, neben der Wasserverwaltung, für den Bereich Naturschutz im aquatischen Raum, wobei die Wasserverwaltung ist auch dafür zuständig, da gibt es Kompetenzüberschneidungen. Ab und zu auch schwierig". (interview n°61)*

Inter-organisational relations aggravated by interpersonal conflicts have affected the planning of measures such as river restorations throughout the period covered by the Syr case study in part IV.

In addition to competences from ANF, AGE also took over competences from the Administration of Agricultural Technical Services (ASTA). From 1883 to 2004, ASTA had been in charge of river regulation and maintenance. In the 19th century, its predecessor (the ´agricultural service´) had cooperated with intermunicipal and agricultural syndicates to improve sanitary and health conditions of the population by channelizing rivers and draining wetlands and thus contributed to increasing food production (see part I of case studies). Its work had been a cornerstone in the ´industrial revolution´ of the 19th century. In the previous part, ASTA has been attributed to an anthropocentric supply- and control-oriented paradigm in water and land management. In 2005, one of its former directors wrote:

> *"Die Ackerbauverwaltung, die vor rund 120 Jahren aus der Not der versumpften Wiesen- und Flußtäler heraus geboren wurde, ist kürzlich von ihren wasserwirtschaftlichen Kompetenzen entbunden worden; die Abteilung „Wasserwirtschaft und landeskulturelle Verbesserung" ist abgeschafft worden". (Frisch, 2006)*

For the first time in Luxembourg´s history as a nation-state, agriculture was no longer in charge of river regulations and maintenance.

The simultaneous preparation of the new water law and the first EU WFD management plan entailed a heavy workload for AGE. Interviews confirm the diagnosis that one of the significant changes the EU WFD produced was that water management would require more specialised scientific/technical expertise than before (Mostert, 2003b; Ollivier, 2004):

> *„Also die Wasserrahmenrichtlinie verlangt sehr viel […] Wie man das Monitoring macht, ist alles festgehalten, wie man die Qualitätsermittlung macht, alles mit Farben und Methoden hinterlegt und obligatorisch hinterlegt. Das heißt, jedes Labor, das die Einschätzung der Gewässergüte macht, muss eine gewisse Methodik anwenden und sich auch noch akkreditieren lassen auf EU-Ebene". (interview n°31)*

Extensive WFD requirements and what they meant for AGE will be further discussed under ASF 3, 5 and 6.

Formal outcomes (organisational):

- creation of Water Management Authority (AGE),
- formal restructuring of water-related competences, including from the Nature and Forest Agency (ANF) and the Administration of Technical Agricultural Services (ASTA).

Informal relational outcomes and effects (organisational and interpersonal):

- Uneasy interorganisational and -personal relations, partly overlapping competences and distribution of roles between AGE, ANF, and ASTA.

8.3 ASI 1: Interreg projects initiate river partnerships

Summary	The Upper Sûre River Contract and the Syr River Partnership emerged from self-organised project activities of the Upper Sûre Nature Park, respectively, the Fondation HfN and SIAS. While approaches and organisational contexts of the two river partnerships and their parent organisations are different, they both emerged from EU Interreg projects in 2005 that anticipated national EU WFD transposition.			
Synergies and tensions	Synergies: With the EU WFD as common basis, overarching purposes, and operational objectives of the river partnerships and the Water Management Authority were very similar.			
Action situation	Documents	Interviews	Observations and meetings	Workshop content
ASI 1: Interreg projects initiate river partnerships in the Upper Sûre and Syr basins (2005-2011)	National water law of 2008, Upper Sûre and Syr Interreg reports and documents	N° 2, 3, 9, 13, 32, 33, 34	-	-

Following the entering into force of the EU WFD (but preceding national transposition), the Upper Sûre Nature Park and its municipal members, natur&ëmwelt/Fondation Hëllef fir d´Natur (Fondation HfN) and the SIAS syndicate began to work on the establishment of their respective river partnerships, based on a Walloon model and with Interreg co-funding. The Interreg programme had existed since the 1990s to support regional development and crossborder cooperation under the European Regional Development Fund[197]. In Belgium, Walloon authorities had finalised a legal framework for the creation of river partnerships (*´contrats de rivière´*) shortly after the EU WFD had entered into force (Ministère de la région wallonne, 2001). By that time, the first crossborder river partnership in Luxembourg, the river contract of the Belgian-Luxembourgish Attert basin, had already been created[198].

[197] Interreg programme: ec.europa.eu/regional_policy/fr/atlas/programmes/2000-2006/european/interreg-iii-a-belgium-france-luxembourg

[198] Attert River Contract: www.attert.com/qui-sommes-nous

The first steps towards the establishment of the river partnerships Upper Sûre and Syr largely followed the Belgian model, if only at different speeds and intervals, beginning in 2005. The main phases consisted in[199]:

1. Establishing an inventory of the state of the hydrographic network of the river basins, including the gathering of all existing information and data on the physical-chemical quality of rivers and streams, the biodiversity in the aquatic ecosystems, and also of tourist infrastructures and other water-related aspects. Problems (´points noirs´) were identified and registered in a database adapted from the Belgian partners;
2. Bringing together partners and stakeholders in river committees and elaborating a "water charter": river committees are the decision-making bodies of river partnerships and responsible for project management as well as for the mobilisation and coordination among actors, including public authorities from local and regional/national levels, scientists, farmers and farm advisors, fishermen, environmentalists, forest owners, tourist boards and operators, etc. River committee members commit to serving as interface between the (future) river contract and their own organisations or groups. They work out a joint charter that outlines outlining the overall mission to "restore, protect and valorise the water resources" (CRHS, 2008);
3. Setting-up working groups to elaborate a detailed action programme: Based on the objectives outlined in the charter, thematic working groups (open to all interested parties) were to be set up, in order to work out and propose actions to tackle the problems identified, supported by the project coordinators and external experts;
4. Implementing actions and measures.

As regards the Upper Sûre, the Walloon Nature Park of Upper Sûre Anlier Forest had established a river contract for its sub-basin already before the Interreg programmes III and IV[200]. Insufficient wastewater treatment was identified as one of the major sources of pollution - and the programme ´Interreg IIIA Wallonie-Lorraine-Luxembourg 2000-2006´ as a possible source of funding to address the issue. There had already been personal contacts and joint activities between the Belgian Nature Park of Upper Sûre Anlier and the Luxembourgish Upper Sûre Nature Park. They launched a joint Interreg IIIA project on the "protection of water resources" in 2005 with EU and regional/national funding. The focus of the project in Luxembourg in was public awareness-raising and the ´transfer´ of the Belgian river contract model to Luxembourgish river (sub-)basins. In addition to the Nature Park, the Ministry of Sustainable Development and the water department of the Ministry of the Interior were among the Luxembourgish partners. Two Interreg project coordinators were employed (one on each side of the border). By 2008, the Belgian and Luxembourgish partners of the river contract Upper Sûre were ready to sign a joint charter. The crossborder Upper Sûre River Contract was born. The partners established two separate river committees, with a joint executive bureau representing both the Belgian and Luxembourgish partners.

The charter already contained an action programme for the period 2008-2011. It aimed to contribute to the protection of aquatic ecosystems via an integrated crossborder management of rivers and water resources. The action programme also stressed the needs to maintain the "development potential" of agriculture and tourism in the region and to enhance exchange among diverse actors (CRHS Interreg, 2008). A follow-up Interreg project (IVA – PACTE Haute Sûre) allowed the Upper Sûre partners to directly proceed to implementation of its action plan 2008-2011. It already mentioned the expected

[199] These phases largely correspond to the governance phases developed for the present thesis (see chapter 3.2.4).

[200] https://www.parcsnaturelsdewallonie.be/en/parcs/haute-sure-foret-danlier/

new drinking water protection zones in the Luxembourgish sub-basin. Moreover, the action plan aimed to establish cooperation with farmers to make agricultural practices ´water-friendlier´ and to reflect on the future of agriculture in the area (CRHS Interreg, 2008).

In the meantime, the existence of the Nature Park had been renewed for another ten years (Mémorial A, 2010). While water had played a comparatively minor role during its first ten years, the municipal members and staff decided to put the fact of being a (or even *the*) "water region" of Luxembourg at the heart of their activities on tourism, environment, regional marketing, agriculture and culture, following a study on and discussions about the profile of the nature park[201]. Not exclusively focused on the Upper Sûre river basin, the Interreg IVA project also included the elaboration of guidelines for the establishment of more river partnerships in Luxembourg and the organisation of joint activities on the Ramsar World Wetlands Day[202], in cooperation with the Fondation HfN.

In the Syr basin, the Fondation HfN participated in an Interreg IIIB project (2001-2008) of the Rhine network that had been set-up by the organisations in Germany (Naturlandstiftung Saar) and France (Solidarité Eau Europe, SES, international NGO). The objective of the 14 project partners (in four countries) was to develop approaches to engage citizens in activities to contribute to the WFD objective of reaching a good water status. In Luxembourg, foundation staff that would later coordinate the Syr River Partnership teamed up with the SIAS syndicate to elaborate a ´Charter for a clean Syr´. 25 actors were engaged in a process that lasted from 2005 to 2006 (Réseau Rhenan & Fondation HfN, 2008).

When compared to the Upper Sûre basin, there was a less strong tradition of cooperation and self-organisation in the Syr valley. A working group was formed with stakeholders from the municipalities (incl. municipal citizens´ environment commissions) and their syndicates, from agriculture and forestry. The guiding questions posed to participants were "*how do you assess the status of the Syr*?", "*how do you imagine your river basin*?". Working group members met several times on specific issues, including on groundwater sources, agriculture, pollution, airport, emergency planning and awareness-raising. A first mapping of problems along the Syr was also conducted. The result was a 25-page "Charter for a clean Syr" (Réseau Rhenan & Fondation HfN, 2008). Overarching purposes of the Syr charter were to improve water quality and the state of aquatic ecosystems, and to reduce drinking water consumption. As regards agriculture, the charter highlighted the need to reduce nitrates, pesticides and sediments, and promoted organic agriculture. Moreover, the international airport Findel was identified as a major source of the Syr due to the large quantities of deicing substances that have regularly exceeded treatment capacities of the Uebersyren wastewater treatment plant. As a result, insufficiently or entirely untreated effluents have flown into the Syr during winters (see Syr case study of part IV). The charter also identified pesticides used on the train embankments that run in parallel to the Syr river as a source of pollution. In parallel, the same foundation staff members also participated in another Interreg IVA project that established the cross-border river partnership of the Belgian-German nature park Our (2008-2011).

The charter and social network that were established back then would later form the basis of the Syr River Partnership. However, the process to establish a partnership at the Syr took longer than in the Upper Sûre basin, as activities in the Syr basin had been just one element of a much larger Interreg project and as there was no possibility to obtain (additional) EU funding, the Syr being a purely national river basin. Through their Interreg project experiences, however, several foundation staff members had become familiar with the river partnership model, had established and consolidated contacts in

[201] see www.naturpark-sure.lu/der-naturpark/aufgaben/

[202] Ramsar World Wetlands Day takes place every year on the 2nd of February

the Syr basin, gained a first overview of problems facing the river basin, and had inscribed common principles and objectives in a joint charter.

Both the Upper Sûre River Contract and the (later) Syr River Partnership thus emerged from informal network governance processes that were inspired by examples and partners from Belgium and supported by EU and national co-funding. In case of the Upper Sûre, the River Contract could build on a tradition of strong regional cooperation (including farmers), while networks had to be built more or less ´from scratch´ in the Syr valley. Both projects pursued integrated water management as their overarching objective. An important difference, however, is that water was one element in a wider regional development perspective of the Upper Sûre Nature Park, while the Syr project was entirely directed towards aquatic ecosystems.

On this basis, the Upper Sûre Nature Park can be characterised as having adopted a broad anthropocentric approach characteristic of integrated water management, while the Fondation HfN and its project activities were more ecocentric. In this sense, the Upper Sûre River Contract and (later) Syr River Partnership inscribed themselves in the histories and overarching missions of their parent organisations (see previous part).

Formal outcomes:

- Charters signed by member municipalities, governmental and other actors

Informal outcomes and effects:

- Emerging river partnerships in the Syr valley and (cross-border) Upper Sûre basin with the Upper Sûre Nature Park and the Fondation HfN as their parent organisations
- Emerging social networks in river basins co-creating professional and local knowledge
- Growing professional knowledge of river basin characteristics in project teams

8.4 ASF 3: Water Management Authority elaborates 1st WFD management plan

Summary	When preparing the first WFD management plan (2009-2015), AGE had to rely strongly on external researchers and consultants. Gradually, however, efforts to move towards integrated water management were accompanied by organisational, professional, and personal learning processes that profoundly changed how challenges were understood, and the scope and means applied to water management.			
Synergies and tensions	Tensions: Despite the fact that water management began to be oriented towards adaptive and integrated water management principles, nearly 90 % of the national WFD implementation budget was dedicated to technical infrastructures (also reflecting Luxembourg´s backlog) Synergies: Growing recognition of the need to cooperate internally among staff members with different specialisations			
Action situation	Documents	Interviews	Observations and meetings	Workshop content
ASF 3: The Water Management Authority elaborates 1st national WFD management plan	1st national WFD management plan 2009-2015 and related studies	N° 8, 31, 40, 48, 60, 61	-	-

In parallel to preparations of the national water law, AGE and the Ministry of the Interior prepared the 1st national WFD management plan 2009-2015. Before the EU WFD, the river basin approach had not existed in Luxembourg. One possible reason (in addition to the previous focus on infrastructures rather than ecosystems) is that all major Luxembourgish rivers except the Syr river are transboundary (Maganda, 2013). Considering the small size of the country, objectives and measures for each of the Luxembourgish river basin districts were included in one single management plan (rather than in separate management plans for each river basin).

Considering stringent requirements and limited capacities, AGE relied on the expertise of scientists from the public Luxembourg research institute Henri-Tudor[203] and the University of Saarland to produce the first national WFD management plan 2009-2015 (AGE, 2009a). Hydrologists from Saarland University compiled a ´manual of methods´ for the assessment of parameters relating to the status of water bodies (Saarland University, 2009). Moreover, 102 surface water bodies were mapped, including the Upper Sûre reservoir lake and the Syr. The researchers from the public research institute identified six stream types in Luxembourg, based on environmental abiotic variables (including stream dimension, elevation and geology) according to which the water bodies would be classified and to which monitoring, assessment, and biomonitoring programs would be tailored (Ferréol et al., 2005).

The first national WFD management plan was thus predominantly produced on the basis of specialised scientific/technical studies of external consultants and researchers. Its most relevant aspects for the purposes of the present thesis are (AGE, 2009a):

- The classification of 102 streams and river sections, and establishment of hydrological river basin districts, including the Mosel district (to which the Syr belongs) and the Upper Sûre district, with the Upper Sûre lake classified as "heavily modified water body" due to its dam (which means that a "good ecological potential" instead of a "good ecological status" has to be attained)[204];
- The putting into place of a surveillance monitoring network to measure physicochemical water quality of surface and groundwater bodies;
- For the Syr river basin: A programme of measures that included plans for the extension and modernisation of the Uebersyren wastewater plant and measures to improve the hydromorphological status of the Syr;
- The creation of drinking water protection zones around sources used for the extraction of water for human consumption (which concerns the Upper Sûre lake although it is not explicitly mentioned);
- The entire territory of Luxembourg is designated as "sensitive" in relation to the EU wastewater and nitrates directives.

As a result of the preparatory work for the 1st management plan, professional knowledge about water bodies greatly increased within AGE. Notably, interviews suggest that not only was ecological, but also systems knowledge enhanced in the organisation:

[203] The CRP Henri Tudor merged with the CRP Gabriel Lippmann into today`s Luxembourg Institute of Science and Technology (LIST)

[204] In the national WFD management plan, the river section of the Syr valley examined in the present study is classified under code I-3.1, the Upper Sûre lake under code III-2.2.1. (AGE, 2009a)

"Wir wissen viel mehr über die Gewässer. […] diese ganzen Strukturgütekartierungen, ökologische Aufnahmen, chemische Aufnahmen sind halt einfach viel detaillierter geworden, als es vorher war. Gleichzeitig eben auch Hochwasserrichtlinie […] hat einfach eine andere Arbeitsmethode vorgegeben, wie man die Gewässer evaluiert, wie man das Hochwasser evaluiert und wie man dann Maßnahmen definiert und weiterschreibt, wie das dann wieder überprüft wird. Und das hat eigentlich die Arbeitsweise geändert. Vorher gab es schon auch verschiedene Richtlinien, wo dann Substanzen im Gewässer gemessen wurde, aber es gab nie diesen Link mit dem gesamten System. Das ist eigentlich die Änderung, die gekommen ist" (interview n°40)

Some actors experienced this as part of an ongoing personal learning process:

"Man hat die Richtlinien, die Gesetze, man hat die Projekte, die Genehmigungen und die Akteure. Man sieht irgendwie, wie das zusammenhängt. Warum erreichen wir keinen guten Zustand? Auf was basiert das? Das basiert auf Messungen oder Probennahmen, die im Gewässer stattfinden, von der Biologie her und auch andere Parameter und mit der Zeit versteht man die Zusammenhänge auch immer mehr und irgendwann macht es ´klick´ und dann sieht man, ja eigentlich ganzheitlich […] diese Zusammenhäng sind klarer geworden, aber es ist noch immer ein Prozess, der auch läuft" (interview n° 31)

When asked what had contributed to growing systemic awareness, one of the interview partners answered that it was not so much the studies by themselves but rather the experiences s/he had gained by working in several *different* units, which resulted in a 360° perspective ("Rundumblick") on water management issues. Interview partners also highlighted that there was growing awareness in the administration that more cooperation among colleagues was necessary due to the complexity of issues and specialised knowledge:

"Aber es ist so komplex und multidisziplinär, dass man nicht alleine irgendwo hingehen kann und Entscheidungen treffen kann. Und das ist für einige Personen sehr schwierig. Aber es wird immer wichtiger, weil es fließt Geologie, Ingenieurwesen, Biologie, Hydraulik, Hydrologie mit ein – und das kann keiner alleine abdecken. Und da haben wir halt wirklich viel dazugelernt die letzten Jahre" (interview n°31).

Interviews thus suggest that the required paradigm shift towards ecological objectives and integrated management was accompanied by significant organisational and professional learning processes within AGE. Among the most frequently highlighted aspects of changes in water management approaches were the importance of the hydromorphological condition for the ecological status of and water quality in rivers, ecosystem-based flood protection, and the principles that prevention of pollution and protection of water bodies should have priority over water *treatment*. For example, as regards drinking water protection one interview partners stressed "*die Prävention geht vor dem Kurieren"* (n°40), describing the principle as a new "philosophy" that had not existed in Luxembourg before. AGE thus began to appropriate key principles of adaptive and integrated water management (see chapter 4.3.1).

As regards hydromorphology (river and riverbank structures), interview partners stressed that self-generation capacities (i.e. the improvement of the physico-chemical status of water bodies) depended on the presence of diverse flora and fauna, impossible to create in straightened and consolidated ´channels.

As regards flood risk management, several interview partners described non-technical protection as a paradigm shift (see also Syr case study, part IV):

> *"Und da ist jetzt eigentlich der Paradigmenwechsel, dass man versucht, möglichst wenig technisch, also doch, technischen Hochwasserschutz zu machen, wo es einfach anders nicht geht, aber dass man vor allem versucht, eben diese Kombination von Renaturierung und Hochwasserschutz oder solchen Green Infrastructures, sei es auch dort, wo es möglich ist […], irgendwelche Flutpolder zu kreieren, um so Hochwasserschutz zu betreiben, und nicht durch Spundwände oder auch mobile Wände". (interview n°40)*

Synergies between hydromorphology and flood protection were described as "win-win" situations that could be leveraged via river restorations and other measures that aim to improve the ecological status of rivers and create more space for water to expand.

As a result of EU WFD requirements, the ´modernisation´ and expansion of water monitoring systems made possible a comprehensive assessment of the water bodies. It led to insights that some interview partners described as "bitter awakening" (n°31, "böses Erwachen"). In 2009, the following results on the ecological status of surface water bodies were presented to the public (AGE, 2009b):

- Good status: 7 %
- Moderate status: 54 %
- Unsatisfactory status: 27 %
- Bad status: 12 %

One omnipresent problem concerned hydromorphology (see Syr case study, part IV), another the amount of nitrates in water bodies (see Upper Sûre case study, part III). In addition, and under the shadow of EU infringement procedures and fines, Luxembourg had to modernise its wastewater treatment infrastructure (see case study chapter 7.4.1). The first WFD management plan established a budget of nearly 1,2 billion EUR for the period until 2027, with 86 % of expenditures planned for the upgrading of technical infrastructures:

- more than 1 billion EUR for the construction of wastewater treatment plants, sewage canalisation, and rain overflow basins,
- nearly 110 million EUR for investments in hydromorphological measures,
- more than 3 million EUR for agricultural measures.

Budget allocation thus reflected a continuing strong emphasis on technical infrastructures. On the basis of these investments, AGE expected constant improvements of the ecological status (and potential) of water bodies until the final target date of 2027 (AGE, 2009b):

- 2015: good status: 28 %, moderate status: 63 %, unsatisfactory status: 9 %,
- 2021: good status: 85 %, moderate status: 14 %, unsatisfactory status: 1 %,
- 2027: good status: 99 %, moderate status: 1 %.

These estimates would prove to be overoptimistic (see ASF 6).

Formal outcomes:

- 1st national WFD management plan (2009-2015) with a detailed programme of measures for each river basin district (AGE, 2009a)

Informal outcomes and effects:

- Specialised scientific/technical knowledge, information, and data about water body types, chemical water quality and the ecological status of water bodies
- Growing organisational, professional, and personal knowledge of systemic interconnections between the biological and hydromorphological status of water bodies and physico-chemical water quality within AGE
- Expectations of constant improvements and that a good ecological status would be attained for nearly all water bodies by 2027 at the latest

8.5 ASF 4: Stakeholder involvement is carried out on the 1st WFD management plan

Summary	From 2007 to 2009, Luxembourg conducted its first-ever formal public consultation and stakeholder involvement with the support of external consultants. In a network governance mode, it included working groups composed of diverse actors who provided input to the first national WFD management plan.			
Synergies and tensions	Synergies between river partnerships and national WFD objectives Some tensions between agricultural and other actors during working groups			
Action situation	Main documents	Main interviews	Observations and meetings	Workshop content
ASF 5: Stakeholder involvement is carried out on the 1st WFD management plan (2007-2009)	1st WFD management plan 2009-2015, statement of the river contracts Upper Sûre, Our and Attert (Gewässerverträge Luxemburgs, 2009)	n°41	-	-

In accordance with WFD recommendations for active stakeholder involvement and the obligation to organise formal public consultations on WFD management plans, Luxembourg from 2007 to 2009 conducted its first-ever formal participatory process (Maganda, 2013, Arendt, 2018a). It was a milestone in terms of governance, Luxembourg having no "culture" of public participation (Arendt, 2018a, interviews n°34, 41). Managed by external consultants, it encompassed the following activities and steps (AGE, 2009a):

- a public information and plenary session in November 2007 on which the inventory on the status of water bodies and main implementation issues were presented to interested citizens and working groups were announced,
- the creation and meetings of three working groups (WG 1: structure of water bodies, WG 2: diffuse pollution, including from agriculture and the transport sector, WG 3: urban pressures),
- two additional plenary sessions of the working groups in May and December 2008,
- a formal public consultation in mid-2009.

Approximately 40 actors participated in the working groups. They came from intermunicipal syndicates (incl. SIAS from the Syr valley, the Nature Park and SEBES from the Upper Sûre region), agricultural organisations (incl. farm advisors), environmental organisations (incl. the Luxembourg Nature and Bird Protection League, the Fondation HfN, and the House of Nature), two public research centres, and diverse other organisations.

The working groups 1 and 3 met three times, while the working group on diffuse pollution met five times, with an additional five meetings held by a sub-group on agriculture. The fact that agricultural actors held their own separate closed meetings was not well-received among other actors. The working groups discussed measures that they believed could contribute to improving the ecological status of water bodies. As a result of the process, a "toolbox" (or "catalogue") of measures was put together by the participants (AGE, 2009a).

During the formal consultation period, the three river contracts that had already been created (Attert, Our, Upper Sûre) remarked on the ´general character´ of the measures proposed and asked for more detail. They regretted that access to information had been limited in the run-up to the consultation and that the "toolbox of measures" from the consultation process had not been included in the management plan (Gewässerverträge Luxemburgs, 2009). Furthermore, they asked for more "intensive reporting" towards the river contracts and other interest groups, as this would enable everyone to support WFD implementation more effectively. Concretely, they asked to be regularly informed about WFD-related studies and documents and of projects planned in their river basins. Moreover, they listed measures with which each of them planned to contribute to WFD implementation and the attainment of its objectives. According to the final version of the WFD management plan, the comments were subsequently taken into account to correct mistakes und provide more detailed explanations (AGE, 2009).

Due to the EU WFD, national authorities and diverse stakeholders alike had now gained first experiences with public consultations and stakeholder involvement. Cross-scale multi-party network governance had made its entry in Luxembourg and created expectations among the existing river basin organisations and other actors that they would contribute actively to water governance and management in the years to come.

Formal outcomes:

- Formal submission of statements to the public consultaiton, including by the Upper Sûre River Contract and two other river partnerships (taken into account during the finalisation of the 1st WFD management plan)

Informal outcomes:

- Networking among diverse actors and expectations to be able to contribute to water governance in the future
- Some tensions between agricultural and environmental actors

8.6 ASF 5: National water law creates new legal basis

Summary	One year before Luxembourg´s first WFD management plan was finalised, the national water law transposing the EU Water Framework Directive entered into force. It created a legal basis for river partnerships and other elements that will be examined in more detail in parts III and IV of the case studies.			
Synergies and tensions	Some tensions between ecocentric and anthropocentric concerns, and between top-down and bottom-up approaches coming together in integrated water governance and management.			
Action situation	Documents	Interviews	Observations and meetings	Workshop content
ASF 4: The national water law enters into force (2008)	EU WFD, National water law of 2008, EU Floods Directive of 2007	N° 8, 31, 40, 48, 60, 61	-	-

Following delays (see ASF 2), parliament passed the new national law on the protection of water in 2008 (Mémorial A, 2008)[205]. In addition to transposing the WFD, it also contained provisions on the management of flood risks (EC, 2007). Reflecting the hybridity of the WFD, the national water law contains similar tensions between ecocentric and anthropocentric objectives, and top-down and bottom-up approaches (see chapter 4.5). As regards overarching purposes, it reiterates the WFD objective to reach a good status of water bodies by 2015:

> *"Toutes les masses d´eau de surface doivent être protégés contre la déterioration de leur état. […] elles doivent être protégées, améliorées ou restaurée de sorte à répondre aux critères de définition d´eau de bon état au plus tard au 22 décembre 2015" (preamble 1-2).*

One of the means by which this should be achieved is the reduction of diffuse pollution (such as from various forms of land use) and other forms of pollution (article 26). In order to survey water bodies, an extensive monitoring programme is put into place (to be overlooked by AGE) (article 21).

However, in line with the EU WFD it also stipulates that up to two postponements are possible (i.e. until 2027), if duly justified. The law also outlines ´legitimate´ reasons for not achieving the good status, including technical feasibility, excessive costs, and "natural conditions" (article 8). A "temporary deterioration" is permissible, but only as a result of natural causes or "force majeure" (article 10).

Until the entering into force of the national water law, no drinking water protection zones had existed in Luxembourg. The only exception were the sanitary protection zones around the Upper Sûre lake. However, as they had hardly been based on hydrological criteria, they did not cover the entire watershed (i.e. including incoming streams to the lake). For this reason, the national water law would also provide the basis for the creation of new and much larger drinking water protection zones in the Luxembourgish part of the river basin (see Upper Sûre case study, part III). In the spirit of adaptive and integrated water management, the law stresses that measures should be taken to reduce the degree of treatment and purification necessary to produce drinking water (article 2). This includes the reduction of diffuse pollution from agriculture and point pollution from wastewater treatment plants.

[205] Loi du 19 décembre 2008 relative à l'eau. Mémorial A N° 217

The national water law covers the following types of protected areas (article 20):

- water protection zones around water bodies that serve drinking water supply bodies (such as the Upper Sûre lake) (article 44),
- areas for the protection of natural habitats and particular species in aquatic ecosystems (under the EU Birds and Habitats Directives that created the Natura 2000 network, see also ASF1),
- bathing water bodies (such as the Upper Sûre lake),
- the designation of the entire territory of the Grand-Duchy as "sensitive" as regards pollution caused by nitrates from urban wastewater and agriculture.

As regards river restorations, it prescribes that a programme of measures be elaborated by AGE together with (today´s) ANF (article 37). If necessary, it would be possible to recognise restoration projects as of "public interest" (in which case property can be expropriated, article 37 (4)). As regards flood protection, the law stipulates that AGE, together with the municipalities and other public administrations concerned, should assess and map flood risks and elaborate a programme of measures that aim for (article 38 (4)):

- the conservation and improvement of ecomorphological structures of riverbeds,
- the prevention of erosion in and along rivers,
- river regulation and protection measures.

As regards wastewater, the law encourages the municipalities (in charge of the urban water management cycle and respective plans, article 50) to ensure appropriate water treatment and infrastructures, while AGE is authorised to inspect urban water facilities (articles 46).

Furthermore, the national water law set up a water management fund (´Fonds pour la gestion de l´eau´, articles 62-65), which would become the main funding source for the river partnerships analysed in parts III and IV as well as related projects and activities. It provides up to 100 % funding for various measures and projects recognised as of national interest, including those that serve to improve water quality, wastewater treatment, river restorations, and flood protection. Moreover, it (co-)funds feasibility studies on various issues, including studies for the designation of protected areas (50%). In 2017, funding for agricultural advisory services would also become eligible (see Upper Sûre case study, part IV). Moreover, the law established the legal basis for various new bodies: a national water observatory (to monitor the status of water bodies, article 54) and a new consultative stakeholder body (´*comité de la gestion de l´eau´*, article 53) charged with accompanying the elaboration of WFD management plans). The creation of the committee also signalled a more integrated and participatory approach. At the same time, it played no role in the governance processes analysed in the Upper Sûre and Syr river basins (parts III and IV).

For present purposes, the creation of the legal basis for river partnerships is of particular interest (article 55). The national water law (article 55) gave municipalities and organisations the possibility to conclude conventions with the ministry to set up river partnerships (not entailing legal personality). During the elaboration of the water law, it was decided to choose the term ´river partnerships´, departing from the Belgian denomination ´river contracts´:

> *"[…] es gibt dann aber noch einen parallelen Bottom-Up-Prozess […] Das sind zum Beispiel die Flusspartnerschaften. Das hieß am Anfang ´contrat de rivière´, weil es in Belgien so heißt und der Staatsrat hat dann gesagt, das ist eigentlich ein schlechter Begriff, weil es ist ja kein Kontrakt, sondern eigentlich ist es ja eine Partnerschaft" (interview n° 61)*

The legal basis defines the ´mandate´ of river partnerships in broad terms. On the one hand, river partnerships have the overall formal objective to "associate actors of the water sector and the public

with a view to inform them and raise awareness of the integrated and global management of the water cycle" (own translation). This can include activities on "information, awareness-raising, education and concertation", in addition to technical missions (article 55, own translation)[206]. On the other hand, no further details are provided. It thus remains open who river partnerships can concert with and for what specific purpose (beyond awareness-raising)[207].

Moreover, river partnerships are not explicitly mentioned in the provisions concerning public information and consultation (article 56). Neither are they explicitly mentioned among the "associations écologiques" that have the possibility to exercise the civil right to legally address infractions (article 69), as river partnership do not possess legal personality (Arendt, 2018b). The law itself, therefore, does not provide river partnerships with a strong legal basis, nor with a clear mission that can be directly linked to active stakeholder involvement in water governance and management at the river basin scale.

Half a year later, Luxembourg also transposed the EU directive on environmental liability (EC, 2004) into national law (Mémorial A, 2009)[208]. The EU directive on public access to environmental information had been transposed into national law back in 2005 (see chapter 7.4.1).

Thus, by 2009 a whole new set of water and environmental policies were in place to improve, on the one hand, the status of water bodies and flood protection in Luxembourg via integrated and adaptive management approaches (in addition to technical measures) and, on the other hand, to enhance public participation and access to information. The EU Water Framework Directive profoundly changed the formal objectives, scope, and preferred means of water governance and management in Luxembourg.

Formal outcomes:

- National water law providing a framework for integrated water governance in Luxembourg, creating new funding opportunities and the legal basis for the creation of river partnerships

[206] Art. 55 of the law of 30 December 2008: « (1) A l´initiative des communes, des syndicats de communes, des associations régulièrement constituées œuvrant dans le domaine de l´eau, le ministre est autorisé à conclure sous forme de conventions des partenariats de cours d´eau qui ont pour objet d´associer les acteurs du secteur de l´eau et le public en vue de les informer et de les sensibiliser à la gestion intégrée et globale du cycle de l´eau. (2) Les conventions peuvent porter sur des missions d´information, de sensibilisation, de formation et de concertation"

[207] With a view to the case studies of parts III and IV, one of the crucial questions – that could be regarded as underlying different interpretations of the role of river partnerships - concerns the term ´concertation´. The Larousse online dictionary derives the French term ´concertation´ from the "action to concert" and defines it as a practice of consulting concerned parties before taking a decision. In English, ´concerted action´ denotes activities that are planned or done together for a shared purpose (Cambridge online dictionary) by, for example, by several people or groups working together (Collins online dictionary).

[208] Texte coordonné de la loi du 20 avril 2009 relative à la responsabilité environnementale en ce qui concerne la prévention et la réparation des dommages environnementaux. Mémorial A, n°158 du 13 aout 2014.

8.7 ASI 2: Syr and Upper Sûre partnerships are formally institutionalised

Summary	Giving birth to potential boundary organisations, the river partnerships of the Syr and Upper Sûre basin were formally established in 2011/2012 based on the new national water law. The present action situation explains some of the similarities and differences between the two river partnerships by reference to the histories of their river basins and parent organisations.			
Synergies and tensions	Synergies between the WFD objectives of the national water law, AGE, and the river partnerships.			
Action situation	Main documents	Interviews	Observations and meetings	Workshop content
ASI 2: The Syr and Upper Sûre river partnerships are formally institutionalised (2011-2012)	National water law, organisational documents (incl. charters and cooperation conventions) of the river partnerships	N°2, 3, 8, 9, 13, 32, 34, 36, 37, 40, 41, 43, 53, 60, 61	-	-

Following the entering into force of the national water law, AGE encouraged the setting-up of river partnerships in all river basins in Luxembourg. It signalled a possible shift away from hierarchical government to network governance in water matters. In many other countries, such shifts had begun to emerge in the 1980s together with calls for adaptive (co-)management of common-pool resources. Developments towards decentralisation and network governance correspond to what has been referred to as "phase 3" in the modernisation of water and land management (see chapter 4.2.3). In Luxembourg, in addition to the existing and emerging river contracts of the Attert, Upper Sûre and Our, three more partnerships would follow suit in the years to come, one of them at the Syr[209].

In the Upper Sûre basin, after the transboundary Interreg project had ended and its action plan 2008-2011 had been implemented, the cooperation between the Belgian and Luxembourgish river contracts of the Upper Sûre nature parks became less close, each of them working on the basis of their respective national agreements and funding arrangements.

As we have seen, the Fondation Hëllef fir d´Natur and SIAS had already been active in the Syr valley during Interreg project times. In the following years, the foundation met with the 15 municipalities of the basin and other actors to mobilise support for a Syr River Partnership. By the end of 2011, twelve municipal councils and other partners came together in a new river committee and drafted a joint charter (signed in 2012). In the charter, the riverine municipalities recognised their "collective obligation to act as guardians responsible of the water in the river basin" [210].

Hence, in 2012, the Upper Sûre River Contract and the Syr River Partnership were both founded by formal conventions on the basis of the national water law of 2008. Their overarching aim was to contribute to bringing actors "of the water sector and the public" together and to contribute to raising awareness of integrated water management (see ASF 5). Both river partnerships have pursued the

[209] See also www.flusspartnerschaften.lu

[210] Own translation of excerpts of the Charter of the Syr River Partnership Syr: "[…] reconnaissent leur obligation collective d´agir comme gardiennes responsables de l´eau du bassin versant […]" (FP Syr, 2012a)

protection of aquatic ecosystems as main overarching objective and committed to enhancing participatory bottom-up approaches to water governance and management via environmental awareness-raising, education, and dialogue (CRHS, 2012a; FP Syr, 2012b).

8.7.1 Formal institutional design

The ´founding fathers´ of the two river partnerships were the municipalities of their regions, their parent organisations (Upper Sûre Nature Park and, respectively, natur&ëmwelt/Fondation Hëllef fir d´Natur), and the Ministry of the Interior. The Syr River Partnership counts 12 of the 15 municipalities entirely or partly located in the basin among its founding members (an additional municipality joining in 2019)[211], with its parent organisation being a national NGO with an administrative seat located outside the river basin itself (see historical context). In contrast, the Upper Sûre Nature Park provides a common organisational structure for five Luxembourgish municipalities located in the vicinity of the Upper Sûre lake. Three neighbouring municipalities have since become members of the River Contract[212].

Both their founding agreements refer to "river contracts" as "moral, technical, and financial commitment of an ensemble of partners" founded on "local solidarity at the level of a river basin district". They propose a "strategic approach concerning water use, the protection of aquatic ecosystems and the preservation of related ecological functions […]" (own translation[213]). In addition, the agreements specify that river partnerships can carry out technical measures that are defined as contributions to (FP Syr, 2012b, CRHS, 2012a, article 2, own translation):

- the concerted management of the river basin,
- the elaboration of river basin management plans,
- the implementation of financial water management schemes,
- research programmes and action plans for the conservation or improvement of water quality and related ecological functions,
- the collection of scientific data.

Technical projects are to be carried out in concertation with AGE. Following the Belgian model, the conventions provide for the creation of river committees that are the main decision-making bodies of the river partnerships and serve to ensure that objectives are fulfilled. In addition to the contractual parties, and in line with established definitions of social networks (see chapter 3.2.5.1), membership of the river committee is open to anyone interested in contribute (FP Syr, 2012b, 2012c). In addition to the member municipalities, the river committees of both the Syr and Upper Sûre partnerships – meeting approximately twice a year - include representatives of:

- intermunicipal syndicates (particularly, drinking and wastewater),

[211] They are the municipalities of Bech, Betzdorf, Biwer, Contern, Flaxweiler, Grevenmacher, Junglinster, Manternach, Mertert, Niederanven, Sandweiler, Schuttrange, and Weiler-la-Tour (see also www.partenariatsyr.lu).

[212] The municipalities of Rambrouch, Wahl and Goesdorf, in addition to the municipalities of Boulaide, Stauseegemeinde, Winseler, Wiltz and Esch-Sauer that are members of the Upper Sûre Nature Park (see also www.naturpark-sure.lu)

[213] Own translation from article 1: „Contrat de rivière: le contrat de rivière est un engagement moral, technique et financier d´un ensemble de partenaires […]. Il est fondé sur la solidarité locale construite à l´échelle d´une unité hydrogéographique cohérente (bassin versant) et propose une démarche stratégique en matière d´usages de l´eau, de protection des écosystèmes aquatiques et de préservation des fonctionnalités écologiques associées ainsi qu´en matière d´information et de sensibilisation du public" (FP Syr, 2012b, CRHS, 2012a)

- the (regional branches of) the three administrations for water (AGE), nature (ANF), and agriculture (ASTA),
- agricultural associations or farm advisory services,
- interested citizens.

Public officials from AGE, ANF, and ASTA had already participated in the foundational work of both river partnerships during their Interreg projects (see ASI 1). Members of the river committee elected a President who chairs meetings. In case of the Upper Sûre, the President would be a local farmer. In the Syr valley, the committee elected a mayor of one of the member municipalities.

In addition to their river committees, the river partnerships dispose of an ´accompanying committee´ (´*comité d´accompagnement´*) composed of representatives of the contracting parties, including representatives of the ministry in charge of water (e.g. in 2012 the Ministry of the Interior, as of 2013 the Ministry of Sustainable Development and Infrastructure) and AGE. The committee is to come together approximately twice a year. It oversees the tasks listed above and serves to ensure the "concertation and cooperation" between the governmental representatives and the local partners. (article 4.7.1) The river partnerships are obliged to submit annual working programmes and activity reports and (draft) budgets to the contractual parties.

As regards funding, the ministry contributes with 50 % to staff and administrative costs, the other half is paid by the member municipalities (article 5). For all actions that entail expenditures, the river partnerships have to seek funding sources at the national level (usually, via the water or environments fonds). Typically, the municipalities have to advance the costs. Projects and technical measures can be financed via public funds (such as the national water management fund), upon application. Technical measures carried out by the river partnerships (and agreed to by the new Water Management Authority) are eligible for 100 % state funding, other activities typically receive up to 50 % co-funding.

Since then, up to two employees have coordinated and implemented activities of the Upper Sûre and Syr river partnerships (with approx. 75 % fulltime-equivalent in total). Considering their limited resources, the river partnerships carry out some technical measures themselves, but for most actions they rely on the municipalities, administrations, and other partners.

The two river partnerships have thus worked within a very similar formal and financial framework. If we analyse their structures in terms of the concepts outlined in chapter 3.2.5.1, the river partnerships can be characterised as river basin organisations who act as potential boundary organisations in aiming to foster social networks among members and partners. Their networks are based on open and evolving membership of diverse nongovernmental and governmental actors (Folke et al., 2005; Pahl-Wostl, 2009). Likewise, their formal objectives – the protection of aquatic ecosystems via *integrated* approaches to water management and the involvement of various stakeholders in their river basins – reflect principles of adaptive and integrated water governance and management inscribed in the EU WFD[214].

[214] In terms of the typologies developed by Huitema and Meijerink (2017), the Upper Sûre River Contract and Syr River Partnership largely correspond to "coordinating organisations" who have no formal competences and do not commonly own a resource, but act as facilitators between diverse organisations ("authority rules"). Members are directed towards different geographical scales (boundary rules), hold divergent interests and take decisions by consensus or majority ("aggregation rules"), contributing financially to the organisation, while keeping most of their own budget ("pay-off rules"), with the river basin organisation carrying out some own research as regards measures to be taken ("information rules"). (Huitema & Meijerink, 2017; Meijerink & Huitema, 2017). However, in contrast to ´typical´ coordinating organisations, local and nongovernmental actors (incl. citizens) hold more prominent roles in the Luxembourgish river partnerships (incl. their river committees) and most information is shared publicly.

River partnership	Parent organisation	Municipalities	Funding
Flusspartnerschaft Syr / Partenariat de cours d´eau Syre (FP Syr, 2012b)	*natur&ëmwelt Fondation Hëllef fir d´Natur*	12 (13 since 2019)	50%/50% between state and member municipalities for up t 75 % full-time equivalent staff member, operational costs and some measures
Gewässervertrag Obersauer / Contrat de Rivière Haute-Sûre (CRHS, 2012a)	*Naturpark Öewersauer*	5	50%/50% between state and member municipalities for up to 75 % full-time equivalent staff member, operational costs and some measures

Table 8.2 – Comparison of the formal institutional set-up of the Syr River Partnership and Upper Sûre River Contract

8.7.2 Local embeddedness, informal arrangements, and paradigms

The present thesis examines how diverse contexts (along with their respective formal, informal, and material factors) shape how actors frame and address sustainability challenges.

While the formal organisational architecture of the Upper Sûre River Contract and the Syr River Partnership themselves are nearly identical, the informal and formal organisational and local contexts vary widely. The context chapters have examined the historical backgrounds of the Upper Sûre Nature Park and the Fondation Hëllef fir d´Natur. While the Upper Sûre Nature Park has provided a common infrastructure to local communities sharing a regional identity, the Fondation HfN itself does not have municipal members, neither do the Syr municipalities share any overarching organisational structure. Instead, the municipalities are members of different intermunicipal drinking, wastewater and environmental syndicates. Some of them cover only a part of the river basin (such as in the case of SIAS that has brought together four of the 13 member municipalities of the river partnership[215]), while others cover territories much larger than the Syr basin (such as the wastewater syndicate SIDEST[216]). While it has emerged from the historical part that the Upper Sûre region is bound together by a shared regional identity, no shared identity congruent with the river basin was detected for the Syr. Thus, in the case of the Luxembourgish Upper Sûre region, the river basin demarcated for WFD purposes *happens* to correspond to a region that has grown historically, while the Syr basin is primarily an administratively and hydrologically defined unit. In general, river basin organisations are hallmarks of adaptive and bioregional approaches that, however, can be divided into two different strands (see paradigms chapters 4). The Upper Sûre basin corresponds more closely to ideals of *community*-based bioregionalism (privileging cultural and social over hydrological considerations) (McGinnis, 1999), the Syr basin is closer to bioregional approaches that attribute more importance to *ecosystem*-based (co-)management (Cook et al., 2016; Huitema & Meijerink, 2017)

[215] The intermunicipal environmental syndicate SIAS currently expands to potentially include 23 municipalities of Eastern Luxembourg (in addition to its historical core members of Contern, Niederanven, Sandweiler and Schuttrange) stretching far beyond the Syr basin (status: Sept. 2020). Website: www.sias.lu

[216] The wastewater syndicate SIAS brings together 25 municipalities of Eastern Luxembourg. It took over the management of the Uebersyren wastewater treatment plant from SIAS in 2009). Website: www.sidest.lu

Furthermore, as discussed above (see ASI 1 and chapter 7.3), a notable difference is that the Upper Sûre Nature Park and its River Contract have sought to integrate the protection of aquatic ecosystems with wider regional development purposes and projects that have included close cooperation with farmers and the tourism sector. In contrast, the Fondation HfN and its Syr River Partnership have focused almost entirely on ecocentric purposes. For this reason, the River Contract can be attributed to a broadly anthropocentric adaptive and integrated paradigm, while the Syr River Partnership is closer to a narrow ecocentric paradigm carried by bottom-up environmentalist self-organisation. It will be a matter of the case studies of parts III and IV to investigate how they evolve.

As regards their staff, the coordinator of the Upper Sûre River Contract was recruited towards the end of the 2008-2011 Interreg project. He has since divided his time between the River Contract and the Nature Park, working from the historical textile factory of the Nature Park Centre. Likewise, in the Syr valley, the initial coordinators had already been active within the Interreg Rhine project. One of them has remained coordinator until today and also works for SIAS, the other left to work for AGE and was succeeded by another staff member of the Fondation HfN. Their main offices are located in the "House of Nature" outside the Syr river basin, while the coordinator also has an office at SIAS located in the Syr valley. Both of the main coordinators are geographers by education and German, but fluent in Luxembourgish.

Both river partnerships have close relations with the other five river partnerships of Luxembourg, as they take turns in organising a joint annual colloquium on World Water Day (22 March), to which public authorities, municipalities, other partners and actors and the public are invited. The main objective of the colloquia is to stimulate direct exchange and discuss issues and difficulties encountered during WFD implementation. The annual colloquia of 2018 and 2019 are analysed as part of the Syr case study of part IV.

Outcomes and effects (influencing processes in the case studies of parts III and IV):

Formal outcomes of (organisational):

- Formal creation of the Upper Sûre River Contract and Syr River Partnership, based on formal agreements between their parent organisations (Upper Sûre Nature Park, respectively, natur&ëmwelt Fondation Hëllef fir d´Natur), member municipalities, and the Ministry of the Interior

Informal outcomes and effects:

- Emerging boundary organisations and social networks between diverse actors from different scales and sectors in the Syr and Upper Sûre river basins
- Expectations to contribute to integrated water management, including by associating diverse actors

8.8 ASF 6: AGE prepares 2nd WFD management plan, assesses progress

Summary	The 2nd national WFD management plan was based on more specialised scientific/technical studies and data than the first. Furthermore, it provided reasons for why a "good status" had only been reached for 3 water bodies, asking for prolongations of the deadline on grounds of "technical feasibility", while also highlighting scientific uncertainties.			
Synergies and tensions	Tensions between the legal obligation to attain EU WFD objectives by 2015 and progress in implementation Tensions between compliance with EU WFD requirements and recognition of scientific uncertainties			
Action situation	Main documents	Interviews	Observations and meetings	Workshop content
ASF 6: The Water Management Authority elaborates 2nd WFD management plan, assesses progress	1st and 2nd WFD management plans	N° 8, 31, 40, 48,	Annual colloquium of the river partnerships on the occasion of World Water Day on 22 March 2018 in Noertrange	-

The second WFD management plan 2015-2021 (AGE, 2015b) was much more extensive than the first. It falls into the period covered by the subsequent case studies of parts III and IV. The chronological order of action situations is slightly disrupted here, because the plan sets the context for some of the processes analysed in the period 2012-2019 and is not directly related to their dynamics.

The 2nd national WFD management plan was based on additional specialised research and consultancy studies and included revisions of different monitoring indexes. A few are listed here, in order to illustrate the large variety of specialised studies, standards, indices, and data that AGE drew upon. Besides analysing anthropogenic pressures, many of them served the establishment (and update) of reference conditions and assessment tools for the "good ecological status" and the "good ecological potential" (Upper Sûre lake). They included:

- Baseline scenario 2015-2021 done by the ACTeon consultancy (Mattheiß et al., 2015) to assess the evolution of pressures and sources of pollution in Luxembourg, serving to adapt planned measures to attain a good ecological status;
- Assessment of the hydromorphological status of surface water bodies by the consultancy Zumbroich[217];
- Standards and studies relating to the biological assessment of watercourses and intercalibration by German LAWA[218];

[217] Organisation und Durchführung der Strukturkartierung des Luxemburgischen Gewässernetzes für die Fließgewässer mit einem Einzugsgebiet – 10 km2, Abschlussbericht (2014) & Bewertung des hydromorphologischen Zustandes der Oberflächenwasserkörper Luxemburgs auf Grundlage der Strukturgütekartierung, Planungsbüro Zumbroich (2015)

[218] LAWA-AO-Expertenkreis „Biologische Bewertung Fließgewässer und Interkalibrierung", der Bund/Ländergemeinschaft Wasser (LAWA) (2015), „Hintergrund- und Orientierungswerte für physikalisch-chemische Qualitätskomponenten zur unterstützenden Bewertung von Wasserkörpern entsprechend EG-WRRL" (Arbeitspapier II)

- Characteristics and type-specific reference conditions of watercourses elaborated for AGE in cooperation with external consultants, including the ´Umweltbüro Essen´ (Birk & Pottgiesser, 2014);
- Contributions, incl. to the status review report (AGE, 2014b), by FreshThoughts Consulting and Umweltbundesamt on lake typologies[219] to establish reference conditions and the ecological potential for the Upper Sûre lake;
- A study on the definition of the ´ecological potential´ of the Upper Sûre lake by the Luxembourg public research institute LIST[220];
- Revision of the Macrobenthos French AFNOR NF T90-395 monitoring index (to assess status of biodiversity and the ´ecological potential´)[221], from the Normalised Global Biological Index (IBGN)[222] to the IBG-DCE Global Biological Index equivalent, which was used for the 2014 status assessment;
- The French AFNOR River Fish Index (IPR), NF T90-344 of 2004[223] (which, however, is no longer WFD conform and will therefore have to be revised as well for the next WFD management plan, status in 2018 (AGE, 2018a);
- An environmental report by AGE on the strategic environmental impact assessment for the programme of measures of the WFD management plan, in cooperation with the consultancies ProSolut S.A. and ahu AG[224].

The overview underscores the argument that integrated water management in Luxembourg (as in other EU member states) has relied strongly on specialised studies and data since the EU WFD entered into force. One of the main objectives of the data is to tailor the status to be achieved and the respective measures for each watercourse to its specific characteristics (tied to its typology), rather than to apply uniform targets and standards indiscriminately. An interview partner explained:

> *"Präzise Vorstellung von jedem Typ, wie die Aue und das Gewässer aussehen sollte, um mehr darauf hinzuarbeiten. Nicht mehr 0815 zu jedem Gewässer" (interview n°31).*

Thus, on the one hand, this suggests that water management is to be based on specificities of each water body, as part of an integrated and adaptive approach. In this sense, it provides for flexibility on what exactly the "good status" entails. On the other hand, once the ecological reference conditions for each water body type are determined, the EU WFD leaves little room for flexibility to water managers (except for the possibility of exemptions mentioned in ASF1 and ASF 5). Furthermore, it is exclusively based on scientifically established quantified ecological targets that serve to ensure comparability and enforceability across EU member states (EC, 2019a). At the same time, as some of the above examples suggest, the comparability of data across time (i.e. from one management plan to another) has not always been ensured, as several monitoring indexes needed to be revised to fulfil

[219] Riedmüller, U., Mischke, U., Pottgieser, T., Böhmer, J., Deneke, R., Ritterbusch, D., Stelzer, D. & Hoehn, E (2013): Steckbriefe der deutschen Seentypen. Begleittext und Steckbriefe (Auftraggeber: Umweltbundesamt)

[220] Luxembourg Institute of Science and Technology (LIST), Etude permettant de définir le Potentiel Ecologique Maximal (PEM) et le Bon Potential Ecologique (BPE) du lac de barrage de la Haute Sûre au Luxembourg. Rapport 2015.

[221] NF T90-395, October 2003: Qualité de l´eau – Détermination de l´indice biologique macrophytique en rivière (IBMR)/EN 14184: Qualité de l´eau – Guide pour l´étude des macrophytes aquatiques dans les cours d´eaux

[222] Indice biologique global normalisé (IBGN) – Guide technique des agencies de l´Eau

[223] AFNOR (Association Francaise de Normalisation), Qualité de l´eau – Détermination de l´indice poisons rivières (NF T90-344) (IPR), 2004

[224] ProSolut S.A. Ingénieurs-Conseils, ahu AG Wasser, Boden, Geomatik (2015), Entwurf Umweltbericht zur Strategischen Umweltprüfung des 2. Maßnahmenprogramms WRRL für das Großherzogtum Luxemburg, MDDI

evolving scientific and technical requirements, in line with the "scientific and technical progress" mentioned in the EU WFD.

Contrary to principles of adaptive management (Waylen et al., 2019), none of the above-mentioned studies takes into account social criteria and contexts except the monitoring of anthropogenic pressures and baseline scenario. This underscores the argument that the EU WFD combines integrated water management with a hierarchical and science-based governance approach that is based on fixed goals to be achieved, leaving little room for *adaptive* management based on experimentation, evolving objectives, and iterative social learning.

The 2nd WFD management plan (AGE, 2015b) includes assessment of the current status for each of the 110 Luxembourgish surface water bodies demarcated for WFD purposes. Only three of them had reached a "good status" by 2015. For all other water bodies, a prolongation of the deadline to 2021, respectively 2027, was necessary. As regards the biological status (measuring biodiversity), most water bodies in Luxembourg were found in a moderate state, such as the Upper Sûre and Syr river sections. Among the main reasons identified for why the good status could not be reached were too high nutrient levels and river structures (hydromorphology) that hinder more substantial improvements of aquatic ecosystems due to barriers to river continuity and connectivity (for example, because fish cannot pass through the streams).

The high level of nutrients is reflected in the physico-chemical quality elements measured. Only 18 river sections had attained a good physico-chemical status, the other 89 were found to be in a moderate, poor or bad state. Most water bodies exceeded the limits for phosphates and 28 % of water bodies showed too high nitrate concentrations that accelerate algae growth and disturb the balance of organisms in water bodies, including fish. Finally, as regards the chemical status, the amounts of diverse pesticides detected (in addition to polycyclic aromatic hydrocarbons PAH) were identified as having a negative impact on the status of water bodies. For these reasons, the plan emphasises:

> *"Abwassertechnische sowie hydromorphologische und landwirtschaftliche Maßnahmen werden nötig sein, um den guten ökologischen Zustand an vielen Oberflächenwasserkörpern zu erreichen" (AGE, 2015b).*

The annexed catalogue includes a total of 2 170 measures (AGE, 2015b, 2018a):

- 913 hydromorphological measures outlined for each river section including river restorations
- 1 257 measures concerning urban water infrastructures, mainly wastewater treatment

The plan points out that hydromorphological measures are indispensable to reach a good ecological status:

> *"Erhebliche Verbesserungen sind vor allem in Gewässerumfeld und an der Uferstruktur der Oberflächengewässer unabdingbar. Ohne ausreichend breite und naturgemäß strukturierte Ufer ist eine eigendynamische Gewässerentwicklung nicht möglich. Wenn dem Gewässer der nötige Raum bereitgestellt wird, können sich nach und nach naturnähere Strukturen bilden. Diese bilden wichtige Lebensräume für die Tier- und Pflanzenarten. Aber auch die Belastung der Gewässer mit chemischen Stoffen kann durch Gewässerrandstreifen reduziert werden. Baumarten der Gewässerflur wie zum Beispiel Weiden steigern sogar die Selbstreinigungskraft der Gewässer indem Nähr- und Schadstoffe von den ins Wasser ragenden Wurzeln aufgenommen werden. Um die Ziele der WRRL zu erreichen, ergibt sich ein hoher Handlungsbedarf zur Verbesserung der Gewässerstrukturen. Jedes hinzukommende Stück extensiv genutzter Randstreifen am Gewässer bilden dabei eine wertvolle Grundlage und bringt das Gewässer ein Stück näher an das Erreichen des guten Zustandes" (AGE, 2015b).*

As regards the Upper Sûre and Syr, the WFD management plan assesses their status as follows (see tables 8.3. and 8.4).

Water body	Biological status 2009	Biological status 2015	Physico-chemical status 2009	Physico-chemical status 2015	Overall ecological potential - 2009	Overall ecological potential 2015	Chemical status 2009	Chemical status 2015
III-2.2.1. Sûre (lake)	Good	moderate	Good	Good	Good	Moderate	Good	Not good

Table 8.3 – Comparison of the status of the Upper Sûre lake in 2009 and 2015 (AGE, 2015b, annexes 9, 22)

Water body	Biological status 2009	Biological status 2015	Hydro-morphol. status 2009	Hydro-morphol. status 2015	Physico-chemical status 2009	Physico-chemical status 2015	Overall ecological status – 2009	Overall - Ecological status 2015
I-3.1 Syr	Poor	Moderate	poor	Bad	bad	Moderate	Poor	moderate
		Chemical status 2009		Chemical status 2015				
		Not good		Not good				

Table 8.4 – Comparison of the status of the Syr (river section I-3.1) in 2009 and 2015 (AGE, 2015b, annexes 9, 22)

The programme of measures lists several measures to improve the hydromorphological status of the Syr river, including river restorations and riverbank flattening (annex 15). Moreover, as the previous management plan, it points out the need for improvements relating to the connection of the international airport to the Uebersyren wastewater treatment plant.

As regards drinking water protection zones, the 2nd WFD management plan reiterates the obligation that drinking water protection zones around all sources for drinking water supply are to be set up by the end of 2015. As the case study in part III on the drinking water protection zones will analyse, however, the designation of new drinking water protection zones in the Upper Sûre sub-basin had still not been completed by 2020.

The national WFD management plan itself admits to great uncertainties in scientific estimates (ibid.):

> *"Es ist wichtig zu unterstreichen, dass es sich bei der Abschätzung der Zielerreichung um eine Einschätzung von Experten handelt, welcher mehr oder weniger großen Unsicherheiten unterliegt (z.B. Unsicherheiten bei der Wirkung der Maßnahmen, Unsicherheiten bei der zeitlichen Umsetzung der Maßnahmen, Unsicherheiten bei der Finanzierung der Maßnahmen, Unsicherheiten in Bezug auf die zukünftigen Entwicklungen auf Ebene der Landesplanung). Die Angaben haben somit einen orientierenden Charakter"*

"Da das Maßnahmenprogramm sowohl aus finanziellen Gründen (z.B. Verteilung der Kosten auf mehrere Jahre) als auch aus administrativen (z.B. begrenzte personelle Kapazitäten) und technischen Gründen zudem schrittweise umgesetzt werden wird, ist die Erreichung des guten ökologischen Zustandes bzw. des guten ökologischen Potenzials bis Ende 2021 in vielen Oberflächengewässern gefährdet bzw. unwahrscheinlich. Zusätzlich hat sich gezeigt, dass die Biologie oftmals mehrere Jahre braucht um sich zu regenerieren. Eine Verbesserung des Zustandes tritt also auch nicht immer sofort nach Umsetzung der Maßnahme ein".

One of the most interesting aspects of the justification of the need for prolongations is the reference to "technical feasibility". The WFD provides a list of reasons to be ticked by each country in case of prolongation. The list is limited to "natural conditions", "disproportional efforts" and "technical feasibility". Of 141 reasons provided by AGE for postponement, 91 concern "more time is needed to solve the problem" (under "technical feasibility").

The following Upper Sûre and Syr case studies will suggest that many of the factors hindering WFD implementation can only be termed technical, if ´technical´ is used as a generic term that covers diverse formal, informal, and material factors. The use of the term "technical" seems to perpetuates the technical framing of challenges characteristic of the command-and-control paradigm in water management. It seems to suggest that ecological challenges need to – and can - be ´solved´ by technical-instrumental means. Moreover, it is interesting to note that the authors of the national WFD management plan stress that ecological regeneration does "not always happen immediately" (own translation of the above excerpt). Similar to the previous points made the statement suggests that the EU WFD rests on the assumption that there can be "quick fixes" to ecological challenges relating to dynamic ecosystems. In this sense, the national WFD management plan intermarries terms and approaches typical of command-and-control with ecocentric purposes characteristic of managerial ecological restoration paradigms. At the same time, the ´admittance´ to scientific uncertainties could be interpreted as expressing mild doubts of underlying WFD assumptions.

The case studies of parts III and IV will inquire into barriers in WFD implementation, exploring the extent to which factors hindering WFD implementation are material, formal, and informal (e.g. social).

Formal outcomes (influencing processes analysed in case studies of parts III and IV):

- The 2nd WFD management plan 2015-2021 with programmes of measures, including river restorations, the reduction of pollutants and nutrients from wastewater and agriculture and the designation of drinking water protection zones
- Prolongation of the target date to reach a good ecological status/potential in the Syr and Upper Sûre basins from 2015 to 2021.

8.9 Summary: Changes in water and land governance and management (research question 2)

The first decade of the 21st century was a watershed year for water governance in Luxembourg, providing the formal and organisational foundations for a new direction. The EU Water Framework Directive (in combination with the EU Floods Directive and directive on public access to environmental information) resulted in profound formal re-framing of purposes, objectives, and means that reflect the hybrid character of the new regulatory framework transposed into national law:

- *Actors:* creation of the national Water Management Agency (AGE) *and* river partnerships, while municipalities kept autonomy in the urban water management;
- *Purposes*: Ecocentric purposes aiming for the attainment of a scientifically-defined ´good ecological status´ with anthropocentric supply-oriented purposes (drinking water protection) based on precautionary and preventive principles addressing pollution at source;
- *Scope*: extending water governance and management to aquatic ecosystems;
- *Social coordination*: combining more extensive and detailed scientific/technical requirements (including as regards the creation of drinking water protection zones) and the creation of new national funding instruments, with increased need for coordination with environmental and agricultural actors, including the respective ministries and their administrations (who had lost their water competences to the new Water Management Authority), and with stakeholder involvement and public consultations, and public access to environmental information;
- *Management means:* high priority given to infrastructural measures (in terms of budget and number of measures), but also includes river restorations and other hydromorphological measures, with possibilities of exemptions of reaching a good ecological status or potential, if measures are disproportional, technically not feasible or contrary to overriding public interest.

The co-emergence of the Water Management Authority and the river partnerships signalled that network governance would henceforth supplement hierarchical and multi-level governance (encompassing EU, national, and municipal levels). With active stakeholder involvement organised in the preparation of the first national WFD management plan, the Water Management Authority and all other stakeholders had made their first experiences with participatory water governance processes. The Interreg projects leading to the creation of the river partnerships of the Upper Sûre and Syr basins were founded on the expectation of nongovernmental actors that they would actively contribute to water governance and management in the future.

The fact that a stronger centralisation of competences was accompanied by the creation of decentralised river partnerships is reminiscent of how, in the 19th century, the founding of central agricultural administration (´service agricole´) was followed by the possibility to create agricultural syndicates. It also reminds us of how, in the 20th century, the set-up of a nation-wide semi-governmental drinking water supplier (SEBES) followed upon the creation of intermunicipal syndicates for water supply. These examples suggest that centralisation and decentralisation in water and land governance in Luxembourg have often accompanied each other, resulting in increasingly hybrid multi-level arrangements that crucially depend on vertical and horizontal cooperation and coordination to be effective (see chapter 3.2.3.1).

The EU WFD has partly been attributed to an emerging managerial ecological restoration paradigm. Despite stakeholder involvement and consultations, the elaboration of the national WFD management plans suggest that the EU WFD significantly strengthened the need for and status of scientific/technical expertise and data, with AGE having relied heavily on specialised researchers and consultants. At the same time, with generational changes, professional experience and following the administration´s re-allocation to the Ministry of Sustainable Development, administrators increasingly acquired significant new professional knowledge beginning to appropriate scientific data and principles of adaptive and integrated water management.

Similar professional learning took place in the Upper Sûre and Syr river basins. One of the differences, however, was that the river partnerships self-organised in a bottom-up manner, with Belgian river contracts providing common models. In the Upper Sûre region, the Interreg project could build on existing social networks. In contrast, in the Syr valley, project partners only began to create social networks. In both cases, it was the participating actors themselves who came together in working

groups, doing field research and carrying out systematic assessments that brought together local, professional, and specialised scientific/technical data and knowledge.

Together, the specialised studies, data, and plans of AGE and the inventories of the river partnerships provided a more systemic, detailed, and daunting picture of water challenges than had ever existed in Luxembourg before. The studies, inventories, and data provided organisations with collective knowledge bases bolstering top-down and bottom-up efforts to improve the ecological state of water bodies, including via the 2 170 measures laid out in the WFD management plans. While municipalities remained in charge of the urban water cycle there were, for the first time in Luxembourgish history, governmental and nongovernmental organisations in place dedicated *entirely* to tackling water issues and, what is more, to do so not only by the help of technical means, but also via nature-based and preventive approaches.

At the same time, the WFD management plans and budget allocation suggest that engineered infrastructures (especially wastewater treatment plants) continued to have high priority over other measures, not least because Luxembourg faced EU infringement procedures and fines. Furthermore, the first decade of the 21st century was dedicated entirely to the elaboration of purposes, operational objectives, plans and measures, with the exception of ongoing infrastructural works, the implementation of the Interreg action plan 2008-2011 of the Upper Sûre River Contract and first river restoration projects discussed in part IV of the Syr case study.

In the 2nd WFD management plan, Luxembourg had to admit that the implementation of measures and progress in improving water quality and the state of aquatic ecosystems remained far behind its plan and original expectations, citing "technical feasibility" as main reason, and especially the need for more time. The catalogue of measures was not revised.

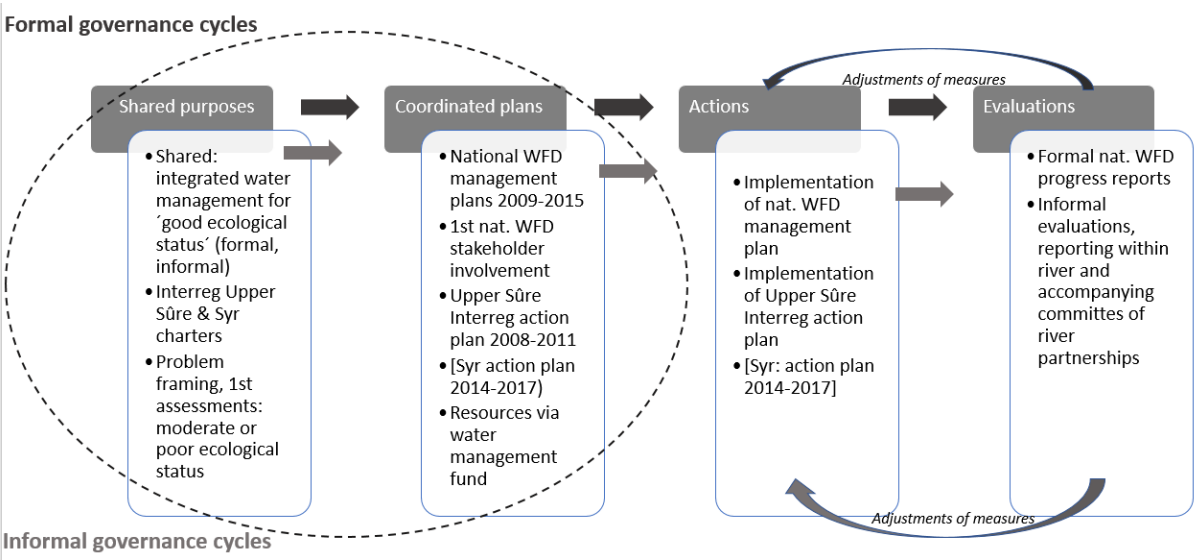

Figure 8.2 - Graphic representation of formal and informal water governance processes in the period 2004-2012

In terms of interplays and learning between formal and informal processes, the following most significant feedbacks have been identified (see figures 8.2, 8.3) in the present part:

- Interplays: the participation of the Upper Sûre River Contract (and other river contracts and actors) in the 1st public WFD consultation in 2009 and the formal creation of the Upper Sûre River Contract and the Syr River Partnership, based on the national water law, encompassing governmental co-funding and representatives on their accompanying committees;

- Policy learning within the Water Management Authority in relation to EU WFD purposes, principles and approaches, including ´expert´ studies and participatory processes
- Informal social learning (including organisational learning) within the river partnerships and their networks in relation to purposes, principles and approaches of self-organisation and integrated water management

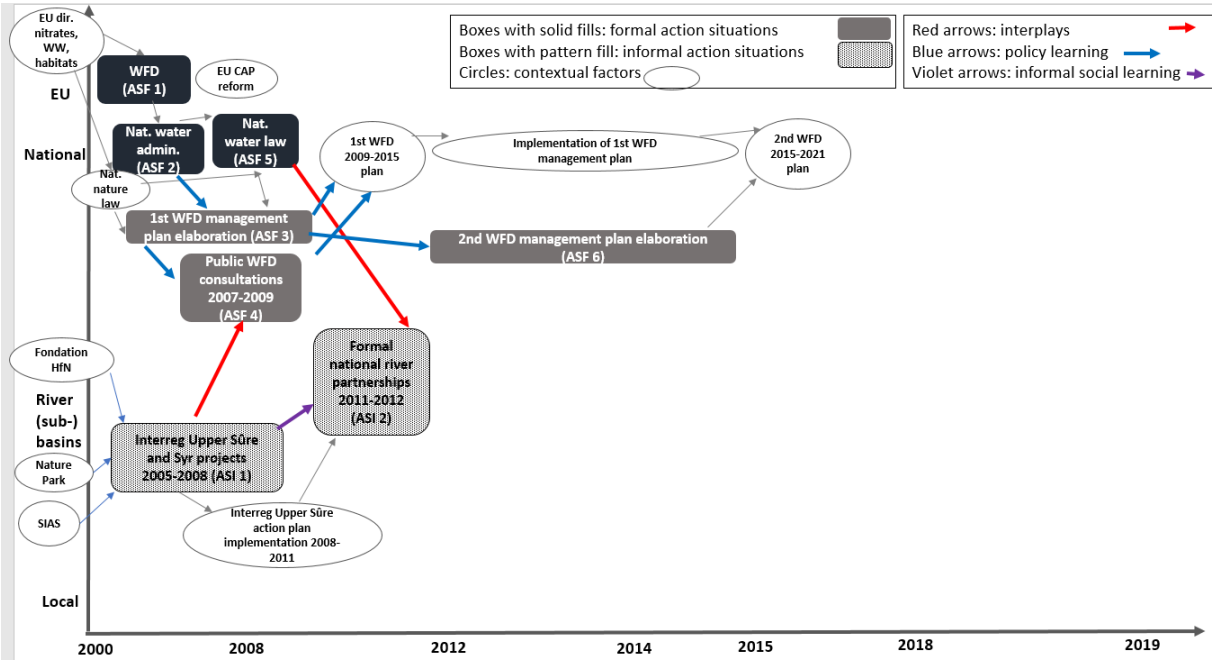

Figure 8.3 - Links between action situations of formal and informal governance processes

Based on the above analyses, it is possible to preliminarily map actors in relation to established and possible emerging governance and management paradigms for the period 2000 to 2012 (see figure 8.4). The mapping illustrates possible tensions that may exist between different paradigms (and related narratives), approaches and actors, as a result of different overarching objectives (priorities) attributed to governance and management (anthropocentric versus ecocentric) and to different modes of social organisation and coordination (top-down versus bottom-up). Based on the mapping, the potential challenges faced by actors to bring together these different poles in adaptive and integrated approaches in both formal and informal governance processes (incl. via social networks) seem significant.

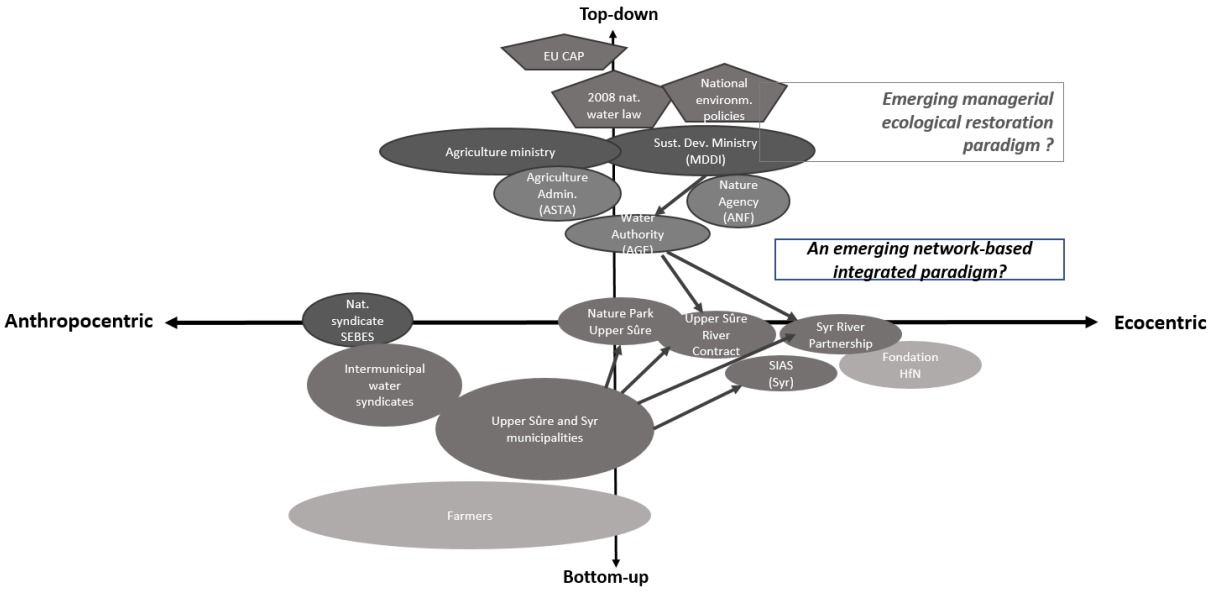

Figure 8.4 - Analytical grid: Selected policies and actors in water governance after the governmental change of 2013

Parts III and IV of the case studies investigate how some of the changes, possible tensions and synergies identified tentatively in national water governance and management following the EU WFD have played out in the Syr and Upper Sûre valleys, with a special view to interrelations with municipal, environmental and agricultural actors, their knowledge and problem framings, projects, and institutions. Particular attention is devoted to the question if and how changes in water governance and management have facilitated and hindered the emergence of social learning and actionable knowledge in the social networks of the Upper Sûre River Contract and Syr River Partnership.

9 CASE STUDIES (PART III): Governance processes relating to drinking water protection in the Upper Sûre basin (2012-2019)

Figure 9.1 - The Upper Sûre lake (source: Naturpark Öewersauer, photo: Pierre Haas)

Part III of the case studies is dedicated to processes relating to the elaboration of new drinking water protection zones in the Luxembourgish sub-basin of the Upper Sûre lake, as provided for by the EU Water Framework Directive (WFD) and the corresponding national law (see part II). The analysis thus concentrates on the anthropocentric objectives of the EU WFD, which encompass the principle to reduce and prevent pollution through restrictions on certain human activities and changes in practices. The Ministry of Sustainable Development and the Water Management Agency (AGE) have furthermore hoped that a new "drinking water protection culture" would emerge with the protection zones (MDDI, 2018c). The case study examines governance and management processes at the nexus of water, agriculture, and regional development. It seeks to provide tentative answers to the following research questions:

- *Research question 2: How has the EU WFD changed water and land governance and management in Luxembourg?*
- *Research question 3: What factors facilitate or hinder the emergence of social learning and actionable knowledge for sustainability?*

The following processes are analysed:

- **Formal governance processes** aiming to establish new drinking water protection zones involving the national water supplier SEBES, consultants, the Water Management Authority (AGE), Ministry of Sustainable Development (MDDI), and the Ministry of Agriculture (MAVDR);
- **Informal governance processes** organised by the Upper Sûre River Contract and the Nature Park aiming for, firstly, coordinating local public participation in the elaboration of the protection zones and, secondly, for developing more ´water-

friendly´ agricultural practices and technologies in cooperation with farmers, farm advisors, SEBES, AGE, and MDDI.

The selection and empirical analysis of action situations (see table 9.1) has emerged from interpretative iterative and collaborative processes (see introduction 6.1 and methods chapter 5.6.1).

Informal action situations selected (ASI)	Formal action situations selected (ASF)
	ASF 1: National water law enters into force, prescribes drinking water protection zones (2008)
ASI 1: River Contract assumes mandate to coordinate public participation (Dec.2012)	ASF 2: SEBES, consultants, and AGE prepare protection zones concept (2013-2017)
ASI 2: River contract organises working groups amidst governmental change (2013-2014)	
ASI 3: Working group co-creates knowledge, launches farming experiments (2014)	ASF 3: Pesticides accident leads to restrictions and controversies concerning agriculture (2014-2017)
ASI 4: Farmers, water supplier, nature park and river partnership launch formal cooperation and more experiments (Sep. 2015)	
ASI 5: Local actors increase pressure for participation (Oct.2017 - Apr. 2018)	ASF 4: Ministry revises water law and prepares 1st protection zones draft law (2017-Jun.2018)
ASI 6: River contract, municipalities and farmers prepare for formal public consultation amidst scientific and political arguments (Jul.-Oct.2018)	ASF 5: Public consultation is held, new protection zones postponed following elections (Sept.-Nov.2018)
ASI 7: Future perspectives: Local and national actors develop ideas and action fields for the future at NEXUS workshop (Feb. 2019)	ASF 6: The 2nd draft protection zones law and new agricultural funding elaborated, uncertainties remain (Nov.2018-Jul.2019)

Table 9.1 - Action situations selected for the period 2012-2019 relating to drinking water protection in the Upper Sûre region

The action situations will be attributed to different phases in formal and informal governance: purposes and problem framing, plans, actions, and evaluation, as a basis for analysing possible interplays (see chapter 3.2.4). The analysis will thus seek to enrich the simplified map below by determining diverse interconnections and qualitative characteristics (see figure 9.2).

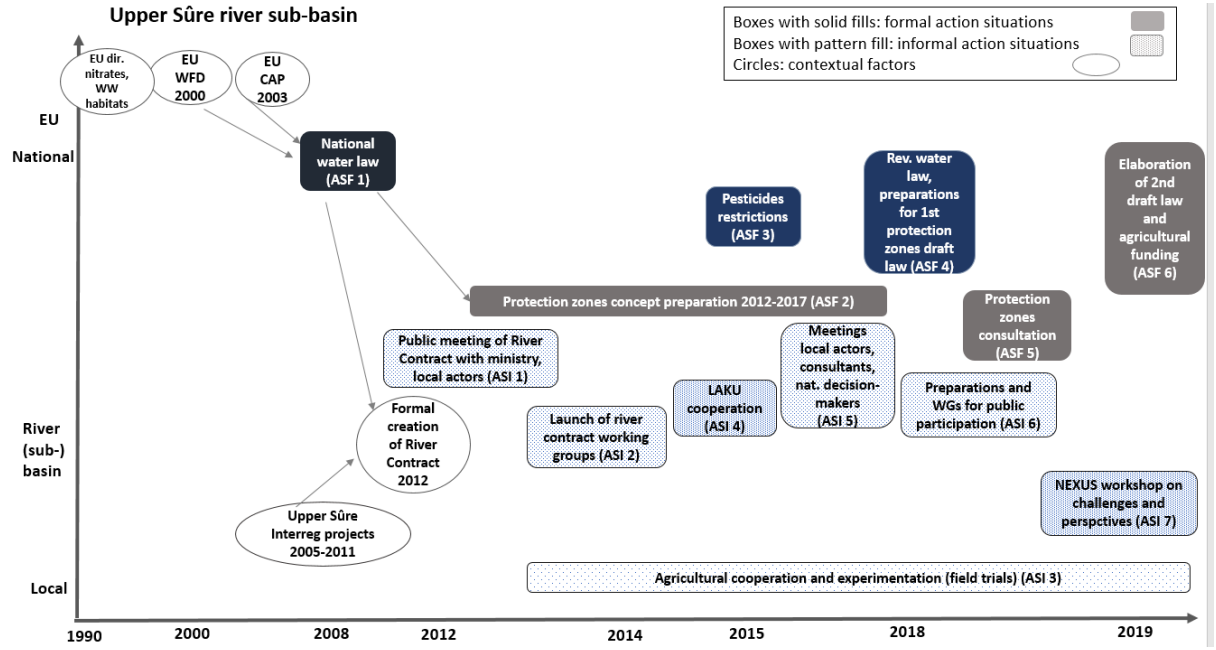

Figure 9.2 - Action situations and related contextual factors selected for the Upper Sûre case study (part III)

9.1 ASF 1: National water law prescribes drinking water protection zones

Summary	Based on the principle of pollution prevention, the Luxembourgish water law of 2008 laid out the formal procedures for the creation of drinking water protection zones around water bodies used for the extraction of drinking water by 2015. The law provides for the elaboration of a technical dossier and a formal public consultation, as basis for the law that would introduce the new protection zones.			
Synergies and tensions	Tensions arising from the fact that the AGE groundwater department was put in charge of protection zones, while the Upper Sûre lake is a surface water body			
Action situation	Main documents	Main interviews	Observations and meetings	Workshop content
ASF 1: National water law prescribes drinking water protection zones (Dec.2008)	National water law of 2008 (& revised version of 2017)	N° 10, 28, 40, 43, 48, 60	-	-

Until the national water law of 2008 was implemented, the sanitary protection zones around the Upper Sûre lake (Mémorial A, 1961) had been the only drinking water protection zones that existed in the Grand-Duchy. However, the sanitary protection zones did not correspond to EU WFD requirement, among others, because they did not cover the entire hydrological watershed of the Luxembourgish part of the Upper Sûre lake. In line with the EU WFD, the new national water law provided for measures that aimed to reduce the need for treating water intended for human consumption (article 29[225]).

[225] "Art. 29 Mesure de base. Les mesures de base comprennent: […] 4. […] notamment les mesures visant à préserver la qualité de l´eau de manière à réduire le degré de traitement de purification nécessaire à la production d´eau potable […] » (Mémorial, 2008)

Thereby, it introduced a new "philosophy" that had hitherto not existed in Luxembourg (interview n°40). Before that, governments had been reluctant to tackle water quality issues produced by agriculture, wastewater, and other sources, according to some interview partners:

> *"Wasser, Wasserqualität, Wasserversorgung war bis zum Gesetz von 2008, bis zur Direktive, eigentlich kein Thema. Es war normal. Es lief einigermaßen ordentliches Trinkwasser aus dem Hahn zu Hause. Mit der Quantität hatten wir dank des Stausees an der Sauer kaum ein Problem. Die Probleme waren schon da, aber eher nicht an der Oberfläche, eher verdeckt. Und die haben sich zugespitzt. Durch die demographische Entwicklung wurde es irgendwann klarer, dass wir irgendwann auch über die Quantität diskutieren müssen, aber nach und nach kam auch die Qualität an die Oberfläche" (interview n°60).*

According to other interview partners, preventing rather than treating pollution made also sense economically, because water treatment can assumedly be up to times more expensive than measures to prevent pollution (interview n°28). Furthermore, the focus on prevention has been associated with a new "drinking water protection culture" that would entail a change in ´mindsets´ and enhance general awareness of the value of water:

> *"[…] das Bewusstsein, dass man die Ressource schützen kann, dass die Ressource etwas Wertvolles ist, von der jeder abhängt, und dass jeder, wenn auch vielleicht nur einen kleinen Teil, aber jeder seinen Anteil beitragen kann" (interview n°40).*

From this perspective, the new legal requirements were to herald a step towards changes in awareness and informal institutions in society or, we might say, towards a more integrated paradigm that – unlike the incumbent ´command-and-control´ paradigm - was no longer to rely predominantly on ´end-of-pipe solutions´ and technological fixes (see chapter 4.2.1). The water law provided for the creation of protection zones in three concentric circles around drinking water sources, with different degrees of restrictions on human activities and installations that could have a negative impact on chemical water quality (article 44). The law also stipulated that water bodies used for the extraction of drinking water could be declared as of national interest (article 44). The formal processes for the creation of drinking water protection zones in the Upper Sûre basin analysed in the present case study were based on the steps outlined by the national water law of 19 December 2008 (Mémorial A, 2008, revised by Mémorial A, 2017b, own simplified translation)[226]:

1. The water supplier addresses a demand for the creation of a protection zone to the minister.
2. In case of acceptance, the supplier elaborates a draft on the creation of protection zones, on the basis of a demarcation dossier that has been established in accordance with the instructions of the Water Management Authority (AGE).

[226] "Art.44 (6) of the´Loi du 20 juillet 2017 modifiant la loi modifiée du 19 décembre 2008 relative à l'eau, Mémorial A °690 : « L´exploitation du point de prélèvement adresse une demande de création d´une zone de protection au ministre. En cas d´acceptation de la demande par le ministre, l´exploitant rédige un projet de création de zones de protection sur la base d´un dossier de délimitation établi suivant les instructions de l´Administration de la gestion de l´eau. Le dossier est soumis au ministre qui l´adresse, aux fins d´enquête publique, aux communes territorialement concernées. La procédure d´enquête publique doit être initiée par les communes territorialement concernées dans les deux mois à compter de la réception du dossier. Le dossier est consultable à la maison communale de la manière usuelle, tout en invitant le public concerné à prendre connaissance des pièces et observations afférentes. (7) Dans le délai prévu à l´alinéa qui précède, les objections contre le projet doivent être addressées au collège des bourgmestre et échevins qui en donne connaissance au conseil communal pour avis. Ce dossier, avec les réclamations et l´avis du conseil communal, doit être transmis dans le mois de l´expiration du délai de publication au ministre avec les pièces et observations afférentes » (Mémorial, 2017b)

3. The dossier is submitted to the minister who, for the purpose of public consultation, addresses it to the municipalities concerned.
4. The municipalities have to initiate the public consultation within two months of the reception of the dossier.
5. The dossier is made public at the municipalities for thirty days and the public invited to take note of the dossier.
6. Objections against the draft have to be addressed to the mayors and aldermen who pass them to the municipal council for opinion.
7. The dossier, with the objections and opinion of the municipal council has to be submitted to the minister within the month of the publication deadline to the minister.

Still part of the Ministry of the Interior until late 2013, AGE began to elaborate requirements and guidelines for the demarcation of protection zones. In order to reduce nation-wide dependence on drinking water from the Upper Sûre lake water (see introduction 6.1.2.3), the focus was placed on *ground*water sources first (interviews n° 48, 60). For this reason, it was the AGE groundwater department that was put in charge of drinking water protection zones and of drafting guidelines for their protection. For the first years, the groundwater department would also be in charge of plans for the Upper Sûre surface water protection zones (see ASF 2 below).

The formal governance processes analysed below are divided into two phases. The first is a "technical phase" that consisted in the elaboration of the above-mentioned dossier under the water supplier SEBES (ASF 2). The second is the "political phase" (ASF 4-6) that began with the preparation of the first draft law for the designation of drinking water protection zones, culminating in a formal public consultation.

Formal outcomes:

- National water law of 2008 prescribing the process for designating drinking water protection zones (including public consultations) and the principle that the need for drinking water treatment should be minimised
- AGE groundwater department is in charge of drinking water protection zones

9.2 ASI 1: River partnership assumes mandate to coordinate public participation

Summary	Together with governmental and SEBES representatives, the Upper Sûre River Contract organised a public event on the future protection zones. Coordinating stakeholder involvement with the Nature Park became its expectation and new mandate, if only informally. Some local actors felt reminded of how national actors had once thought to "impose" a national park on them, strengthening their resolve to participate.			
Synergies and tensions	Tensions between governmental actors who questioned the environmental commitments of actors in the region and local actors who were concerned not to be actively involved in the process			
Action situation	Main documents	Main interviews	Observations and meetings	Workshop content
ASI 1: River partnership assumes mandate to coordinate public	River Contract annual report (CRHS, 2012b), report on public participation in drinking water	Numbers 32, 33, 34, 36, 43	-	-

participation (Dec.2012)	protection zones (CRHS, 2015), minutes of 1st agriculture working group (CRHS, 2013)			

After the Upper Sûre River Contract had completed its Interreg project and been formally institutionalised as national river partnership, the future drinking water protection zones became one of its priorities. The River Contract established contact with SEBES to discuss how to proceed, proposing to set-up working groups for the elaboration of the protection zones concept (CRHS, 2012b). As one of its first major initiatives as national river partnership, the River Contract organised a public event in December 2012. It invited representatives of AGE, the Ministry of the Interior and SEBES to inform the public about the legal framework and the upcoming designation process. More than 100 people came, many of them municipal representatives, farmers, and farm advisors. The Upper Sûre Nature Park moderated the event. Participants were invited to sign up for the future working groups. The new working groups partly built on social networks and experience from Interreg times.

The public event and plans for working groups inscribed themselves in expectations and efforts for more network governance in water management. For several local actors interviewed, it was a milestone event and remained imprinted in their memories. Based on their accounts, the event seems to have anticipated some of the tensions that would increasingly surface. Most importantly for present purposes, it pre-announced tensions between hierarchical and network governance that would mark the entire process (see conceptual chapter 3.2.3.1).

On the one hand, the Nature Park and River Contract recall that public officials participating in the event "promised" that local actors would be actively involved in the protection zone concept and that they had given the River Contract a mandate to coordinate public participation (even if only informally):

> *"Ein Schlüsselerlebnis war da ziemlich am Anfang – das war in dem Kontext, wie läuft der Gewässervertrag weiter – im Grunde genommen eine Art Auftrag gekriegt haben, die Öffentlichkeitsarbeit zu organisieren bei der Erstellung des Schutzzonenkonzepts und auch die Zusicherung bekommen [haben] seitens […] Wasserverwaltung [AGE] und SEBES, dass wir mitarbeiten dürfen beim Entwurf […]". (interview n°36)*

On the other hand, some of the participants interviewed had the impression that the invitation to participate in the process was half-hearted:

> *"Sie haben zwar eine Infoversammlung gemacht, es wurde auch vieles verspochen. Aber es war meiner Meinung nach halbherzig. Es war einfach nur, „wir machen mal eine Infoversammlung, dann haben wir die gemacht und dann nachher, dann sind sie ruhig, sie hatten ja eine Infoversammlung" (interview n° 34).*

Based on this impression, especially older actors (among them municipal representatives and farmers) felt reminded of how central government had intended to ´impose´ a national reserve or government-driven nature park on the region in the period from the 1950s to the 1980s (see case study chapter 7.3.2). Similarly, many local actors now suspected the state would unilaterally introduce restrictions on agriculture and regional development without offering new perspectives:

"Damals haben sie sich quasi gefürchtet, sie bekämen etwas von oben herab diktiert und haben es dann von unten herauf gemacht. So ein bisschen die Gallier gegen die Römer. Also, hier ist ganz klar, dass sich gewisse Leute wirklich daran erinnert gefühlt haben, wie es damals war, wo man [ihnen] den Naturpark, sage ich mal, vor die Tür setzen wollte mit vielen Restriktionen […] Und hier, das ist ganz klar, das sind jetzt teilweise noch die gleichen Leute dabei, die damals hier schon gekämpft haben" (interview n°34)

"Man legt uns Bremsen auf und wir können uns nicht…haben keine Möglichkeiten uns zu wehren" (interview n°33)

"Und wir wollten auch eine positivere Vorgehensweise, ähnlich wie beim Naturpark". (interview n°32)

Recalling activities of the 1990s, local actors underlined that it was not a matter of being *against* drinking water protection zones and possible restrictions, but rather of developing local ideas of how to reconcile water protection with (new) regional perspectives. Interviews thus suggest that local efforts and expectations to actively participate in the process inscribed themselves in local narratives and memories of the past. One of the main "lessons" drawn from the 1980s and 1990s was that the region would have to mobilise, if local concerns were to be taken seriously by national decision-makers. The bottom-up community paradigm that had emerged in the 1980s and 1990s thus seemed to re-surface, with the Nature Park and River Contract in a central role.

From organisational documents, two different missions of the River Contract can be discerned: to act as boundary organisation and to contribute to knowledge about pollution sources. As regards the first, the mandate assumed by the River Contract was that it would organise public participation to "give the region a voice", based on an explicit reference to EU WFD requirements on stakeholder involvement (CRHS, 2012b)[227]:

"So wird im Rahmen des Gewässervertrags ein konstruktiver und akzeptierter Beitrag zum Schutzzonenkonzept geliefert werden. Gleichzeit erfüllt das Projekt damit die EU- Vorgaben für den Staat, eine Öffentlichkeitsbeteiligung bei dem Prozess der Schutzzonenerstellung zu gewährleisten, so dass hier klar nationale Aufgaben erfüllt werden." (CRHS, 2012)

In this regard, the River Contract derived its legitimacy from the fact that its ´river committee´ (see part II of case studies) was composed of diverse actors, from local and private actors to national and public actors active in the water system that offered a platform for debates on issues relating to water protection in the region. A report on activities carried out to coordinate public participation stated:

"Der Gewässervertrag bietet eine wichtige Diskussionsplattform zum Thema Wasserschutz in der Region – das Flusskomitee. Das Flusskomitee ist eine Plattform, auf der sich Gemeindevertreter, Staatsvertreter, Verwaltungen und andere öffentliche und private Akteure begegnen, die an den Gewässern agieren oder Einfluss darauf nehmen" (CRHS, 2015b).

The River Contract underlined that the Upper Sûre Nature Park, as representative of the region´s municipalities, should act as "strategic partner" in the process to ensure that communication and processes involving local citizens and public administrators would be transparent and open:

[227] „Der Gewässervertrag hat sich in diesem Zusammenhang zur Aufgabe gemacht, eine Mitarbeit der Öffentlichkeit zu organisieren, um der Region eine Stimme zu geben" (CRHS, 2012b).

"Als lokaler Akteur und Vertreter der lokalen Gemeinden sollte der Naturpark als strategischer Partner in den Prozess u.a. koordinierend und informierend eingebunden sein, um einen transparenten Prozess und eine offene Kommunikation zwischen Bürgern und den Planern zu gewährleisten" (CRHS, 2015b).

Based on the conceptual framework (see 3.2.5.1), the new ´mission´ can be characterised as an expectation of the Nature Park and River Contract to be able to assume the role of boundary organisation between local and national actors. The aim was to enhance stakeholder involvement by enhancing the existing cross-scale and cross-sectoral social network, thereby contributing to more network governance in water and land sectors in Luxembourg, however, with a strong bottom-up drive.

Secondly, the River Contract – with its working groups – assumed the mission to contribute to identifying sources that could pose risks to the quality of crude water in the Upper Sûre lake and to elaborating measures to reduce those risks (CRHS, 2015b, 2012b) [228]. From the outset, this included the consideration of scientific studies and data (e.g. provided by SEBES and AGE) and of local and professional knowledge of working group members (see ASI 3).

The historical context chapter has provided evidence that water and environmental concerns had not figured prominently on the agenda of the Nature Park during the first ten years of its existence (1999-2009). Afterwards, it moved the fact of being a "water region" more into the centre of its activities. However, intra-organisational tensions have remained resulting from efforts to integrate different concerns:

"Hier zahlen die Gemeinden in den Naturpark, der auch Naturschutz macht. Sie wollen aber auch andere Sachen. Das ist ganz klar, dass die Gemeinden sagen: "es wird zu wenig für Tourismus gemacht"" (interview n°34)

Conversely, governmental actors have perceived the Nature Park as primarily serving to represent – and to give more weight to – municipal interests (despite state representatives in its statutory bodies), with the River Contract as part of its structure:

"Naturpark gibt der Region ein Gewicht, eine Stärke, im Vergleich zu anderen Gemeinden […] Wenn ein Naturpark einem Minister schreibt, ist das was anderes als wenn […] eine Gemeinde irgendetwas fragt. Eine Riesenvisibilität für die Region". (interview n° 43)

"[Der Gewässervertrag] ist ja da die 6. Flusspartnerschaft. […] Im Grunde eine Fortsetzung des Naturparks. Naturpark sollte ja an sich schon für den Umweltschutz sein, Wasserschutz, Sensibilisierungsarbeit, aber kein spezifischer Fokus Wasserschutz". (interview n° 43)

The below analysis suggests that these diverse perceptions, expectations, and tensions would come to strongly influence governance processes in relation to the drinking water protection zones. It is important to note that the ´mandate´ the River Contract had received remained entirely informal (even if explicitly stated in diverse organisational minutes and reports). Furthermore, in 2013, Luxembourgish voters elected a new government, with the Green party heading the Ministry of

[228] „Im Rahmen der Arbeitsgruppen sollen die verschiedenen Gefahrenquellen für die Rohwasserreserve diskutiert werden und mögliche tragbare Maßnahmen formuliert werden". (CRHS, 2012b)

Sustainable Development and AGE coming under its aegis. The political change would also become an important contextual factor.

Main informal outcomes and effects:

Knowledge:

- Public information about upcoming governance processes to designate new drinking water protection zones around the Upper Sûre lake

Organisational:

- ´informal mandate´ of River Contract to coordinate public participation and to contribute to water protection in the framework of the planned new protection zones

Relational (inter-organisational and interpersonal):

- first contacts between River Contract, Nature Park, and SEBES
- expectations of local communities (municipalities, farmers, etc.) to contribute to the elaboration of drinking water protection zones, including as a means to "defend" their interests

9.3 ASI 2: River partnership organises working groups amidst governmental change

Summary	Based on the December 2012 public event, the Upper Sûre River Contract re-activated its Interreg working groups on agriculture, municipal development, forestry and tourism, in cooperation with the Nature Park, SEBES and AGE. Many meetings included not only local, but also governmental actors and national nongovernmental actors. Thereby, the working groups were an example of network governance that appeared to receive a boost by the election of a new government coalition in 2013 committed to "participatory democracy".			
Synergies and tensions	Synergies between the objectives and activities of the Upper Sûre River Contract, the social network and resources of the Nature Park, and the coalition programme of the new national government			
Action situations	Documents	Interviews	Observations and meetings	Workshop content
ASI 2: River contract organises working groups to contribute to protection zones concept (2013-2014)	River contract minutes of its working groups, its report on public participation, nat. government programme 2013-2018	Numbers 20, 32, 33, 36	-	-

The working groups of the River Contract offered a framework for local self-organisation as well as for cross-scale contacts with national actors and policy-makers. Four working groups were formed: on tourism, forestry, municipal matters, and agriculture. Coordinated by the River Contract, the Nature Park provided the organisational structures and resources.

Local actors interviewed described the main added-value of the Nature Park as follows:

> *"Wir kennen uns alle gut. Nachbargemeinden kennen sich. Aber der Naturpark beinhaltet auch diese Infrastruktur und das fachliche Know-How". (interview n°32)*

In the view of local actors, the Nature Park and River Contract were essential to support actors in contributing to the governance processes surrounding the drinking water protection zones and to put forward "constructive arguments" (interview n°32). The working groups were open to all interested actors and roles, and tasks and activities were to emerge from the process. The minutes of the first working group meeting of March 2013 presented the role of the River Contract and objectives and possibilities of the working groups as follows (CRHS, 2013a):

> *"Durch die unabhängige Finanzierung des Gewässervertrags (2012 etwa 50% Ministerium für Inneres und die Großregion und 50% durch die lokalen Gemeinden) kann dieses öffentliche Forum als Sprachrohr der Region angesehen werden. Der Gewässervertrag wird die Mitarbeit der Öffentlichkeit und der Akteure vor Ort organisieren und betreuen. In Form von Arbeitsgruppen zu Landwirtschaft/Forstwirtschaft, Siedlungswirtschaft und Tourismus werden Möglichkeiten eruiert, um einen Beitrag zum Schutzzonenkonzept zu leisten bzw. Stellungnahmen zu bündeln und auszuformulieren. Der Austausch von Informationen spielt bei dieser Arbeit eine wichtige Rolle, so könnten Vorträge, Exkursionen eventuell sogar Feldversuche organisiert werden. Die aktiven Teilnehmer der Arbeitsgruppen haben die Möglichkeit den Inhalt zu bestimmen und Wünsche werden im Rahmen der Möglichkeiten realisiert werden".*

The diversity of working groups proposes underscores the main purpose of the River Contract to contribute to an integrated management of the water cycle. In the following, the members of the tourism group would meet twice and the forestry and municipalities working groups met once each (CRHS, 2015b). The agriculture working group met nine times in the period from 2013 to 2015. It will be further discussed below.

Here, some of the main aspects of working groups on tourism, forestry and of municipal matters will be outlined, based on minutes and the 2015 report on ´public participation activities´ of the River Contract. They suggest that participants regarded the River Contract as a legitimate interlocutor and mediator and that local actors used the working group to put forward proposals on how to enhance water protection in the river basin and other local interests. Some of the proposals concerned single initiatives, others proposals for structural changes, and a reorganisation of roles and competences in various matters.

The working group on tourism proposed measures to counteract vandalism, garbage and parking problems along lakeshores, a place to sell regional products, to remove non-registered boats and to introduce fishing permits for tourists and foreign guests (CRHS, 2013c). It deplored the lack of a coordinating body and unclear distribution of competences for all matters concerning the lake. Local forest rangers of the Nature and Forest Agency (ANF) or staff of the National Roads Administration (P&Ch) should be endowed with more competences. Participants also argued that the new protection zones should not entail the same restrictions on tourism around the lake as the sanitary ones, as touristic activities around the lake would otherwise be rendered "impossible". Finally, they asked for data on the impact of tourism on water quality and charged the River Contract with representing its viewpoints towards SEBES, public administrations, and ministries.

The working group on forestry (CRHS, 2014a) emphasised the need to regulate clear-cutting in forests to prevent erosion and to improve the education of drivers of large forest machinery, in order to reduce negative impacts on forest soil and to improve practices as regards fuelling and use of

lubricants. They also regarded it as desirable to be paid a premium for certified forestry and asked for an information meeting with SEBES.

The intermunicipal working group on urban water management (including representatives of intermunicipal water syndicates) mainly dealt with wastewater treatment and measures to reduce the amount of effluents released into the lake. They deplored that growth perspectives of municipalities were limited, partly due to the limited possibility to create commercial zones, and that water protection measures would incur additional costs. They also discussed how to improve communication between various actors to be able to react more quickly to accidents along the lake, the need to control construction sites better, and to update an old action plan to de-pollute the lake (CRHS, 2014c).

9.3.1 Political contextual factors

In October 2013, the long series of conservative-led governments in Luxembourg ended. Luxembourgish voters elected a new government coalition into office. It was composed of liberals (DP – also putting up the new prime minister), socialists (LSAP), and greens (déi gréng). The Green Party, party headed the new Ministry of Sustainable Development and Infrastructure that took over AGE from the Ministry of the Interior. The ministerial move signalled that water policies and management in Luxembourg would henceforth be integrated with environmental policies, in line with EU WFD objectives. Among others, the parties had been elected on the promise of renewing the country and its political culture (Gouvernement, 2013)[229]:

> *"Notre pays doit retrouver une culture du dialogue qui a longtemps été sa force. Le Gouvernement cherchera le dialogue direct avec nos cocitoyens et promouvra celui entre tous les membres de notre société"*
>
> *"Le Gouvernement entend renforcer l´association des citoyens à la vie politique et promouvoir la démocratie participative".*

In the terms of concepts outlined in the concepts´ chapter, the change in government thus seemed to herald a shift of emphasis away from hierarchical to network governance. The government programme reinforced expectations among local actors of active involvement. The new government, in its programme of 2013 also expressed a clear commitment to the EU WFD, as to environmental objectives in general. The creation of groundwater protection zones by the end of 2015 was explicitly mentioned, those of the Upper Sûre protection zones, however, were not.

The backlog of work inherited from previous governments in terms of water management and environmental protection was significant. It included not only the set-up of drinking water protection zones, but also wastewater treatment, and the revision of the national nitrates regulation (see context chapter 7.4.1).

Informal outcomes:

- Network effects: Working groups on agriculture, municipal matters, tourism and forestry coordinated by the Upper Sûre River Contract as part of the Nature Park
- Growing expectations among local actors to be able to contribute actively to the concept on the new drinking water protection zones

[229] Programme gouvernemental 2013-2018. Gouvernement du Grand-Duché de Luxembourg

9.4 ASI 3: Working group on agriculture launches farming experiments

Summary	Of the four working groups, the one on agriculture was the most active. It met nine times in the period from 2013 to 2015, organised seminars, excursions, and experiments that brought together the River Contract, SEBES, and diverse agricultural actors from all levels. Its twin objective was to contribute to the protection zones concept and to develop more ´water-friendly´ farming practices. It is an example of social learning based on collaborative and experiential engagement that included best practice examples from abroad and specialised scientific/technical data.			
Synergies and tensions	Tensions in working group between "changing something" and preserving "competitiveness"			
Action situation	Documents	Interviews	Observations and meetings	Workshop content
ASI 3: River contract, farmers and water supplier launch experiments, co-create knowledge (2014)	River contract minutes of agricultural WG (CRHS, 2013a, 2013b, 2013d, 2014e, 2014b, 2014d, 2015a)	Numbers 5, 19, 20, 43, 44	-	Systems diagram „Bodenbearbeitung" (see chapter 9.14.2.2)

As outlined above, the working group on agriculture built on the structures and networks of the Nature Park. Part of the structures were an agricultural advisory service and a ´biological station´ that has been in charge of concluding biodiversity contracts (see context chapter 7.4.2). The minutes of the first meeting of the working group in 2013 reflects the expectation of the River Contract to contribute with land use data (in close cooperation with AGE, ANF, ASTA, and the Chamber of Agriculture). It also expected that the consultants employed by SEBES to coordinate the dossier preparing the protection zones (see ASF 2) could have the role of "advisor" to the working group:

> *"Der Naturpark Obersauer erarbeitet voraussichtlich in Form eines Auftrags die Grundlagendaten zur Land- und Forstwirtschaft. Wichtige Partner sind u.a. Ackerbauverwaltung, Naturverwaltung, Wasserverwaltung, Landwirtschaftskammer, Parc naturel Haute Sûre Forêt d'Anlier und besonders die regionalen Betriebe. Das „IWW Zentrum Wasser" ist von der SEBES als Koordinator der Studie beauftragt worden. Das Institut kann gute Kompetenzen im Bereich Landwirtschaft aufzeigen und kann somit als Ratgeber für die Arbeit in der Arbeitsgruppe dienlich sein" (CRHS, 2013a).*

Membership of the working group was informal, open, and evolving. Among the participants were diverse local farmers (conventional, organic, small- to more large-scale farmers), farm advisors (incl. of the Nature Park and the Chamber of Agriculture) and, as of 2014, a SEBES representative. At the first meeting, the River Contract outlined the main principles underlying the working group (CRHS, 2013a, *own translation*):

- The competitiveness of farms in the river basin needs to be maintained,
- Agriculture is not regarded as solely responsible for worsening water quality,
- The willingness to "*change something*" is a pre-condition for participation in the working group,

- Possible measures should rest on evidence, factual links should be clarified,
- Every opinion will be heard and discussed, based on a constructive and respectful engagement among the members.

These principles are interesting in several regards. First of all, it formulates two of the main preconditions for social and sustainability learning (and, for that matter, *any* learning): notably, the willingness to "change something" and to enter into constructive dialogues (see conceptual framework 3.2.6). At the same time, the principles also emphasise that water protection should *not* be carried out at the expense of the competitiveness of farmers. This suggests that the prevailing productionist paradigm would not be questioned (see chapter 4.2.2). On the other hand, it also made explicit the need for compromises characteristic of integrated approaches to water and land management (see chapter 4.3). This ´precondition´ had been articulated, in order to get farmers and other agricultural actors on board at all. Finally, it seems to have been equally important to underline that farmers were not regarded as sole "polluters" and that (scientific) evidence should contribute to ´factual´ debates.

Despite these principles, some interview partners recalled that the first meetings of the working groups were characterised by defensive attitudes of farmers and other agricultural actors who seemed to ´expect the worst´:

> *"Da wurden direkt Fronten gesetzt, "sie gegen uns", […] "wir müssen uns wehren, auf die Barrikaden gehen"" (interview n°43).*

Examining the minutes of working group meetings, the following issues emerged (CRHS, 2013a, 2013a, 2014d, 2015b, 2013, 2013)

- Fertilisation: a reduction to 130N/ha was discussed as unacceptable, as farmers argued that they had too few possibilities to bring manure and dung elsewhere, therefore, alternative technologies should be considered (see below);
- Experiments with cropping techniques that reduce soil erosion;
- Considering riverbank protection and fencing of water bodies to prevent livestock from entering them (risk of pollution by sediments, faeces, and bacteria);
- Experiments with more ´water-friendly´ cultivation of crops such as maize;
- Experiments to reduce pollution by pesticides and weed prevention: use of pesticides on fields and handling of pesticides during cleaning and maintenance work on field sprayers, particularly, as regards glyphosate (´round-up´).

Issues relating to the use of organic fertilisers (e.g. manure) and pesticides would be recurrent ´hot´ topics throughout the governance processes analysed. For a better understanding of these issues, the working group complemented their own professional knowledge with specialised scientific/technical studies and data from various scientific and non-scientific actors, information about legal and financial possibilities, and, additionally, with professional farming knowledge derived from experiments and practices abroad (ibid.):

- digital model on slope gradients in the hilly area of the river basin developed by the Nature Park,
- water quality data from SEBES, AGE, and LIST relating to nutrients and micropollutants such as pesticides (Terbuthylazine, Metalochlor-Esa, Dichlorobenzaminde from forbidded ´Casoron´, Bentazone),
- information about laws and funding schemes of the ministries for agriculture and environment, presented by the farm advisor of Nature Park,
- erosion maps and soil data from the Ministry of Agriculture,

- exchange of experience between farmers with ´soil-friendly´ cropping techniques (as substitute for conventional ploughing), such as mulch drilling, direct sowing, catch and cover crops and margin strips,
- exchange of experience regarding cooperations between farmers and water suppliers.

The last point would provide a significant impetus to further cooperation. Furthermore, working group participants identified the following needs and knowledge gaps (idem):

- lack of detailed water data relating to nutrients and pesticides – farmers stressed the need for a detailed monitoring network for water quality with frequent measurements,
- more information about erosion and the washing-out of nutrients,
- data on how many nutrients in water originate in the topsoil itself or in forests and from forestry (e.g. as a result of clearcutting),
- more professional agricultural advice, particularly in relation to water protection,
- more funding for water protection measures.

As regards nutrients and phosphates in water, farmers often referred to the long-standing problem of insufficient wastewater treatment in the river basin (on the Luxembourgish and Belgian sides of the border) and to growing local populations, which aggravated the problem. In their view, they contributed significantly to water pollution.

Therefore, needs and gaps identified are a double-edged sword. On the one hand, they were to serve as basis for more targeted, adapted, and potentially effective approaches to problems, based on a better understanding of origins and sources of water pollution and of water flows. On the other hand, a number of actors have suspected that at least some participants of the working group demanded more data as a way to postpone action or to pass on responsibility and find other ´culprits´ for water pollution such as municipal wastewater management.

The members of the working group identified the cooperation between farmers and water suppliers as a particularly promising path to combine agriculture and water protection. The cooperation between farmers and water suppliers (known from neighbouring countries) had been mentioned from the very beginning of the working group. The “Wahnbachtalsperre” in Germany served as best practice example. Financed by an extraction fee that the water supplier pays back to the region, farmers and water suppliers have cooperated there for 25 years[230]. The cooperation has included services of specialised water protection advisors for farmers, innovative agricultural machinery, and various measures to reduce agricultural impacts on water quality. It has also had a “back-up land cadastre” with lots on which farmers can bring out manure if other soil is saturated and during periods in which fertilisation is legally prohibited.

At a guest lecture of the working group, a farmer from the cooperation told the Luxembourgish and Upper Sûre participants that he considered it important that “farmers actively tackle the issue of water protection and take action immediately rather than letting themselves be cornered and having to react to public pressure” (CRHS, 2014d, own translation)[231]. The guest lecturer told participants that farmers now enjoyed a higher recognition among the population, were regarded as co-guarantors of water quality, and had changed their own attitudes towards water as a result of the cooperation. Upper Sûre farmers and the River Contract felt that this example provided a possible way forward. They felt

[230] www.wahnbach.de/wasserschutz/landwirtschaft/

[231] “[…] dass die Bauern das Thema Wasserschutz aktiv angehen und am besten sofort agieren sollten anstatt sich in die Enge treiben zu lassen, und dann auf den Druck der Allgemeinheit reagieren müssen“ (CRHS, 2014d)

confirmed by secretary-of-state for environment and the minister of agriculture who were present at the event. One participant recalled:

> *"Und danach haben die beiden Herren gesagt, also Camille Gira und Fernand Etgen: „Ja, macht das, arbeitet weiter dran. Das könnte ein Modell für uns sein". (interview n°36).*

The minutes summarise (CRHS, 2014d):

> *"Der [Landwirtschafts-]Minister begrüßt die Idee einer Kooperation zwischen allen Teilnehmern […] Es wird geäußert, dass das Landwirtschaftsministerium und die zugehörigen Verwaltungen bereit wären in einer solchen Kooperation teilzunehmen. Das Vertrauen zwischen den verschiedenen Partnern wird wohl nicht von heute auf morgen entstehen, kann aber nur produktiv für die Landwirtschaft, für das Wasser und für die Region sein".*

The secretary-of-state, moreover, said that he was working on a legal revision to ensure that some water funds would flow back into the Upper Sûre region. Via the national water fund, they would later contribute to the financing of a formal cooperation between farmers, the Nature Park, and SEBES. As a result of these ´best-practice exchanges´ the idea emerged to set up a similar cooperation between farmers and SEBES around the lake. In addition to financial support for new techniques and experiments, the farmers – based on the model from Germany - hoped for more flexibility on measures and restrictions, if they cooperated with the drinking water provider. More specifically, they hoped to obtain a "cooperation privilege" ("Kooperationsvorrang") that would grant farmers participating in the cooperation more freedom and room of manoeuvre in return for their organisational commitment to the cooperation with the drinking water supplier, transparency in farming information and practices, and educative and experimental activities.

Inspired by the input, members of the working group sent a catalogue of possible measures they could carry out to SEBES. They included the joint purchase and sowing of catch crop seeds, facilities to fill and clean pesticide sprayers, experiments with mechanical weed control, mulch sowing, CULTAN fertilisation (by manure injection into the soil), dung storage, and water quality monitoring.

With financial aid from and via SEBES, a dozen farmers thus started experimenting with new technologies for crop fertilization and cultivation. After almost two years of meeting in working groups, there was a strong drive to do something in practice and to demonstrate it was possible to produce in a more ´water-friendly´ manner:

> *"Und deshalb haben wir versucht, frühzeitig jetzt schon durch die Kooperation die Produktion in Richtung…also das Vorzuzeigen, wie produziert werden kann, wasserschutzkonform. Dass das aber mehr Aufwand kostet, durch zusätzliche Arbeitsaufwendungen, hochspezialisierte Technik, die wir ja nicht über den Produktpreis finanziert bekommen". (interview n°5)*

Starting in 2014, the first experiment was to inject liquid manure directly into the soil by the help of a sophisticated and expensive machine that had never run in Luxembourg before. Other experiments that followed consisted in sowing seeds by the aid of techniques that do not require ploughing and mechanical week control (see figure 9.4).

Figure 9.3 - Mechanical weed control (source: Naturpark Öewersauer)

On the one hand, the experiments reflect elements of adaptive agricultural and soil management by being based on learning-by-doing and adjustment of measures based on monitoring. On the other hand, they did not aim for changes in – but rather maintenance of – established business models. This is further discussed below (ASI 4).

Informal outcomes of working group on agriculture:

- Non-scientific professional and scientific knowledge, information, data and knowledge ´gaps´ in relation to agricultural techniques, soil quality, and water protection
- Network effects: cooperation of farmers, SEBES, farm advisors, River Contract

Material outcomes:

- First experiments with innovative farming techniques and technologies

9.5 ASF 2: SEBES, consultants and AGE prepare protection zones concept

Summary	Based on the procedures stipulated in the national water law of 2008, SEBES, AGE, consultants from 2013 to 2017 engaged in a ´technical process´ to draft the dossier that was to serve as a basis for the protection zones´ draft law. What added to the managerial approach adopted were perspectives and narratives of how multi-party collaborative processes rarely resulted in social learning and that, moreover, they were unsuitable to contribute to risk assessments. The analysis interprets the process as an expression of the prevalence of technocratic top-down governance and management.			
Synergies and tensions	Synergies between approaches of SEBES, AGE, and the consultancy, based on specialised scientific/technical procedures and data Tensions between existing national *groundwater* provisions and the Upper Sûre lake being a *surface* water body Tensions between the ´technical´ dossier to be prepared and expectations of stakeholder involvement			
Action situation	Main documents	Main interviews	Observations and meetings	Workshops
ASF 1: SEBES, consultants and	National water law (Mémorial A,	N°6, 10, 36, 43, 47, 48	-	-

AGE prepare protection zones concept (2013-2017)	2008), consultancy study on drinking water protection zones (IWW Zentrum Wasser, 2017), SEBES legal basis			

The action situation analyses the roles of the three main actors involved in the elaboration of the dossier for the designation of future drinking water protection zones: SEBES, AGE and a German consultancy. As outlined above, SEBES was in charge of the concept, on the basis of which the new national law creating the protection zones would be drafted. Nearly five years after the national water law had entered into force, SEBES entrusted the elaboration of the concept on the creation of drinking water protection zones to a German water consultancy, IWW Zentrum Wasser, that had carried out similar work in Germany and was to follow instructions from AGE. None of the actors had a mandate to actively involve stakeholders in the process.

As outlined in part I of the case studies (see 7.2.1), SEBES had a formal mandate to ensure nation-wide drinking water supply from the state-owned Upper Sûre reservoir. In line with its legal basis, the syndicate has been in charge of drinking water treatment and supply via its treatment facility and technical infrastructures (Mémorial, 1963). The syndicate has been set up by the state, together with all intermunicipal drinking water syndicates of Luxembourg, with voting rights in its statutory bodies being split 50/50 between the state and the intermunicipal representatives. The municipalities of the Upper Sûre region are represented in SEBES via the syndicate DEA (*´Distribution d´eau des Ardennes´*) that manages water supply for the Northern municipalities of Luxembourg and buys approximately 50 % of its drinking water from SEBES. With the exception of its engagement with the River Contract and farmers in the agriculture working group, SEBES has concentrated its activities on its formal mission to treat and distribute drinking water from the Upper Sûre lake.

Neither SEBES nor AGE had experience in demarcating surface water protection zones in accordance with the extensive formal, scientific, and technical requirements of the EU WFD. Work of AGE administrators and the Ministry of the Interior had focused on the designation of *groundwater* protection zones[232]. For this reason, the dossier was commissioned from IWW Zentrum Wasser whose consultants had experience in drafting similar concepts for water reservoir districts.

The AGE groundwater department was in charge of accompanying the dossier, providing instructions and data to IWW. IWW consultants were asked to take a point of departure in the Luxembourgish groundwater provisions to ensure formal coherence. Groundwater approaches thus had to be adapted to the hydrological and geological conditions of the Upper Sûre lake and to technical standards applying to surface water protection zones. IWW consultants based their work on the technical rules, standards and guidelines for drinking water protection zones for artificial dams (DVGW, 2002) developed by the German Technical and Scientific Association for Gas and Water (DVGW). They included principles on how to define concentric protection zone belts around reservoirs and incoming streams based on risk assessments, and also encompassed examples of restrictions on human activities and recommended measures in water protection zones, in order to minimise potential water pollution risks. The reconciliation of the guidelines of DVGW and the Luxembourgish groundwater protection zones made the task complicated. The original 2015 deadline for the creation of drinking water

[232] In mid-2013, a national regulation had entered into force that laid down administrative measures relating to the protection and demarcation of groundwater bodies that supply drinking water (Mémorial A, 2013).

protection zones was postponed to 22 December 2018. According to the contract with SEBES, the consultancy was to finalize the concept by the end of 2017. IWW Zentrum Wasser prepared a 170-page concept that included the following elements (IWW Zentrum Wasser, 2017):

Part A: Framework conditions

- A general description of the river sub-basin Upper Sûre (incl. its morphology, climate and land uses)
- Geological, hydrogeological and hydrological conditions, including water quality
- Risk assessments relating both to water courses and specific uses and practices and infrastructures – as potential sources of pollution - in the area (industry and commerce, settlements, streets and traffic, agriculture, wastewater)

Parts B and C: Plan and recommendations for the protection zones

- Proposal for the protected area
- Demarcation and structure of the area
- Recommendations concerning matters requiring interdictions or authorisations (as regards buildings and diverse human activities such as agriculture)
- A catalogue on measures to enhance water quality concerning industry, settlements, transport, agriculture and wastewater
- Monitoring network and surveillance and measurement data and programme for water bodies

As regards agriculture, the dossier mentioned the new-born agricultural cooperation LAKU (see ASI 4). It recommends that LAKU members should be able to apply for derogations from certain restrictions in the future drinking water protection zones ("Vorrang der Kooperation"), if they have committed to principles and rules that ensure water protection and lay open their activities, particularly as regards fertilisation and the use of pesticides. The consultants needed a host of data and information to compile the concept. Some of it was generated via specific part-studies and by other specialised consultancies and scientists (ibid.):

- Hydrological modelling and calibration (Hydron GmbH, April 2015-July 2017),
- Hydraulic data concerning the pre- and main dam of the reservoir (Matheja Consult, April 2015-July 2017),
- Research into algae growth and related risks in connection with the two pre-dams (LIST, January 2015-December 2016),
- Nutrition and pesticide studies (LIST, January 2015-December 2016),
- Evaluation and interpretation of the agricultural land use data (IWW Zentrum Wasser itself),
- Collection of land use data relating to agriculture (Nature Park, April 2014-August 2015).

The land use data provided by the Nature Park Upper Sûre included, among others, which crops were cultivated and where, and a risk map. The fact that the Nature Park could contribute with a part-study had been the result of negotiations, but had remained behind the expectations of the River Contract to be able to coordinate some of the tasks serving the elaboration of the concept.

However, as outlined above, the national water law provided for a public consultation only after the dossier of the water supplier had been passed from the ministry to the municipalities concerned. SEBES and AGE had no formal mandates to engage with stakeholders in the framework of the dossier; neither did the contract of IWW Zentrum Wasser encompass active stakeholder involvement. Furthermore, none of the actors had any professional experience in stakeholder involvement, their activities centring on technical water management.

What is more, there had been the change of government in Autumn 2013 (see 9.3.1). It had been officials of the previous government who had allegedly made "promises" of stakeholder involvement to the Upper Sûre River Contract in 2012 (perhaps even, some actors suspected, to gain more local support for the upcoming elections). In interviews and conversations held in 2019, actors, indeed, cited legal constraints to early involvement of local actors in the elaboration of the dossier and, later, the draft law. Accordingly, the elaboration of the dossier was exclusively based on specialised scientific/technical studies and data. Public authorities regarded it as an objective and neutral basis for the future designation of the protection zones:

> *"Schutzzonenkonzept wird von einem neutralen Büro ausgearbeitet, von Fachleuten auf ihrem Gebiet". (interview n°10)*

At the same time, interviews also suggest that the IWW study was influenced by a number of difficulties and subjective factors. The consultants embarked on an "iterative process", in which they collected and interpreted data and maps from different sources, asked for further explanations, information and definitions, partly in exchange with AGE. Some data was easy and quick to obtain, other data required more time and effort. Not all data was readily available and some of it only existed at other ministries or administrations than AGE. Moreover, there was data that some ministries were reluctant to share with reference to data protection (e.g. as regards farming data).

Another difficulty of the study concerned the inclusion of ´third-degree watercourses´, i.e. creeks that flow into streams that flow into the lake. IWW was asked to include *all* watercourses into the protection zones, but data on some creeks was insufficient. Some of them did not appear on maps because of their size and the fact that they tend to dry up in the summer. Consultants thus decided to carry out some on-site visits to gather more information on smaller creeks to assess their hydrological and hydraulic relevance. However, given the vastness of the area, a thorough on-site inspection of all small watercourses would have been time-consuming and have required significant additional efforts. Therefore, hydrogeological knowledge was incomplete and reflected the data that could be obtained by the consultants and administrators within the given time-frame, with scientific interpretations and judgements seeking to ´fill the gaps´. Furthermore, no simple transfer of DVGW guidelines was possible, considering that all reservoir dams are different:

> *"Insgesamt unterscheiden sich die verschiedenen Talsperren hinsichtlich ihres Betriebs, ihrer Topographie, den räumlichen Landschaftszusammenhängen etc. zum Teil erheblich". (interview n°47)*

One of the distinguishing features of the Upper Sûre basin was the fact that its landscape is very fissured and ragged compared to other reservoir landscapes.

The assessment of risks associated with different forms of human activity and physical conditions were one major element underlying the demarcation of the three zones. Among others, it required knowledge of agricultural practices. Risk assessment was partly quantitative (e.g. as regards weather and climate), but the consultants also made qualitative evaluations of the probability of nonrecurrent events such as accidents. Moreover, the proposed demarcation of the different protection zones was not only based on scientific risk assessments, but also took into account existing demarcations of land plots (approximately, 40 000 land parcels with different types of land use), including buildings and roads. The underlying principle was to adapt the protection zones to existing borders of plots and thus to avoid that the protection zone borders would cut through single plots. In other words, consultants needed to take decisions on attributing single plots of lands to either a stricter or less strict protection zone. Plot attribution would turn out to be one of the most frequent reason for objections to the future

draft law by landowners and users. The consultants themselves expected objections (as they had experienced in relation to other protection zones they had elaborated):

> *"Das kann im Einzelfall […] zu nachvollziehbaren Diskussionen führen, ob ein Flurstück nun der einen oder anderen Wasserschutzzone zugeordnet wird – mit entsprechenden Konsequenzen für den jeweiligen Flächenbesitzer bzw. –nutzer" (interview n°47)*

IWW saw their concept as proposals to be further adapted by AGE and the Ministry of Sustainable Development, being aware of the fact that they could not take into account all local and contextual – incl. political – specificities. The consultants finalised the concept in autumn 2017 and submitted it to SEBES, after having participated in a local meeting (see ASI 5).

In addition to *formal* reasons explaining why local actors were not involved during this stage of preparations, a number of possible *informal* reasons were cited during interviews. They point to the prevalence of a managerial approach to water management that combined elements from both the anthropocentric ´command-and-control´ paradigm and from a top-down ecocentric paradigm, both of which have been associated with the EU WFD, with science-based approaches as common denominator (see WFD chapter 4.5). The following quotes provide some evidence for this interpretation. The ministry perceived the elaboration of the concept as a technical task and chose to adopt the same procedures as for the 51 groundwater protection zones that were in the process of being introduced in Luxembourg:

> *"Hatten gesagt, das ist technisch, da braucht sich das Ministerium nicht einzumischen […] Im Grund so, der technische Prozess muss erst ablaufen, dann fängt der politische an" (interview n°43)*

Furthermore, referring to the imperceptibility of pollutants and water flows, few actors interviewed expressed the view that professional and local knowledge could have added value to the demarcation of protection zones:

> *"Ich glaube nicht, dass die, die das infrage stellen, mir erklären können, wie der Abfluss vom Wasser und das Ausspülen funktioniert…und Erfahrungswerte? Glaube ich nicht: Nitrate, Pestizide, die sieht man nicht, die riecht man nicht" (interview n°10)*

Finally, few national interview partners believed that it would not have been realistic to gather municipalities and farmers around a table and to reach a common ground and agreements on some of the most controversial issues (n°10, 17, 40, 43).

> *"Wie schafft man das, ein solches Schutzzonenkonzept auszuarbeiten? Bei all diesen Sachen sagt einem die Erfahrung, man muss Experten nehmen, in einem begrenzten Kreis, und dann arbeitet man neutral etwas aus. Man weiß auch ganz gut aus Erfahrung aus allen möglichen Bereichen, dass wenn man bei so etwas jeden, der irgendwie betroffen ist, oder sein könnte, oder meint, er könnte betroffen sein, an einen Tisch bringt, dann wird man nichts erreichen. Dann wird man sich auf nichts einigen können". (interview n°10)*

> *"Von der Basis aus: Habe ich oft mitgemacht, versucht. Also, ich bin mittlerweile kein Freund davon. Vom Prinzip her absolut. Aber Bilanz war immer: […] Die drei ersten Versammlungen sind immer so, dass jeder mal selbst seine Position wieder reaffirmieren will. Sie kriegen eine objektive Diskussion schon die ersten Male nicht hin. Und dann, sobald man glaubt, man hätte einen Konsens, etwas diskutiert, und das steht etwas auf dem Papier, was dann einem nicht gefällt, dann kommt wieder einer: „Mit dem Punkt können wir nicht einverstanden sein". Dann fangen*

sie die ganzen Runden wieder von Neuem an. Das ist jedes Mal so. Ich wäre froh, wenn wir das geändert kriegen" (interview n°17).

The reluctance to embark on participatory processes was thus also rooted in past experiences that suggested to those involved that efforts had been fruitless, i.e. not resulting in social learning. Some governmental actors have drawn the conclusion that regulatory frameworks have to be put into place *first* to increase pressures to *subsequently* foster innovation and ´solutions´:

"Manchmal ist ein gesetzlicher Rahmen unerlässlich, um Innovation zu fördern". (interview n°25)

"Und erst wenn ein gewisser Druck, ein gewisser Handlungsdruck besteht, ist es dann auch einfacher, wirklich Lösungen zu finden". (interview n°60)

Formal outcomes:

- Drinking water protection zones dossier submitted by SEBES to the Ministry of Sustainable Development (see ASF 4)

Informal relational effects:

- Disappointed expectations among local actors (see ASI 5)

9.6 ASF 3: Pesticide accident leads to restrictions and controversies

Summary	In 2014, a pesticide accident polluted the Upper Sûre lake and incoming streams. This meant that national drinking water supply had to be secured via emergency wells that, however, also turned out to contain pesticides. Luxembourg had to apply for a derogation of drinking water quality standards at the EU and introduced additional restrictions on pesticide use. The threat posed by pesticides to societal water security resulted in political and public controversies about agriculture that increased informal barriers to dialogues between governmental and local actors in the region.			
Synergies and tensions	Tensions between commitment to dialogues and societal debates, in which farmers were perceived as ´culprits´ Tensions between farmers´ doubts about pesticides and (perceived) existence of alternatives			
Action situation	Documents	Main interviews	Observations and meetings	Workshop content
ASF 2: Pesticides accident (2014) leads to restrictions and controversies	National regulation on drinking water, AGE and SEBES communications, scientific and press articles	N°5, 6, 10, 15, 16, 17, 18, 19, 20, 23, 34, 36, 38, 40, 43, 60	-	-

On 17 September 2014, a pesticides accident in the Belgian Upper Sûre sub-basin shook Luxembourg. It would profoundly influence legislation, political, and public debates on water protection and agriculture in the months and years to come. A Luxembourgish farmer had an accident with his tractor and boom sprayer. As a result, the herbicide metazachlor flowed from a small creek to the drinking water reservoir within a few days. Local fire brigades had aggravated the situation by washing spilled contents into the river Sûre (Karier et al., 2017). Luxembourgish authorities had been informed by their Belgian counterparts, but could not prevent the flow of contaminated water into the lake. SEBES and AGE measurements soon revealed increasing concentrations of metazachlor-ESA (SEBES, 2014). As a precautionary measure, drinking water supply from the lake was interrupted in the period from 1 to 7 October 2014. Instead, SEBES water supply came from 15 alternative groundwater wells (Karier et al., 2017). However, alas, increased measurements showed that, independent of the accident, groundwater sources in Luxembourg were also contaminated by metazachlore breakdown products (metabolites) and surpassed Luxembourgish legal thresholds that were based on EU legislation (Mémorial A, 2002b)[233]. The government thus had to make use of the possibility to derogate from established legal thresholds to secure national drinking water supply. It informed the European Commission of this decision, accompanied with an action plan on how to improve the situation (AGE, 2014a). During this period, the Ministry of Health temporarily increased the threshold for metazachlore-ESA from 100 ng/l to 3000 ng/l and put into place an extensive monitoring programme for all drinking water sources in Luxembourg (ibid.). Following further findings of pesticides and their metabolites, the use of the herbicide S-metolachlor was completely prohibited in Luxembourg and the use of metazachlor was banned in drinking water protection zones and restricted in other parts of the country (Mémorial A, 2015). Following the accident, SEBES invested significantly in the expansion of its ozonation system, in order to be able to reduce the concentration of metazachlor-ESA in drinking water (interview n°6, Karier et al., 2017).

These formal and technological processes were accompanied by intense debates in the Upper Sûre region and nation-wide. Following the accident, the River Contract Upper Sûre addressed a letter to the minister and secretary-of-state of the Ministry of Sustainable Development and to SEBES, upon initiative of its agriculture working group (CRHS, 2014f). In the letter, it offered its cooperation to contribute to inquiries into the accident and to the "removal of the [pesticides] problem" (own translation). It also underlined that the Nature Park, with its farm advisory service and the River Contract, made important contributions to water protection in the area and that there had been increasing cooperation with SEBES since 2011. It pointed out that it had initiated debates on the issue of pesticides in public and within the working group since 2012 (i.e. before the accident).

Furthermore, the letter expressed regret about the fact that the River Contract had not been informed directly about the pesticide accident and hopes for better future cooperation. Finally, the River Contract invited the Ministry of Sustainable Development and SEBES to participate in the agriculture working group to "share insights" so that "common strategy to improve the situation" could be developed (ibid., own translations)[234]. However, between September 2014 and the end of 2017 there

[233] Règlement grand-ducal du 7 octobre 2002 relatif à la qualité des eaux destinées à la consommation humaine (Mémorial A N°115) based on Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption.

[234] "Aufgrund der aktuellen Erkenntnisse bezüglich des Pestizids Metazachlor und dessen Metaboliten möchten wir mit […] dem Angebot zur weiteren intensiven Zusammenarbeit zur sachlichen Aufklärung und der Beseitigung des Problems beitragen. […] Wir bedauern, dass wir bisher noch nicht über die aktuellen Vorfälle informiert wurden. Wir möchten Sie deshalb unbedingt einladen im Rahmen unserer Arbeitsgruppe zu uns zu kommen und uns an Ihren Erkenntnissen teilhaben zu lassen und eine gemeinsame Strategie zu entwickeln um die Situation zu verbessern. In der Hoffnung auf eine zukünftig verbesserte Zusammenarbeit verbleiben wir […] ". (CRHS, 2014f).

would, in general, be few direct contacts between the River Contract, its agriculture working group, the Ministry of Sustainable Development, SEBES and AGE concerning the future protection zones. It will be suggested below that the debates surrounding pesticides triggered by the accident – and, later, a WHO statement on glyphosates as potentially carcinogenic (see below) - increased informal barriers to communication between the actors.

Following the accident, the government faced public fears and debates. A national newspaper titled that drinking water had been contaminated by the accident: "Nach Unfall in Belgien: Trinkwasser belastet" (Luxemburger Wort, 2014). The article *did* stress that the pollution in the river basin did not mean that the consumption of tap water was unsafe. Nonetheless, bottled water in supermarkets sold out within hours. Following the derogation from pesticide thresholds, AGE also officially informed the public that a concentration of less that 3000 ng/l of metazachlor-ESA did not pose any health risk and that the previous threshold had not been based on toxicological studies, but rather reflected the former analytical limit of detection for phytopharmaceutical products (AGE, 2014a).

According to actors interviewed, the pesticide accident and subsequent findings had the consequence that drinking water availability and water pollution, for the first time, became objects of public debates, while it had simply been taken for granted before (interview n°60). Some went as far as calling the accident "one of the best things that ever happened" (interview n°34), as it increased public awareness of the preciousness of water.

It also added fuel to debates about agriculture in Luxembourg, with divergent assumptions held by environmental and agricultural actors surfacing in narratives that can be related to an ecocentric paradigm and, respectively, the productionist paradigm in agriculture. Two aspects of the controversies will be outlined in the following, because interviews suggest that their political character deeply affected relations and processes in the Upper Sûre region: the polluter-pays principle and the use of pesticides often evoked in debates about conventional versus organic agriculture.

As regards the polluter-pays principle, two views emerged from interviews: those in favour of debating if and how the principle should be applied to agriculture (voiced especially by environmentalists) and those rejecting that farmers be regarded as polluters ´who should pay´. One proponent of the principle stated:

> *"Und man muss gesellschaftlich vielleicht auch bereit sein, dieses ´pollueur-payeur´-Prinzip einmal öffentlich zu machen. Man bezahlt an die Landwirtschaft über 700 Mio. Euro über sieben Jahre, nationale und EU-Gelder. Fast 100 Mio. Euro pro Jahr. Aber was dann die Gesellschaft…die Kläranlagen, die gebaut werden müssen, die Trinkwasseraufbereitung, genau.[…] Wenn man sagen würde, „okay, ihr kriegt so viele Subsidien, aber dann müsst ihr auch die Nebenkosten bezahlen, die anfallen". Das ist gesellschaftlich bis jetzt nicht diskutiert, nicht so gewollt. […] dann kann es auch sehr schnell gehen, dass man sagt, „okay, da will ich nicht als Landwirt ´pollueur-payeur´ sein. Das wird sehr teuer". Eine Wasseraufbereitung kostet horrend. Das bezahlt bis jetzt immer die Gesellschaft" (interview n°17).*

Not only agricultural actors, however, reject the idea. Others interviewed expressed the view that not only farmers were responsible, but that consumers also had a share:

> *"Ja, das Prinzip ist sicherlich richtig, aber […] wie sie so etwas politisch umsetzen möchten, wollen, sehe ich nicht direkt. Und wenn sie sagen, der Landwirt ist ´Pollueur´, dann bin ich mir auch nicht so sicher. […] Das hängt ja alles zusammen. In letzter Konsequenz ist es dann der Konsument. Wenn der mehr bezahlt für das Fleisch, dann braucht der Landwirt nicht ´Pollueur´ zu sein" (interview n°27).*

Furthermore, agricultural actors argue that, if a farmer is legally allowed to use certain pesticides, then there is no reason to object:

> *"Weil wenn das erlaubt ist, dann darf er das auch machen. Wenn das nicht erlaubt ist, dann darf er das nicht". (interview n°38).*

In its government programme of 2013, the liberal-socialist-green coalition had agreed on the promotion of organic agriculture as a way to "conciliate" agriculture with environmental and water protection. In order to facilitate the conversion, an action plan on organic agriculture of the Ministry of Agriculture (MAVDR, 2014) [235] was to be reinforced:

> *"Le Ministère encouragera notamment avec de plus amples moyens financiers le développement de l´agriculture biologique et la conversion – à court et moyen terme et en étapes successives – vers l´agriculture biologique" (Gouvernement, 2013).*

Following the pesticides accident, the Green party and the Green-led Ministry of Sustainable Development promoted organic agriculture (in which the use of pesticides is forbidden) even more fervently than before. Organic farmers felt strong public and political support. Non-organic farmers in the Upper Sûre region, however, felt that dialogues and cooperation were becoming increasingly difficult. Some farmers interviewed felt their arguments were hardly listened to and that they, moreover, were perceived as environmental polluters:

> *"[…] nur als Umweltverschmutzer. Einer, der eine Ideologie hat von Bio-Bauernbetrieb […] dass…die ideologische Überzeugung von den Leuten, die im Wasserwirtschaftsamt arbeiten bzw. im Umweltministerium in eine Richtung ist. Vielleicht falsch. Aber wenn du z.B. nur von Bio überzeugt bist, dass das der einzige und richtige Weg ist, dann ist es schwieriger, auf Argumente von anderen zu hören, und da Überzeugungsarbeit zu machen. Den Eindruck habe ich, wenn man nicht in der Richtung fährt". (interview n°18)*

Several interview partners from agriculture deplored what they experienced as arrogance among officials within the Ministry of Sustainable Development and AGE. One actor recalled a discussion on Jacob ragweed (a poisonous domestic weed, *senecio jacobaea*, that spreads particularly on extensively used – or unused – prairies and that can cause chronical diseases in cattle when it cumulates in the liver). He felt that farmers´ concerns about the weed were not taken seriously. Instead, farmers were allegedly accused of "spreading their pesticides everywhere" (Interview n° 16).

Other interview partners mentioned a request from the agricultural cooperation LAKU (see ASI 4) to equip pesticide sprayers with new techniques to facilitate filling and cleaning and, thereby, to prevent pesticide spills (interview n°5). The Ministry of Sustainable Development rejected to fund the measure. This alienated some actors who saw this as a sign of – and still use the argument today – that greens and environmentalists were not willing to support improvements that would have produced tangible outcomes. Actors in the area suspect that this was due to the fact that the ministry feared being associated with pesticides and conventional agriculture in any way at all (interview n°5, 18). On the other hand, the possibility to retrofit pesticide sprayers had already existed via SEBES before (a fact not mentioned by interlocutors who voiced the criticism). However, there had been only few requests from farmers (personal communication n° 2 of 5 November 2019). Thus, the controversy also seems to be an example of how different sides selected different ´facts´ that suited their arguments best.

[235] Le plan d´action national pour la promotion de l´agriculture biologique. Rétrospective 2014. Ministère de l´Agriculture, de la Viticulture et du Développement rural

Only a few months after the pesticides accident in the Upper Sûre river basin, the World Health Organisation (WHO) declared that the pesticide glyphosate (used in ´Roundup´) might cause cancer (Cressey, 2015). This further added fuel to political and public controversies in Luxembourg (as EU-wide) about the use and possible health impacts of pesticides. A Luxembourgish retailer reacted by banning Roundup from its shelves (Luxembourg Times, 2015). In its programme of 2013, the government in Luxembourg had declared its intention to promote regional and national organic quality-products and to raise awareness among consumers to be willing to pay a "fair price" for agricultural products (Gouvernement, 2013). Linking the two debates, some environmental actors interviewed argued that farmers should stop using glyphosate voluntarily as a precondition for producing and marketing their products in Luxembourg:

> *"Also auf dem Weltmarkt sind wir sowieso weg. Wir können nicht produzieren wie die Australier, wie die Russen, wie die Amerikaner. Das heißt, wie müssen uns […] unterscheiden. Wie können wir uns unterscheiden? Qualität! Qualität heißt für die Leute, wir nutzen kein Glyphosat. Proaktiv könnten die Landwirte mal sagen […] „Kommt, wir nutzen kein Glyphosat". Warum muss das von den Bestimmungen, oder von den Ministerien kommen?! Okay, „wir können nicht anders". Es geht [aber doch] anders." (interview n°17)*

From the perspective of other interview partners, however, the glyphosate debates were not based on "facts":

> *"Die Debatte Glyphosat ist ja abseits von jeglichen Fakten, ist eine rein politische Diskussion, und die Politik wird getrieben von einer Meinungsmache, das muss man klar sagen, speziell in Luxemburg. Das ist schwierig […] Also, Glyphosat im Grundwasser ist kein Thema, im Oberflächenwasser wird das Abbauprodukt gefunden. Deutsche Studien haben erwiesen, dass das wenig Impakt aufs Ökosystem hat. Ich glaube [aber], wir sind in der Bringschuld, vernünftig mit dem Produkt umzugehen […] Ich sehe das Glyphosat als ein Puzzleteil von einem ganzen System, und, ich glaube, da wird vieles durcheinander geworfen. Die Leute verstehen auch nicht den Unterschied zwischen den genmanipulierten Pflanzen […] Ja, Monsanto ist dann der Teufel, der an die Wand gemalt wird. Das Mittel [Glyphosat] ist billig, es hat eine breite Wirkung, natürlich. Ob man das in dem Maßstab einsetzen muss, wie es eingesetzt wird, das ist eine [andere] Frage". (interview n°15)*

As the first EU country, Luxembourg would later ban the use of herbicide containing glyphosate as of 1 January 2021 (MAVDR, 2020). In 2014 and 2015, however, the debates about metazachlor, metolachlor and glyphosate ´contaminated´ debates and relations between the Ministry of Sustainable Development, AGE, on the one hand, and farmers and other agricultural actors, on the other. The debates also affected relations with the River Contract who was perceived as too close to conventional agriculture.

One of the main differences between perspectives and narratives of environmental and agricultural actors interviewed was the question whether farmers actually had the choice of producing without the use of pesticides (and to ´go organic´) or whether they were ´caught´ in a system that left them with little room for manoeuvre. As in the quote above, some farmers interviewed explained what they perceived as a choice or ´trade-off´ to be made between different approaches in agricultural practices that either focus on reducing erosion by not using ploughs (but with occasional use of pesticides such as glyphosate) and those approaches where ploughing is used, but pesticides much less (interview n°18). As a "piece of a puzzle" they felt that glyphosate could not simply be removed or replaced without changing the entire approach, unless glyphosate was simply replaced by another (and potentially more harmful) substance. For this reason, some agricultural actors have pinned their hope

to phytopharmaceutical companies succeeding in producing biodegradable pesticides (interview n°18).

Other farmers, however, contest the argument, believing it possible to reduce both soil erosion *and* pesticide use. Some felt that conventional farmers had a lot to learn from organic farmers in this regard, for which the working group of the River Contract provided a forum (interview n°19).

At the same time, agricultural actors interviewed agreed that the success of one approach and its desired effects, in general, depended on a combination of a wide variety of factors, including soil characteristics, the crops and, notably, the weather. In general, dry seasons would reduce the need to use pesticides. Some conventional farmers were proud to tell the interviewer that they had not had to use glyphosate (or any other pesticides) for years (interview n°44). They presented this as a "proof" of the quality of the job they did. They also stressed that pesticides were a cost factor.

Some conventional farmers therefore felt particularly dismayed at allegedly being depicted as irresponsible pesticide sprayers. They explained that there were many different ways of using pesticides such as glyphosate and argued that they were probably more aware of how to handle them "responsibly" than most private households or businesses (interview n° 18).

Furthermore, farmers themselves may be uncomfortable with the use of pesticides. In interviews, pesticide use was often presented as the most problematic issues in agricultural practice – not only as regards their environmental impact, but also as regards their possible impact on the health of farmers themselves. One farm advisor explained:

> *"Die Leute sagen, „effektiv, ich vertrag das nicht. Die verschiedenen Produkte vertrage ich nicht". Oder: „ich mache meine Kabine sehr fest zu". Ist sogar ein Betrieb, der hat gesagt, „ich habe extra Karbonfilter auf meine Kabine eingebaut". Damit da nix reinkommt […] die Leute erzählen dann schon". (interview n°20)*

For one farmer, concerns about pesticides (and his children´s health) and public opinion had been one of the main reason for ´going organic´:

> *"Ich bin ja leicht nervös. Aber ich bin schon viel ruhiger geworden seit ich die Umstellung hinter mir hab. Ich bin mit mir im Reinen, weil ich weiß…ich rette die Welt nicht, aber…ich bin ja auch mit der Feldspritze gefahren. Da kamen die Kinder angelaufen, musste die wegtun, habe gesagt, "nee, ich gehe zuerst unter die Dusche und dann könnt ihr" […] Das hier ist jetzt mein letzter Weg. Ich weiß von der Gesellschaft, die akzeptiert das voll und ganz, was ich hier mache…biologisch". (interview n°23)*

On the other hand, some farmers interviewed explained that they had considered the option to convert to organic (e.g. before making significant investments to modernise their stables), but had decided against this for a number of diverse reasons. One reason was that organic agriculture required a lot more knowledge and attention, along with an acceptance of higher risks of losses in yields: "*da ist so viel Zusatzwissen, und Zusatzaufpassen erforderlich…was viele vom Kopf her gar nicht mehr aushalten*", further referring to the general risk of burnout among farmers (interviews n°5, 16, 20).

Organic farmers interviewed, indeed, referred to a higher level of stress and the need for detailed experience-based professional knowledge of soil, plant, animal, and weather conditions. Their statements thus provide some evidence for scientific claims that e.g. agroecological and other forms of "sustainable" farming are particularly intensive in terms of local ecological knowledge needs (Ingram, 2008; Röling & Jiggins, 1998).

Others again had decided against an organic farming model, because farm advisors had calculated they would have to accept a significant reduction of incomes (interview°44). Others felt that there were only few examples of successful organic farmers that worked in a profitable manner. Several interview partners argued that farmers who had gone organic (or engaged in extensive farming programmes) did so primarily because they had not been successful as conventional farmers and sought to obtain additional financial support from the state before retiring, as part of an ´exit strategy´ (interview n°18). Some farmers also deplored that there were not enough consumers in Luxembourg willing to pay for the more expensive Luxembourgish organic milk and dairy products and that it would, therefore, be a problem, if there were more than the current 12 organic milk farmers in Luxembourg. 50 % of the organic milk had already to be exported as non-organic abroad (NEXUS FUTURES, 2019a, see also annex III, interviews n° 18, 21). Many agricultural actors interviewed expressed dismay at perceived as "Umweltsünder" by the public, consumers were unwilling to pay higher prices for agricultural products. Finally, some farmers did not have the option to become organic producers, because they had only received permits for the construction of stables in places where they had no access to pastures (pasturing is a compulsory requirement for organic dairy products).

One of the main problems of farmers and agricultural actors interviewed was thus that they felt that there was little understanding among environmental policy-makers and the public for the kind of pressures and systemic constraints they experienced in their daily lives. While many environmental and governmental actors interviewed argued that farmers *did* have a choice to work in more organic or extensive manners, many agricultural actors themselves felt farmers were "standing with the backs to the wall" (n°16), served as "scapegoats" (n°12), were "marionettes" (n°12, 44).

These statements inscribe themselves in narratives prevalent in agricultural communities that see farming as characterised by "Fremdbestimmung" (heteronomy or "Reagieren"), caught in a constant struggle for "Selbstbestimmung" (self-determination, or "Agieren") and for economic survival. This framing also finds expression in an article of an agricultural advisor:

> *"Jeden Tag auf allen Ebenen selbstbestimmt Entscheidungen zu treffen ist fast unmöglich […] Es gibt kaum eine Berufsgruppe, die so fremdbestimmt ist, wie der Landwirt. Im Jahreszyklus sind sie abhängig vom Wetter. Die Agrarpolitik lässt sich regelmäßig neue oder geänderte Agrargesetze einfallen. Die Medien mit ihren pauschalisierenden und skandalträchtigen Berichterstattung über die Landwirtschaft tun ihr übriges zur Fremdbestimmung dazu" (CONVIS, 2018).*

The advisor calls for farmers to recognise and use "Spielräume für Veränderung" ("rooms for manoeuvre for change") rather than to continue "business-as-usual" and to seek professional farm advice to be able to do so. This would be a first step towards more self-determination in farmers shaping the future of their own farms. From this perspective, the agricultural working group of the River Contract and later agricultural cooperation LAKU can be interpreted as an expression of the pursuit for more self-determination (see ASI 4)

Overall, the pesticide debates of 2014 and 2015, however, contributed to worsening relations between the Ministry of Sustainable Development, some local actors and farmers. The possibilities of exchanges that the River Contract, its working group – and later LAKU (see below) – offered were hardly used.

The example may thus suggest that hazard events may contribute to *increasing* polarisations and mistrusts rather than to bring actors together, if trustful relations are not in place before an adverse event occurs.

Formal outcomes:

- legal restrictions and bans on pesticides nation-wide and, in particular, in drinking water protection zones

Material effects:

- Ecological: pesticides pollution of Upper Sûre lake and discovery of pesticides in groundwater wells

Informal outcomes and effects:

- Societal – informal: public debates and awareness of the preciousness of drinking water and concerning the pollution of drinking water sources caused by pesticides use in agriculture
- Interpersonal and –organisational relations: cooling down of relations between the Ministry of Sustainable Development, AGE, the Upper Sûre River Contract, and farmers

9.7 ASI 4: Agricultural cooperation LAKU is launched, experiments

Summary	In 2015, the Upper Sûre Nature Park (including its River Contract), SEBES and farmers set up the first formal multi-actor agricultural cooperation in Luxembourg (LAKU). It included a commitment to share water- and land-related information and scientific data. LAKU continued experiments promoting leaning-by-doing and critical reflections between conventional and organic farmers. While there were first signs of double loop learning, the main objective of most farmers was to be able to continue existing business models after the creation of the new protection zones, notably, via efficiency improvements.			
Synergies and tensions	Tensions between farmers´ commitment to ´water protection´, on the one hand, and to existing farming models on the other Synergies between professional farming knowledge and specialised scientific/technical studies and data			
Action situation	Documents	Interviews	Observations and meetings	Workshop content
ASI 4: Farmers, water supplier, nature park found formal cooperation (Sep. 2015)	River contract WG agriculture minutes, LAKU cooperation agreement and annual reports	N°5, 6, 10, 16, 18, 19, 20, 33, 35,36, 43, 44, 50	-	-

As outlined above, the working group of the River Contract on agriculture had identified the cooperation between farmers and a water supplier in the German Wahnbachtalsperre as an example to be pursued in Luxembourg, with the support of the Nature Park (and River Contract), SEBES and the two ministries of agriculture and sustainable development. The cooperation that was to be put into place was driven be a handful of pioneering individuals, one independent farm advisor, a few farmers who had participated in the working groups meetings from the very beginning, and the River Contract. It rested on the commitment and (prospect of) financial support provided by SEBES (which would partly be refunded via the national water fund), with a draft programme of agricultural measures as basis. One of the first concrete steps in this direction was a joint excursion, on which working group members

met with farmers at the "Wahnbachtalsperre". Some actors interviewed recall the excursion as a founding moment. According to them, the idea for the first formal Luxembourgish cooperation LAKU was conceived on the backbenches during the bus trip to and from Germany, which included a SEBES representative.

> *"[…] da habe ich auch das erste Mal gemerkt, dass die SEBES so mit an dem Strang zieht […] Die wollen das wirklich und die machen da mit jetzt und die stellen sich dieser Aufgabe". (interview n°36)*

One interviewee called the planned cooperation between farmers and SEBES that would emerge from the excursion as a milestone, considering that SEBES had been largely absent from local and regional activities. One of the main incentives for the farmers to launch the cooperation was the prospect of being granted more flexibility ("Kooperationsvorrang") once the new drinking water protection zones would be in place.

In 2015, SEBES, the Nature Park, and individual farmers concluded a formal agreement to set up the Landwirtschaftlich Kooperatioun Uewersauer (LAKU). The common objective of the partners was to establish a cooperation that would pursue the following overarching objectives of protecting soil and water bodies by preventing or redressing harmful environmental impact via land use practices that would reduce the amount of nutrients and pesticides washed into water bodies and thereby contribute to the improvement of the quality of crude water used for drinking water supply (LAKU, 2015):

> *"Die Vertragspartner gründen für das Wasserschutzgebiet der Obersauertalsperre eine Kooperation, deren Zweck es ist, gemeinsam mit den zuständigen öffentlichen Stellen dazu beizutragen, dass die Bereitstellung von einwandfreiem Rohwasser für die Trinkwasseraufbereitung auf Dauer sichergestellt wird".*

They committed to putting all necessary data (e.g. regarding land use, results of water and soil analyses, hydrological and cartographic data) at each others´ disposal and to seeking to obtain additional data from public administrations to set up an inventory that should contribute to insights into and evidence concerning causal relations between agricultural practices and water quality:

> *"Artikel IV.: Die Vertragspartner beabsichtigen mit der Kooperation […] ursächliche Zusammenhänge zwischen landwirtschaftlicher Tätigkeit und Gewässergüte festzustellen und den Wissensstand hierüber zu erweitern".*

The Nature Park was to be in charge of coordination and the interpretation of data. The information was be passed on to SEBES and also be used by farm advisors. Farming members committed to making use of specialised farming advice tailored to water protection. The elaboration and implementation of a joint programme of measures (decided upon by unanimity in the LAKU board composed of farmers, SEBES, and Nature Park representatives) was to be financed by SEBES and public funding schemes (e.g. the national water management fund). The cooperation agreement also stipulated that the cooperation aimed to promote "water-compatible" forms of land management ("gewässerverträgliche Landbewirtschaftung") that would be in the interest of both water protection and the participating farmers, i.e. without incurring economic disadvantages.

A part-time coordinator was financed and employed – it was the coordinator of the river partnership (employed by the Nature Park) who would henceforth divide his time between the River Contract and LAKU. The cooperation would grow to encompassing 87 farming members in 2018 (including 7 organic farmers), covering approximately 73 % of the agricultural lands of the Luxembourgish part of the lake watershed (CRHS & LAKU, 2019). There were no membership fees and farmers were to participate on

a voluntary basis. It was not compulsory that members participated actively in LAKU experiments and activities.

In addition to the exchange and production of data, the main activities of LAKU consisted in seminars and field trials of various technologies, techniques, and crops (see figure 9.4). Through these, LAKU sought to offer a space, in which farmers would openly discuss the impact of agriculture on the environment ("*es gibt ja immer noch Landwirte, die das einfach bestreiten*", interview n°5) and to begin to question their own practices:

> *"Ich sehe das als eine der Hauptaufgaben der LAKU, dass die Betriebe mal selbst erkennen, sich ständig zu hinterfragen." (interview n°50).*

Several interview partners argued that LAKU contributed to enhancing dialogues between farmers about their practices, including between organic and conventional farmers who have often been in different ´camps´ and communities:

> *"Das ist ein Austausch, wo jeder von dem anderen lernen kann. Die Konventionellen lernen beim Biobauern, wie´s geht auch ohne Chemie, und [die Biobauern] lernen mit neuesten Maschinen von konventionellen Betrieben, und welche Art und Weise da praktiziert wird. Deshalb sage ich, bin ich persönlich bemüht, Gräben zuzuschütten. Wir sind alle Bauern. Wir müssen ja auch leben können. Und jeder muss sich seine Meinung bilden können" (interview n°19).*

Figure 9.4 – Field trial with catch crops (source: Naturpark Öewersauer)

As regards joint seminars, two to three external speakers (from both science and practice) would be invited during winter months to share their professional knowledge on topics that related to how to reduce the impact of agricultural practices on water and soil quality. Typically, founding members would contact potential external speakers, discuss with them what would be particularly relevant for Upper Sûre farmers, and make sure that information would remain accessible to all participants (e.g. via their website). In this way, they wanted to make sure that the information would remain available as a basis to develop measures adapted to the region:

> *"Es sind auch viele Redner, die wollten das dann nicht, dass das publiziert wurde; ja, den haben wir nicht eingeladen. Ich sagte, dann bringt es nichts. […] Aber das ist so das Spezialwissen, was wir versuchen; auch speziell für unsere Flächen hier aufgearbeitet. […] Die Maßnahmen, die wir*

hier anbieten, sind teils modifiziert. Wir haben die auch nicht erfunden. Wir haben die irgendwo gesehen, aber dann mussten die modifiziert werden, um hier in unsere Gegebenheiten…damit das passt" (interview n°5)

As regards the field trials with diverse technologies rented from an external machine park (e.g. for the direct injection of manure into the soil, see figure 9.3 above), they required extensive technical knowledge that only a few founding LAKU members possessed in the beginning:

" Das ist unmöglich, dass alle […] das Spezialwissen sich so aneignen. Es gib zu viele Details. Wir sind ständig jetzt dran. Heute kommt noch die Hackmaschine, dann ist man wieder am Notizen machen am Handy, um alles zu hinterlegen, sonst hat man es für die nächste Saison wieder vergessen. [An Interviewer gerichtet:] Sie wollen nicht wissen, was wir Landwirte […], was wir an Telefonaten führen müssen. Die haben ja alle unsere Handynummer, die anderen Landwirte. Dann sind die auf dem Feld und fragen: „was soll ich jetzt, was soll ich hier [machen]…?"" (interview n°5)

Participating farmers have regarded it as an advantage that they no longer need to purchase certain machines themselves: "*seit ein Paar Jahren haben wir Lohnunternehmer, die sich richtig spezialisiert haben…hat uns auch einen Schritt weitergebracht, dass man nicht mehr alles [selbst] kauft".* (interview n°18)

According to participating farmers, the main aim of these diverse technologies (see figure 9.5 for manure injection) was efficiency, e.g. to improve the relation between input (e.g. of manure) and output (yields):

"Das ist genau der Punkt, den die LAKU von Anfang an ja als Aufhänger hatte: die Effizienzsteigerung in allen Bereichen, sei es jetzt vom Management her, vom Einsatz von der Organik her, von den gesamten Dünge- und Spritzmitteln. Wenn man da schon die Effizienz komplett ausreizt, hat man viel erreicht" (interview n°50)

Figure 9.5 – Liquid manure injection (source: Naturpark Öewersauer)

In addition to diverse cultivation techniques, LAKU has been in the process of adapting a GIS-based tool to its purposes ("Landmanager"[236]), as part of collecting and making available extensive land use and fertilisation data. Among other functions, the tool provides farmers with detailed information about when and how much they can fertilise which land plots. The tool is tailored to water protection zones, in which farmers often face diverse restrictions depending on whether their land is situated in an immediate or more remote protection zone.

Thus, the main aim of LAKU farmers has not been to change business models, but rather to facilitate and make it possible for farmers to maintain production and be economically viable, especially after the setup of the new protection zones. Efficiency is assumed to also have environmental benefits, as the principle implies that only so much should be fertilised or sprayed as can be absorbed by the crops, with as little residues and excess as possible. In this sense, LAKU can be said to be characterised mainly be incremental learning or, put differently, "business-as-usual" (see chapter 3.2.2.2).

Modern technologies have been a crucial means to increase the compatibility between economic viability and water protection. Some farmers interviewed regarded technological innovation and new ways of handling manure as the only way to save current livelihoods: *"[…] damit wir den Betrieb nicht so verkleinern müssen, dass da ein oder zwei Arbeitskräfte andere Beschäftigung suchen müssen*" (interview n°18), said a farmer who had family members working on the farm. Many farmers interviewed emphasised they had not actually wanted to continue to expand farms, but that they considered growth necessary to remain survive economically: „*Wir sind gewachsen, um zu überleben*" (interview n°5).

One municipal representative saw in LAKU an example of civic engagement in a time he experienced as increasingly dominated by individualism and selfishness:

> *"Für uns ist die LAKU trotzdem…[…] Ja, es ist ihr Betrieb. Aber sie arbeiten auch für die anderen Landwirte […]. Sie opfern ihre Zeit, also sie opfern zum Teil ihre Zeit für die ganze Gemeinde. Und hier ist die LAKU…hat einen sehr hohen Stellenwert. Sehr. Und auch menschlich muss ich sagen ist…die LAKU ist ein Beispiel, wo Bürger sich für Bürger einsetzen. Es ist ihr Betrieb – natürlich. Aber sie könnten auch vielleicht anders reagieren". (interview n°33)*

All agricultural and governmental actors interviewed stressed the increasing importance of farm advisors in supporting farmers to adapt (or transform) their business models and practices by adding an external perspective to farmers who may be so immersed in daily routines that they become "blind" to shortcomings of their practices and opportunities to change them. One farm advisor underlined:

> *"Man wächst auch ein bisschen in die Betriebe rein. Die schätzen das auch, wenn man vielleicht mal eine Meinung von außen mit reindenkt. Als Betriebsleiter ist man ja eher irgendwann betriebsblind. Man ist so in seiner Arbeit drin, dass man vielleicht verschiedene Aspekte nicht berücksichtigt. Und was die auf jeden Fall schätzen, dass man ehrlich und immer gerade raus…ja, da kommt man am ehesten weiter. Und das kriegen die bei mir". (interview n°16)*

Many farmers in Luxembourg resort to farm advisors for support with their accountancy, fertilisation plans, funding applications and general farm management and restructuring issues. Increasingly, farm advisors have to be experts in agriculture regulation and different funding programmes of the ministries for agriculture and the environment. Hence, they have an important role as mediators between farmers and public authorities:

[236] https://www.zebris.com/landmanager/landmanager-wsg.html

"Von daher muss man immer so ein bisschen als Vermittler amtieren. Was die Landwirte gar nicht wollen, ist, dass einer von oben herab ein Dekret erlässt. Das geht gar nicht. Wenn ich dann aber auf den Betrieb fahre und dann weiß, was das MDDI [Ministry of Sustainable Development], oder was die AGE gerne hätte, und ich kann dem das dann erklären, dass er das auch einsieht, ja, dann habe ich meine Aufgabe gut gemacht. Auf der anderen Seite kann ich aber auch der AGE mitteilen: "hört mal, was ihr da vorhabt geht so nicht mehr"". (interview n°16)

As farmers use different advisors – to whom they build confidence over many years - LAKU invites all of them to its meetings and has thus brought together farm advisors from the main farm advice organisations that exist in Luxembourg: the Agriculture Chamber, Convis (cooperative for animal breeding)[237], Ibla, and the Nature Park farm advisor (see context chapter 7.4.2). The Nature Park farm advisor does not deliver ´classical´ farm advice, as he is mainly specialised on environmental issues (interview n°20). Several scholars have examined the increasing importance of external professional farm advisory services in agriculture, especially as regards "sustainable" soil management and farming (Gerber & Hoffmann, 1998; Ingram & Morris, 2007), see also chapter 4.3.2. In Luxembourg, increasing specialisation in scientific expertise and data, advisors, and farmers, has led to discussions on how to better coordinate the different structures. Increasingly specialised scientific data and regulation poses a challenge on how they can be communicated to farmers in a comprehensible manner adapted to their practices (interviews°12, 16). The reason for reflections on how to improve coordination also is that farmers sometimes receive conflicting advice.

Despite all support and exchanges, active farmers´ participation in LAKU has however not met expectations of some of the lead actors. While the share of land cultivated by LAKU members is significant, the share of land on which new techniques have actually been implemented systematically is much smaller. Only a minority of members have systematically introduced new techniques and practices. In the view of some, one of the reasons is that many farmers prefer to stick to established routines and that they have not been enduring and patient enough in participating in experiments. When desired results did not materialize after a few (or even just one) trials, some farmers have chosen not to pursue experiments any further.

"Wenn man zwei Jahre vorher in der…bei vollem Regenschauer mit schweren Maschinen über die Parzellen gefahren ist […] dann ist [der Boden] ja wie Beton und dann kommt man mit einem neuen System, das wir uns dann als gut vorstellen, und dann funktioniert nichts. So, das sind aber die ganzen Sachen, wo viele Betriebe sich das einfach machen: „Ja, du siehst ja, hat ja nicht funktioniert!" Und dann sind die wieder raus. Die brauchen sich nicht schwer Gedanken um etwas Neues zu machen. Weiter wie bisher." (interview n°50)

This suggest that one of the informal barriers to agricultural experimentation is that some farmers tend to regard single elements of experiments in isolation without recognising multiple variables that influence outcomes, for example, that soil regeneration takes time and success and failure often depend on specific weather conditions, previous cultivation techniques and multiple other factors. In other words, ecological and systems knowledge seems to be insufficient, as is the dedication to persist with experiments and to change professional practices.

[237] The Agriculture Chamber, which is the official body of farm representation towards ministries, close to the Bauernzentrale known as traditional and conservative farm lobby, and at the same time, delivering farm advice – and Convis (cooperative for animal production). They have historically represented different and often opposing camps in farm advice. Historical tensions have ebbed off, but can still be felt today.

There are also other reasons for why some farmers do not support LAKU. Interviews suggest that some farmers do not share its technology-orientation. They expressed scepticism concerning what they see as a trend towards increasingly heavy and expensive machines. They were reluctant to become dependent on external machine contractors and relying increasingly on subsidies for being able to pay for technical services and equipment. They wished to continue farming by working the land by themselves, preferably with their own machines, and by generating incomes from other sources than subsidies. A few of these farmers also reject the idea of investing in milking robots, both for reasons of their own perception of what it means to be a farmer, but also for the costs robots incur (interview n°44). This suggests that there are diverse narrative identities among farming communities (see chapter 11.3.2.1).

There are also environmentally-inspired doubts that concern the harmful impact of big and heavy machines on soil life and the need to have increasingly big fields for them to be able to work in the most efficient way. One interview partner pointed out that big machines increase the distance between farmers and soil and may be part of the reason for why there continues to be too little ecological knowledge, e.g. about the importance of humus:

> *"Auch von der LAKU aus […] mit Maschinen unterwegs, die haben 40 Tonnen Last. Der große Injektor von dem Lohnunternehmer […] Landwirtschaft, wie sie heute ist. […] Aber das ist das Problem. Die Leute sitzen über ihren Maschinen, aber sie wissen nicht mehr, was im Boden abläuft. […] Regenwürmer, Asseln, wie sie alle heißen – die den Kompost bilden, die Umwandlung machen, die bearbeiten den Boden, und die braucht man nicht zu bezahlen. Man muss sie nur gut behandeln. Aber dieses Wissen ist verloren […] oder wird nicht beachtet" (interview n°20).*

At the same time, the same interview partner also referred to LAKU asking farmers (and farm advisors) to pay more attention to humus, as important storage for nutrients.

To sum up, of all working group activities of the River Contract, the agricultural working group went furthest in expanding networks and brought together actors in a formal organisation who had not cooperated much before: conventional and organic farmers, the water supplier SEBES, farm advisors from different structures, agricultural and environmental governmental actors. The changing role of SEBES is perhaps the most notable.

The cooperation has relied on – and co-created – professional farming knowledge from a wide variety of sources: joint activities and experimentation, best practice exchanges and specialised scientific and technical data. Environmental impact of farming has been openly acknowledged and discussed and LAKU data has contributed to better understandings of causal relations between different agricultural practices and water quality. Experiments have sought to reduce pollution of water bodies and the environment caused by agricultural practices. At the same time, LAKU members have concentrated on increasing efficiency to be able to safeguard established business models, as food producers. Therefore, overall, interviews suggest that there has been little double-loop learning among farmers, at least so far.

Furthermore, only a minority of LAKU members have systematically introduced new techniques and practices. Therefore, empirical analysis has not found strong indications of more widespread and profound changes in farming communities.

Nonetheless, the LAKU cooperation and its activities have been the most tangible example of the expansion of social networks, of changing roles and modes of social organisation among diverse actors, knowledge that resulted in manifest actions and produced tangible results in informal post-WFD governance processes that have been analysed in the framework of the present thesis. Thus, even if

social learning may not (yet?) have extended to more fundamental reframing of purposes, identities and narratives, there have been some tangible outcomes. The action situation, input factors and outcomes are also summarised in figure 9.6 according to the scheme developed in the methods chapter (see 5.6).

Formal organisational outcomes:

- Formal cooperation agreement on the creation of the *Landwirtschaftlech Kooperatioun Uewersauer* (LAKU) between SEBES, the Nature Park, and farmers, coordinated by a River Contract employee

Material outcomes:

- New tools, technologies, techniques aiming to reduce environmental impact (e.g. water pollution and soil erosion) of agricultural practices

Informal outcomes and effects:

- Network effects: closer relations between the Nature Park, River Contract, conventional and organic farmers, farm advisors from diverse structures and SEBES
- Co-created and enhanced professional agricultural knowledge flowing from diverse experiences and types of information and data (including scientific)

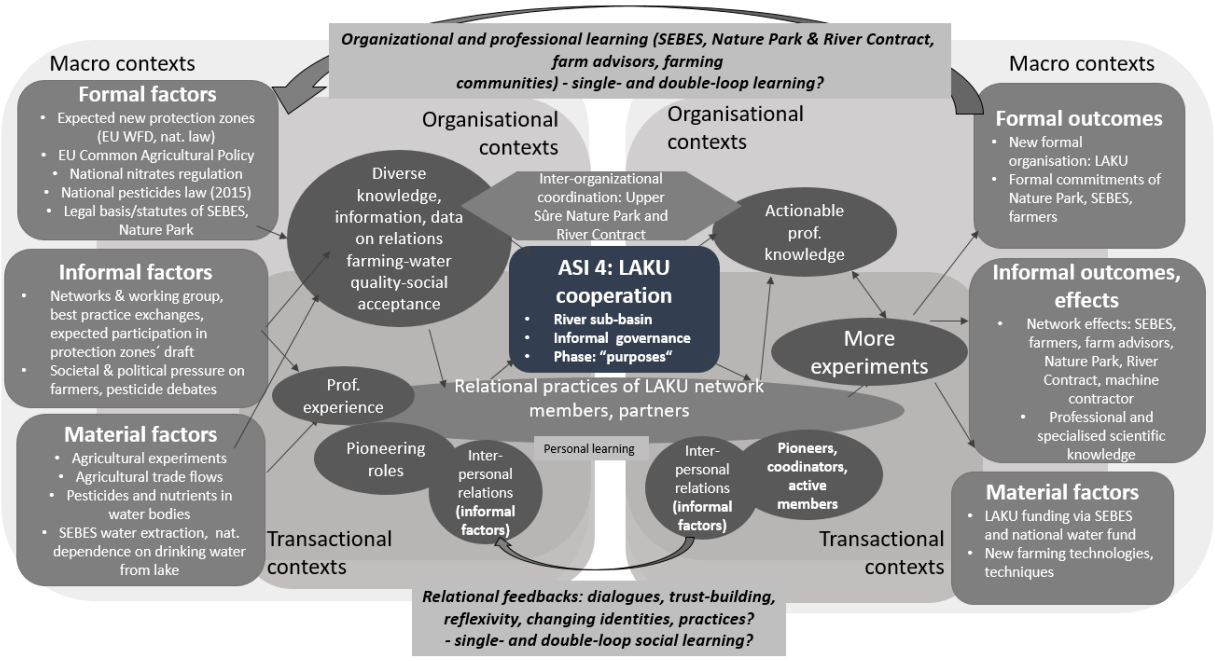

Figure 9.6 – Graphic presentation of factors that have influenced LAKU cooperation, and of outcomes and effects produced

9.8 ASI 5: Local actors increase pressure for participation, hold meetings

Summary	From Autumn 2017 to April 2018, while SEBES was finalising its dossier and public authorities were preparing the draft law on the future protection zones, local actors undertook efforts to gain access and contribute to it. The issue becoming increasingly political, conservative national deputies from the Upper Sûre region submitted formal questions to the minister of the environment. First meetings between local actors and ministerial representatives were held, but did not entail exchanges on the content of the draft law.			
Synergies and tensions	Tensions between local and national actors			
Action situation	Documents	Interviews	Observations and meetings	Workshop content
ASI 5: LAKU meeting with consultants and local actors increase pressure for participation (Oct.2017 – June 2018)	Letters and questions to the minister of environment minister, minutes of meetings	N°32, 36, 43, 50	Observations at World Water Day colloquium 2018 on 22/03/2018	

Since LAKU had been founded, farmers continued to carry out seminars and experiments. The River Contract was actively involved in LAKU via its coordinator and the Nature Park. Increasingly impatient, they were waiting for opportunities to contribute to the draft concept and laws, along with the municipalities of the region.

In Autumn 2017, SEBES invited consultants from IWW Zentrum Wasser to participate in a meeting to present elements of their draft concept to LAKU members before finalising their study. At the meeting, the possible future borders of the protection zones and proposed related restrictions were outlined to participants for the first time. Some local participants criticised the overall approach, underlying principles, and assumptions, particularly concerning demarcations and some of the interdictions and measures proposed. The impression of some local participants was that the proposed demarcation of protection zones were ill-adapted to local hydrogeological conditions and had numerous gaps. Some argued that the proposals were too restrictive on agriculture in some aspects, and too lean on water protection in others. Some local participants interviewed also remarked that they had the impression that the consultants (who wrote their report in German) had difficulties in working with documents and legal passages in French (the official legal language of Luxembourg). At the meeting, many questions were raised and there were suggestions for improvements of details, including of specific wordings (interview n°36). For this reason, some interview partners found the meeting useful and that it did contribute to the improvements of certain elements of the concept. Overall, however, the meeting seems to have left an unfavourable impression among local participants that would also influence future reactions to the later draft law.

Officials within the Ministry of Sustainable Development and Infrastructure and AGE, on their part, were dissatisfied with the fact that the LAKU meeting had taken place and that draft passages had been revealed. They saw it as stirring up sentiments at a moment in time where the public authorities themselves had not yet evaluated and, potentially, revised the concept as part of the future draft law

(interview n°43). The River Contract addressed another letter to the minister of the environment (CRHS, 2017). It emphasised that public participation would be crucial for the future acceptance of the protection zones and that the River Contract remained at the disposal of the ministry to serve as partner and potential co-organiser:

> *"Mit diesem Brief möchten wir deshalb zu diesem Zeitpunkt, darauf hinweisen, dass die Beteiligung der Öffentlichkeit in dem nun folgenden Prozess außerordentlich wichtig für eine zukünftige Akzeptanz der Schutzzonen und ihren Ge- und Verboten ist. Wir weisen erneut darauf hin, dass im Gegensatz zu den Grundwasserschutzzonen eine wesentlich größere Fläche bis hin zu ganzen Gemeinden betroffen sind" (CRHS, 2017).*

As the letter remained without reply, the municipalities at the beginning of 2018 got together to send a joint letter and to ask for meetings with the ministry. Some municipal representatives interviewed felt reminded of the "pioneering times" of the 1980s when the municipalities had cooperated closely to oppose governmental plans for a nature park in the region (see chapter 7.3.2):

> *"Das war schon für mich exemplarisch. Das war für mich…weil ich vorhin gesagt habe […] die Naturpark-Gemeinden müssten sich wieder mehr auf die Hinterpfoten stellen und sich bemerkbar machen. Hier war es wirklich wie die alte SYCOPAN-Pionierzeit" (interview n° 33[238])*

An informal working group emerged among municipalities and other local actors that some interviewees referred to as "crisis community" (interview n°36). Some of its ´members´ underlined that one of the main reasons for getting together to increase pressure on national officials had been the secrecy surrounding the concept and draft law and the impression that their offers and concerns were falling on deaf ears. One municipal official expressed the view that it was his duty to be "on the side of my citizens" (interview n°32). The River Contract was also involved in some of the activities, as municipalities appreciated the support of River Contract staff and their know-how relating to the drinking water protection zones.

> *"[…] ohne Hilfe des Naturparks und des Gewässervertrags wäre das nicht möglich gewesen, das ist ganz klar." (interview n°32)*

The coordinator, however, sometimes felt in an awkward position, as it was not always clear if he participated in meetings in any of his capacities relating to the River Contract, the Nature Park or LAKU.

In March 2018, it was the turn of the River Contract to organise the annual World Water Day colloquium of the Luxembourgish river partnerships. Representatives of the Ministry of Sustainable Development and Infrastructure, AGE, other public administrations, and diverse regional and national actors got together to discuss barriers in WFD implementation, mainly as regards hydromorphological measures (see case study of part IV, 10.6.2). While the topic itself was not related to the protection zones in the Upper Sûre area, interviews suggest that the event contributed to tense relations between the River Contract and public authorities and that they became increasingly personal. The coordinator of the River Contract, on behalf of all six river partnerships and as moderator of the event, presented difficulties encountered during implementation in relation to administrative procedures. Some participants of the national public authorities felt that the event contributed to giving them a bad image and, thereby, to making WFD implementation in Luxembourg even more difficult.

As a result of local pressure, public officials, in April 2018, held a meeting to inform all farmers of the Upper Sûre region of the upcoming draft law and related procedures, stressing that LAKU members

[238] SYCOPAN was the regional intermunicipal syndicate, founded in 1988, that preceded and prepared the Upper Sûre Nature Park (see part I).

could not be privileged over other farmers. Moreover, a first meeting between officials from the Ministry of Sustainable Development, AGE, municipal representatives, and the River Contract took place in the same month. During the meeting, public officials underlined that they had assumed the municipalities would have been informed about the dossier via the Northern drinking water syndicate DEA, who was represented in SEBES and of which the Upper Sûre municipalities were members (2018a[239]).

Furthermore, public officials explained why stakeholder involvement would only begin after the Council of Government had approved the draft law and in the framework of the formal public consultation:

- formal provisions of the water law did not allow for stakeholder involvement during the elaboration of draft laws,
- the draft law needed to be professionally and technically correct ("fachlich korrekt"), which has been ensured by the consultancy study of IWW Zentrum Wasser and the fact that the consultants based themselves on established norms and standards,
- time pressure, as the new drinking water protection zones had to be in place by 22 December 2018,
- stakeholder involvement would not have been fruitful and would have put municipal representatives in the "firing line": "Eine weitere Beteiligung (außerhalb der Offenlegungsprozedur) würde unnötige Diskussionen fördern und zu nichts führen. Man könne nicht alle Aufgaben der Politik auf die Bürger umwälzen. Durch die vorgesehene Prozedur würden die Gemeindeväter aus der direkten Schusslinie genommen" (CRHS, 2018a),
- the same formal procedures have been adopted for all groundwater protection zones (where they had been accepted by local actors) and that public authorities held many more local meetings in the Upper Sûre region than in the other (future) protected areas,
- that there would be time to make some revisions to the draft law to consider substantiated statements and objections of local actors that would be submitted during the formal public consultation,
- that local actors would be able to contribute actively to the programme of measures that would be elaborated for the protection zones following their formal designation.

The reasons provided correspond to those cited by several interview partners and in a NEXUS reference group meeting (NEXUS FUTURES, 2019c)[240].

> *"Legale Prozeduren: Du hast einen Gesetzentwurf - ´avant projet de RGD´. Wenn wir das schreiben, können wir noch was daran ändern und dann muss der Regierungsrat erstmal einverstanden sein, dass das nach außen öffentlich gemacht wird. Und hier wollten die Leute erstmal reingucken bevor der Regierungsrat überhaupt „okay" gesagt hat. Das ist das, was nicht geht. Dem kann man nicht vorgreifen, weil dann sagst Du, wir machen es so und so und so. Aber die Regierung hat nicht "ja oder nein" sagen können. Die Prozedere sind einfach so." (interview n°43)*

[239] DEA has two representatives in SEBES: one in its executive board ("bureau"), the other in its committee (www.sebes.lu). The municipalities clarified later that the SEBES dossier had only been discussed at the SEBES executive board, but not publicly in the SEBES committee (CRHS, 2018a)

[240] Kurzbeschreibung der vergleichenden Fallstudie im Rahmen des Projekts NEXUS FUTURES als Gesprächsgrundlage für die Auswahl von ´Handlungssituationen´: Nachhaltigkeit in Politik und Praxis – Lernprozesse und Handlungssituationen in Wasser-Governance- und Management in den Flussgebieten von Obersauer und Syr. Vorläufige ergänzte Fassung vom 14.11.2019. NEXUS project (see annex IV)

Some of the local actors were deeply affected when it dawned to them that they would not be able to contribute:

> *"Ich habe viel nicht geschlafen, ganz viel. […] also, wo es im Grunde klar war, dass die das eiskalt durchziehen wollen, uns nicht zu beteiligen. Das, muss ich ehrlich sagen, hat mich getroffen. Das hat mich richtig getroffen. Also, ich meine, wir haben fünf Jahre daraufhin gearbeitet" (interview n°36).*

Some local and nongovernmental actors interviewed did not regard the legal reasons provided as credible. Some of them cited examples of national nature protection laws and plans on which they had been able to comment. They felt that if policy-makers had wanted to involve local actors, they would have found a way to do so. In contrast, some local actors interviewed also argued that, indeed, it was generally not easy to find a "common denominator" in larger groups. According to them, this provided an argument in favour of LAKU:

> *"[…] immer das Problem, dass so viele Interessen mit im Spiel sitzen, dass man nicht auf einen Nenner kommt. […] Die Gruppe darf nicht zu groß sein, man muss aber auf die hören, und auch einsehen, dass wenn jemand ein Argument bringt, was überzeugend ist, dann muss man sagen, „ja, du hast recht". Es darf nicht nur ein Weg geben, und die anderen müssen sich anpassen, daher die LAKU-Kooperation" (interview n°18).*

In addition to the formal reasons provided at the April meeting, it is interesting to note that active stakeholder involvement was associated with policy-makers shifting responsibility to citizens (in the negative sense). During the meeting there was, however, agreement among all participants that the public consultation should only take place after the summer school holidays. Despite the meetings, dissatisfaction among local actors remained, because local actors had not been presented the content of the draft law:

> *"Aber es wurde uns nie das präsentiert, was wir sehen wollten […] waren im Ministerium und es wurde immer die Prozedur vorgestellt, aber nie…Wir wollten das Reglement sehen, also das Projekt sehen, und das wurde uns nie gezeigt". (interview n°36)*

During this period, a collaborative NEXUS FUTURES workshop was postponed, because of concerns that tense relations would not be conducive to dialogue[241].

Pressure on the ministry was also exerted via the national parliament. In May 2018, a conservative deputy from the Upper Sûre region submitted a formal parliamentary question to the minister of the environment via the Chamber of Deputies. She asked about the ´state of play´ concerning the procedure, when local inhabitants and the municipalities would be involved and be able to submit objections and when the new law would enter into force (Hansen, 2018). In a formal reply, the minister explained that the procedures followed article 44 of the national water law (Mémorial A, 2017b) (Mémorial A, 2017b) and that a public consultation would be held from September to October 2018, following the approval of the draft by the Council of Government (MDDI, 2018b). Furthermore, the minister referred to the six meetings that had already taken place with LAKU representatives and farmers, the River Contract, municipal representatives and the Nature Park. Six additional meetings

[241] The collaborative NEXUS project workshop on water and land use challenges in the Upper Sûre region had been prepared and announced to take place in January 2018, in cooperation with the River Contract. However, the NEXUS FUTURES team (incl. the author of the thesis) postponed the workshop for an indefinite period due to concerns that it would be difficult to conduct dialogues between local and national stakeholders if workshop participants received a ´no comment´ from public officials in response to their main concerns. Instead, the workshop took place in 2019 (see ASI 7).

with the municipalities would be organised in June, followed by a public meeting in the Upper Sûre region (see ASI 6 and ASF 5 below).

Informal outcomes and effects:

- Information about upcoming procedures provided to local actors
- Agreement between national and local actors on not organising the public consultation during summer holidays
- More meetings planned between local and national governmental actors
- Interorganisational and interpersonal relations: Disappointed expectations among local actors, tensions between conservative deputies and the Ministry of Sustainable Development (MDDI)

9.9 ASF 4: Ministry revises water law, prepares 1st protection zones draft law

Summary	From 2017 to 2018, the MDDI and AGE prepared the legal basis for the future drinking water protection zones. It included a revision of the 2008 water law and the elaboration of the draft law on the designation of the future protection zones that would be submitted to public consultation. The protection zones dossier increasingly became an issue of political controversy in the national Chamber of Deputies.			
Synergies and tensions	Tensions between the MDDI and conservative deputies			
Action situation	Main documents	Main interviews	Observations and meetings	Workshop content
ASF 3: Ministry revises water law and prepares 1st protection zones draft law (Jan.-Jun.2018)	Revised water law, 1st protection zones draft law and presentation by the minister for the environment (MDDI, 2018c)	N°43, 48, 60	Observations at presentation of 1st draft law by minister at SEBES (04/07/2018)	

While SEBES, AGE, and consultants were still working on the protection zones concept, the MDDI initiated a revision of the national water law of 2008 (Mémorial A, 2017b). The most notable revision was that agricultural advisory services for farmers located in drinking water protection zones became eligible for 75 % co-funding via the national water management fund (Article 65). In addition, the revised law specified that expenditures for the implementation of the future programme of measures to be implemented in in water protection zones would also be eligible for 75 % co-funding via the water management fund (article 65).

At the end of 2017, SEBES had passed its dossier on the future Upper Sûre protection zones on to the Ministry of Sustainable Development, which examined it together with the Water Management Authority. According to officials, SEBES would have had the possibility to informally consult with the MDDI and AGE on its content before the official submission. This would have given national actors the possibility to ask the consultants to revise elements and correct possible mistakes, before the formal procedure began. One reason cited for why this did not happen was the pressure exerted by local actors (see ASI 5 above).

"Und hier war soviel Druck, auch von der LAKU, vom Naturpark, dass die SEBES das einfach zack an Verwaltung und Ministerium offiziell geschickt hat, und da war es zu spät….mussten wir an einer Studie arbeiten, die Lakünen hat, einige Fehler […] Der ganze politische Druck […] war meiner Meinung nach total kontraproduktiv für die Schutzzonen." (interview n°43)

Local actors interviewed, however, argue that the MDDI and AGE, at any rate, made major modifications that meant that the new draft law was different from the original SEBES and IWW concept. One of the revisions was that the proposal of the SEBES dossier that LAKU members would have privileges in relation to the protection zones was not retained (see also ASF 5). The elaboration of the draft law necessitated extensive coordination between various ministries and administrations. The minister of the environment listed them in her response statement to the conservative deputy from the Upper Sûre region who had submitted the parliamentary question mentioned above (see ASI 5):

"[…] le dossier a été finalisé dans le cadre de réunions avec les experts techniques du Ministère de l´Agriculture, de la Viticulture et de la Protection des consommateurs, de l´Administration des services techniques de l´agriculture, du Service d´économie rurale, du Ministère du Développement durable et des Infrastructures, de l´Administration de la nature et des forêts, de l´Administration des ponts et chaussées, de l´Administration de la gestion de l´eau et du Ministère de l´Economie" (MDDI, 2018b)

Within the Water Management Authority the dossier was handed over from the groundwater to the surface water unit. Among others, they cross-checked the consultants´ proposals with the requirements of other EU directives than the WFD, such as the nitrates directives. The clock ticking, the surface water unit of AGE had to hurry to become acquainted with the concept, to make revisions where deemed necessary and to prepare the draft regulation to set up the drinking water protection zones before the end of 2018. The assessments of possible future restrictions on agriculture required some knowledge of agricultural practices, which is why some interview partners pointed out that it was useful that at least some AGE civil servants had backgrounds in agriculture (interview n°48). The finalised draft passed the Council of Government on 22 June 2018.

The approval was followed by several municipal council meetings, in which the minister and other officials presented aspects of the draft law and agreed with local actors that the public consultation would be held from 15 September to 15 October 2018. At the beginning of July 2018, the minister (together with other officials) presented details and underlying principles of the draft law to the public in SEBES premises. With regard to the future programme of measures for the protection zones, LAKU measures were presented as examples of agricultural initiatives (MDDI, 2018c). At the event, several participants expressed dissatisfaction about the fact that they had not been involved in the procedures and criticised aspects of the draft law, particularly in relation to planned restrictions on organic fertilisation. Some appreciated, however, that the minister herself had faced the local public and stayed for informal discussions.

Formal outcomes:

- Revised water law (Mémorial A, 2017b) giving farmers and farm advisors additional funding possibilities

- 1st version of the protection zones draft law to be submitted to public consultation from 15 September to 15 October 2018 (MDDI, 2018c)[242]

9.10 ASI 6: Local actors prepare for public consultation amidst arguments

Summary	During the summer of 2018, local actors prepared for the public consultation on the future drinking water protection zones. The River Contract re-convened its working groups, and analysed possible consequences for individual farms with farm advisors. Municipalities commissioned consultancy studies. One of them contested the scientific principles on which the demarcation of protection zones had been elaborated. Due to upcoming national elections, relations between local and national actors became increasingly polarized, with the River Contract perceived as ally of conservative mayors and conventional farmers.		
Synergies and tensions	Tensions and increasing polarisation between local and national actors, also reflected in narratives on both sides that drew parallels with the origins of the Nature Park in the 1980s and 1990s		
Action situation	Documents	Interviews	Observations and meetings
ASI 6: Local actors prepare for public consultation amidst scientific and political arguments (July-Nov. 2018)	Summary of agriculture working group meeting, consultancy study commissioned by municipalities, IWW answer, Letter of municipalities to environment minister, Parliamentary questions of deputies	N°32, 33, 34, 36, 43	Observations at four working group meetings: - Agriculture 24/7/2018 - Forestry 8/8/2018 - Municipal matters 9/8/2018 - Tourism 9/8/2018

First local reactions to the draft law presented to the municipalities and the public were guarded. It seemed to governmental actors that some reactions and general assessments were actually based on the original SEBES concept rather than on the draft law itself. However, the following reaction reflects the overall impression of several local and national actors interviewed that, at first, the draft law was perceived as "not as bad as it could have been" (interview n° 43):

> *"[…] die ersten Tage fand ich das ein sehr gutes Projekt. Aber desto mehr ich das mit anderen diskutiert habe, und es selbst gelesen habe… […] wenn man die Details dann gesehen hat, dann war es eine Katastrophe. […] Da gab´s wirklich Dinge, die wir nicht verstanden haben und die für mich auch unlogisch waren". (interview n°33)*

In the following, there would be increasingly intense debates, both in the public at large as well as among farmers. Among the aspects that caused most public debates (and outrage) was the interpretation that the draft law would forbid private barbecuing and horse-riding along the lake (interviews n°33, 34). Some municipalities also realised that many parts of their territories would be

[242] Projet de règlement grand-ducal délimitant les zones de protection autour du lac de la Haute Sûre et déterminant les installations, travaux et activités interdites, réglementées ou soumises à autorisation dans ces zones et modifiant le règlement grand-ducal du 11 septembre 2017 instituant un ensemble de régimes d'aides pour la sauvegarde de la diversité biologique en milieu rural. MDDI

affected by restrictions as regards, for example, the creation or expansion of residential areas and business parks. In terms of water protection, some actors noticed that the new draft law would allow mineral fertilisation until the lakeshores, which had been forbidden under the sanitary protection zones that were in place.

Three types of local reactions and self-organised activities will be outlined in more detail in the following: working groups of the River Contract, parliamentary questions of conservative deputies from the Upper Sûre region, and studies commissioned and letters sent by the municipalities.

The River Contract became a central actor and local partner in the run-up to the public consultation, because its staff had thoroughly studied the draft law. As part of the Nature Park, it offered advice to municipal members, farmers and citizens, and would support them in drafting statements for the public consultation.

Hoping there would be sufficient time and willingness on behalf of public authorities to make revisions, the River Contract in July and August 2018 re-launched its four working groups from 2013/2014 and invited representatives from the MDDI, AGE, farmers, municipalities and other interested parties to meetings to study and discuss details of the legal draft. Working group meetings focused on the 20-page annex that contained the provisions and restrictions for farmers, municipalities, businesses, forestry, fishery and leisure, and sports activities that would apply in each of the five protection zones. There was one meeting on agriculture in July, and one meeting each for settlements and transport, tourism and forestry in August (with the author of the present thesis as observer). The following concentrates on the working group on agriculture.

Dissatisfaction reigned high among some local actors, who would have preferred to have been given the opportunity to address underlying principles and fundamental issues earlier rather than to seek to ´fix´ details. Some were convinced that this would have contributed to improving the quality of the draft:

> *"[…] weil sie haben ein schlechtes Projekt präsentiert, wo unheimlich vieles vorher…Man hätte vieles vorher abfangen können und qualitativ oder zielgerichteter oder einfach richtig formulieren können. […] Einstimmig wären wir damit durchgekommen. Das hätte man alles vorher machen können, dann hätte man der Öffentlichkeit etwas Hochqualitatives präsentieren können, was auch Akzeptanz gebracht hätte. […] Die Hoffnung besteht bei Einzelnen, dass das gut wird noch, aber eigentlich ist die Akzeptanz seit der ersten Vorstellung total gesunken". (interview n°36)*

Nonetheless, all actors interviewed and spoken with perceived the working group meetings as constructive and useful. The River Contract, Nature Park, LAKU members and farm advisors prepared questions and remarks ahead of the meeting that would be addressed to ministerial and AGE representatives who participated in all meetings. During the meetings, some questions could be clarified directly, but some loopholes and critical issues were identified as well (CRHS, 2018b). The 19-page minutes summarised the main issues and answers that AGE officials later also supplemented with additional information.

Among the main issues was the question why organic fertilisation would be limited, but not mineral fertilisers. Participants referred to the positive impact of manure on soil quality, its availability on farms and the fact that, in organic agriculture, there were few other options to fertilise. One of the answers provided concerned alleged bacterial problems (organic micropollutants) in crude water resulting from manure and that some types of extensive farming did not require organic fertilisation. Another issues concerned restrictions on livestock grazing (including the ´fencing obligation´) and year-round

pasturing that was to be forbidden, with possible exceptions made for pastures with extensive grazing supported under the national biodiversity programme (see figure 9.7)

Figure 9.7 - Grazing of cattle along a river (source: Naturpark Öewersauer)

Public officials promised some revisions and further clarifications, but local actors regretted that they did not receive any commitments in writing.

On the same day as the agriculture working group of the River Contract took place, a mayor of one of the Upper Sûre municipalities, who was also a national member of parliament for the conservative party (and former environment minister), addressed a formal parliamentary question (Hansen & Schank, 2018a) to the ministries of the environment and agriculture. It contained very similar remarks and questions as had been prepared and discussed in the run-up to the working group. In addition to the fertilisation issues mentioned above, it also inquired into the extent to which the Ministry of Agriculture and Chamber of Agriculture had been involved in the draft law, the future role of LAKU and ´its´ technologies, drainage systems, and conditions for receiving certain authorisations.

In their formal answer, the ministers of the environment and agriculture underlined that LAKU had already been supported with roughly 1,2 Mio EUR and that, in the future, up to 5 Mio EUR would be invested in water protection projects (Luxembourg Government, 2018). Insights from the LAKU project had informed the draft law, while policy-makers had not wanted to prescribe technological details, but counted on voluntary participation by farmers.

> *“Et gëtt bei dësem Projet de règlement grand-ducal och bewusst op d´Fräiwëllegkeet von den Acteure gesat. […] Et ass erwënscht, datt d´Bauere sech un de fräiwëllege waaserschützende Mossnamen vum Agrar-Emwelt-Programm respektiv vum Biodiversitéitsprogramm bedeelegen. Dës Méiglechkeet besteet just, wann et kee Verbuet respective keng zu grouss Aschränkungen gëtt. Et ass och bekannt, datt de Programmer et schonns gewiss hunn. Dowéinst gëtt*

d´Landwirtschaftlech Kooperatioun Uewersauer (LAKU) finanziell vum Emweltdepartment vum Nohaltegkeetsministère duerch de Waasserfonds ënnerstëtzt." (MDDI & MAVDR, 2018)[243]

The parliamentary question would fall back on the River Contract and affect relations with MDDI and AGE. The River Contract was suspected of letting itself be instrumentalised for political purposes by the conservative party CSV and it felt it was even regarded as instigating local actors against national plans. In other words, some perceived the River Contract as at best "naïve" in its cooperation with conservative mayors and conventional farmers and stressed the river partnership would be better off in working for water protection and in the interest of the ministry that co-funded it. Political factors thus played a significant role in shaping processes and relations. The liberal-socialist-green coalition government stood for re-election on 15 October 2018, the last day of the formal public consultation.

"Es waren Wahlen und das ist keine gute Zeit zu argumentieren. Da bekommt jeder vorgeworfen, es ist wegen der Wahlen". (interview n°32)

Controversies surrounding the protection zones ended up adding fuel during political campaigns, particularly between conservatives, farmers´ organisations, on the one hand, and greens on the other. They would also be carried into the press. The media RTL published reports (including radio emissions) about existential fears of farmers in one area of the protection zones (Eschdorfer Plateau) that suggested that organic farming would become impossible, while chemical fertilisation would remain possible (RTL, 2018). The next day, the national newspaper, Luxemburger Wort, published an article stating that only 2 % of fields around the lake were concerned by the restrictions. Moreover, according to a high-ranking official from the Ministry of Sustainable Development, manure had already been forbidden on parts of the Eschdorfer Plateau under the sanitary protection zones and that future restrictions should have been expected. The article also stressed that organic farming would *not* be forbidden and that private barbecuing and horse-riding on paths would remain possible (Luxemburger Wort, 2018). The articles reflect some of the press coverage and public controversies that influenced preparations for the formal public consultation. Some actors regarded some of the press articles and arguments used as "polemic" and as part of political campaigns (n°43). Others insisted that local actors had never acted "politically" or "polemically" (n°36).

In addition, scientific arguments added to the debates. Municipalities sought consultants´ and legal advice. The municipality of Esch-sur-Sûre commissioned a consultancy opinion of the German engineering office Bohné on the hydrogeological and pedological principles of the drinking water protection zones proposed by IWW (Bohné, 2018). The consultancy submitted an ´expert opinion´ that argued that, in line with the principles of the DVGW 102 (see ASF 2), the demarcation of zones should not have been done in such a generalised manner (e.g. general application of the 100 m from water body belt). Instead, the demarcation should have taken into account the geology, morphology, and hydrology of the landscape on a much more fine-grained scale. Based on their hydrogeological assessments, the consultants contested one of the main assumptions underlying the vulnerability assessments of IWW Zentrum Wasser, notably, that risks to water quality in the lake were predominantly the result of the run-off of surface water and dependent on land use type, distance, slope shape, and gradients. Instead, their statement claimed that in many areas no signs of erosion could be discerned and that a significant amount of water was absorbed by the soil seeping into

[243] Own translation: "Es wird bei diesem Entwurf der großherzoglichen Verordnung bewusst auf Freiwilligkeit der Akteure gesetzt. […] Es ist erwünscht, dass Bauern sich an den freiwilligen wasserschützenden Maßnahmen des Agrar-Umweltprogramm bzw. des Biodiversitätsprogramms beteiligen. Diese Möglichkeit besteht gerade dann, wenn es keine Verbote bzw. keine zu großen Einschränkungen gibt. Es ist auch bekannt, dass die Programme das schon gezeigt haben. Derweil wird die Landwirtschaftliche Kooperation Obersauer (LAKU) finanziell vom Umweltdepartment des Nachhaltigkeitsministeriums durch den Wasserfonds unterstützt"

groundwater[244]. In a response statement, IWW Zentrum Wasser countered that its study had been written on the basis of – and in agreement with – AGE and the (relatively large-scale) data it had received as well as on the basis of on-site observations, on the basis of which surface run-off was considered the main factor (IWW Zentrum Wasser, 2018)[245].

Furthermore, the municipalities jointly recruited the Luxembourgish consultancy PACT to analyse, which areas of the municipalities would be in which protection zone, notably, commercial and residential areas as well as agricultural land. The consultants found that the new protection zones, in terms of municipal areas covered, would be four times larger than the sanitary protection zones (increase from 4.000 to 15.500 hectares). Of these, 538 hectares of built land would be concerned, in comparison to 105 hectares before, and 7.676 hectares of agricultural land, forests, and prairies, compared to 1 774 hectares under the sanitary protection zones (PACT, 2018). The numbers were broken down for each municipality and served as a basis for the official joint opinion the municipalities submitted during the formal consultation period. Local actors interviewed regarded the fact that the municipalities had united to commission expert reports as a proof that they were interested in conducting factual debates and, at the same time, of local cooperation and solidarity.

> *"Ich denke auch, es war unsere Stärke, dass wir eben nicht polemisch waren, wir von Anfang an konstruktiv und sachlich argumentiert haben […] Nicht nur die Region hat zusammengehalten. Es wurde auch das Geld locker gemacht, um diese Studien zu machen. Um all diese Dinge zusammen zu machen. Das war unsere Stärke". (interview n°32)*

Towards the end of the year debates about the assessment of run-off further intensified (including via another parliamentary question)[246], when a scientific study was published that had been commissioned by the Ministry of Agriculture (independently of the drinking water protection zones) and concerned erosion and run-off in the Upper Sûre basin (Maugnard et al., 2018). Actors wondered why MDDI and AGE had not been aware of the fact that another study had been prepared in parallel. It seemed to confirm the widespread impression that there had been little communication between the environmental and agricultural ministries concerning the new protection zones.

Overall, as regards the content of these diverse studies, the impression gained by the author of the present thesis is that both local and national actors have tended to refer to the ´scientific evidence´ that suited their own arguments best. In this sense, what appeared as scientific debates at the surface covered up political controversies, and other concerns and interests.

In addition to the studies, the municipalities also commissioned a legal assessment on possible procedural errors committed during the process and considered to take legal actions against the protection zones, if necessary.

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[244] Bohné, 2018, „Eine pauschale Zuordnung von Stoffeinträgen aus den Flächen der ausgewiesenen Schutzzonen über einen im wesentlichen oberflächlichen Abtrag in den Stausee ist nicht sachgerecht und zulässig. Für eine angemessene Beurteilung sind örtliche Kenntnisse über die bodenkundliche und hydrogeologische Situation zwingend erforderlich, welche nur unzureichend vorliegen bzw. in das Dossier nicht eingeflossen sind".

[245] IWW Zentrum Wasser, 2018: „Ein direkter Einfluss eines Zwischen- oder Grundwasserabflusses auf die Talsperre wurde – nicht zuletzt auch nach Kenntnislage und Information durch AGE – als vernachlässigbar gering gegenüber dem Oberflächenabfluss eingestuft. Hierfür spricht neben der Bewertung der bodenkundlichen und geologischen Gegebenheiten im Einzugsgebiet, die aber tatsächlich nur großskalig durchgeführt wurde, auch die Beobachtung, dass im Einzugsgebiet eine Vielzahl von intermittierenden und teilweise episodischen Bachläufen vorliegt, die bei Trockenwetter keine oder eine nur sehr geringe Wasserführung aufweisen, bei Niederschlagsereignissen aber stark anschwellen"

[246] Parlamentarische n°29 vom 14.11.2018 an den Präsidenten der Abgeordnetenkammer zu den neuen Wasserschutzzonen im Stauseegebiet. (Hansen & Schank, 2018b)

Some farmers hired farm advisors (some of whom also paid via the Nature Park or via LAKU) to carry out comprehensive analyses of their current business models that took into account possible impacts of the future protection zones (interview n°44). They used elements of these analyses for the statements they submitted during the formal public consultation. Some of them also sought legal advice. The case studies suggest (see also Syr case study in part IV) that legal advice and (possible) actions (in addition to consultancy and scientific studies) have been one of the main means chosen by actors when there was low confidence that formal and informal governance processes would bear fruit, and when there were low degrees of trust between local and governmental actors

As regards the municipalities, they, in September, sent another letter, in which they asked the minister of sustainable development to provide replies to statements and proposed revisions of the River Contract working groups and the consultants´ reports before the launch of the public consultation (Gemeinden der Obersauerregion, 2018a). At that time, the new protection zones were still to be set up by the end of December 2018, allegedly without a ´plan b´. For this reason, the municipalities reiterated:

> *"Gleichzeitig bedauern wir die späte Umsetzung der eigentlich schon für 2015 abzuschließenden Überarbeitung und weisen ausdrücklich darauf hin, dass deswegen für die aktuelle und sehr wichtige Phase der Öffentlichkeitsprozedur nicht voreilig gehandelt werden darf. Die gewissenhafte Einarbeitung der Stellungnahmen u.a. der Bürger, Betriebe und Gemeinden nach dem 15. November 2018 ist von besonderer Bedeutung. In Anbetracht des kurzen Zeitraums (bis 22. Dezember) stellt sich hierbei jedoch die Frage der Machbarkeit. Dieser Zeitdruck wäre nach dem geplanten Vorgehen des Gewässervertrags, eine Beteiligung der Öffentlichkeit zur Steigerung der Akzeptanz und Praxisnähe vor der Veröffentlichung eines Entwurfs der Verordnung vorzunehmen, nicht entstanden." (Gemeinden der Obersauerregion, 2018a).*

Based on the empirical evidence, the author of the present thesis is unable to judge to which extent municipal activities were politically motivated. For the purposes of the present thesis, what stands out is that, due to divergent expectations and mutual lack of trust, the River Contract was unable to assume the function as boundary organisation between local and national actors, when situations and relations became highly polarised due to political factors. Before this happened, however, exchanges during its working groups helped clarify a number of issues in relation to the future protection zones, for both local and national actors involved. Given the tight schedule and the fact that the draft law had already been prepared the meetings, however, did not provide spaces for more profound dialogues.

The combination of political factors (upcoming national elections) and time pressure (entering into force of protection zones by 22 December 2018) have thus been major hindering factors for the emergence of mutual trust and collaborative approaches. They have caused significant degrees of frustration among *all* actors involved.

Informal outcomes and effects:

- Political and public controversies surrounding the future protection zones
- Scientific controversies and diverse consultancy and farm advisory studies that related to the draft law on the protection zones, including their possible impact on municipalities and individual farmers
- Relational: Uncertain local expectations and tense relations between local and governmental actors in the run-up to the formal public consultation

9.11 ASF 5: Public consultation is held, protection zones postponed

Summary	During the public consultation 337 statements were submitted to demand various revisions. Following the consultation and its re-election, the socialist-liberal-green government postponed the December 2018 deadline for the protection zones to have more time to analyse the remarks submitted. Local actors regretted this had not been done and announced earlier.			
Synergies and tensions	Tensions between previous governmental statements that delays would not be legally possible and the subsequent postponement Synergies between all actors welcoming the availability of more time for revisions			
Action situation	Documents	Interviews	Observations and meetings	Workshop content
ASF 4: Formal public consultation is held, protection zones are postponed (Sept.-Dec. 2018)	1st protection zones draft law, law postponing protection zones (Mémorial A, 2018d)[247], and statements submitted by local actors	N° 10, 35, 36, 43		

The public consultation procedure took place from 15 September to 15 October 2018, just a few weeks ahead of national parliamentary elections (on 15 October 2018) and three months before the new drinking water protection zones were to enter into force. In accordance with the national water law, the public consultation was organised by each municipality, via municipal disclosure of the draft law, municipal meetings and advice for local citizens, including farmers. In the end, a total of 337 written comments were submitted to the municipalities and passed on to the ministry by mid-November (MECDD et al., 2018b). The Upper Sûre Nature Park (also representing the River Contract, Upper Súre Nature Park), LAKU, the six municipalities concerned, and SEBES were among those actors who submitted formal statements. Their remarks concerned numerous aspects of the draft law. All of them stressed that they welcomed the fact that new protection zones would increase water protection in their region. For the purposes of the present thesis, the following seem particularly relevant:

- The Nature Park and several municipalities expressed regrets that local actors had not been involved sufficiently in the elaboration of the protection zones concept (Gemeinde Bauschleiden, 2018; PNHS, 2018);
- The municipalities demanded that the protection zones should be declared of national interest, that 100 % of the costs necessary to meet future requirements should be state-financed and that financial losses of local actors should be compensated (Gemeinden der Obersauerregion, 2018b);
- The municipalities and LAKU criticised the fact that restrictions were introduced on organic fertilisers (e.g. manure), but not on mineral fertilisation (LAKU, 2018; Gemeinden der Obersauerregion, 2018b);

[247] Règlement grand-ducal du 18 décembre 2018 modifiant le règlement grand-ducal modifié du 16 décembre 2011 déterminant les installations, travaux et activités interdites ou soumises à autorisation dans la zone de protection sanitaire II du barrage d'Esch-sur-Sûre. Mémorial A, N°1147

- The municipalities and the Nature Park demanded that the protection zones should be adapted with regard to several land parcels and to take into account the hydrogeological studies of Bohné (2018) (PNHS, 2018; Gemeinden der Obersauerregion, 2018b);
- They proposed a coordinating role for the Nature Park and the formal requirement that it should be asked for statements in case of revisions of the regulation should be formally stipulated (Gemeinde Bauschleiden, 2018; PNHS, 2018);
- Municipalities, SEBES, and LAKU regretted that the agricultural cooperation and the technologies developed by it had not been taken into account, including for fields with more than 10 % slope inclination, and that derogations should be possible to allow the use of new methods and techniques (LAKU, 2018; SEBES, 2018; PNHS, 2018; Gemeinden der Obersauerregion, 2018b).

The two last aspects merit a bit more attention. As regards water protection in the Upper Sûre region, the nature park stressed that it would be important to involve actors in the implementation of the new regulation. It proposed the creation of an advisory council, composed of representatives of administration, municipalities, and diverse interest groups ("Beirat Obersauerstausee") and that it would be willing to assume coordinating tasks (in close cooperation with the future SEBES water coordinator, see below), if the council was endowed with sufficient financial means and competences. It referred to the fact that it already hosted several initiatives and structures that could serve to increase public acceptance of the future drinking water protection zones, including the River Contract, LAKU and its agricultural advisory service:

> *"Als Initiator und regionales Kompetenzzentrum u.a. nationaler Ziele im Bereich Tourismus, Kulturpflege, Natur- und besonders Wasserschutz muss unbedingt die Rolle des Naturparks Öewersauer in dem Reglement zum Trinkwasserschutzgebiet genannt werden. Zusätzlich sollte hier geregelt werden, dass bei zukünftigen Anpassungen der Verordnung der Naturpark um Stellungnahme gefragt werden muss" (PNHS, 2018).*

This aspect will be further addressed under ´Future perspectives´ below (ASI 7).

As regards LAKU, members had hoped that their cooperation would grant them more flexibility and a certain privileged status in the compliance with future restrictions. The SEBES statement included remarks in this regard, describing LAKU as a success:

> *"Le SEBES constate que les restrictions et interdiction du projet de règlement grand-ducal du secteur Agricole suivent une autre philosophie que le dossier élaboré par SEBES […] Le SEBES a initié la création de la coopération avec les agriculteurs (LAKU). Le but de cette collaboration est la promotion d´une exploitation agricole en respect avec la protection des eaux des affluents du lac et du lac lui-même. […] Le nombre croissant des membres de la LAKU, environ 90 agriculteurs, montre le succès de la coopération. C´est pour cette raison que le SEBES a introduit dans la proposition du dossier de délimitation des zones de protection l´idée du ´Kooperationsvorrang´. Le SEBES a donc proposé des restrictions sévères pour le secteur agricole tout en offrant la possibilité de dérogation aux agriculteurs pour utiliser des techniques agricoles respectueuses de l´eau" (SEBES, 2018).*

In order to promote a "spirit of collaboration" with the agricultural sector, SEBES proposed to include the principle of granting LAKU members rights of derogations (upon application) in the draft law. Derogations should concern provisions such as pasturing and, in particular, organic fertilisation, but should also contribute to reducing the overall amount of nutrients.

Actors who had submitted statements wondered whether their comments would be taken into consideration, given that the new protection zones were to enter into force by the end of the year. A day before the end of the consultation, the liberal-socialist-green government was re-elected. The Green Party saw the highest increase in votes compared to 2013, while the Conservative Party continued to be the strongest party[248]. When the three parties had agreed on continuing in government, it was announced that a legal solution had been found after all to prolong the sanitary protection zones (Mémorial A, 2018d). This gave the new Ministry of the Environment, Climate and Sustainable Development (MECDD, ex-MDDI) and AGE time to study and consider all comments received.

While some local actors received the news of the postponement well, others felt bitter about the fact that the protection zones concept had been in the coming since 2012, that the deadline had been postponed from 2015 to 2018, but that local actors, nonetheless, had had only a few months to discuss the draft law and prepare for the formal consultation.

> *"[…] nach fünf Jahren Gutachtenerstellung kann es nicht sein, dass wir uns nur einen Monat Zeit nehmen für eine öffentliche Beteiligung. Das ist ein Unding. Das ist eine Frechheit. Wir hätten mehr Zeit gebraucht und die hätte man sich auch nehmen können". (interview n°36)*

> *"Und ich muss ehrlich sagen, jetzt ist so eine Phase – ja, wie soll ich sagen – so ein Burnout, was Naturschutz betrifft. Also, ich habe die Nase voll" (interview n°35)*

Some local actors suspected that the government had never intended to involve the public. When asked what they should have done differently in hindsight, some local actors felt that they should have been firmer in demanding involvement and meetings with officials at an earlier stage.

Public officials interviewed also found that the process had not gone well: "*Der normale Ablauf, der bei all anderen 51 Trinkwasserschutzzonen gut gelaufen ist, ist hier einmal schlecht gelaufen.[…]*" (n°43)

Why had the deadline not been postponed earlier? The main reason seems to be political. The Green Party had not felt sure of its re-election. According to interview partners, the policy-makers had been concerned that a possible successor government could have watered down and further postponed the drinking water protection zones. Asked about ´lessons learned´, one public official interviewed reflected that the ´political phase´ should perhaps have started earlier:

> *"Wir hätten mit dem Politischen viel früher anfangen sollen. Dann hätten wir vielleicht vieles vermeiden können. Im Nachhinein wahrscheinlich das, was passiert ist, war im Grunde gut. Viele Sachen auf Nachfragen der Gemeinden. Wir hätten das vielleicht auch einfach selber initiieren [können]" (n°43)*

[248] The parties of the government coalition succeeded in securing a majority: the Socialists (LSAP, 17,60 %), the Liberals (DP, 16,91 %) and the Greens (déi gréng, 15,12 %), with the Greens being the only government party who increased the number of votes and seats compared with 2013 (3 parliamentary seats more). The Conservatives continued to be the strongest party (CSV, 28,31 %), but did not have coalition partner. In the Upper Sûre municipalities, the Green Party gained between 9-13 % of votes (seeing increases here, too), the Conservative Party between 32-40 %. Source: https://elections.public.lu/fr/elections-legislatives/2018/resultats.html

Formal outcomes:

- 335 formal statements submitted by local actors with demands for revision of the 1st version of the draft law on the future drinking water protection zones

Informal outcomes and effects:

- Hopes, doubts, and frustrations among local actors

9.12 ASF 6: 2nd draft protection zones law and agricultural funding are elaborated

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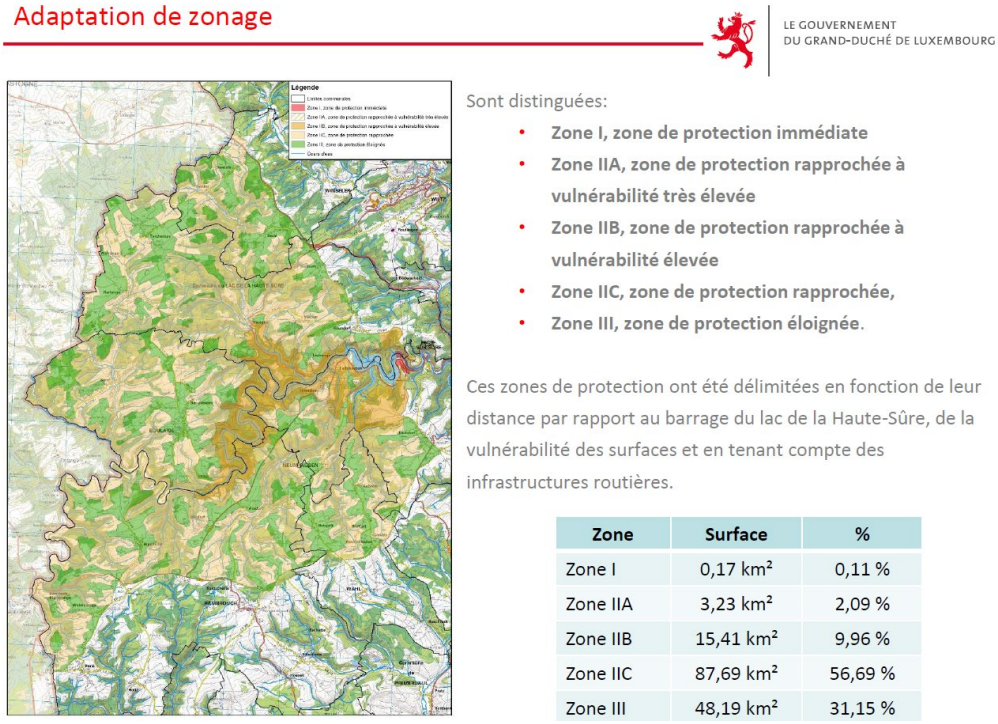
Summary	Following the formal public consultation, the new Ministry of the Environment and AGE revised the first draft of the protection zones law. The revised draft was presented to the public in mid-2019 along with new funding opportunities for farmers. Local reactions were guarded. How actors will cooperate in the future and how the region will evolve remains uncertain. By Autumn 2020 the new law had not yet passed legislative procedures.			
Synergies and tensions	Tensions between a recognition of interdependence as regards the future and the quality of interorganisational and interpersonal relations between actors of the Upper Sûre region and the government.			
Action situation	Documents	Interviews	Observations and meetings	Workshop content
ASF 5: Ministries elaborate and present 2nd draft protection zones law and new agricultural funding (Nov.2018-Jul.2019)	2nd protection zones draft law, public presentations by ministers	N°34, 36, 50, 48, 44, 51	Observations at public presentation of 2nd draft law in Grevels (2/7/2019)	

The minister of the new Ministry of the Environment, Climate and Sustainable Development (MECDD) and public officials presented the revised draft law to nearly 200 participants in July 2019, including all revisions made. The River Contract and other local actors had been asked to disseminate the invitations locally, but were discontent because the programme carried their logos although they had allegedly not been involved in the preparations of the event. This contributed to a tense atmosphere. The minister of agriculture (with whom the Ministry of Environment had coordinated preparations more closely than for the earlier draft) presented new funding opportunities for the farmers in the drinking water protection zones that it had succeeded in negotiating with the European Commission (MAVDR, 2019).

The presentation of the minister of the environment contained an overview of the 18 meetings the ministry and AGE had held with local actors in 2018, stressing that there had never been as many stakeholder meetings when compared with the designation of drinking water protection zones elsewhere in the country (MECDD, 2019d). Some participants remarked afterwards that almost all meetings listed had been convened on local initiative. The minister and other speakers underlined the

importance of partnership in moving into the future. Mainly based on the 337 statements submitted, the new draft contained numerous revisions.



Zone	Surface	%
Zone I	0,17 km²	0,11 %
Zone IIA	3,23 km²	2,09 %
Zone IIB	15,41 km²	9,96 %
Zone IIC	87,69 km²	56,69 %
Zone III	48,19 km²	31,15 %

Figure 9.8 – Future drinking water protection zones in the Upper Sûre region (source: MECDD, 2019d)

The most substantial revisions concerned changes of protection zones borders (see figure 9.8) and the possibility to apply for authorisations and exceptions for certain activities. With a focus on agriculture, some of the main elements of the new draft law are outlined in the following (MECDD, 2019aa). Some of them (indicated in brackets) are close to agroecological principles (see chapter 4.3.2):

- The introduction of three main protection zones (with the second subdivided into three sub-zones) that surround the lake in concentric belts and in which different restrictions apply, article 3)– adaptations were made on a case-by-case basis following the consultation – the protection zone I (in which any activities were forbidden within 100 m from lakeshores) is smaller than originally planned (see figure 9.8)
- The Upper Sûre river (sub-)basin is declared a drinking water source of national interest (article 29)
- A programme to promote awareness-raising (mainly among farmers) to be introduced as part of the future programme of measures (article 21)
- Restrictions on pesticides: in all zones the use of pesticides and phytopharmaceuticals is prohibited (with the exception of those authorised for organic agriculture) (article 24) (agroecological principle)
- Year-round soil cover and other measures to prevent soil erosion are compulsory (agroecological principle)
- Existing drainage systems can be maintained upon authorisation in zones IIB-III, extensions and new installations are only allowed in zone III (annex II, 6.38)
- Restrictions and provisions concerning the stocking of mineral and organic fertilisers and silage (constructions and permitted duration of stocking)
- The fencing of riverbanks along pastures in protection zones II in successive steps (annex II, 6.20.1.)

- Grazing of cattle is allowed from mid-February to mid-November upon authorisation outside the 100 meter belt around the lake and with low cattle density (0,8 to 1 to 1,6 to 2 livestock unit per hectare) (close to agroecological principles), requires a pasture register (annex II(6))
- Phosphor-based fertilisers are permitted in zones IIB to III (outside the 100-meter belt around the lake, 6.24)
- Mineral nitrogen fertilisers are permitted in zones IIB-III under certain conditions (annex II, 6.40)
- Ploughing/tilling of permanent pastures for renewal can be permitted in zone III, for temporary pastures after four years, but no organic fertilisation is permitted during the first vegetation period following the ploughing (annex II, 6.36)
- Organic fertilisation on arable land is limited to 80 kg N/ha for the month of September
- Organic fertilisation can be permitted in zone IIB upon authorisation (outside the 100 meter belt of the lake) if the fertilisers are injected directly into the soil (annex II, 6.26.-6.31)
- Organic fertilisation can be permitted on land with a slope gradient of less than 10 %, if there is no direct connection with receiving water and if mulch drilling and innovative fertilisation technologies are used (annex II, 6.27-6.31
- Organic fertilisation can be permitted on land with a slope gradient of more than 10 %, if direct injection is used and if a 6 meter strip exists and its lower margins (annex II, 6.27-6.31)

As regards the last three aspects mentioned, LAKU farmers have regarded it as the fruit of the work of the Ministry of Agriculture that injection and mulch drilling techniques pioneered by LAKU were included in the revisions.

According to farmers and municipal representatives interviewed, the question of how the future law will influence their development and practices would significantly depend on how the possibility to receive authorisations or derogations would be handled in the future (i.e. how swiftly and generously they would be granted). Farmers also wondered how easy it would be to receive financial compensations for losses in productivity.

Asked about the future of agriculture in the area, few actors dared to make predictions. Some agricultural actors interviewed expected that there would *not* be more organic farms as long as markets did not change, but that new techniques and technologies developed by LAKU would gradually become the new standard for farming in the area, with differences between conventional and organic farming becoming smaller (interview n°50). There were two main reasons for why some interviewees did not expect more widespread changes in farming models. Firstly, they regarded market demand as more decisive than public incentive schemes and subsidies. Secondly, they expected that farmers would have even less time and leisure to consider other models. It would take farmers two years to gain sufficient insights into the new restrictions applying.

> *"Es sind nur noch Vorsichtssachen, wie verbrechen wir jetzt nichts?! Kontrollsachen. Und wie willst du dann noch einem Neuerungen verkaufen?! Das ist schwierig" (interview n°50)*

> *"Es geht, wie vorhin gesagt, fast nur noch drum zu schauen, dass man die nächsten Jahre überlebt. Der Druck wird so hoch, über die Fläche. Wir arbeiten fast nur noch, um das Land zusammen zu halten, sei es jetzt, Pachtpreise zu bezahlen oder Flächen kaufen zu können. Und daran hängst alles. Und daran orientiert sich die gesamte Produktion. Es geht an sich nur noch um Umsatz und Gewinn, um irgendwie seinem Sohn oder seiner Tochter, die vielleicht in 30 Jahren das weiterführen will, das hinterlassen zu können. Also, das ist die einzigste Sache noch.*

Und das beschränkt natürlich auch ein bisschen das freie Denken, wenn man ständig unter Druck ist“ (interview n°5)

Other farmers, too, referred to the additional stress caused by diverse restrictions and legal periods for applying manure and for pasturing. Not only was it increasingly difficult to keep all rules in mind, moreover, they sometimes made little sense depending on (changing) weather conditions. The following quote is given in ´full length´, because it reflects the views of many farmers and other agricultural actors interviewed and talked with:

”Das sind dann die Sachen, womit ich schon Probleme habe: mit all diesen Daten. Am ersten darfst du das. Gülle fahren darf ich vom 15. Februar an, aber auf meinen extensivierten Flächen erst am 01. März. Dann soll wieder etwas geändert werden, dass du nur Weideperiode vom 01. April bis 01. November [machen kannst]. Ich komme aus den Zeitfenstern nicht mehr raus, verstehen Sie?! Das sagt sich wohl einfach, du hast bis zum 01. November oder bis zum 01. Oktober kannst du Gülle fahren, aber du musst erst am 15. September anfangen, wenn es dann 01. Oktober ist, musst du am 15. September anfangen zu gucken: Was habe ich denn noch an Arbeit? […] Wie ist das Wetter…? Kann ich…? Wo habe ich noch Tiere…? Darf ich da…? Also das ist ein Unding! […] Das hast du permanent im Kopf. Das geht ja schon mit dem System der Bearbeitung der Parzellen einher, dass du dann denken musst: „Ah, an diesem Flurstück darf ich noch bis zum 01. Oktober Gülle fahren, also muss ich das geweidet haben. Wann weide ich es…? Das muss ja dann weggeweidet sein, wenn ich Gülle drauf habe. Habe ich es nicht weggeweidet, fahre ich Gülle drauf, habe ich Gras stehen, fressen meine Tiere nicht, muss auf Regen vielleicht warten. Kommt noch etwas Regen…? Aber auf diesen Flächen werden die Tiere nicht mehr weiden. Das ist alles ein Blödsinn ohne Ende! […] Wir hatten dieses Jahr Tiere draußen bis zum 20. Dezember. Die haben immer noch geweidet draußen, ohne zu füttern. Hat super funktioniert, war super Wetter. Und wenn das Schutzzonenkonzept fertig gewesen wäre, hätte ich sie am 01. November reinnehmen müssen, obwohl ich nicht genug Futter gehabt hätte, um sie über den Winter zu bekommen. Also das kostet dann richtig Geld [Futter zukaufen]. Und Tiere in den Stall stellen, und ich lasse mein Gras draußen verfaulen?! Das gibt auch Nitrat […] Aber von Gülle kann man ja noch absehen, aber von Tiere draußen lassen…?! Um das auch noch zu regulieren?! Das tut mir leid. Was soll das?!” (interview n°44)

During discussions with other actors, the new GPS-based tool developed by LAKU and the Nature Park (´Landmanager´), was mentioned as a way to help farmers to keep an overview of which periods and restrictions applied where on their land. Thus, technologies were the main means cited to help farmers cope with increasing complexity. Interviews, however, also suggest that concerns were not only practical. Some have also perceived regulation as patronising and as a threat to their (narrative) identities (see also chapter 11.3.2.1):

“Da fehlt der klare Menschenverstand drin und ich sehe nicht ein, dass ich bluten soll für Sachen, die ich versuche gut zu machen und andere nicht in Ordnung haben. Das tut mir leid, das sehe ich nicht […] Denken sie oder wird gedacht, dass wir uns überhaupt keine Gedanken über unser Wirtschaften machen?! Ja, das wird gedacht. Man macht einen Text, wie wenn man es mit Kleinkindern zu tun hat […] Ich passe mich an, so wie ich denke, dass mir die Jacke passt, nicht, wie man sie mir anziehen möchte“ (interview n°44).

Finally, several farmers and farm advisors saw a contradiction between the planned restrictions on the use of fertilisers and pesticides and the simultaneous restrictions on pasturing, regarding grassland for cattle as the most suitable option, also considering local soil conditions too nutrient-poor for crop cultivation:

"Die Ökosysteme: wir sind eine Grünlandgegend, wir sind ein Grünlandstandort. Vom Acker kann man hier nicht leben, d.h. wir werden immer Wiederkäuer brauchen, um dieses Gras auch zu verwerten. Und Gras ist ja auch von Vorteil, immer grün, nimmt Stickstoff raus, kaum Überschüsse, ja, kaum Herbizidbehandlung, das hat nur Vorteile. Aber dann irgendwo mit einem Wasserschutzreglement die Rinderhaltung einzudämmen und dann gleichzeitig Gras zu fordern, das passt nicht". (interview n°45)

On the other hand, other agricultural actors *did* expect that more farmers would consider other business models and decide to convert to organic production due to the new protection zones (interview n° 51). Furthermore, the higher subsidies for ´water-friendly´ production were, the more would farmers become aware that the "production of drinking water" was "no shame". Due to roots of crops and soil, no other land "produced" as much drinking water as cultivated land:

"Dass man diese Beihilfen noch höher macht, damit das auch den Landwirten richtig bewusst ist, dass sie ihren Erwerb auch über solche Sachen machen können. Auch die Produktion von Trinkwasser ist… Trinkwasser ist ein Lebensmittel und die Produktion von Trinkwasser, es ist keine Schande und dafür könnte man bezahlt werden. Übrigens, es gibt keine Flächen, wo mehr Trinkwasser produziert wird als auf landwirtschaftlich genutzten Ackerflächen. Ackerflächen!" (interview n°51)

Besides being an argument that is financially in the interest of farmers, the statement nonetheless hints at the *possible* emergence of an *expanded* productionist paradigm in agriculture, including "water production".

At the same, most agricultural actors interviewed were convinced that structural change towards fewer and ever-larger farms (conventional and organic) specialised on milk production, in particular, would continue. In addition to local soil conditions that limited options, one of the most frequent reasons cited were strong hikes in land prices and shrinking availability of land (in both Luxembourg and neighbouring Belgium). Many farmers did not expect (or recommend) their children to take over their farms. Among various reasons provided was the fact that farmers´ incomes in Luxembourg are often below the minimum wage and that the gap between farm incomes and average salaries continues to widen (see chapter 11.2.2.4).

Similarly, when asking participating officials at the public event on the protection zones law if and how quickly they expected to see improvements in water quality as a result of the law, none of them dared to make predictions.

Not mentioned in the draft law, the future roles of LAKU and the Upper Sûre Nature Park remain uncertain. Some participants at the public event presenting the 2nd version of the draft law remarked that LAKU had not been mentioned during the presentation of the Ministry of the Environment. LAKU members, however, continue to hope that it would be easier for them than for other farmers to obtain derogations from certain restrictions. In this way, LAKU membership would remain attractive for farmers. The Nature Park staff has awaited initiatives from SEBES and governmental actors (see also ASI 7 below).

Funding of technical LAKU measures will no longer be covered via SEBES and the water management fund, but instead directly (for each farmer individually) by the Ministry of Agriculture. LAKU members expect this to imply that LAKU will have a less prominent role in the future and, potentially, less close relations with SEBES and the Ministry of the Environment. One possible reason for the move of funding from the Ministry of Environment to the Ministry of Agriculture was a clearer delineation of

competences and that AGE has less knowledge of agriculture to make judgements on the likely impact and effectiveness of different farming measures (interview n°50).

For some of these reasons, some local actors have continued to doubt whether national-level officials recognised them as partners and interlocutors. It would be decisive how strongly they would be involved in the future programme of voluntary measures to be elaborated for the protection zones. The elaboration and implementation of the programme will be coordinated by a new regional ´drinking water coordinator´ for the protection zones employed by SEBES. According to the guidelines published (AGE, 2018b; SEBES, 2019), his formal tasks will include the coordination among actors (including in a multi-stakeholder steering committee) and the integration of the diverse elements prescribed in detail for the future programme of measures. The programme is to be in place within two years following the entering into force of the protection zones law, including: an analysis of the current situation, of risks to water quality, and of actors in the region (´stakeholder mapping´). The guidelines specify that the analysis of the current situation and risks can be elaborated in cooperation with external experts such as geological consultants and farm advisors. The protection zone coordinator is also to participate in the LAKU cooperation. The future programme of agricultural measures for the area is expected to be based on LAKU measures.

As regards further structural changes in agricultural business models and practices - and related possible improvements in water quality in the Upper Sûre streams and lake – they are expected to depend on:

- the upcoming new protection zones law itself (including the authorisations and exemptions granted after it enters into force),
- funding schemes for farmers and the new EU Common Agricultural Policy (CAP) and related national rural development programme 2021-2027,
- a possible agreement between the government and Walloon authorities on the extension of the drinking water protection zones to the Belgian part of the sub-basin (see ASI 7),
- developments in land prices and availability (on both sides of the border),
- developments in food markets and consumer demand regional and national products, possibly encouraged by more regional and national product marketing and labels.

Main formal outcome:

- Second version of the revised draft law for the creation of drinking water protection zones – to be submitted to the state council and the national parliament for approval (had not passed by Autumn 2020)
- At SEBES (organisational): creation of new position, description of tasks, and recruitment of new water coordinator

Informal outcomes and effects:

- Uncertainties about future perspectives and roles of the Upper Sûre Nature Park and River Contract, LAKU, and SEBES

9.13 ASI 7: Perspectives: Workshop fosters ideas and action fields for the future

Summary	In February 2019, a collaborative conceptual systems workshop was organised in the framework of the NEXUS FUTURES project, in cooperation with the Upper Sûre River Contract. 33 local and national actors developed action fields for the future, with a focus on regional products and marketing, tourism, and local social and cultural life. Future roles among actors was a major topic.			
Action situation	Documents	Interviews	Observations and meetings	Workshop content
ASI 7: Future perspectives: Local and national actors develop ideas and action fields for Upper Sûre sub-basin	Summary of NEXUS FUTURES workshop (see annex III)		At workshop and evening event of NEXUS FUTURES (see annex III)	Conceptual maps of participants and timelines (see annex III)

In February 2019, the author of the present thesis organised a collaborative conceptual systems workshop (in the framework of the NEXUS FUTURES project) with local and national actors in the Upper Sûre region, in close cooperation with the Upper Sûre River Contract. Participants discussed local challenges at the nexus of water, soil and nature and possible action fields and future perspectives (*what could the Upper Sûre region look like in 2045?*), elaborating conceptual systems maps in groups (see methods chapter 5.1.2). The 33 participants brought together actors from the Nature Park and River Contract, farmers (including LAKU members), farm advisors, actors from private forest and fishermen´s associations, municipalities, SEBES, a regional wastewater syndicate, the Ministry of the Environment, AGE, and non-affiliated citizens. The workshop conclusions suggest that the Upper Sûre region – similar to the situation in the 1980s/90s - is in need of common projects, perspectives, and visions to supplement the restrictions and measures to be introduced with the new drinking water protection zones (see annex III, figure 9.9).

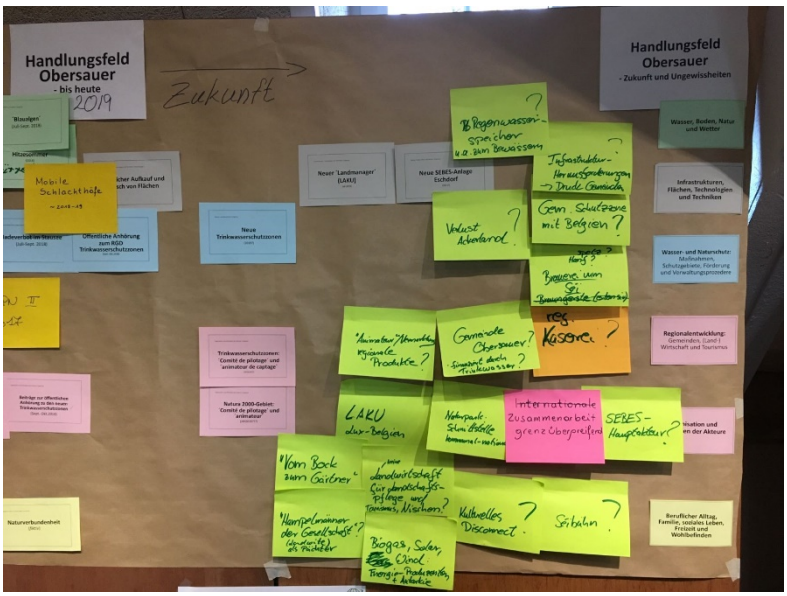


Figure 9.9 – Action fields and ideas for the Upper Sûre region in 2045

Perspectives and possible action fields and projects discussed at the workshop would entail new modes of social organisation in the region and new roles of actors such as SEBES, the Upper Sûre Nature Park and River Contract, municipalities, LAKU, and farmers in general. Concretely, discussions on future perspectives centred on the question how actors could strengthen regional development, ecologically, economically, socially, and culturally. Three main and interrelated paths for possible future actions were explored collaboratively. They concerned regional products and marketing, tourism, and local social and cultural life.

As regards regional marketing, participants regarded the strengthening of regional products as the main option for how to combine agriculture, environmental and water protection, and regional development. It was the central idea on how to make the region more attractive (for both tourists and inhabitants) and to generate more public acceptance and support in Luxembourgish society for agriculture. One group proposed that consumers could pay farmers a voluntary "wellbeing premium" ("Wohlfühlprämie") to create incentives for them to support diverse ecosystem services – and as alternative to restrictions.

The "vum Séi" label ("from the lake") is already the most known regional brand in Luxembourg, but it relies mainly on a few niche products (see chapter 7.3.2). As regards organic products in Luxembourg, 50 % of the organic milk produced by the 12 Luxembourgish dairy farmers is currently exported abroad, because most consumers in Luxembourg prefer to buy cheaper (organic and non-organic) products from elsewhere. Participants, therefore, thought of possible ways to add value to products ´from the lake´ and to increase national demand. Product and marketing ideas included (see figure 9.9):

- a cheese factory using milk from the region,
- a re-launch of a malting barley project (from the beginning of the 1990s) either in cooperation with an existing regional brewery or a new "lake brewery" (malting barley has low nutrient needs and is therefore ´water-friendly´),
- an regional mill and bakery for spelt bread (based on successful examples from Belgium and Boulaide, spelt also has low nutrient demands),
- mobile abattoirs for a more "stress-free" slaughtering of livestock (not requiring transportation over long distances),
- direct marketing from producers to consumers.

As regards regional products, few participants considered it likely that farmers themselves would be able to set up new production and marketing structures. Instead, some proposed that the state could finance "product coordinators" that would support initiatives and set up infrastructures (in addition to the one existing coordinator of regional nature park brands in Luxembourg). Participants saw public procurement for canteens of schools, elderly homes, etc. that privileged regional (and national) products as a possible way forward to enhance demand.

An object of heated debate was the question if farmers would continue to be mainly food producers or if they could also be ´landscape managers´. Some participants from agriculture were highly sceptical of such ideas and visions, rejecting the notion of farmers as "landscape gardeners" or "energy producers" (e.g. via alternative crops such as low-nutrient miscanthus grass for heating). Referring to increasing state purchases of agricultural land in the region and restrictions on fertilisation and plant protection, they feared that farmers – as tenants of state-owned land - would be turned even more strongly than already the case into "marionettes of society" ("Hampelmänner der Gesellschaft"). If agriculture would take that turn, farming would increasingly have to rely on labour from abroad to

take care of fields and landscapes[249]. They regarded it as of utmost importance that any perspectives and visions developed should seek to safeguard the continued existence of family farms as *food producers.* Several participants wondered whether agriculture in the area had a future at all.

Many participants regarded tourism as closely related to regional marketing. The more attractive the region was for tourists, the higher the demand for regional products. Bathing tourism alone would not be sufficient. Rather, diverse forms of "slow tourism" (also "agro-tourism") that would keep guests for longer in the region than for a day or a weekend, but would be compatible with water-related building restrictions, were considered necessary. Recreational and cultural offers and infrastructures would need to be enhanced, for example, via the re-launch of projects and festivals such as the "Séibühn" ("lake stage"). A long-standing idea to construct a "lake wellness hotel" was also re-evoked, although most expected the idea to be incompatible with protection zones restrictions.

A reinvigoration of cultural and social life was also considered important with a view to making the region more attractive for young people, to enhance social engagement, and a sense of community among inhabitants – across generations and different cultural backgrounds. Some expressed concerns about an increasing "cultural disconnect" associated with cultural and linguistic diversity, others expected that rural populations would shrink depending on national economic development and land price developments. Several participants highlighted the need for more local jobs. Concerns such as these suggest that it may be difficult to dissociate water protection from wider issues connected to local social life and contexts. This had been the *raison d´être* underlying the foundation of the Upper Sûre Nature Park (see chapter 7.3.2). They provide some arguments in favour of calls to regard environmental and social regeneration efforts as interconnected, be it as part of more broadly anthropocentric or broadly ecocentric approaches (see chapters 4.3.2, 4.4)

Finally, most participants agreed that these action fields required cooperation and changing roles among a diversity of actors and across scales as well as more autonomy in regional matters (including in tourism, where the Upper Sûre region currently follows national provisions). Most discussions centred on the possible futures roles of SEBES, the Upper Sûre Nature Park, LAKU and the municipalities. As regards the latter, the influence diagram one group was based on the idea that municipalities would benefit from joining forces and merge into one larger "Upper Sûre municipality", in order to gain to have sufficient capacities and resources to make attractive offers for local inhabitants and tourists (see figure 9.10). It was proposed to expand the role of the Nature Park by adding an overarching coordination of regional development to its portfolio of environmental and water protection activities. The role of the Nature Park in enhancing environmental awareness and the appreciation of water via its educational activities (including the ´Nature Park School´ that offers seminars) was also considered important.

[249] By contrast, other agricultural actors anticipated that structural changes in agriculture, driven by increasing digitalisation (e.g. through precision farming), would continue to reduce the number of farms and make them bigger and more "technology-intensive".

Figure 9.10 - Collaborative conceptual map with a merged "Upper Sûre municipality" in 2045

This idea that the Nature Park could assume a more prominent role in regional development was echoed by another group that proposed the Nature Park could drive initiatives (such as for a “lake brewery”), in close cooperation with municipalities. Some participants proposed that SEBES demonstrated its new role in – and identification with – the region (“regionaler Bezug”) by financially supporting initiatives such as these. In general, a majority of participants expected that SEBES would become a (or even *the*) major actor in the region in the future, not least due to its new ´water coordinator´ and his portfolio. Close coordination between SEBES, the Upper Sûre Nature Park and River Contract, municipalities, LAKU and the Water Management Authority would be crucial (see figure 9.11).

Figure 9.11 - Collaborative conceptual map on possible roles of actors in 2045, with SEBES and the Nature Park as key actors (Upper Sûre NEXUS FUTURES workshop)

Finally, as regards farmers several conceptual maps underscored the importance of giving farmers the opportunity to participate actively in decision-making on operational objectives and measures (e.g. via LAKU). In order to avoid (more) legal restrictions, it was considered desirable that more farmers engaged actively in voluntary activities. Self-imposed and flexible measures (rather than standardised prescribed practices) and involvement in decision-making could be a source of motivation for farmers and a precondition for them to identify with water protection as a shared - and self-understood – vision (see figure 9.12).

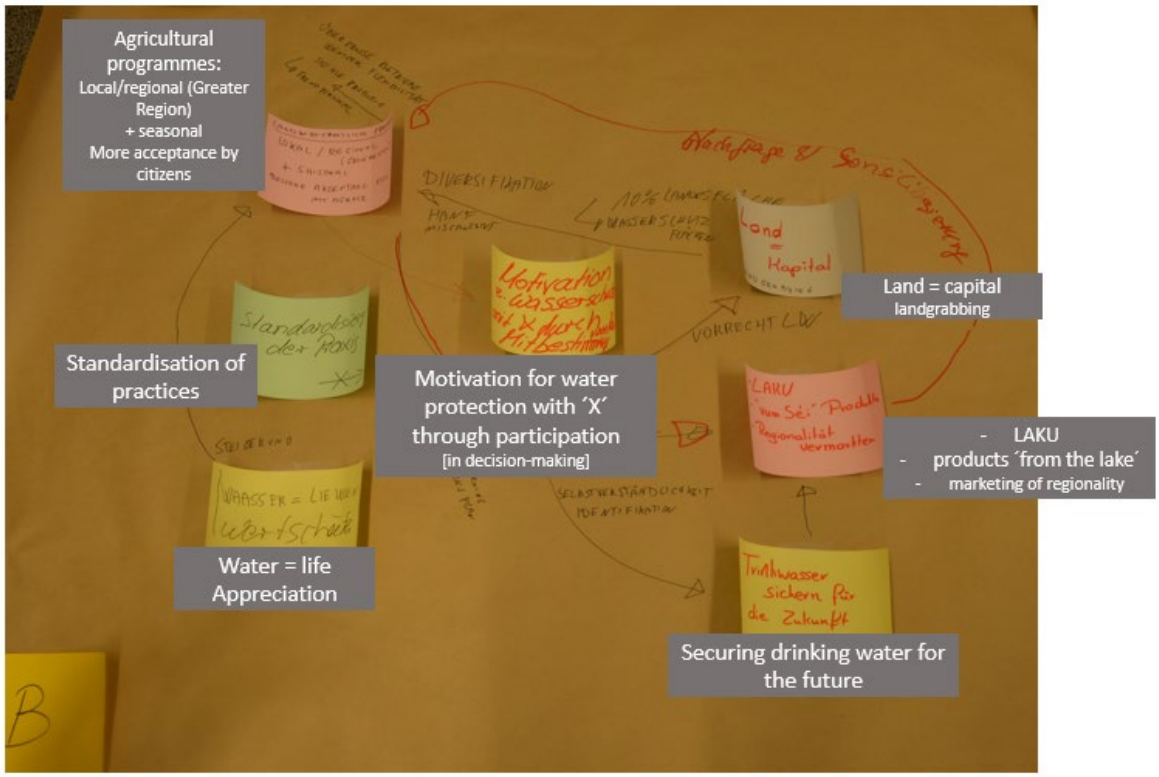


Figure 9.12 – Collaborative systems map focusing on the involvement of farmers in water protection

9.14 Concluding summary and analysis

The present case study has examined how the EU WFD provisions concerning drinking water protection zones and public consultations have contributed to changing water and land governance and management in the Upper Sûre sub-basin (research question 2), and what factors have facilitated and hindered the emergence of social learning and actionable knowledge for sustainability (research question 2).

Its findings contribute to a better understanding of how governmental and nongovernmental organisations (incl. local and professional communities) can shape governance processes and how organisations and communities are shaped by their histories and paradigms reflected in shared narratives. Many of the organisations analysed are, indeed, epistemic communities sharing an organisational and/or professional culture, knowledge and practices that rest on specific experiences and assumptions. Only what resonates with these, can be actionable knowledge. They have shaped both inter-organisational and interpersonal relations in the processes analysed. Even if, overall, social learning across scales and sectors has remained limited, the case study illustrates how pioneering actions and experiments of individuals may contribute to challenging prevailing knowledge, changing inter- and intra-organisational relations and professional practices, going hand-in-hand with the emergence of new social networks, relations and roles. The EU WFD contributed to this in two ways: formally, by requiring new drinking water protection zones that would entail restrictions on farming and introducing formal public consultations, informally, by raising expectations among local actors to be actively involved in the preparation of the dossier serving as basis for the protection zones law.

9.14.1 Changes in water and land governance and management (research question 2)

The case study suggests that national EU WFD implementation has, indeed, contributed to changing water and land governance and management in the Upper Sûre basin. Firstly, the introduction of the river basin principle and hydrological criteria has extended the scope of the area to be protected around the Upper Sûre lake to include the entire Luxembourgish sub-basin.

Secondly, the obligation to set up new drinking water protection zones based on risk assessments and the principle to reduce water treatment needs introduced a new "philosophy" to Luxembourg. It resulted in the necessity to attribute more attention to (potential) effects of agriculture on chemical water quality. The overarching ecocentric purposes of the EU WFD – reinforced by the election of the Green party into the government and Ministry of the Environment - has meant that water supply- and production-oriented paradigms move increasingly towards integrating more environmental criteria and services. Conversely, the ecocentric paradigm has been expanded to include anthropocentric drinking water concerns.

Thirdly, the EU WFD has strengthened both hierarchical and network governance. Hierarchical governance has been strengthened because of the extensive requirements regarding scientific risk assessments, measurement regimes and data, as basis for detailed regulation. They are one of the main reasons for why the protection zones have still not entered into force (nearly five years after their initial due date). The science-orientation also resulted in municipalities themselves commissioning specialised scientific studies to argue against certain principles and provisions. Overall, therefore, hierarchical governance has dominated. At the same time, network governance has, in principle, also received a boost. This is mainly due to the introduction of formal public consultations (that did not exist before) and the growing recognition of the need for coordination that, overall, resulted in more interactions between governmental and nongovernmental stakeholders.

Together, these factors resulted in a new role for SEBES, with its recently employed coordinator for measures to be carried out in the protection zones. At the same time, the role of the ´historical´ organisations in place (Nature Park and River Contract) has been weakened. Local actors were not actively involved in the elaboration of the dossier on the drinking water protection zones, but only had a chance to contribute once a first draft law had been finalised and in the framework of the formal public consultation. Finally, as regards management, the EU WFD has contributed to a stronger emphasis on soil management and on reducing the use of nitrates and pesticides in agriculture. At the same time, agriculture continues to aim, first and foremost, for productivity (coupled with increasing efficiency). Likewise, the construction of a large-scale new water treatment plant suggests that engineered infrastructures and technological water treatment continue to have priority over pollution prevention. Therefore, overall, water and land governance and management in the Upper Sûre region have become more complex, hybrid, and contradictory (see table 9.2).

Water governance and management in the Luxembourgish Upper Sûre sub-basin	***Before* national EU WFD implementation (pre-2008/2013)**	***In the course of* national EU WFD implementation (post-2008/2013)**
Paradigms and purposes	Dominance of anthropocentric supply- and growth-oriented paradigms (water, agriculture) co-existing with an integrated bottom-up community paradigm centred on regional development (Nature Park, municipalities)	Anthropocentric paradigms supplemented by a managerial ecocentric paradigm, all of them moving towards more adaptive and integrated paradigms, co-existing with the bottom-up community paradigm
Main actors	Formal processes: Ministry of the Interior, AGE, water syndicates (SEBES, DEA), engineers, consultants, municipalities Informal processes in the region: Municipalities, farmers, Upper Sûre Nature Park	Formal and informal processes: Ministry of the Environment, AGE, water syndicates (SEBES, DEA), engineers, consultants, municipalities, Nature Park and River Contract, LAKU and farmers, farm advisors
Scope	Upper Sûre lake (sanitary protection zones) and technical water infrastructures	Entire Luxembourgish Upper Sûre sub-basin in addition to (expanding) technical water infrastructures
Social coordination	Dominated by hierarchical governance with some network governance (via Nature Park), but no formal public participation and stakeholder involvement	Hierarchical governance relying *more strongly* on specialised scientific/technical knowledge, regulation and financial incentive schemes, complemented by formal public consultations and some stakeholder involvement and network governance
Management means	Centred on technical infrastructures and pollution treatment (´technological fixes´) with limited pollution prevention in sanitary protection zones, agricultural productiviy	Stronger focus on pollution prevention, however, with ongoing massive investments in drinking water treatment infrastructures, and agriculture oriented predominantly but not entirely towards food production

Table 9.2 - Overview of changes in water and land governance in the Upper Sûre basin after 2008/2013

The above broad-brushed summary of WFD effects in the Upper Sûre region neglects the role of organisations and narratives in the processes analysed. They have been essential. The case study suggests that the dynamics formal institutions such as the EU WFD unfold depends crucially on how actors interpret and act on them. This again depends on various *contexts*. By examining interplays between formal and informal processes and by analysing diverse narratives the case study has cast light on elements of both continuity and disruption in national WFD implementation, notably with a view to relations between the actors involved.

At first sight, processes to introduce new drinking water protection zones in the Upper Sûre region have been characterised by tensions along the top-down/bottom-up governance axis, with the status of regulation and specialised scientific/technical knowledge vis-à-vis self-organisation, stakeholder involvement and the consideration of local and professional knowledge as main bones of contention. At a deeper level, however, some of the tensions have equally reflected controversies about how human-environment relations are framed and how to reconcile diverse purposes tied to water and

land use, particularly, between farmers and the Ministry of the Environment. The formal protection zones process re-affirmed national water supply as an overriding regulative priority for the Upper Sûre region. In this sense, both bottom-up/top-down tensions and drinking water supply inscribed themselves in a history that began in the 1950s with the construction of the national Upper Sûre dam. The aim to reduce pollution from agriculture and wastewater via regulation and public funding had also existed before. However, the EU WFD introduced the requirement to demarcate protection zones based on detailed risk assessment of diverse anthropogenic pressures expected to result in more extensive, fine-grained, and restrictive regulation imposed on farms and municipalities. This provided for a much more systematic approach to water protection. It also contributed to reigniting pre-existing debates and sentiments.

Parts I to III of the case studies have analysed five different categories of actors, and the narratives and paradigms prevailing *before* national WFD implementation (respectively, before AGE was moved to the Green-led Ministry of Sustainable Development):

- *Farmers* (conventional and organic): an anthropocentric productionist paradigm with narratives centring on food production and farmers´ self-determination;
- *Local municipalities*: broad anthropocentric paradigm with narratives centring on serving citizens (e.g. via regional development) and regional self-determination;
- *Upper Sûre Nature Park and River Contract:* hybrid and integrated approaches combining broad anthropocentric and ecocentric paradigms characterised by uneasy relations between water, environment, agriculture, and regional development;
- *SEBES, AGE, and consultants*: managerial anthropocentric paradigm focusing on water quality with a view to drinking water supply (´command-and-control´).

As regards these categories of actors, it is notable that they, when WFD implementation began in Luxembourg interpreted the EU WFD and drinking water protection zones processes based on established narratives and paradigms. In addition, after 2013, an ecocentric paradigm emerged in formal governance, focusing on water quality with a view to primarily ecosystem health and narratives combining halting ecological deterioration and making Luxembourg´s political culture more participatory. However, with the exceptions of the Nature Park and River Contract and SEBES, many framings have continued to be dualistic in the form of “us-versus-them” and “water protection versus conventional agriculture and regional development”:

- *Farmers*: regarding drinking water protection as a threat to agricultural production with professional self-determination (versus regulation) and the survival of farms as dominant themes
- *Municipalities*: regarding drinking water protection as a threat to regional development, with self-determination (versus regulation) and the well-being of local communities as main themes
- *Upper Sûre Nature Park and River Contract*: putting WFD provisions concerning public participation to the fore, seeking to reconcile water protection with environmental protection, regional development, and farming
- *SEBES and AGE* (cooperating with consultants): adopting objectives and technical framings of EU WFD and related national provisions concerning risk assessments and restrictions to reduce potential risks to - and costs of - national drinking water supply with societal water security among dominant themes
- *Ministry of Sustainable Development* (post-2013): promoting drinking water protection and organic agriculture via regulation and incentive schemes as a means to achieve wider

ecocentric political purposes, with environmental protection (e.g. versus intensive agriculture) the dominant themes

- *Ministry of Agriculture* (albeit to a lesser degree): continued focus on agricultural productivity, but promoting financial compensations for more water- and environmentally ´friendly´ farming beyond food production

Overall, the narratives "us-versus-them" and "water protection versus conventional agriculture and regional development" produced significant tensions between governmental and local actors that did not fundamentally change throughout the processes (see figure 9.13). In this polarised situation, the role of the Nature Park and River Contract in acting as potential boundary organisation and mediator was weakened, being perceived as more ´on the side of´ local farmers and municipalities than of water protection (further elaborated below).

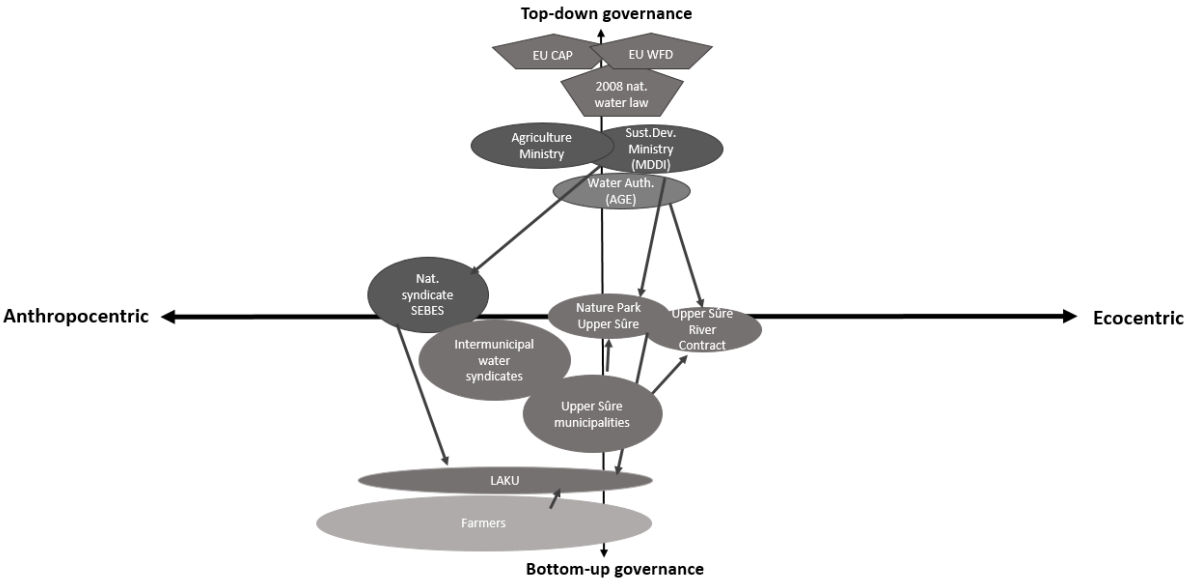


Figure 9.13 - Analytical grid: Selected laws and actors in the Upper Sûre region (post-2013)

At the same time, the case study has identified certain changes in some of the narratives that substantiate some of the above claims on possible first signs of possible emerging paradigm shifts. The changes can be attributed to two different types of learning: policy learning and social learning (see figure 9.14). In *policy* learning, governmental actors adjust policy objectives and/or means to better achieve overarching purposes, e.g. in the light the effects of past policies or new information (Pahl-Wostl, 2015). The present case study suggests that new regulatory requirements (such as WFD provisions), governmental change and hazard events can equally contribute to policy learning. *Social* learning, in contrast, involves diverse actors across levels of decision-making and sectors who engage in self-organised relational practices from which new knowledge may emerge that entails changes in social relations, knowledge, and action. Interplays between formal and informal processes, e.g. via close interaction between governmental and nongovernmental actors, were assumed to be particularly conducive to double loop social learning denoting the questioning and re-framing of overarching purposes, narrative identities, and roles that alter organisational and professional contexts.

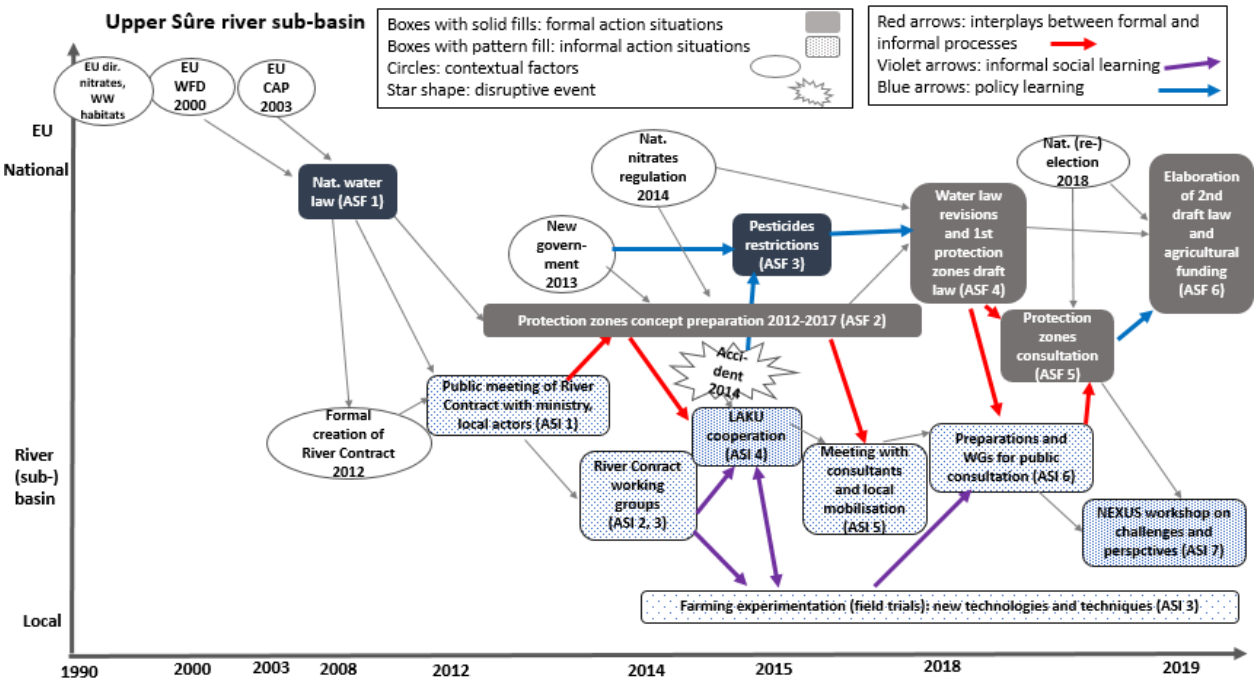


Figure 9.14 – Upper Sûre: Interplays and policy and social learning effects between action situations analysed

In the present case, WFD implementation has produced few mutual feedbacks between formal and informal processes that enhanced social learning across local and governmental contexts. This can be attributed to weak cross-scale social networks (see below). Instead, separate instances of policy learning and social learning have been identified (see figures 9.14, 9.15). The most significant social learning took place within the agricultural cooperation LAKU that brought together the water supplier SEBES (with support from the Ministry of the Environment and the Water Management Agency), farmers, farm advisors, and the Nature Park and River Contract. The social network fostered some convergence between productionist narratives of farmers and the technical framing of water supply issues by the water operator, both expanded to aim for the ´production´ of cleaner raw water via the joint development of ´water-friendlier´ farming techniques, with the River Contract acting as boundary organisation. Framings moved away from a narrow focus on food production, respectively, water treatment and supply. It also entailed the questioning of established roles and self-understandings. At the same time, overarching production- and supply-oriented purposes hardly changed. The depth of social learning and the factors that facilitated and hindered its emergence are further summarised below (research question 3).

Policy learning, on the other hand, has entailed some convergences between top-down ecocentric and anthropocentric and agricultural productionist paradigms towards more integrated approaches. Convergences between the Ministry of the Environment, AGE, and SEBES have manifested themselves, firstly, in the (re-)framing of drinking water protection as an element in environmental protection, and vice versa. Secondly, they surfaced in the division of formal processes preparing the future protection zones into a “technical” and a “political” phase. The analysis of the technical phase (from 2013-to 2017) suggests that the EU WFD has perpetuated and further strengthened technical framings in water governance. Compared with the sanitary protection zones introduced in the 1960s, the new protection zones have required more extensive specialised scientific/technical knowledge to carry out risk assessments in line with the precautionary approach. Expert-driven sectoral preparations (carried out almost exclusively by engineers and natural scientists with little knowledge of agriculture) hardly considered local stakeholders, historical contexts, and self-organisation. This is in contrast with network governance principles laid out in WFD recommendations that stakeholders be involved at an

early stage and that context factors such as the history of relations and management in the river basins be taken into account (see chapter 4.5). Some governmental actors have cited formal reasons for this (thereby underlining the technocratic character of water governance), stressing that "facts" needed to be generated first and be separated from normative and interest-driven debates. Weak involvement of stakeholders also reflected widespread doubts among governmental actors that involving local actors and considering their local and professional knowledge would have contributed to a more effective new protection zones law in terms of water protection.

Finally, the political phase encompassed intra-governmental negotiations to prepare the 1st draft law, the formal public consultation, and preparations and presentations of the 2nd draft law (end of 2017-2019). During this time, more significant interplays between formal and informal processes emerged, notably, in the form of several meetings between representatives of the Ministry of the Environment, the Water Management Agency, and local actors (see below). Furthermore, following the public consultation and national elections, the ministries for environment and agriculture coordinated themselves more strongly to integrate environmental and agricultural objectives in a new funding scheme for farmers and subsidise technologies developed by LAKU. The case study suggests that this may have been a result of policy learning.

The pesticides accident in 2014 aggravated relations between environmental and agricultural actors, governmental and nongovernmental. The event and pesticide findings in groundwater wells was a ´wake-up call´ for, in particular, the Ministry of the Environment, the Water Management Authority, SEBES, and for the public. Public and political debates coincided with wider European and global debates about the use of glyphosate in agriculture. Learning from the pesticides accident and responsive to public concerns, the national government and parliament thus restricted, respectively, banned the use of certain pesticides, under the lead of the Ministry of the Environment. At the same time, some agricultural actors until today have continued to hold a diverging view on the use of glyphosate until today.

The revisions of the national water law in 2017 and of the 1st protection zones draft law and the 2019 additional agricultural funding measure (M12) in 2019 suggest that the Ministry of the Environment and the Ministry of Agriculture have begun to coordinate water and land governance more closely. The fact that the two ministries opened up new funding opportunities for farmers and farm advisors and integrated some of the technologies developed by LAKU and considered some of the statements by LAKU, farmers and farm advisory bodies in the 2nd draft law also reflects a greater recognition of the important role of agriculture in water protection. As a result of policy learning fostered by the EU WFD and other factors, therefore, the case study suggests that water and agricultural governance may gradually move towards more integrated approaches, slowly overcoming decades of divides and sectoral approaches. This also begins to be reflected in statements and narratives of actors within the Ministry of Agriculture that recognise contributions of agriculture to drinking water ´production´ (after all, also a basic "aliment"!) as a service for which it would be "no shame" for farmers to receive payments for.

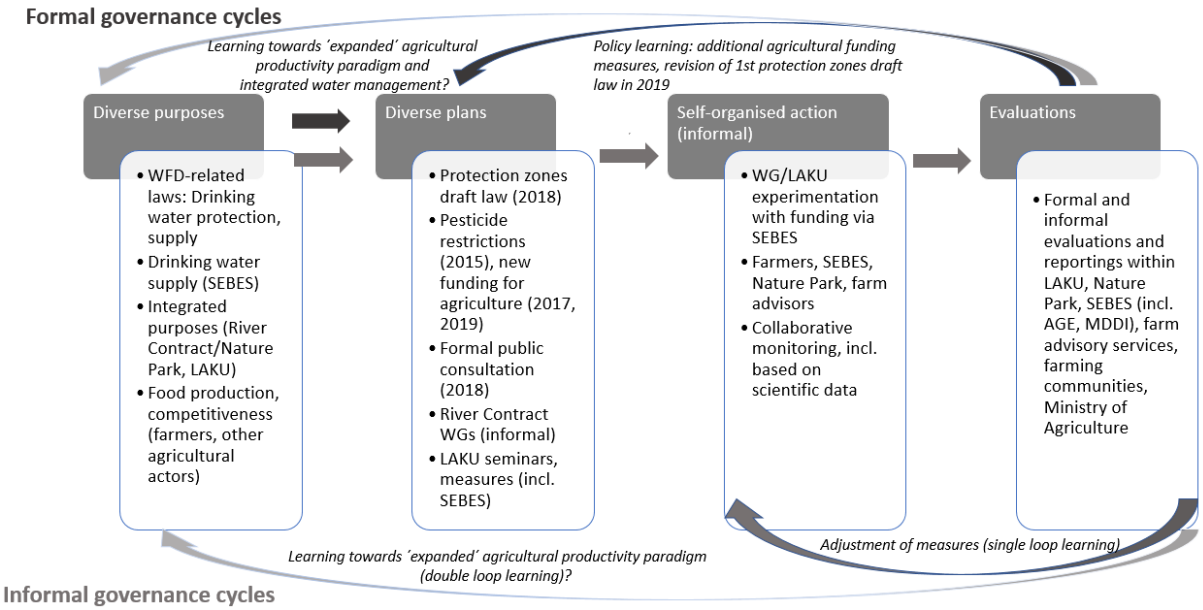


Figure 9.15 – Schematic representation of informal and formal governance cycles in the Upper Sûre region (2012-2019)

At the same time, the above argument that water and agricultural governance and management begin to become more integrated and, furthermore, begin to reflect the adaptive and ecocentric emphasis on pollution *prevention* needs to be qualified in a number of ways. Firstly, notwithstanding all efforts to curb effects of agriculture and wastewater on the chemical quality of lake water, a new SEBES drinking water treatment plant will become operational by 2021. Its two-fold purpose is to increase drinking water production from 70 000 m3 to 110 000 m3 to meet the needs of a growing population and to modernise water treatment. The treatment of raw water will include eight steps, including membrane filters (of a size corresponding to 12 football fields), ozonation to reduce micropollutants such as pharmaceuticals and pesticides (e.g. up to 90 % of metazachlor-ESA, see ASF 3) and ultra-violet (UV) light disinfection to remove microbiological contamination (i.e. bacteria and viruses)[250]. This means that, while the EU WFD and drinking water protection zones serve to reduce the need for water treatment, the new treatment plants bears witness to ongoing massive investments (approx. 166 million EUR) in large-scale infrastructures and ´technological fixes´ characteristic of the command-and-control paradigm. Unlike the 1950s and 1960s when the construction of the Upper Sûre dam was praised as a sign of Luxembourg raising to the rank of other great industrial nations (see chapter 7.2.1), the new modern treatment plant has hardly been reflected in narratives of actors interviewed and documents consulted. That is, the paradigm persists, but narratives celebrating infrastructures as materialised technological and societal progress have perhaps become less pronounced.

Furthermore, despite increasing coordination between the ministries for environment and agriculture (and additional financial incentives) one of the effects of the new drinking water protection zones is already tangible; notably, the displacement of some agricultural activities to the Belgian part of the Upper Sûre sub-basin (making up two thirds of the lake´s catchment area). In terms of chemical quality of lake water, it is uncertain if reductions in the use of nutrients and pesticides on the Luxembourgish side of the border will outweigh displacements to Belgium. Much of the effectiveness of policy initiatives to curb environmental effects of farming in the Upper Sûre region may depend on if and when an agreement between Luxembourg and the Walloon authorities to expand the drinking water protection zones will be in place (see also workshop summary in annex III).

[250]On the new SEBES treatment plant see sebes.lu/fr/actualite/nouvelle-station/

Last but not least, the question if farming in the Upper Sûre region will become less intensive and perhaps more organic crucially depends on factors such as the future Common Agricultural Policy[251], global food markets, land availability and prices, climate change, and, last but not least, on Luxembourg´s residents and consumers (see ASI 7). Will they be willing to accept farming in their neighbourhoods and to reward farmers for producing products living up to higher environmental and animal welfare standards? The EU Water Framework Directive and related national regulation are but few factors in a much larger system in need of transformative change.

9.14.2 Social learning factors (research question 3)

Social networks are a precondition for the emergence of social learning and actionable knowledge among diverse actors. Therefore, the concluding analysis focuses on factors that have hindered and facilitated network effects involving two different constellations of actors.

The first constellation consists in relations between the River Contract, municipalities, farmers, the Ministry of the Environment and the Water Management Authority. Overall, their relations have not been close and trustful enough to enable social learning across scales. During the "technical phase" of the elaboration of the protection zones dossier interplays were limited to data input provided by the Nature Park and River Contract (ASF 2). During the "political phase", the main learning effects identified were predominantly technical in concerning details of the 1st version of the draft law on protection zones discussed and clarified during joint working group meetings. That is, during the "political phase", too, there was little room for normative debates and re-framing. As regards this constellation of actors, the below analysis, therefore, focuses on factors hindering social learning. They are attributed mainly to a combination of extensive technical requirements and divergent narrative identities engrained in organisations and communities that have also had a political dimension.

The second actor constellation analysed is composed of SEBES, farmers, and farm advisors, the Nature Park and River Contract, amongst whom a new social network emerged (formally institutionalised in the agricultural cooperation LAKU) that fostered some timid signs of double loop social learning as regards roles and narrative identities. While triggered by the WFD obligation to set up drinking water protection zones, their activities largely ran in isolation from formal governance processes. Only during the "political phase" did direct feedbacks between LAKU activities and formal processes emerge. The analysis below summarises factors that facilitated the cooperation focusing on spaces for self-organisation, the co-creation of actionable knowledge and the personal commitment of individuals, but also reasons for why more far-reaching double loop social learning did *not* occur during the period analysed. A combination of systemic constraints and the need for more professional and organisational learning that would re-frame established narrative identities and practices more profoundly have been identified as main hindering factors. Figure 9.16 presents some of the main factors and effects of processes analysed.

[251] CAP 2021-2027 is expected to include more financial aid for farmers tied to environmental criteria, while Luxembourg (as all EU members states) will also have more freedom in setting funding criteria and priorities: see ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/future-cap_en

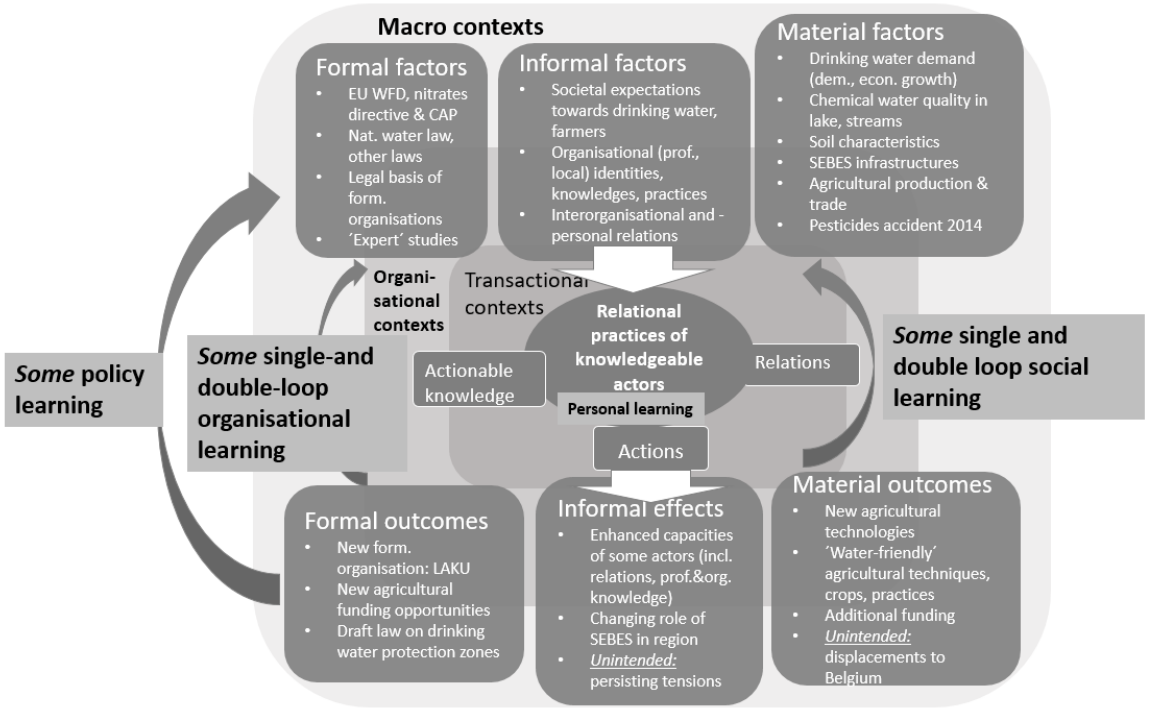


Figure 9.16 - Schematic representation of Upper Sûre governance processess

9.14.2.1 Actors and relations: network effects?

Social network effects in the present case study have been the result of inter-organisational and interpersonal relations that have mutually influenced each other enhancing or worsening the quality of relations between actors. The Upper Sûre River Contract has had a key role in the informal governance processes analysed. As regards the cooperation between farmers and SEBES, it effectively assumed the role of acting as boundary organisation. However, it did not succeed in bridging local-governmental divides. The main factors identified to explain why it was successful in one endeavour, but not in the other, concern a combination of formal regulatory, and informal inter-organisational and political factors.

As regards local-governmental relations, the River Contract sought to assume the role of an intermediary in relations between municipalities, farmers, SEBES, the Ministry of the Environment and the Water Management Agency and offer a "platform" coordinating the involvement of local stakeholders in the elaboration of the drinking water protection zones. Its commitment was rooted in the structures provided by the Nature Park as regards its resources (working time and space, funding) and its inter-organisational and interpersonal relations that have emerged from a history of local self-organisation and cooperation with the government. The expectation and mission to coordinate local stakeholder involvement was thus not only the result of WFD recommendations and the informal mandate received from the Ministry of the Interior in 2012, but they also inscribed themselves in the tradition of the Nature Park and its municipal members. Given close relations amongst local actors who had cooperated for decades (both as organisations and individuals), the Upper Sûre region comes close to ideals of ´community-based bioregionalism´ that builds on congruencies between communities and river basins (McGinnis, 1999), with the River Contract and Nature Park as potential coordinating boundary organisations (see conceptual framework 3.2.5.1).

Despite the fact that the Nature Park and River Contract are co-funded by the state and that governmental actors participated in their creation and are represented in its statutory bodies, relations

between the local and governmental level have been less close as those *within* the region. The role assumed by the Nature Park and River Contract to offer a platform "to give the region a voice" in a matter of high local and regional interest has nurtured the perception of governmental actors that the Nature Park and River Contract primarily served local rather than water protection concerns. Within the Nature Park and River Contract themselves the current case study has indeed identified intra-organisational tensions resulting from the strong environmental commitment and narrative identities among the staff and the strong emphasis on regional development of municipal members. Pursuing an integrated approach, staff members have striven to reconcile these divergent purposes for decades. Efforts have also been rooted in the conviction that water and environmental protection can only ´work´ locally, if conducted in partnership with municipalities and farmers. Furthermore, given their local and professional knowledge, they were convinced they could have added not only to the later effectiveness (public acceptance) but also the quality of the protection zones law itself.

However, unfavourable mutual perceptions and lack of trust between local and national levels were enhanced by political factors, notably, by the election of the Green party into government (and its re-election in 2018) and public and political debates following the pesticide accident in 2014. The period seems to confirm that social networks thrive best when issues at stake have not moved into the public arenas, becoming objects of political controversies (Folke et al., 2005; Pahl-Wostl, 2015). It also points to the potential importance of trustful relations being in place, in general (Mostert et al., 2007; Sol et al., 2013) - and even more so before adverse events hit. When this is not the case, it may be more unlikely that actors come together to deal with a crisis conjointly. It could thus be argued that the absence of good relations between actors may decrease both adaptive and transformative capacities of a governance system in the face of sudden unexpected challenges, making it less resilient (Folke et al., 2002).

A recognition of mutual interdependence – regarded as a precondition for cross-scale social networks (Bouwen & Taillieu, 2004; Mostert et al., 2008) - could only be discerned during the working groups preceding the public consultation and the last event in 2019 when the ministries for environment and agriculture presented the final draft law to the public underlining the importance of partnership. At the same time, the case study did not detect significant changes in narratives on either side.

The above argument suggests that the reason for why local stakeholders were not actively involved during the "technical phase" of the processes were not only formal. At the same time, the processes indeed leave open the question how stakeholder involvement could be organised on issues that are both highly controversial *and* technical. It is unlikely that a few stakeholder meetings would have sufficed. Moreover, established water management actors (SEBES, AGE, consultants) did not have any experience in conducting participatory processes. Certainly, from the perspective of transformative sustainability science, the non-involvement of local actors in the "technical phase" of the process seems a missed opportunity in at least two ways. Firstly, there continues to be a great need to develop approaches suitable ways to integrate local and professional with specialised/scientific studies and data (Raymond et al., 2010), e.g. as regards hydrology and agriculture (see also chapter 2.1.3). Few governmental actors interviewed believed that non-scientific actors were in a position to contribute with "useful" knowledge and "facts" concerning highly complex aspects such as water run-off and environmental effects of nitrates and pesticides (that are also controversial among scientists, as the case study has found). In contrast, local actors were convinced that they could, for example, have improved the protection zones demarcation based on their local and professional knowledge of e.g. hydrogeological characteristics of the basin not reflected in the data used, and that they could have contributed to provisions making water protection more applicable for municipalities and farmers in practice. Secondly, and perhaps even more importantly, there are few examples of when and how to conduct participatory processes and normative dialogues among diverse actors that go beyond

“preaching to the already-converted” and are embedded in ´real´ regulative processes. The analysis of action situations (ASI 6, ASF 5) concerning preparations for formal public consultations suggests that debates held – and contributions submitted - on finalised technical drafts may not provide an adequate framework for addressing more fundamental normative issues and for opening spaces for meaning-making and re-framing. Instead, local actors themselves commissioned specialised expertise (from consultancies, engineers, farm advisors) to be able to assess the impact of the protection zones and to question certain details of the provisions, frustrated about not having had the opportunity to discuss underlying principles and assumptions (e.g. as regards the use of manure versus mineral fertilisers). General ´statements of principle´ submitted during the formal public consultation could hardly be taken into account by the Water Management Authority when working on the revision of the legal provisions.

The Upper Sûre case study thus suggests that – in addition to organisational and political factors discussed further above – increasing detailed legal provisions, based on rigid scientific/technical requirements, have contributed to making water *governance* more of a *technical management* issue that – as in the command-and-control paradigm – neglects normative issues. The protection zones process has thus increased the gap between specialised scientific/technical expertise and data and the knowledge of those needing to apply and comply with the provisions based on them. In the case studied, many local non-scientific and nongovernmental actors seeking to understand and question the intricate legal and technical provisions felt they could only do so by themselves seeking specialist advice (with legal actions as *ultima ratio*). Here, the River Contract and Nature Park, on their own initiative, by providing support to municipalities, farmers, and citizens (both during workshops and local meetings), acted as a boundary organisation in the sense of ´translating´ legal and technical provisions into lay language, and vice versa (Reid et al., 2006).

What is more, in the run-up and following the public consultation overarching normative and fundamental questions got lost in technicalities, expert study ping-pongs, and threats of legal action. While formal public consultation supported the argument that ´voices will be heard´ (and many if not most statements on specific provisions were indeed taken into account), they also triggered debates and sentiments that could not find an outlet in the processes and spaces formally provided. In this sense, the present thesis argues that regulatory frameworks and formal public consultations following the EU WFD need to be accompanied by *other* processes to enhance dialogues, the emergence of social networks, and social learning. If not, increasingly detailed and rigid regulation based on specialist data risks to increase divides between government and local and professional communities, and, thereby, to undermine network governance.

The LAKU case is different. Starting with the working group on agriculture, the Nature Park and River Contract provided informal spaces, from which a new formal organisation (LAKU) emerged that institutionalised direct cooperation and new roles between a water facility operator who had hardly engaged with local actors before and farmers who were willing to acknowledge and reduce harmful environmental effects of farming practices. What were the main factors facilitating the emergence of this new social network? As above, the emerging cooperation was launched by farmers concerned about new formal restrictions and the expectation that own initiative would enable them to both contribute to the ´dossier´ and to secure a better position and advantages under the new water protection law. In contrast to the above, however, there was no history of tense relations among initiators. Notwithstanding the fact that SEBES was generally not well-perceived among local communities, there had been no direct organisational relations between SEBES, farmers and farm advisors at all. In this situation, pioneering individuals embarked on informal joint activities through which interpersonal trust was built, less tarnished by historical organisational memories (see also narratives below). They served to develop a model and experiments for a future cooperation that was

regarded as potentially of mutual interest. Farmers hoped to gain a better reputation and professional knowledge through experiments funded by SEBES (incl. via the Ministry of Sustainable Development) serving to reduce nutrient and pesticide wash-outs. SEBES, for the first time, engaged in activities serving the new adaptive and integrated ´philosophy´ of pollution prevention and partnership. Organisational commitment by SEBES followed personal commitment that had paved the way for establishing interpersonal relations. SEBES engagement anticipated the future coordinating role of SEBES in the new drinking water protection zones.

It is interesting to note that the period, in which SEBES became actively involved with the River Contract and farmers, runs in parallel to the SEBES cooperation with the German consultants on the ´technical´ elaboration of the protection zones concept. LAKU cooperation and the technical elaboration of the concept thus show two different facets of SEBES activities and roles that have continued to co-exist seemingly independently of one another. In the case study, they were found to have come together only once, against the background of increasing local pressure that seems to have made it difficult for SEBES to maintain the separation of the two roles without risking negative impacts on its local relations and cooperation: during the SEBES-LAKU meeting with the IWW consultants in the autumn 2017. The fact that the meeting took place suggests that it may be difficult to keep participatory and technical approaches separate.

As regards facilitating factors, it is interesting to note that the activities of the working group (and later LAKU) were practice-oriented rather than political, and may therefore have been more conducive to the emergence of social networks and learning. Whilst farmers pursued the objective to gain a´ cooperation privilege´ (”Kooperationsvorrang”) in the future regulatory framework, their activities themselves were not centred on political or normative debates. The network that began to emerge also involved farm advisors from diverse organisations. Some of them *did* have histories of tense competitive relations, but as drinking water protection zones were set up across the Grand-Duchy, they were also interested in enhancing their professional knowledge and improving their standing vis-à-vis decision-makers. Likewise, the nascent network included different-size farms and both conventional and organic farmers, some of whom, in the past, had been separated by an “ideological divide”. In general, participating farmers (and farm advisors) stressed that the working group and LAKU provided a space in which “farmers finally talked with each other again” counteracting what they perceived as a tendency of increasing social isolation. Similarly, municipal officials welcomed LAKU as an expression of locally engaged citizens contrasting them with phenomena of growing egoism. At the same time, LAKU activities did not expand much beyond a core group. Therefore, LAKU continued to operate in a niche that spread less into farming communities than hoped for and expected. Furthermore, the fact that LAKU activities will no longer be financed via SEBES and the Ministry of the Environment, but by the Ministry of Agriculture, and that LAKU membership might not yield any specific privileges to its farming members in the future protection zones, makes future roles and relations uncertain.

In all of these activities, the River Contract coordinator had the role of facilitator, first within the working group, later as ´formal´ LAKU coordinator employed by the Nature Park. The Nature Park thus continued to have a crucial role in offering the organisational ´backbone´ of the cooperation. The double-hatted role of the River Contract coordinator reflected the overarching role of the Nature Park as umbrella for and facilitator for diverse regional activities and was in continuity with the River Contract´s working group activities. At the same time, the close association with conventional and comparatively large-scale farmers weakened the River Contract´s credibility in promoting water protection vis-à-vis the Ministry of the Environment and its administrations, thereby weakening its (potential) boundary role between local and governmental actors. Thus, while the River Contract contributed to enhancing *local* capacities for action and social networks (including SEBES), cross-scale

and cross-sectoral relations were, overall, hardly enhanced. Taken as a whole, the case study seems to illustrate some of the dilemmas and pitfalls that boundary organisations in river basins may face.

Overall, therefore, while the Upper Sûre Nature Park and River Contract have been associated with network governance due to their formal co-funding arrangements and structures, their activities – despite efforts to the contrary and notwithstanding cooperation with SEBES – have *de facto* been closer to a bottom-up community-based paradigm (see chapter 4.4.2). Overall, the role of the Nature Park did not change. A key subject raised by participants of the NEXUS FUTURES workshop, it remains, however, to be seen how relations between SEBES, LAKU, the Nature Park (incl. the River Contract), municipalities, and the two ministries and their respective administrations will evolve in the future (see ASI 7). Institutionalisation does not seem to have been far-reaching enough to necessarily last. Rather, the Upper Sûre region finds itself in a transitional period with uncertain prospects.

Notwithstanding future uncertainties, the following elaborates in more detail on other than relational issues that facilitated and hindered social learning. Firstly, it outlines factors that facilitated the emergence of some double-loop learning and actions among actors engaged in the working group on agriculture and LAKU. Secondly, it summarises how divergent narratives and paradigms hindered the emergence of more far-reaching social learning and networks.

9.14.2.2 LAKU: Knowledge, action, and technologies

As outlined above, the LAKU cooperation is the most significant example of how social learning and actionable knowledge may emerge together with concrete actions undertaken among diverse actors.

The institutionalisation of LAKU, changes in the role of SEBES and the willingness of participating farmers to openly address environmental impacts and to develop technologies to reduce the impact are the most tangible formal, informal, and material outcomes of informal governance processes identified in the present case. Social learning processes have been assumed to contribute to enhance synergies, while reducing trade-offs (see chapter 2.2.2) (Pahl-Wostl, 2015). The LAKU cooperation – with its objective to contribute to improving chemical water quality in the Upper Sûre lake without incurring economic disadvantages for participating farmers – can be seen as an attempt to enhance synergies between SEBES and the farmers, while reducing trade-offs between water protection and farming. The overall purpose of farmers was to continue to be able to produce food to pay off their debts, to ´make a living´ for themselves and their families, and to remain competitive. They did thus not entail a questioning of established farming business models. But they did encompass the co-creation of professional knowledge. Therefore, even if LAKU has mainly been an example of single loop learning, it is worthwhile to pose the question: What facilitated knowledge co-creation and collective actions?

In addition to formal pressure exerted by the upcoming drinking water protection zones and organisational support, the short answer to the question is space for self-organisation and the drive of dedicated individuals to do something in practice. Mainly depending on financial support from and via SEBES, members of the agricultural working group and, later, of LAKU were relatively free in organising themselves and setting up experiments. Several interview partners pointed out that it was essential that the farmers, farm advisors, SEBES and River Contract moved quickly to action (roughly one year after the first working group meetings), in order for the working group not to “lose momentum”.

Self-organisation was thus at the heart of knowledge co-creation. It rested on projects from abroad that seemed suitable to serve as a model for how to reconcile agriculture with water protection in the Upper Sûre region. The seminars and excursion co-organised by leading farmers and farm advisors in the agricultural working group and LAKU were key in this regard, as they built on exchanges,

information and data tailored to professional knowledge and practice of farmers. They could directly inform – and be tested in - the design, implementation and evaluation of joint field experiments ranging from crop rotation and catch crops, over manure injection to mechanic weeding techniques. It was through joint activities that interpersonal relations and trust were built among actors who had not cooperated before. They centred on ´learning-by-doing´ accompanied by scientific methods and data (such as soil sample tests and water quality data) of a research institute, SEBES, and farm advisors. Specialised knowledge could thus be directly integrated in and further expanded through professional experience.

It contributed to enhancing ecological knowledge of impacts of pesticides, nitrates and ploughing techniques on water and soil quality (incl. drinking water supply). Several farmers and farm advisors remarked on increasing significance attributed to soil management (see figure 9.14). This suggests that LAKU experiments encompassed elements of adaptive agricultural management that aims to adapt farming practices to local soil and weather conditions (see chapter 4.3.2). Therefore, adaptive approaches are more demanding in terms of both ecological and technological knowledge than conventional practices, with farmers often relying more strongly on specialised advisory services and science (Ingram & Morris, 2007; Röling & Wagemakers, 1998). In the Upper Sûre region, local soil characteristics are also used as an argument supporting the strong specialisation on dairy production and livestock. Soils being comparatively poor in nutrients, it was thanks to the industrial revolution (incl. the use of phosphorus-rich industrial slags, ´Thomas-Mehl´, see chapter 7.1.2.1) that made fields arable and more productive. Grassland used e.g. for milk cows require less nutrient input compared with grain or vegetable production.

During the NEXUS workshop in 2019, a group of participating farm advisors and farmers drew a conceptual systems map centred on soil management, and interconnected with diverse systemic factors that extended the role of farming in society and ecosystems beyond food production, including landscape maintenance (“Landschaftspflege”) and increasing water retention capacities of soil and societal water security (see figure 9.16). Even if those aspects were considered secondary to their ´main business´, it is another indication of what could be called a shift towards an *expanded* productionist paradigm.

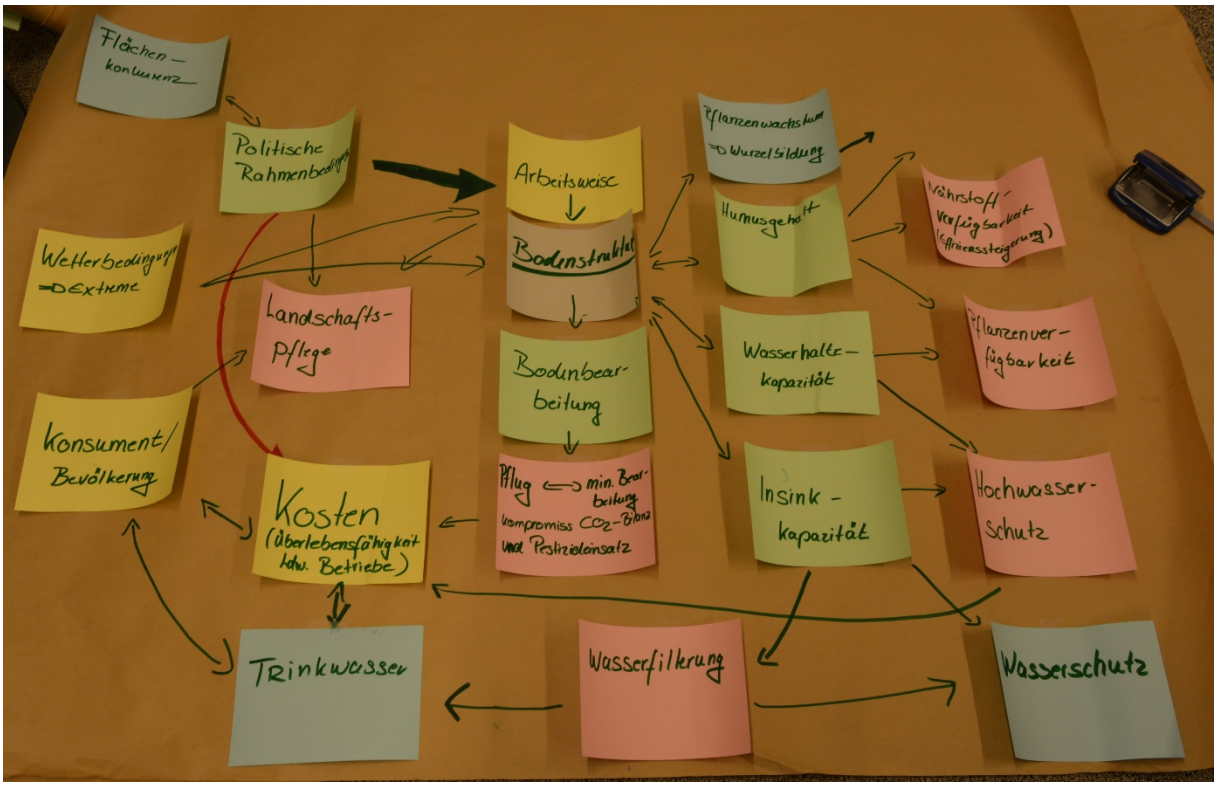


Figure 9.17 – Collaborative systems map on soil management elaborated by a group of farm advisors and farmers

LAKU experimentation can thus serve as an example of adaptive agricultural management and the importance attributed to ´learning-by-doing´ in the adaptive management literature and transformative sustainability science. The availability of – and learning from - ´best-practice´ projects that could be adapted was another key factor.

At the same time, experiments mainly served incremental learning ("business-as-usual"). They were predominantly technology-based to make agricultural production more compatible with water protection (e.g. by reducing soil erosion, the use of manure or pesticides). The technologies used were entirely new in Luxembourg, relatively complicated, large, and expensive. This had several implications. Firstly, LAKU farmers needed to cooperate with a large commercial machine contractor willing to invest in their purchase and maintenance. Farmers would rent or hire the machines predominantly paid by SEBES. Secondly, the technologies required extensive technical know-how. Thus, LAKU farmers supported each other in the operation of the machines and sought to record technical details on their mobile phones.

Several actors interviewed have thus interpreted LAKU experiments as reinforcing structural changes towards ever-larger farms and trends towards more sophisticated and expensive machinery in agriculture – with the technological knowledge requirements attached. Some have regarded this as "progress", not only technologically, in terms of efficiency and, perhaps, economic competitiveness and environmental impact. They also refer to the fact that the technologies and techniques used also require more ecological knowledge of, for example, soil characteristics. Both conventional and organic farmers engaged in these experiments.

Some of the technologies and techniques are now eligible for funding by the Ministry of Agriculture and promoted (or even prescribed) in surface and groundwater protection zones alike. What started out as niche experimentation is thus being formally institutionalised and upscaled with ministerial support and public funding to potentially become standard practice throughout Luxembourg. LAKU farmers experienced in their application might be at a (competitive) disadvantage vis-à-vis colleagues

who did not participate. Furthermore, the development of the GIS-based "Landmanager" tool suggests that increasingly detailed and complex restrictions applying to farming may drive the development, use of and dependence on expensive technologies. One of the objectives of the tool is to help farmers in keeping an overview of if and when they are allowed to use fertilisers on specific land plots, and in which quantities.

In this sense, the LAKU example seems symptomatic of the general technologisation and automatisation in society, in general, and agriculture in particular (including milking robots, potentially, high precision weeding robots, etc.). On the one hand, they may contribute to making farming more efficient and reducing environmental impacts. On the other hand, they may also further widen the distance (or "disconnect", Ives et al., 2018) between farmers, their soil, plants, and animals. Last but not least, however, technologies serve to maintain current business models, increase the need for high investments (and, therefore, public subsidies) and for specialised technical knowledge. Focusing on technologies, LAKU did not develop a new vision – or imaginary – for agriculture in Luxembourg.

Among the constraints cited during interviews and the NEXUS workshop (see AS1 7) were consumer behaviour, land availability and rising land prices, a lack of labour, and the need for specialised knowledge and entrepreneurs to set up alternative marketing chains (e.g. regional). Last but not least, several interview partners argued that due to growing regulation and market pressures, farmers struggled to "get their heads free" to be able to think about – and do – anything else than trying *not* to break rules and to avoid fines while paying off debts. Farmers *without* milking robots remarked that they, compared with colleagues *with* robots, had hardly any time in the mornings and evenings to attend meetings. LAKU members and farm advisors saw lack of time and growing pressures and requirements "from all sides" as some of the reasons for why not more farmers had engaged actively in the cooperation. Some suspected the new drinking water protection zones would further contribute to this.

In the conceptual terms of the present thesis, the factors cited mean that spaces for personal meaning-making, social engagement and actionable knowledge are experienced as limited, and perhaps even shrinking.

9.14.2.3 Narratives and paradigms

In the tentative answers to the second research question, the role of narratives and paradigms has been mentioned. Crucial informal factors, they were found to have influenced mutual perceptions and relations, knowledge (co-creation), and action. The following elaborates on some of them, focusing on farmers, municipalities, environmental authorities, and SEBES.

At a personal level, the case study suggests that actors most actively engaged in the governance processes analysed above did so based on personal narrative identities. Pioneering individuals combined a strong identification with certain purposes with a belief in own-initiative. This applies to farmers regarding themselves as "Freiberufler" and "Betriebsleiter" (refusing to be "marionettes"), with farming as continuation of family traditions and, at the same time, a vocation requiring continuous professional learning. Farmers contrasted *modern* agriculture with what they perceived as public and environmentalist preferences for "Heidi agriculture" and expanding "Naturschutzgebiete". The combination of regulation with perceived visions of outdated and unprofitable agriculture, has been identified as the main reason for tensions with the Ministry of the Environment. Both are perceived as not only threats to not only economic viability, but also to their identities. Reflecting the productionist paradigm, food production remained at the heart of the narratives of *all* agricultural actors interviewed. Regarding themselves as subsidy recipients by necessity, they strongly preferred

to be paid fair prices for their products rather than to depend on public funding. A higher dependence on subsidies (paid by changing governments) was also one reason for widespread scepticism towards moving to farming models based on public ´payments for ecosystem services´ (PES) such as landscape management in the service of biodiversity (see chapter 4.3.2). Nonetheless, the LAKU example also suggests that farmers in the Upper Sûre region have begun to acknowledge and seek to tackle environmental impacts of their practices more actively, including by taking into account scientific data. Furthermore, contributions to drinking water production have slowly begun to enter narratives, even if sometimes mentioned with an ironic undertone. Therefore, overall, the case study suggests that an *expanded* productionist paradigm might be emerging containing elements of adaptive and integrated land management. Furthermore, many agricultural actors expected that conventional and organic agriculture would slowly converge (with pesticides as main unresolved obstacle).

Less changes in narratives and paradigms have been identified in municipalities. Water and environmental protection have been elements of inter-municipal cooperation in the Nature Park since its beginnings. Local mobilisation to be involved in the elaboration of drinking water protection zones inscribed itself in personal and shared narratives (e.g. “Gallier gegen die Römer”, interview n°34), in which local self-determination and regional development needed to be defended against perceived governmental imposition. This shaped local reactions and relations to the Ministry of the Environment and Water Management Agency, even more so as some of the municipal actors engaged had already been active in the 1980s and 1990s. Compared with past “pioneering times” and “Aufbruchstimmung”, however, the main difference to today is that local mobilisation and cooperation with the government resulted in shared visions centred on the Nature Park as an “opportunity for the region” (“eng Chance fir d´Regioun”), not least via its numerous LEADER projects (see chapter 7.3.2). With some projects having stopped and others continuing in niches and the drinking water protection zones expected to entail more restrictions on regional development (e.g. tourism) (see ASI 6), local expectations towards the future today seem less hopeful than in the past. There is thus a contradiction between water governance and management having, formally, become more participatory, and the narratives that tell the story that in the end of the 20th century (dominated by hierarchical governance) there was *more* self-organisation than today. So far, the governance processes analysed dealt almost exclusively with restrictions and how to make them more ´acceptable´ via public funding. In contrast, collaborative work at the NEXUS FUTURES workshop (see ASI 7) and interviews have revealed a strong need for new future perspectives and imaginaries for the region.

The analysis of governmental actors in the present study focused on the Ministry of the Environment and the Water Management Agency. The former has been associated with a managerial ecocentric paradigm centred on science-based regulation and, increasingly, land purchases serving to protect the environment. In the case study, it was expanded to include anthropocentric drinking water protection and a stronger consideration of farming (incl. via subsidies). Narratives of governmental actors have been rooted in environmentalist identities promoting systems transformations towards new social and economic models and organic and extensive agriculture, with the necessity of the departure from conventional intensive agriculture as one of the dominant themes. In the literature, top-down governance is associated with a “rational choice” theory of action that assumes that actors strive for what they estimate to be in their best interest. In contrast, interviews with governmental actors suggest that the emphasis on regulation is rooted in the perception that farmers are reluctant to change because of deeply established identities and practices. From this perspective, regulation is the only means to increase pressures for – and enforce – changes in relation to problems perceived as urgent. In other words, the assumption is that farmers would not explore new paths without having a pressing reason to do so. Given the analysis that expected new restrictions were a major reason for self-organisation in LAKU and that, at the same time, active participation in LAKU was low (many

farmers adopting a ´wait-and-see´ attitude), the case study seems to confirm this assumption at first sight.

At the same time, the case study does not confirm the assumption that farmers "do not want to change". This assumption has deeply affected relations between the Ministry of the Environment and the Water Management Agency, on the one hand, and farmers on the other. It was one of the main arguments why active stakeholder involvement was perceived as making little sense. Insights from interviews, however, suggest that several LAKU and non-LAKU farmers interviewed have actively considered and examined options to ´go organic´ using professional farm advice (e.g. before taking over their parents´ farm and/or before investing in new stables). Reasons for not doing so have not appeared to be dogmatic, but rather practical, financial, and psychological (i.e. more stress). Practically, some farmers did not receive authorisations from the Ministry of the Environment to construct stables in places that would have made possible pasturing (a requirement of organic agriculture). While reasons were not communicated, the impact on local ecosystems and landscapes are alleged reasons. Others had legal disputes with neighbours about noise and odours. Financially, organic farming proved not be more profitable (or even less) for some farmers according to calculations made by farm advisors, because of fierce organic price competition and consumers choosing cheaper organic products from abroad. Some were also concerned about the ´vegan trend´, expecting that demand for organic dairy and meat products would decrease in the future.

The prevailing narrative among many farmers was that most farmers converting to organic (or extensive) agriculture did so because they had not been capable enough as conventional farmers due to a lack of skills, or because they were growing old, and wanted to benefit from the state-paid organic premium before ending their business ("exit strategy"). On the other hand, they expressed admiration for the professional skills of "successful" organic farmers. Finally, farmers cited a higher level of psychological stress among organic farmers caused by a higher exposure to risks of pests. They felt, however, that the Ministry of Sustainable Development did not undertake sufficient effort to understand and address these concerns. Furthermore, they all agreed that the decision to go organic required time and personal learning and needed to flow from intrinsic motivation (or, in the conceptual terms chosen for present purposes, from personal meaning-making and learning), rather than regulation and funding ("sonst geht das in die Hose", interview n°19).

Finally, the case study has identified the continuous and reinforced existence of ´technocratic narratives´ combining elements from command-and-control and managerial ecocentric paradigms. Whether for anthropocentric or ecocentric reasons (or both), they are based on a belief in the necessity and superior validity of specialised science and data. The increasing awareness of the multiple systemic factors that need to be taken into account because they affect water quality, characteristic of integrated approaches, seems to have contributed to scepticism of administrators and consultants vis-à-vis the ´lay´ knowledge of locals and professions. In other words, it seems to have increased gaps between those perceiving themselves as specialists in the maze of complex system dynamics and those perceived as seeing only ´what is in front of their nose´. SEBES involvement with farmers has been the only notable exception analysed. At the same time, it remains to be seen how its coordination of the elaboration and implementation of measures in the protection zones will change organisational and professional narratives and formal statutes and expand what it means to be a drinking water provider.

To sum up, the above narratives and resulting mutual perceptions hardly changed throughout the processes analysed, which proved a major obstacle to dialogues and better relations. What is more, interviews suggest that when regulatory frameworks are perceived as rigid and patronising, local and professional actors may interpret them as threats to narrative identities. Notwithstanding manifest

social and economic concerns, this perspective helps explain the emotional character of some of the controversies analysed, and some of their (possible) repercussions (e.g. legal actions).

Finally, the Nature Park and River Contract were caught in-between these different narratives and paradigms, identifying with both local concerns and water protection objectives. The processes have left a sense of disillusionment. It is an open question if processes and relations would have evolved in the same way, if the Ministry of the Environment, the Water Management Agency and SEBES had actively approached and involved them at an earlier stage of the elaboration of the protection zones dossier (or had managed expectations more actively) and following the pesticides accident.

In general, it remains to be seen if and how a “drinking water protection culture” will emerge that is shared by all actors involved. Based on insights from the case study, such a “culture” may be unlikely to emerge in the absence of new narratives and imaginaries suitable to serve as a source of regeneration, inspiring knowledge co-creation, and collective action among diverse actors.

10 CASE STUDIES (PART IV): Governance processes relating to river restorations and water quality in the Syr basin (2012-2019)

Figure 10.1 – Schlammwiss in the Syr valley

The Syr valley is the only river basin in Luxembourg that does not stretch beyond national borders. Located close to Luxembourg City, many pressures exerted by demographic and economic developments can be felt here. The case study analyses processes at the nexus of water, nature, agriculture, and transport that concern water quality and river restorations in three consecutive areas along the Syr river. Most of their territory is part of the EU-wide Natura 2000 network[252]. Two of the areas (divided by a highway) have been protected as national nature reserve since 2018 ("Schlammwiss-Bril", see figure 10.2):

- Schlammwiss (south of the highway between Uebersyren and Schuttrange): an area dominated by reed where a birdringing station is situated, and neighbouring a wastewater treatment plant that receives wastewater from municipalities and the international airport of Luxembourg;
- Mensder Brill (between the highway and Mensdorf) where the Syr river was restored in 2003, followed by a permanent pasture project that ended in 2016.

[252]With the national transposition of the EU Habitats Directive in 2004, parts of the Syr basin ("Vallée de la Syre de Moutfort à Roodt/Syr", LU0002006) under investigation were integrated in the Natura 2000 network with the overarching aim to protect wild birds. Another Natura 2000 area was created further downriver ("Vallée de la Syre de Manternach à Fielsmillen", LU0001021) (Mémorial A, 2004a). It was followed by a third Natura 2000 in the Syr basin: "Région de Mompach, Manternach, Bech" (LU0002016)

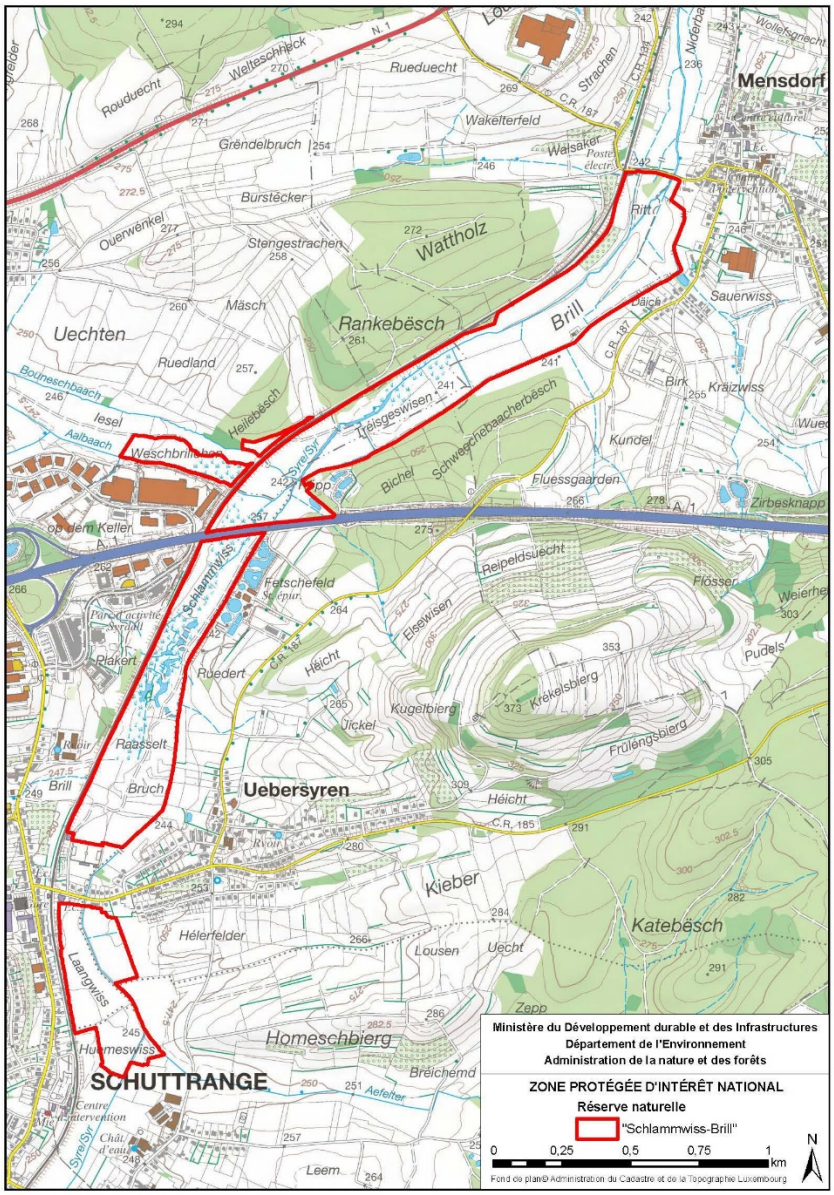


Figure 10.2 - Map of the protected Schlammwiss-Brill area in the Syr valley

The third area covered is situated downstream from Mensder Brill and partly located outside the Natura 2000 area:

- The Syr river between Mensdorf and Betzdorf where a feasibility study has been elaborated to carry out more river restorations.

One of the main differences compared with the previous Upper Sûre case study is the absence of overarching processes and organisational structures that tie together diverse challenges, activities, and actors. The governance processes have involved different issues and constellations of actors. It has not been possible to establish a ´plot´ with sequences of action situations that follow ´logically´ upon one another. Instead, the case study is an attempt to analyse and juxtapose *various* processes that are directly related to the issues and areas under investigation, but not necessarily to each other (see figure 10.3, table 10.1).

As regards formal governance (*ASF – formal action situations,* see table 10.1), the case study analyses three different strands:

- Processes relating to the EU Water Framework (WFD) and Floods Directives, their national implementation (ASF a, ASF b, ASF c), and the EU WFD "fitness check" (ASF d)
- Processes relating to the implementation of the EU Birds and Habitats Directives, including national environmental plans and laws (ASF1, ASF2, ASF3)
- Processes relating to the extension of the Uebersyren wastewater treatment plant (ASF A)

The action situations selected for informal governance processes (*ASI – informal action situations*, see table 10.1) are centred on the Syr River Partnership (ASI 1-5). In addition, they include plans for river restorations in the municipality of Betzdorf (ASI A).

Methodologically, this approach constitutes a further development of the Management and Transition Framework (MTF). It adds material sites to the social focus on actors and learning processes as selection criteria for action situations (see methods chapter 5.6). The selection of action situations has been done based on iterative and collaborative processes that have involved data different sources (see case study introduction 6.1).

Informal action situations selected (ASI)	Formal action situations selected (ASF)
ASI 1: River partnership elaborates action plan, builds social network	
ASI 2: River partnership implements measures to improve water quality, meets barriers	ASF a: National flood risk management plan leads to flood partnership
	ASF 1: Natura 2000 management plan for Syr valley enters into force
	ASF 2: New national nature protection plan and law enter into force
	ASF 3: National wetland reserve is prepared in Schlammwiss-Brill
ASI A: Municipal river restorations meet administrative requirements	ASF b: AGE elaborates concept on aquatic habitat connectivity
ASI 3: River partnerships address barriers in EU WFD implementation	
ASI 4: River partnerships address ecosystem-based flood protection	
ASI 5: River partnership addresses Syr pollution caused by wastewater	ASF A: New law paves way for extension of Uebersyren WWTP
	ASF c: Public consultation is held on 3rd WFD management plan
	ASF d: EU WFD is declared "fit for purpose" following ´fitness check´

Table 10.1 - Action situations selected for the analysis of governance processes in the Syr river basin

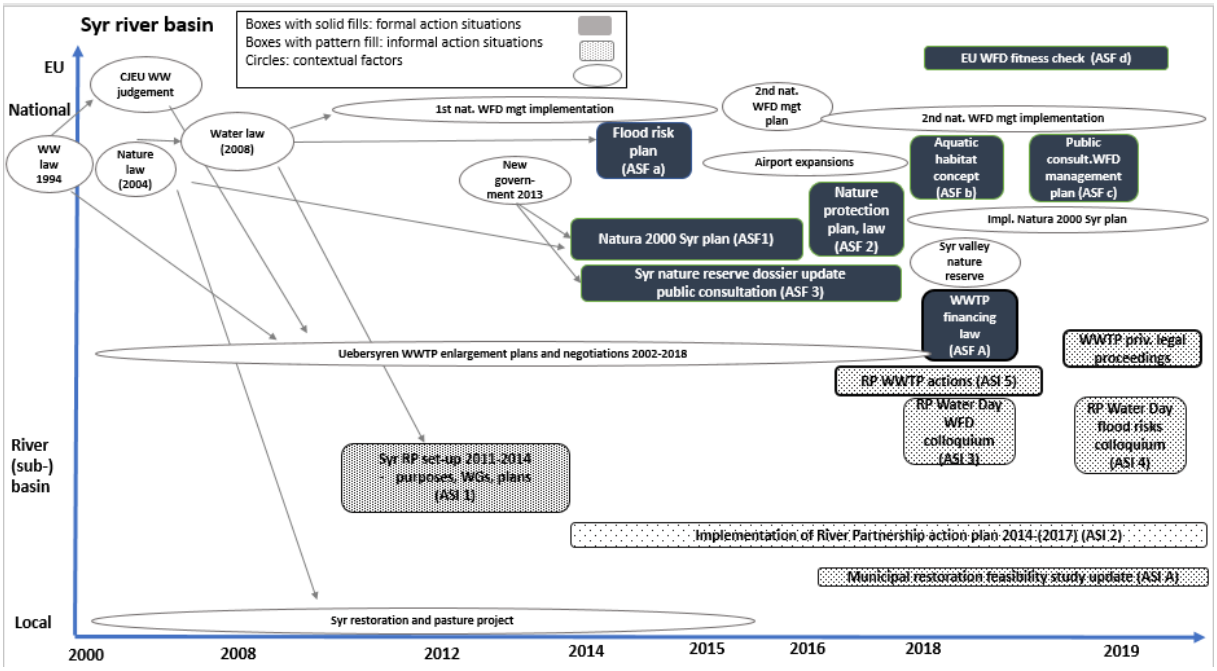


Figure 10.3 - Action situations and related contextual factors selected for the Syr case study (part IV)

However, before embarking on the analysis of the governance processes, the case study elaborates on a river restoration carried out in Mensder Brill in 2003. It does so for two main reasons. Firstly, the restoration has shaped local landscapes and influenced relations among actors and is, therefore, important as local context. Secondly, being the only major river restoration that has been carried out in the Syr basin to date, it also serves to cast light on factors that can facilitate or hinder restoration efforts.

10.1 Local context: River restoration and pasture project in Mensder Brill

Well before Luxembourg transposed the EU Habitats and Water Framework Directives into national law, the administration in charge of water bodies and forests (today´s ANF) initiated a project to restore the Syr river in the ´Mensder Brill´. The Syr Valley Restoration Project was one of the first projects based on principles of adaptive water management and nature-based flood protection in Luxembourg (Min.Env. & Min.Interior, 2007). Following the pond project of the Fondation HfN in Schlammwiss in the 1980s (see historical context 7.3.1), it extended restoration efforts in the Syr valley further downriver and also included “land-sharing” with agriculture. The project is also an example of a top-down managerial approach to ecological restoration (see chapters 4.3, 4.4.1).

The restoration was completed in 2003 on a length of roughly 2 km and an area covering approx. 45 hectares (ANF, 2008; Dir. de la Gestion de l´Eau, 2004). Based on 18th century Ferraris maps (see chapter 7.1), the riverbed was redirected to the historical location of approximately 300 years ago (ANF, 2008). After the removal of a mill in 1960s, the riverbed had deepened significantly and there had been some flood events (Dir. de la Gestion de l´Eau, 2004). The administration exerted strong leadership in bringing together a multiplicity of actors, seeking another demonstration project for what was still a new and barely-tested approach to integrated and adaptive management of aquatic ecosystems. The administration had a comprehensive concept for the area, which involved recreating floodplains, natural habitats for flora and fauna (especially birds), and a nature trail for visitors (ANF, 2008). To maintain a diverse mosaic landscape, the project also included permanent grazing by Galloway cattle managed by three farmers to keep the landscape open. Based on the principle

"Naturschutz durch Nutzung" two local restaurants bought and offered Galloway meat to their guests. Furthermore, the administration collaborated with the University of Freiburg to scientifically monitor the impact of the restoration and grazing project on biodiversity[253]. In 2016, however, the pasture project came to an because some of the cattle had died.

The following analysis of the project is structured along the main dimensions of the analytical grid that has been developed to inquire into approaches in water and land governance (see chapter 3.2.3).

10.1.1 Purposes: Paradigm and narratives

The overarching purposes of the river restoration and grazing project were predominantly ecocentric and based on principles of adaptive management (Schaich et al., 2010). The project served the restoration of natural habitats in semi-open landscapes to protect and re-attract certain plant and animal species, with a focus on wild birds (ANF, 2008).

Traditional approaches to ecological restoration often pursue the ideal of "pristine landscapes" (Higgs, 1997, see chapter 4.4.1). This was also the case with the Syr Valley Restoration Project. Extensive grazing by domesticized cattle was to simulate "the impact of the large herbivores that dominated our landscapes in ancient times" (Schley & Leytem, 2004). The restoration project itself aimed to bring the Syr river "close to nature" (ANF, 2008)[254]. The Syr Valley Restoration project can thus be attributed to an ecological restoration paradigm whose origins in Luxembourg have been traced back to early science-based environmentalists of the 19th and 20th centuries (see chapter 7.1.3). Of all public administrations, ANF has been closest to them, as the 1928 first legal bird protection initiative and the 1954 expert group on the creation of a national nature reserve around the Upper Sûre lake suggest (see chapter 7.2.1). With the Syr Valley Restoration Project and similar projects initiated by the administration, a managerial ecological restoration paradigm emerged in Luxembourg.

At the same time, the Syr Valley Restoration Project also pursued broad *anthropocentric* objectives by integrating ecological objectives with flood protection, alternative marketing channels for extensive farming ("Naturschutz durch Nutzung"), and environmental awareness-raising measures targeting the public (ANF, 2008; ANF, 2015). The overriding importance of ecocentric purposes, however, is underscored by the fact that these measures are presented as additional arguments and *means* to reach overarching nature conservation purposes (ANF, 2008; Schley & Leytem, 2004).

Main narratives (incl. metaphors and imaginaries): For environmental governmental actors, the project was part of their "pioneering work" in promoting nature protection in Luxembourg. This narrative is widely shared among actors across organisations and sectors who attribute the arrival of nature-based approaches such as as river restorations in Luxembourg entirely to ANF leadership.

The most frequent metaphor and imaginary identified in interviews and organisational documents is that of heterogeneous and diverse mosaic landscapes (ANF, 2008; Schley & Leytem, 2004) echoing scientific restoration ideals of "mosaic of habitat types" (Schaich et al., 2010).

[253] Research project conducted in cooperation with ANF on „Auenrenaturierung und extensive Beweidung - Vegetationsökologische und soziokulturelle Evaluation einer Naturschutzmaßnahme im Syrtal (Luxemburg)"(H. Schaich et al., 2010; Schaich, 2009; Schaich et al., 2010): www.landespflege.uni-freiburg.de/forschung/landschaft/auenrenaturierung

[254] Own translation of excerpt (italics added) from "La renaturation de la Syr permettra, tout en prenant en compte les aspects historiques et culturels, de rendre au terrain sa physionomie la plus proche de la nature […] « (ANF, 2008)

River regulations of the 19th and 20th centuries have shaped imaginaries of rivers as channelized ´trenches´ that are supposed to carry away water as quickly as possible (see chapter 7.1.2.1). The restoration project contributed to changing landscape imaginaries of some of the local actors interviewed for the present thesis. The project ´opened their eyes´ to the fact that rivers were not *naturally* deep and straight, and that their state was closely interlinked with their surroundings:

> *"[…] ich habe ja immer viel lernen müssen. Man sieht die Syr da vorbeilaufen. Ich habe als Kind darin gespielt. Aber dass da so vieles schiefläuft, das hat man sicher nicht so erkannt, glaube ich, vor zwanzig Jahren. Das war einem nicht so bewusst. Oder wie weit das gehen muss: was Renaturierung eigentlich bedeutet, wie schwierig das ist, das umzusetzen, wie gewinnbringend das ist, wenn dann so ein Projekt realisiert wurde. Was da alles ineinander greift, nur weil man da den Bachlauf verändert und dann näher an das Ursprüngliche, wie die Natur das geschaffen hatte, heranbringt. […] Ich habe so einen renaturierten Bachlauf nicht gekannt. Also als Kind - über das Dorf hinaus kommt man ja nicht - und für mich war ein Bachlauf eigentlich tief und eng" (interview n°53)*

Heterogeneous landscapes were to emerge as a result of "scientifically sound and successful nature conservation" based on extensive livestock grazing as a "modern conservation management tool" (Schley & Leytem, 2004). The project aimed to provide a model for an agriculture "in harmony" with ecological conservation objectives (ANF, 2008)[255]. The ideal of bringing landscapes closer to "ancient times" preceding major human impact is in interesting contrast to views expressed by other actors in interviews who emphasised that ecological restoration aimed to recreate *cultural* landscapes associated with preindustrial times by the help of agriculture mimicking traditional practices (interviews n°15, 29, 30, 40, and Colling, 2005).

10.1.2 Social coordination

The administration pursued a top-down managerial approach to ecological restoration. Three sets of evidence support this analysis. Firstly, ANF documents inscribed the project in the national implementation of nature protection laws and formal plans, referring to the EU Birds and Habitats Directives and the related national nature protection law and plan that were under preparation at the time (ANF, 2008; Mémorial A, 2004a[256], 2007b). Secondly, the project was predominantly prepared and accompanied by specialised scientific studies. Research and mapping exercises were carried out ahead of the restoration and grazing project to examine the potential impact of restoration on flora and fauna, including pre-studies by the Stiftung Öko-Fonds (2001), the Fondation HfN (2003), and the above-mentioned study of Schley and Leytem (ANF, 2016a). They were followed by the above-mentioned research project.

Finally, the project *did* include several governmental (incl. the water management unit of the Ministry of the Interior that would later become AGE and the Ministry of Agriculture), municipal and private actors. It involved some compromises, but interviews and documents suggest that concerns of actors were hardly taken into account (interviews n°9, 26, 38, 40, 51). A former director of the Administration for Technical Agricultural Services (ASTA) published an article that questioned the project and suggested that the cattle might not resist wet conditions (Frisch, 2006). Local controversies reflected the opposition of some farmers and other local residents to the removal of drainage systems, the re-emerging of marshes and swamps, and the resulting loss of agricultural land and reduction in property

[255] Own translation of excerpt (italics added) from "L´exploitation extensive permet donc de gérer des zones naturelles en harmonie avec les objectifs poursuivis par la conservation de la nature" (ANF, 2008).
[256] Loi du 19 janvier 2004 concernant la protection de la nature et des ressources naturelles

values (interviews n°24, 51, 52, further discussed below). After some controversial debates, local councils of the participating municipalities voted in favour of the project, with some actors becoming more aware of negative effects of river canalisation on biodiversity. Flood protection was another important argument:

> *"Da wurde ein natürlicher Zustand künstlich geändert. Da wurde so eine Kanalisation gemacht. Und ich wusste auch, durch diese Kanalisation - ich bin ja ein offener Mensch und auch lernfähig - ja, dass das eben sehr viele Nachteile mit sich gebracht hat: eben die ganze Biodiversität, die darunter leidet. Und auch, was für mich ein großes Argument war, das war der Überschwemmungsschutz" (interview n°52).*

A precondition for any river restoration is land availability (Schindler et al., 2014). In this case (as most others), the area belonged to several owners: the state itself, municipalities of Betzdorf, Schuttrange and Niederanven (16 hectares), the Fondation HfN (6 hectares), and several farmers. The National Land Consolidation Office (ONR) succeeded in convincing farmers unwilling to have their land ´re-wetted´ to swap plots for drier land elsewhere. The municipalities concerned agreed to lease their land to ANF, although some were concerned about the pasture project.

The ANF concluded agreements with three local farmers willing to participate in the extensive grazing project starting in 2004. The intermunicipal SIAS syndicate concluded biodiversity contracts with the farmers managed by the administration. The scheme grants farmers subsidies paid under the EU Common Agricultural Policy (CAP) that has otherwise been managed by the Ministry of Agriculture that, in parallel, also offers farmers subsidies via the agri-environmental CAP scheme (see chapter 7.4.1). The financial incentives appear to have been the main reasons for why the farmers participated. The choice for Galloway cattle was a compromise between the two ministries and their administrations (including the veterinary service of the Ministry of Agriculture). ANF had originally preferred water buffaloes (interviews n°14, 27, 51). In general, many agricultural actors, the participating farmers themselves, and local actors had been sceptical of holding cattle in the wetland (known among locals to be infested by parasites such as leeches), but relied on the expertise of the nature administration and examples from abroad. A local alderman is cited as saying: "Wir vertrauten einfach der Meinung der Experten" (Luxemburger Wort, 2016). None of the project participants had professional experience with Galloways as they were new to Luxembourg (ANF, 2008).

As an innovation of traditional ecological conservation approaches, the project sought to make nature conservation via grazing economically interesting for participating farmers. The project encompassed a cooperation with two local restaurants that seasonally offered special dishes with Galloway meat to their guests, with success during the first years (ANF, 2008). It would later become part of the ANF-marketed scheme for ´nature protection meat´ ("Naturschutzfleesch"[257]). The scheme is based on the assumption that nature protection needs to be economically viable to be sustainable (ANF, 2008). A certain "euphoria" accompanied the launch of the pasture project and the cooperation with local restaurants (interview n°52). However, local appetite for Galloway meat allegedly decreased when local rumours emerged that the cattle had to be dewormed by soaking their bodies in a liquid substance (interview n°52, the author of the thesis has not been able to confirm these rumours).

Perceptions among local communities: A study carried out in the vicinity of the restored river sections found that a majority of local residents was supportive of the conservation objective to provide more space to water, flora and fauna (Schaich, 2009)[258]. They were informed of the restoration project via municipal bulletins, newspapers, friends or radio/television, but many would have liked to receive

[257] www.naturschutzfleesch.lu

[258] The study was based on a quantitative letterbox survey, combined with qualitative interviews.

more information directly from the planning authorities and favoured greater participation by citizens in decision-making processes concerning restoration projects (Schaich, 2009). Furthermore, as regards the measures themselves the study points to a number of local doubts that are similar to insights from qualitative interviews and documentary analysis conducted in the framework of the present thesis. Doubts concerned, firstly, the ´wilderness´ of seemingly unmanaged areas. In line with findings of other studies (e.g. Vessel et al., 2018), the study suggests that wetlands are often less appreciated than other habitats. The main reason is that wetlands "do not comply with certain cultural values such as a sense of control, neatness and safety, and that wetland attractiveness is strongly influenced by cultural features like mown areas and structures providing views onto open water" (Schaich, 2009).

Similarly, other studies have found that aesthetic preferences are influenced by features that signal "resource availability, habitability and safety, or engage foraging behaviours", such as "openness of the view, the presence of water, signs of care and disturbance, and cues for exploration" (Vessel et al., 2018). The general public acceptance of cattle grazing in the valley among inhabitants (especially older people) provides some evidence for these arguments (Schaich, 2009). At the same time, farmers themselves (although few in numbers in the sample) rejected all measures of the restoration project. This seems to confirm that farmers favour "farm and developed areas over wilderness and non-intensively managed landscapes" (Schaich, 2009).

Secondly, public misgiving also resulted from concerns about possible pests. In the Syr valley study, nearly a third of the respondents feared the restored wetlands "would enhance mosquito plagues" (Schaich, 2009). Fears of mosquitoes and infectious diseases associated with wetlands are further discussed below (ASF3). Several interview partners shared the impression that safety and a sense of control were frequent concerns among many local residents:

> *"Wer möchte schon Natur zulassen? Wir haben aus der Entwicklungsgeschichte heraus immer versucht, die Natur zu unterdrücken, weil sie gefährlich ist, das Wasser, Feuer und so weiter. […] die Wildtiere. Wir versuchen das zu kontrollieren und jetzt soll man den Leuten sagen, „wir müssen nicht alles kontrollieren. Das ist gut, wenn wir nicht alles kontrollieren". Ich denke, das ist schon schwierig, um das zu vermitteln. Wo kann man diesen Kontrollverlust zulassen?" (interview n°37)*

Growing remoteness of residents from nature has also served as a possible explanation:

> *"Was ich generell beobachte, das ist wirklich so, dass sich diese Naturferne bei den Leuten immer mehr manifestiert. […] Plötzlich geht von allem eine Gefahr aus, von dem Unkraut, was jetzt in der öffentlichen Anlage steht, „das springt in meinen Garten" und verursacht irgendein Unheil. Oder diese Insekten, was die alles anstellen können?! Diese Sachen, die es schon immer gab, sind plötzlich ein Problem […]" (interview n°39).*

Finally, local doubts about the Syr project also concerned financial aspects, with nearly a quarter of respondents agreeing with the statement "river restoration measures are too expensive" (the Syr restoration costed approx. 770 000 EUR) (Schaich, 2009). Several actors interviewed had also experienced that nature-based measures, generally, were often regarded more critically than expenditure for technical infrastructures. This is also discussed further below (ASI 2). On the basis of its findings and promoting the concept of "*cultural* sustainability", the Syr study recommends that floodplain restoration be accompanied by broad stakeholder involvement and awareness-raising:

> *"A strategy combining broad ecological information and the open integration of both supporting and opposing social groups could ultimately lead to the creation of ´new floodplain landscapes´ on a socio-culturally sustainable basis" (Schaich, 2009).*

10.1.3 Management means

In order to restore the Syr river to as natural a state as possible, the riverbed of the Syr was moved, lifted, and broadened. In line with adaptive management principles, the creation of larger open water surfaces aimed to enhance the river´s capacities of auto-evaporation and self-regeneration and, thereby, to improve water quality. The increase of the water retention capacities in the valley also served flood protection (ANF, 2008). Indeed, downstream municipalities have since experienced less flooding (interviews n°9, 37, 52). In 2016, however, an "unfavourable development tendency" of the Syr was diagnosed. Due to natural hydrological processes the riverbed again has deepened and become narrower, increasing stream velocity and resulting in drier surrounding wetlands. For this reason, the nature administration has recommended another management intervention (ANF, 2016a). This is further elaborated below (ASF 3).

This seems to confirm the argument that one of the main challenges of ´traditional´ ecological restoration approaches is that it requires ongoing management to preserve semi-open and diverse mosaic, with selective mowing and livestock grazing as established means (Higgs, 1997; Schaich et al., 2010). In the case of the Syr restoration project, extensive grazing was preferred as main management means over mechanical mowing and cutting, because floodplains are difficult to mow (due to their wetness) and only provide low-nutrient and fibre-rich forage that is less suitable for conventional livestock such as milk cows (ANF, 2008; Schaich et al., 2010). Thanks to Galloway pasturing flora and fauna, indeed, became richer than in plots without grazing. Some rare plants and other species reappeared (Schaich et al., 2010).

Figure 10.4 - Information panel on the pasture project, flora and fauna in the Mensder Brill

The grazing project (starting with 14 mature cattle grazing on 29 hectares, corresponding to a low density of 0,5 livestock unit/hectare) rested on some of the following principles and assumptions (ANF, 2008; Schley & Leytem, 2004):

- physiological alimentation needs of the cattle were assumed to be satisfied by fibre-rich and nutrient-poor forage (including reeds), while additional feeding was to be avoided,
- the breed was assumed to be resistant to wet and cold conditions and related diseases.

The cattle was thus assumed to be well-adapted to wetlands (see figure 10.4). Following nature-based principles, no fences were built to prevent cattle from entering water or to separate herds by ownership (i.e. the three farmers). As dung was mostly found outside riparian strips, harmful effects on water quality were assumed to be limited (Schaich et al., 2010). This is in contrast with later WFD-related provisions that have required the separation of livestock from water bodies to prevent water pollution caused by sediments and excrements. For this reason, the project subsequently made it more difficult for municipal and environmental actors to convince farmers to build fences along river pastures. The issue has also resulted in ongoing controversies between the ANF and the later Water Management Authority (AGE) (interviews n°9, 14, 37, 39, 53).

In general, considering their alleged "autosuffisance et autonomie", the Galloway cattle was assumed to require little caretaking (ANF, 2008). Contrary to original assumptions, however, scientific studies carried out to monitor the impact of grazing on flora and fauna suggested that the Galloways preferred the more nutritious grass (provided by mesophilic grasslands) to reed, woody plants and other fibre-rich species. Some actors also recalled hearing the cattle roaring from hunger. Initially, however, the administration had been reluctant to consent to supplementary feeding and the installation of feeding troughs. In general, the Galloways required more work than expected. In the end, the farmers fed them with additional hay (Schaich et al., 2010).

Ecologically, the selective grazing behaviour meant that the cattle was less effective in halting the encroachment of woody plant species and reeds than expected. The study warned this could lead to a loss of biodiversity and of mesophilic grasslands that would risk to "jeopardise cattle nutrition" in the longer term (Schaich et al., 2010). The study therefore recommended long-term monitoring of the situation, additional grazing by other livestock (such as goats), and selective mechanic cutting (Schaich et al., 2010). However, to the best knowledge of the author of the present thesis, no further studies were conducted to monitor Galloway health. However, the cattle was to be regularly inspected not only by their owners, but also by veterinarians (interviews n°9, 26, 51).

Actors with experience in this or other extensive grazing projects point to several difficulties. Firstly, the cooperation between the three farmers (obliged to cooperate as their respective herds were not separated by fences) was a challenge. "Es war wie früher im Kommunismus, jeder hat die Verantwortung auf den anderen geschoben", said one of the farmers (Luxemburger Wort, 2016). The farmers did not agree who would feed what cattle and when. Furthermore, the area was difficult to access due to its wet conditions. Due to the vastness of the area it proved cumbersome for the farmers to keep an eye on the cattle, including on new-born calves (that had to be registered and earmarked), even more so as the cattle grew increasingly ´wild´ and unaccustomed to humans (interviews n°26, 39). Finally, due to a police investigation into a fire, the area had been off limits to farmers for several months during the late summer of 2016 (Luxemburger Wort, 2016). Following the discovery of six dead (and partly decomposed) corpses by an ANF forest ranger in November 2016 (followed by the death of three additional animals), a blame-game between the main participating parties began. Most blame was put on the farmers for not having taken care of their cattle properly, they blamed each other, and the Ministry of Agriculture was blamed for having opposed water buffaloes. It is widely assumed that the cattle died of parasites that their weak immune systems (caused by cold and wet conditions and malnutrition) had been unable to resist (Luxemburger Wort, 2016). Many actors who had voiced doubts about the project felt confirmed. However, causes for death have not been publicly shared. Since the pasture project ended, the Mensder Brill has increasingly fallen into ´wilderness´, contrary to Natura 2000 obligations (see figure 10.5 and ASF 1 below).

Figure 10.5 – Vegetation now grows uncontrolled in parts of the Mensder Brill, almost covering the Syr river in some places

A new project may, however, be launched. Among lessons drawn from the experiment are that a possible future project would not include several farmers, that municipalities and local actors would be involved more actively, and that it would be ensured that cattle had access to more dry land, and that another cattle breed (such as water buffaloes) may be tried out (interview n°9, 15, 51). As a result of how the project ended pasture projects in Luxembourg have however remained controversial, adding to uncertainties about how to manage restored and protected areas. At the same time, several local and national interview partners stressed they supported a new concept and project for Mensder Brill (see also ASI A below).

The project pre-announces some of the main elements discussed in the following analysis.

10.2 Setting the scene

The Syr River Partnership had started as part of an Interreg project in which the environmental organisation natur&ëmwelt Fondation Hëllef fir d´Natur had participated. As part of the project, working groups from 2005 to 2006 had elaborated a "Charter for a Clean Syr" that was based on an inventory of approximately 700 "problem factors" ("Störfaktoren") that they had collaboratively been mapped by walks along the 240 km of the Syr river and its incoming streams (see case studies part II 8.3). The inventory (part of a database) documented problems such as connectivity barriers for fish (e.g. weirs) and visible sources of pollution, water extraction, and riverbank deterioration. Following the entering into force of the national water law that transposed the EU Water Framework Directive (WFD)[259], twelve municipalities, the Ministry of the Interior, and the Fondation HfN officially founded the Syr River Partnership. Two part-time employees of the Fondation HfN have coordinated the river partnership since. Its elected president used to be the mayor of the municipality of Betzdorf.

The interviews cited in the following primarily reflect the perspectives of those individuals actively involved in the processes analysed, as it has proven more difficult to establish contacts with other actors (see methods chapter 5.3.1)

[259] Loi du 19 décembre 2008 relative à l'eau. Mémorial A N° 217

10.3 ASI 1: River partnership elaborates action plan, builds social network

Summary	Following its formal creation in 2012, working groups of the river committee of the Syr River Partnership elaborated an action plan. While measures such as river restorations were also part of the action plan, pollution of the Syr river caused by airport wastewater has been one of the main shared concerns of the river partnership and its municipal members.			
Synergies and tensions	<u>Synergies:</u> • National purposes and operational objectives in EU WFD implementation – purposes and objectives of the Syr River Partnership • River partnership and municipal objectives to address airport wastewater problem <u>Tensions</u>: • Ecocentric purposes of the river partnership – broad anthropocentric municipal purposes • River basin management - weak collective identity and identification with the Syr			
Action situation	Main documents	Interviews	Observations and meetings	Workshop content
ASI 1 – River partnership elaborates action plan, builds social network (2012-2014)	River partnership annual reports, minutes, and action plan 2014-2017	N° 9, 11, 13, 22, 24, 52, 53	River committee meeting on 7/2/2017	Influence diagrams and discussions at NEXUS (see 6.1.1.1, and annex I)

Following the formal foundation of the Syr River Partnership, the inventory of problem factors was updated and the four working groups of the river committee came together again to elaborate an action plan. The working groups concerned water quality, agriculture, aquatic ecosystems, and public awareness raising. Participants included representatives of member municipalities, public administrations, and water syndicates. A few farmers participated, but are remembered as passive "backbenchers". Until 2013, the members of the working group members elaborated details of a total of 91 measures. For each measure, the action plan 2014-2017 specified who was in charge of implementation, timeframes, estimated costs, and possible funding sources. Measures were ranked according to urgency and feasibility. They were also coordinated with the Water Management Authority and the national WFD management plan. The action plan was formally signed by all municipal and public project partners in 2014 who committed to carrying out actions to reach objectives (FP Syr, 2013, 2014b) [260].

The following analysis of issues relating to the action plan and emerging network focuses on a discussion of overarching purposes and operational objectives of the river partnership and its municipal members. While overarching purposes and operational objectives largely correspond to the

[260] "Les partenaires publics et privés ci-après signataires, s´engagent, chacun dans le domaine de leurs compétences, à atteindre les objectifs fixés dans ce programme d´actions à travers des actions pour lesquelles ils sont concernés et ce en fonction de leurs possibilités humaines, techniques et financières et dans le respect des principes généraux de la responsabilité civile et des règles de droit" (FP Syr, 2014b). Signatories were the mayors of the 12 (later 13) member municipalities, the directors of the public administrations for water (AGE), nature and forests (ANF), agriculture (ASTA) and a public research centre (CRP Tudor), intermunicipal syndicates (SIAS, SIGRE, SIDERO, SIDEST), the presidents of the Chamber of Agriculture and a sports fishing association (FLSP) and a waste management operator.

EU WFD, the analysis suggests that there is a discrepancy between the ecocentric purposes of the Syr River Partnership and those of its municipal members. The Syr river is hardly a point of reference or identification among local communities who, in addition, do not have a history of history of cross-municipal cooperation at the scale of the river basin. These factors have rendered the building of a social network more difficult here when compared with the Upper Sûre region.

10.3.1 Purposes and operational objectives

The action plan pursues the aim to improve water quality and the state of aquatic ecosystems in the Syr river basin, with a focus on small incoming streams (FP Syr, 2014b):

- Topic 1: Improving wastewater treatment
- Topic 2: Reducing pollutant input from industry and transport (incl. pesticide use on railway embankments and de-icing substances from the airport)
- Topic 3: Reducing nutrients and pesticide use in agriculture
- Topic 4: Reducing water consumption of and pollutant inputs from households (incl. from detergents and pesticides)
- Topic 5: Protected areas: contributing to the protection of groundwater sources and dependent aquatic ecosystems and habitats
- Topic 6: surveying water levels in surface and groundwater bodies, including in relation to floods and droughts
- Topic 7: identifying and preventing point pollution from former industrial sites
- Topic 8: Hydromorphology: Improving the structure of water bodies (hydromorphology), including via river restorations and measures to improve river connectivity, counteract riverbank erosion (e.g. by fencing rivers along pastures, building troughs and cattle bridges), and riverbed deepening
- Topic 9: Protecting biodiversity and habitats in aquatic ecosystems
- Topic 10: Reaching out to the public and raising awareness among citizens and professional actors (farmers, water manager) of why and how to protect water ("*Pourquoi et comment protéger l´eau*?")

Overall, therefore, the river partnership has pursued ecocentric objectives focused on the protection of water and ecosystems, with stakeholder involvement aiming primarily to minimise human environmental impact. As a project of natur&ëmwelt Fondation Hëllef fir d´Natur, it is embedded in the environmentalist tradition of the foundation.

> *"Mission unserer Stiftung: Naturschutz, immer aus der Sicht vom Naturschutz. Das ist meine Herangehensweise, auch wenn die vielleicht nicht immer offen ist. Aber das ist so die Basis, auf der ich arbeite. Aber immer so im Versuch, Natur und Mensch eben zusammen zu bringen". (interview n°13)*

While not enshrined formally, individuals within the river partnership have also hoped that all partners would seek to make the Syr an exemplary river, demonstrating that it was possible to restore rivers to a good state (interview n° 9).

Environmental commitment is an important element of the narrative identity of staff members, with strong experiential and symbolic dimensions:

> *"Für mich ist Wasser einfach…ich habe immer an Wasser gewohnt, für mich ist das wirklich ein ganz wichtiges Element. Und mir ist es einfach wichtig, dass es sauber ist. Es bringt mich zu mir selbst. Die Ruhe, der Geruch, die Entdeckung, die Sinneswahrnehmungen. Und ich glaube, ich würde krank werden, wenn ich nur in einer Stadt wäre". (interview n°13, interview partner 2)*

"Das verbindende Element von Fließgewässern: dass Bereiche überbrückt werden, ein gewisser Fluss da ist, den man auch übertragen kann auf Leben, Lebewesen; dass verschiedene Räume überwunden werden können und miteinander kommunizieren. Das finde ich immer sehr wichtig. Und da ist sowohl das Fließen des Baches, als aber auch die Struktur an sich". (interview n°13, interview partner 1)

The experiential and personal dimension is at the heart of their professional knowledge (see further below).

The present case study focuses on two main domains of the action plan: firstly, efforts of the Syr River Partnership and its municipal members to improve the ecological state and hydromorphology of the Syr and its incoming stream via technical measures (topics 8 and 9) (see ASI 2). Secondly, ASI 5 analyses their efforts to address pollution caused by insufficiently treated wastewater from the Uebersyren wastewater treatment plant containing de-icing substances from the international airport (topics 1 and 2)[261].

Since its 2008 Interreg Charter, the river partnership has sought to address pollution issues relating to transport. One issue concerns the use of pesticides on train embankments. Following the adoption of the action plan, the river partnership has been in contact with the national railway company CFL. The Luxembourgish state holds 94 % of the CFL group[262]. Track maintenance prescribes the use of herbicides and fungicides to prevent the appearance of weeds. Train embankments have run along the Syr since the 19th century. Nowadays, they pass through Natura 2000 areas, national nature reserves, and drinking water protection zones in which the use of pesticides in agriculture, households, and industry is prohibited. Presumably, CFL uses a pesticide similar to ´Round-up´ and a cocktail of other fungicides and herbicides. The river partnership and CFL agreed on a scientific study to analyse the issue. However, public funding was not granted (interviews n°9, 13).

The international airport Findel has been connected to the Uebersyren treatment plant since the 1990s (personal communication n°1). While a private business, its Board of Directors is composed almost entirely of governmental representatives[263]. For decades, airport wastewater has overstretched the capacities of the Uebersyren treatment plant. The burden increased simultaneously with the growth of the airport, which has seen an increase from 1,5 million passengers in 2005 to more than 4 million in 2018, and in increase in airfreight handled by the Cargocenter from 700 000 tons in 2010 to over 950 000 tons in 2018[264]. In peak times, the Uebersyren treatment plant has received more than 150 000 inhabitant-equivalents of wastewater, while only being designed for approximately 35 000 inhabitant-equivalents of which the airport has reserved some 9 000 inhabitant-equivalents. Airport

[261] Measures from the action programme 2014-2017 (own translation of selected passages): "**Topic 2 - measure 3**: Extending the Uebersyren wastewater treatment plant, lead: wastewater syndicate SIDEST and Luxembourg state, partners: four municipalities (Schuttrange, Sandweiler, Contern, Niederanven, Weiler-la-Tour), implementation period indicated: 2014-2017, estimated costs: 65 Mio EUR (with Ministry of Sustainable Development and Infrastructure as possible co-funder) […] **Topic 2 - measure 20**: Reducing use of de-icing substances at airport (use of more ecological deicing substances et de-icing at a single spot), lead: airport society Société de l´Aéroport de Luxembourg S.A. [not among the signatories], together with the wastewater syndicate SIDEST, the Ministry of Sustainable Development and Infrastructure, and the river partnership as partners [no implementation period specified], **Topic 2 - measure 21:** Reducing the quantity and toxicity of herbicides used on train embankments: lead: river partnership, partner: national railway company CFL [not among the signatories, no implementation period specified]" (FP Syr, 2014b)

[262] Other shareholders are Belgium (4%) and France (2%), see ´Groupe CFL´ https://groupe.cfl.lu/fr-fr/whoarewe

[263] See https://www.lux-airport.lu/corporate/the-company/meet-the-team-2/board-of-directors/ One of the board members was a signatory of the Syr River Partnership action plan 2014-2017 and used to be in its accompanying committee.

[264] www.lux-airport.lu/corporate/the-company/our-story/

wastewater contains sanitary wastewater (incl. from chemical toilets), deicing water containing glycole (used when temperatures fall below 5 degrees Celsius) and other waters used for the treatment of airplanes and runways. Glycole is biologically degradable, but cannot be absorbed in quantities exceeding capacities by the bacteria cultures of the wastewater treatment plant. As a result of too much glycole, the bacteria cultures of the plant can be ´knocked-out´ and insufficiently treated (or entirely untreated) effluents runs into the Syr[265]. The overstretching of the capacities of the treatment plant – and the resulting pollution of the Syr - has been known since 2002, when a study into the contamination burden was conducted (ibid.). The national WFD management plan 2015-2021 recognizes the international airport as a "significant source of pollution" for the Syr (AGE, 2015b). Unlike with the CFL, the Syr River Partnership and its members did not succeed in establishing contacts with the airport.

10.3.2 Anthropocentric municipal purposes

The wastewater problem is one of the main synergies identified between major concerns of the municipalities in the parts of the Syr valley investigated and those of the river partnership. The municipalities of Niederanven and Schuttrange (together with two other municipalities) have been operators of the Uebersyren wastewater treatment plant (first via the intermunicipal syndicate SIAS and later via the intermunicipal wastewater syndicate SIDEST). Furthermore, other municipalities have also been affected by insufficiently treated effluents flowing down the Syr river. The problem has attracted significant public attention locally, because the pollution can be seen and smelled. Private fishery tenants have witnessed dying fish (interviews n°9, 52) (FP Syr, 2017a). For this reason, local inhabitants have repeatedly notified and complained to their municipalities, asking for explanations and a solution.

> *"Als Lokalpolitiker sind wir ja unseren Einwohnern verpflichtet. Und wenn die permanent hier bei der Gemeinde anrufen: „Jetzt schäumt die Syr und die stinkt", und ich kann noch nicht mal Antwort geben!" (interview n°9)*

Moreover, water containing pesticides and tyre wear particles are assumed to pollute drinking water sources in the Birelergronn (that supply neighbouring municipalities and Luxembourg City with drinking water), especially when retention basins for runway water flow over due to heavy rainfalls (guided site visit and interview n° 53, also Réseau Rhenan & Fondation HfN, 2008). Some interview partners framed the issue as a conflict between economic interests of the airport, water quality, and local "health interests".

> *"B: […] sind auch ökonomische Interessen vom Flughafen, die auf gesundheitliches Interesse stoßen. Wir sind die, die das ausbaden sollen. Denn unsere Flüsse oder Bäche werden ja verunreinigt, und die tragen zum Trinkwasser bei. Ökonomisches Problem ist oben beim Flughafen. Sie brauchen das Deicing, um die Flugzeuge fliegen lassen zu können. […]*
>
> *C: Der Verstand sagt einem nur, dass das nicht gut ist. Aber inwieweit das nicht gut ist....gibt immer Faktoren, die nicht gut sind für die Gesundheit, aber das zu Chiffrieren, das ist enorm. Der*

[265] At a Syr river committee meeting on 7 February 2017 (attended by the author) the issue was explained as follows: „Im Winter werden die Flugzeuge mit dem Enteisungsmittel Glycol, eines auf Alkohol basierenden, an sich relativ unschädlichen und bei warmen Temperaturen relativ schnell abgebauten Produktes. Bei kalter und wechselhafter Witterung in den Wintermonaten ist sein Abbau stark verlangsamt und die Bakterienkulturen in der Kläranlage sind damit überfordert. Der Findel kann das mit Enteisungsmittel belastete Wasser nicht selber klären, es muss mit "wärmerem" kommunalen Abwasser gemischt werden. Seit 2008 ist ein Projekt zur Erweiterung der Kläranlage auf 120.000 EW (Kostenschätzung 80 Mio €) ausgearbeitet" (FP Syr, 2017a).

Findel kann aber chiffrieren, was er für einen Ausfall hat, wenn die Flugzeuge am Boden bleiben. Das gelingt ihm". (interview n°24)

The problem seems to have become part of local narratives. One interviewee claimed that due to the issue local inhabitants were more aware of the existence of the Uebersyren wastewater treatment plant than of the local Natura 2000 bird protection area Schlammwiss (interview n°53).

Overall, however, interviews suggest that the municipal members of the Syr River Partnership tend to prioritise broad anthropocentric purposes centred on local quality life. In some municipalities, the local population has doubled or even tripled since the 1970s (STATEC, 2019), with some municipalities now having up to 50 % of non-Luxembourgish residents (sometimes with more than 80 different nationalities), resulting in both the need to extend local infrastructures and to foster social cohesion. The most frequently mentioned municipal concerns and operational objectives related to (interviews n° 22, 24, 49, 52, 53):

- ensuring sufficient and affordable housing, especially by building new residential areas,
- creating sufficient and attractive public social infrastructures such as schools, kindergartens, playgrounds, facilities for child day-care, sports, and culture,
- extending transport infrastructures such as roads, parking lots, but also bike paths and e-mobility infrastructures,
- enhancing social cohesion with initiatives to foster community-building and integration (e.g. social events and activities).

On the other hand, many municipalities also have environmental citizens´ committees and ´climate teams´ that take initiatives in a wide range of areas such as renewable energies, waste reduction and recycling, transport, regional products, etc.[266]. Some of these initiatives are carried out in cooperation with the intermunicipal SIAS syndicate. Furthermore, population increases have also necessitated the expansion of capacities relating to drinking water supply, with some municipalities building larger water towers and tanks and seeking increasingly to exploit more local sources to be less dependent of comparatively expensive SEBES water from the Upper Sûre lake (interviews n°22, 24).

In interviews and conversations, some national actors criticised municipalities for caring mainly about their "small municipal interests" centred on social and cultural projects, and less for the state of water bodies and ecosystems (interview n°40, 43). This was cited as one reason for why the implementation of national WFD management was lagging behind. Municipal actors, on the other hand, have stressed that they hardly had sufficient time and capacities to carry out the main activities to satisfy local needs and demands.

The implementation of the action plan of the Syr River Partnership also depends crucially on the municipalities.

[266] Forty of Luxembourg´s municipalities are members of the national "Klimapakt", in which they commit to measures to counteract climate change. They can also be rewarded for certain initiatives (www.klimabuendnis.lu).

10.3.3 Social network

In order to be able to carry out measures of its action plan, the river partnership depends on building a social network, notably, with its municipal partners and agricultural actors. As regards municipalities, local solidarity among municipal members is one of the core principles of the river partnership. Municipalities are encouraged to ensure that the water that leaves their territory is at least in as good a state as when it entered:

> *"Le Comité de rivière invite les Communes signataires à prendre les mesures appropriées pour assurer que l´état biologique et chimique des cours d´eau quittant leur territoire soit au moins égal á l´état de ceux-ci à leur arrivée sur le territoire communal" (FP Syr, 2012a).*

So far, however, the creation of a social network has been a challenging task. Research and interviews suggest that, so far, the Syr river basin district is predominantly an administrative and hydrological unit rather than a point of identification of inhabitants and local communities. It is thereby closer to ecosystem-based bioregional approaches than to community-based bioregionalism (McGinnis, 1999; Meijerink & Huitema, 2017). Unlike in the Upper Sûre region, the twelve (later thirteen) member municipalities of the Syr river partnership have hardly any tradition of cooperation at the scale of the river basin. The membership fee paid to the Syr River Partnership is modest (1.500-1.600 EUR/year), which may also reflect that the River Partnership has a comparatively low priority in municipal matters (interviews n°13).

Furthermore, while one of the river partnership staff members lives in the Syr valley (as do other foundation members), the Syr River Partnership itself has its offices in the "House of Nature" located near Luxembourg City, i.e. outside the Syr river basin. At the same time, it builds on close relations with the SIAS syndicate (a common structure of four of the Syr municipalities at which one of the Syr River Partnership coordinators is also employed) and contacts made during its Interreg project of 2005-2006. Shared elements in narratives could mainly be discerned among the municipal officials that have been members of the SIAS syndicate, notably in relation to the Uebersyren wastewater treatment plant and airport. When asked about what local inhabitants associate with the Syr, some interviewees remarked that

> *"Die Syr hat jetzt keine so riesige Bedeutung im kollektiven Bewusstsein der Gemeindeeinwohner" (interview n°52).*

The Syr river seems to be best known among the ´original´ inhabitants of the area ("Ureinwohner", interview n°52). Overall, however, few residents were aware of its existence, even more so as the small river was only visible in a few public places. Some interview partners argued that the *name* of the Syr river was more known than the river itself, because the river has lend its name to several cultural and economic sites:

- the commercial area ´parc d´activité *Syr*dall´
- the cultural centre ´*Syr*kus´
- the public swimming pool ´*Syr*dall Schwëmm´
- the Ueber*syren* wastewater treatment plant

These sites are all located in the four municipalities investigated in the present thesis. One interviewee remarked he sometimes jokingly told colleagues he was from the "Syrtal-Metropole" (interview n° 52). Two actors recalled similar childhood memories from playing in the river. In their view, however, children today no longer did so:

"Also, wir als Kinder, wir hatten da im Brill […] in den großen Ferien immer im Sommer, wir haben da in diesen Bächen gespielt. Wir haben die Frösche gefangen, in den Eimer gemacht, mit nach Hause genommen: „Ja, guck, ich habe Frösche." Dann haben wir die laufen gelassen. […] Wir haben Staudämme in diesen Bächen gebaut. Das sieht man heute nicht mehr. Und da hat man eine Relation. […] Aber ich habe noch nie Kinder in diesen Bächen gesehen, spielen gesehen". (interview n° 52)

"Im Bach spielt keiner mehr. […] Also wir haben als Kinder auch im Bach gespielt. Da waren auch noch Fische drin. In der Syr waren noch Fische drin und Blutegel waren drin. Dann ging man nach Hause, dann hat man die Blutegel von den Beinen gezogen. Wir haben Staudämme gebaut und alles. Es ist auch niemand ertrunken. […] Und das wäre ja heute auch so ein Problem, ja, geht das überhaupt noch, dass Kinder so in dem Bach…? Wer hat die Verantwortung dann? […] Jemand ertrinkt, ist dann die Gemeinde schuld" (interview n°53)

Furthermore, interviews suggest that municipal engagement in the river partnership has been based more on personal local and environmental commitments – including the place attachment of individual actors - than on organisational commitments as such. Municipal cooperation has predominantly depended on individual actors and their "affinity for water or nature protection":

„Haben die Affinitäten für das Wasser, oder den Naturschutz, sehen sie in uns einen Partner, und werden uns die Türen geöffnet". (interview n°13, interview partner 1)

„Parteizugehörigkeit egal; sind die Personen, wenn sie der Natur nahestehen". (interview n°13, interview partner 2)

Indeed, particularly active individual members underlined they had always ´cared for´ environmental issues and, moreover, that they had always been active in municipal matters:

"Ja, ich bin auch eigentlich immer als Bürger dieser Gemeinde schon auch sehr aktiv gewesen in den Vereinen […] Aber Umweltthemen sind immer meine Themen gewesen, weil ich habe auch privat in mein Haus investiert, wenig Energie zu verbrauchen und auch mit nachhaltigen Materialien auch diese Arbeiten auszuführen. Also ich mache das aus Überzeugung, nicht nur aus politischem Interesse". (interview n°53)

In order to reach out to municipalities, the river partnership has produced various thematic brochures and leaflets and written articles about water issues in municipal bulletins. It has also organised guided tours for citizens and other interested local actors (in addition to the public meetings of its river committee and annual reports).

It has proven particularly challenging to engage agricultural actors. The river partnership has established relations with the regional branch of the Administration of Technical Agricultural Services (ASTA), but has few contacts with farmers and farm advisors:

"da kenne ich keinen. Ich weiß nicht, wie ticken die? Ich wäre froh, wenn wir in der Richtung weiterkämen". (interview n°13)

In general, many contacts that were established and the reputation that the river partnership has built among local communities has rested primarily on the implementation of concrete projects.

10.4 ASI 2: River partnership implements measures, meets barriers

Summary	The river partnership has encountered a number of barriers in seeking to implement measures to improve water quality and river structures. While there have been some changes in how measures are perceived and coordinated, there is a sense that technology-oriented approaches continue to prevail among farmers, municipalities, and in public funding procedures.			
Synergies and tensions	Synergies between the Syr River Partnership and the Water Management Authority in planning and implementing technical measures Tensions between ecocentric and nature-based solutions and technology-oriented thinking			
Action situation	Documents	Interviews	Site visits, observations and meetings	Workshop content
ASI 2 – River partnership implements measures, meets barriers	Annual reports of the river partnership 2013-2019	N° 9, 13, 31, 49	Trudlerbaach visit, river committee meetings	

This action situation examines challenges and issues that the Syr River Partnership has encountered in relation to farmers, municipalities, and administrations when seeking to plan and implement measures. The action plan 2014-2017 encompasses a number of measures to restore and improve river structures, connectivity, and the creation of new aquatic biotopes (e.g. ponds) (FP Syr, 2014b). While mostly depending on project partners and with several other project applications in process, the measures implemented by the river partnership itself have included (FP Syr, 2015b, 2013, 2014a, 2016, 2017b, 2018, 2019):

- building and repairing cattle bridges (sometimes including enlargements of riverbeds, see figure 10.6),
- fencing or repairing fences along riverbanks,
- installing cattle troughs,
- removing old pipes and/or new pipes along rivers.

The main objective of these measures has been to prevent cattle from entering rivers and streams and, thereby, to prevent riverbank erosion and nutrient input from sediments and excrements. In planning and implementing measures, the river partnership has experienced substantial differences in how actors understand and approach water-related challenges depending on their organisations and professions. One of the challenges they face is to overcome them by the help of "sober argumentation":

> *"Was man beobachten kann: dass sich verschiedene Meinungen, Denkschemata sich verfestigen. Das ist bei einem, der im landwirtschaftlichen Betrieb arbeitet anders als bei einem, der in der Wasserverwaltung arbeitet, und anders als der, der bei einer Naturschutzorganisation arbeitet. Und das ist, denke ich mal, muss man probieren, diese Blockaden aus dem Kopf raus zu bekommen und zu versachlichen". (interview n°13)*

The following summarises experiences with farmers, municipal and other local actors, and public administrations.

Figure 10.6 – Project to fence, flatten, and enlarge a riverbed of incoming stream to the Syr (Trudlerbaach)

In the view of many farmers, fencing often seems to be perceived as diminishing their productivity and as posing practical challenges to pasturing, cultivation and/or fertilisation. Some farmers also seem to fear that new biotopes might emerge, which might then be protected, and decrease the value of their land.

> *"Er befürchtet, dass neue Biotope entstehen, dass diese Uferbereiche, die wir dann auszäunen, dass das aus der Produktivität irgendwann rausfällt und sein Land nicht mehr so viel Wert ist wie vorher". (interview n°13)*

In the experience of several actors, farmers rarely seemed to understand or support the environmental cause (interviews n°13, 37, 39). Several actors interviewed cited examples of stalled projects due to farmers´ oppositions to fences. Many farmers also seem to have a ´natural reflex´ to immediately ask for subsidies and that someone else pays for the fence.

> *"Wenn man mit Bauern unterwegs ist: wofür sauberes Wasser gut ist, im Fluss, immer [muss man] argumentieren. Wenn es zu schlimm wird, sage ich: „Sie sind für die Nahrungsmittelproduktion zuständig, und Sie haben Ihre Kompetenz darin. Lassen Sie mir bitte meine Kompetenz im Bereich des Naturschutzes. Ich denke, da habe ich auch eine Ahnung". Damit es klar ist. Da merkt man schon oft die Mentalität: wofür braucht man Naturschutz? Das macht doch nur Probleme. Mangel an Wissen, dass das wirklich ineinandergreift: intakter Boden, intakte Luft, intaktes Wasser, dass das jedermann braucht. Dass das nicht nur ein Bedürfnis ist von den Grünen: Vernetzter Denken, weil Probleme alle betreffen". (interview n°13)*

Another objective of some of the technical measures planned is to prevent flooding by enlarging riverbeds. This usually requires some cooperation of farmers who, however, often prefer the deepening of rivers and removal of trees so that water can run off more quickly. Allegedly, some farmers perceive staff of environmental organisations as "Biotoperten", which can be translated as referring to people who are a bit crazy or obsessed by biotopes (interview n°24).

While relations with farmers have generally been difficult, the river partnership has gradually begun to build a reputation among municipalities as competent partner as regards the implementation of concrete measures. The river partnership´s sense is that smaller measures awaken their "appetite" to do more (interview n° 9). Support is particularly important as it is usually the municipalities themselves

who are formally in charge of projects when it comes to funding applications and advancing funding (interview n°3).

There is, however, a sense that among the municipalities there continues to be more support for direct and tangible technical measures to improve the connectivity of rivers than for nature-based solutions and green infrastructures. Apparently, technical measures on water bodies are easier to ´sell´ to the press and local populations as tangible achievements that also meet with less opposition:

> *"weil man als Politiker sich neben eine Fischtreppe stellen kann, kommt in Zeitungen, man hat ja jetzt was fürs Gewässer getan, das ist sichtbar, fassbar, konkret. Aber Vernässung eines Bachtals, zum Beispiel, das lässt sich viel schwerer verkaufen, kommt auch mehr Opposition: „bringt Krankheiten mit sich", „dann kommt die Malaria oder Egel, die befallen dann unsere Rinder" [hört man] aus Landwirtschaft und Bevölkerung". (interview n°13)*

Furthermore, in their experience, while a fish ladder project for one million EUR might be approved rather quickly, (less costly) projects to improve flora or fish *fauna* might be more difficult to get through.

> *"Man braucht eigentlich weniger Geld, um was Sinnvolles im Naturschutz zu machen, vergleichsweise zu technischen Maßnahmen. Aber die lassen sich viel schlechter verkaufen. Das Thema ist viel komplexer, wieso man was macht, dass es vielleicht Zeit braucht, was sich da einstellen wird. Man hat nicht direkt Resultate. Und deswegen stößt das viel mehr auf Opposition. Die Sinnhaftigkeit wird auch nicht immer anerkannt". (interview n°13)*

They attribute this to what they experience as a widening disconnect of people from nature to which urbanisation has contributed. Instrumental thinking and modern technologies have reinforced preferences for the treatment of symptoms and ´quick solutions´:

> *C: "Leute von der Natur entfernt aufgrund des Verstädterungseffekts: sie sich von der Natur entfernen, sie nicht mehr richtig erleben und verstehen, die Zusammenhänge sehen und so weiter.*
>
> *B: auch instrumentalistisches Denken. Da ist ein Problem, wir machen das jetzt so. Instrumentalistisch.*
>
> *C: wir haben Kopfschmerzen und nehmen jetzt eine Pille und dann es ist gut. Ursachen der Kopfschmerzen liegen ja aber vielleicht woanders.*
>
> *B: […] Verbreitete Denkweise: Smartphone, googeln, und dann machen wir das und fertig ist*
>
> *C: ja, die Lösungen müssen schnell her, sind schnelllebige Gesellschaft". (interview n°13)*

In addition to trying to convince farmers and municipalities of specific measures, river partnership staff spends most of their working time on identifying potential suitable funding sources and submitting funding requests:

> *"Da muss man sehr kreativ sein, sehr viel Arbeit. Das ist eigentlich die Hauptarbeit, die wir haben: die Finanzierung aufstellen zu können". (interview n°3)*

As regards public administrations in general, the river partnership, depending on the project, authorisations required and pfunding sources (e.g. water, environment or agri-environmental-climate funds), cooperates closely and in varying degrees with the administrations for water (AGE), nature

(ANF), and agriculture (ASTA). As most of its projects are funded via the national water fund, contacts with AGE are the most frequent. Overall, interviews suggest that cooperation has continuously improved. In addition to funding, AGE is also the main interlocutor to obtain authorisations for measures. Their relations have been descried as a "learning partnership". The problem factors identified as basis for the river partnership´s action plan were digitalised in a GIS database and shapefiles exchanged with the Water Management Authority that, on its part, shared measured it carried out in the framework of the 1st EU WFD management plan that were included in the database. Despite good operational contacts, interviewees have had the impression that current funding regimes continue to favour technical over nature-based approaches.

> *"Beispiel Wasserfonds: 90 % geht an Kläranlagen, 10 für Naturschutz-, Wasserschutzprojekte, viele Millionen im Fonds. Und von Finanzinspektion werden dann noch Projekte für ½ Million auch noch in Frage gestellt, ob das Sinn macht. Quellschutzprojekt zum Beispiel: wurde sehr stark begutachtet, wurde als zu teuer empfunden". (interview n°13)*

One possible reason, in their view, is the technical background of funders:

> *"Ich kann mir vorstellen, dass ein Großteil der Leute, die mit solchen Themen zu tun haben […] vielleicht auch eher technisch ausgerichtet sind. Und dass das für gewisse Leute…aber ist ja kein neuer Ansatz…Aber da scheinen auf verschiedenen Stellen eher Leute zu sitzen, die die technischen Dinge bevorzugen". (interview n°13)*

In contrast to what seems to be a continuing dominance of technology-based thinking, the staff of the river partnership itself is staunchly committed to nature-based solutions and green infrastructures, as is its parent organisation. For example, in the framework of an EU-cofunded project, natur&ëmwelt Fondation HfN with one of the staff members participated in a project on how river mussels contribute to cleansing water, improving water quality, and thus to reduce the need for technical treatment[267].

Furthermore, while themselves educated scientists (biologist and geographer), river partnership staff stress that they have gained a tacit "sense" for water and people thanks to professional experience:

> *"Wenn man viel so draußen ist, dann entwickelt man ein Gefühl dafür, wie steht es um unsere Gewässer, was sind Probleme, wie sieht es mit der Zukunft aus, um sie in einen besseren Zustand zu bekommen. Ich bin auch dankbar für die Erfahrungen, die ich da habe machen können, weil das gibt mir die nötige Sicherheit, wenn wir dann mal Maßnahmen planen müssen. An wen ich mich wende. Wo eventuell Konfliktpotential ist". (interview n°13)*

Informal outcomes and effects:

- emerging social network in the Syr basin

Material outcomes:

- Technical measures to reduce nutrient input into incoming streams of the Syr and to improve riverbank structures

[267] The project also produced a video: „Die Bachmuschel: unbekannt, nützlich, bedroht": www.youtube.com/watch?v=8DLQ-S-S9-U&feature=youtu.be

10.5 Formal plans and processes

As outlined above, the case study analyses three formal governance strands that relate to different sets of policies.

The Water Framework and Floods Directive:

- The elaboration of national flood risk management plans, partly in cooperation with the Syr River Partnership (ASF a)
- The elaboration of a new concept on aquatic habitat connectivity by the Water Management Authority (ASF b)
- The public consultation on the 3rd WFD management plan (ASF c)
- The EU "fitness check" of the EU WFD and grassroots mobilisation for WFD prolongation (ASF d)

Natura 2000 and national environmental policies:

- The Natura 2000 management plan 2016-2026 for the parts of the Syr valley that encompass Schlammwiss and Mensder Brill ("Vallée de la Syre de Moutfort à Roodt/Syr", LU0002006) (ASF 1)
- The entering into force of the 2nd national action plan and law aiming for the protection of nature and natural resources and seeking to enhance cross-sectoral coordination, notably in Natura 2000 areas (ASF2)
- The declaration of Schlammwiss-Brill as a national nature reserve (ASF3)

Wastewater treatment:

- The entering into force of a new law providing for state co-funding for the extension of the Uebersyren wastewater treatment located in Schlammwiss-Brill (ASF A)

10.5.1 ASF a: National flood risk management plan leads to flood partnership

Summary	In 2015, the Syr River Partnership also became a "Flood Partnership" and participated in the elaboration of the 1st national flood risk management plan. The plan signalled a first formal move towards nature-based flood protection and adaptive water management. However, facing diverse material and informal barriers, a wider paradigm shift has not yet materialised.			
Synergies and tensions	Synergies between flood risk management plans, Natura 2000, EU WFD, and river partnership objectives Tensions between formal plans and possibilities of implementation ´on the ground´			
Action situation	Documents	Interviews	Observations and meetings	Workshop content
ASF a: Flood risk management plan leads to flood partnership	1st national flood risk management plan 2015-2021, annual reports of the Syr River Partnership 2014 and 2015	N° 13, 31, 49	-	-

The national water law of 2008 (Mémorial A, 2008) provided for nature-based measures to improve flood protection, thereby signalling a move away from ´command-and-control´ approaches towards adaptive and integrated water management (see chapters 4.3, 8.6). The water law was the legal basis for the elaboration of the national flood risk management plan 2015-2021, including public participation (AGE, 2015c). Based on hydrological models and historical data on flood events, AGE elaborated first draft risk maps that were sent to municipalities concerned in 2010 and 2011 and made them accessible to the public in 2014. Furthermore, AGE involved ASTA and ANF, emergency services, and newly created "flood partnerships" (AGE, 2015c). Flood partnerships are based on the voluntary cooperation of local and governmental actors. They serve to increase awareness of flood risks at the local level and to improve cooperation among actors concerned, among others through the exchange of information (ibid.).

Figure 10.7 - Flood event in May 2016 (source: Flusspartnerschaft Syr)

As the Syr was categorised as potentially at risk of floods (see figure 10.7), AGE asked the Syr River Partnership to become a flood partnership and to contribute to the elaboration of the management plan. The process involved sending surveys to the 15 municipalities of the river basin asking them about their exposure to floods. Half of the municipalities answered the survey, five of which said they were somewhat concerned by floods ("leicht betroffen"). Moreover, a workshop was organised to inform municipalities of the new flood risk management plan. The river partnership also held separate meetings with eight municipalities to go through ´checklists´ for measures elaborated together with the water administration (FP Syr, 2014a). In 2015, the AGE presented the draft flood plan at the river committee of the Syr partnership (FP Syr, 2015b). During the formal public consultation in 2015, the river partnership, in close cooperation with the municipalities, also submitted an official statement to the draft of the flood risk management plan. It asked for more details on and a prioritisation of measures, stressing that this would be essential for municipalities, and for access to the national database LuxMaPro on the same terms as the partnerships dedicated exclusively to flood risk management (FP Syr, 2015a).

The first flood risk management plan 2015-2020 contains both "non-technical" and technical flood protection. The river restoration of Mensder Brill is mentioned as one of five examples of nature-based flood protection in Luxembourg, along with two other river restoration projects (AGE, 2015c).

Indeed, several actors confirmed that the restoration project was a positive example of how nature-based approaches contribute to reducing flood events in downstream municipalities.

> *"Das kann man wirklich leicht in Mensdorf beobachten. Also, wenn es viel regnet, das füllt sich so wie eine Wanne, in Brill, aber unterhalb […] sieht man kein Wasser oder es ist vielleicht bis an den Rand gefüllt. Und das dauert eine Weile, ein Tag, zwei Tage, und dann ist dieses Becken wieder leer. Das ist ein ganz tolles Beispiel, wo man beobachten kann, was solch eine Fläche bringt, wie viel Retentionsraum die hat. […] Und wenn man viele solcher Flächen hat, dann gewinnt man natürlich an Rückhaltekapazität und man vermindert das Hochwasser". (interview n°13)*

In the 2nd national WFD management plan (2015-2012), river restoration measures serving both flood protection and the improvement of the hydromorphological status of rivers are referred to as ´win-win measures´ (AGE, 2015b). They have been perceived as a paradigm shift:

> *"Und da ist jetzt eigentlich der Paradigmenwechsel, dass man versucht, möglichst wenig technisch, also doch, technischen Hochwasserschutz zu machen, wo es einfach anders nicht geht, aber dass man vor allem versucht, eben diese Kombination von Renaturierung und Hochwasserschutz oder solchen Green Infrastructures, wo es möglich ist […] Flutpolder zu kreieren, um so Hochwasserschutz zu betreiben, und nicht durch Spundwände oder auch mobile Wände". (interview n°49)*

Flood polders are spaces along rivers that serve as additional retention space for water. By contrast, protection walls are fixed installations are meant to protect specific localities through bulwarks against water. Based on experiences of actors, nature-based flood protection faces two major hindrances. One concerns informal institutions, the other land availability.

Due to population growth residential areas in many places have moved into former floodplains and closer and closer to rivers. This means that when technical flood protection is carried out in one place that flood risks *increase* in areas located either up- or downstream, because the space available for water to be able to spread out is reduced. For this reason, a prerequisite for the authorisation of technical flood protection installations is that applicants (usually, municipalities) have to demonstrate that when they erect walls that they dispose of – or create - additional retention spaces for water somewhere nearby (e.g. through retention basins). Therefore, the availability of space and land is one of the main prerequisites for both technical and non-technical flood protection measures that do not only protect single places, but whole river basins. Public authorities, municipalities, and the river partnership alike have experienced land availability as a major barrier to nature-based ´solutions´. The creation of win-win situations often proves difficult in practice:

> *A: „Wir haben hier im Land so einen Druck auf die Flächen, auf die Gewässer gerade im Süden, ja, die Umsetzung von Maßnahmen ist sehr, sehr schwierig."*
>
> *B: „Das heißt, jeder will etwas gemacht haben, aber keiner gibt sein Land her"*
>
> *A: „und auch die Dörfer wachsen ja immer näher zusammen Das heißt, die Strecken, die ein Gewässer braucht, um bei der Renaturierung sich eigentlich erholen zu können, sind hier im Süden ziemlich knapp"[268]. (interview n°31)*

[268] Public water administration in Luxembourg is divided into two regions: North and South. The Syr river basin is part of the Southern region.

In the experience of public authorities, municipalities usually start planning flood protection measures *after* flood events, i.e. when they face pressure from their citizens. In those cases, municipal authorities typically tend to favour what seems to be the quickest, easiest, and cheapest ´solution´, usually technical measures.

> *"Gerade bei kleineren Kommunen, der Bürgermeister ist immer dann, ja, an erster Front auch und die, ja, was die Bürger angeht, die Bedürfnisse. Zum Beispiel: jetzt war dieses Hochwasser […] zwei Monate danach, dann ist hier die Hölle los, denn jeder Bürgermeister möchte dann natürlich am liebsten überall in jedem Einzugsgebiet eine Mauer ins Gewässer bauen, damit das Hochwasser nicht mehr in das Dorf reinkommt". (interview n°31)*

> *„Da heißt, wir sind dann immer händeringend am Erklären und am Versuchen, den Leuten das auszureden, dass man da eine Mauer bauen soll, versuchen dann so Argumente wie „es ist halt sehr teuer, außerdem wird es nicht oft genug gebraucht, weil das halt nur alle x Jahre so viel regnet, dass hier irgendwie etwas passiert und dann ist es das Landschaftsbild, was halt verändert wird und eben die Ökologie, die darunter leidet, und das ist dann eigentlich verboten". Ja, es ist ganz schwierig, den Leuten, die auch Schaden hatten, das zu erklären". (interview n°31)*

> *„Oder es werden dann Rückhaltebecken im Gewässer angedacht, die aber dann wieder so viel negativen Einfluss haben auf das gesamte Gewässersystem. Und das ist halt sehr oft eigentlich schwierig zu erklären, warum man das doch anders angehen sollte. Und das sind eben die Konflikte, die entstehen […]" (interview n°31)*

In other words, win-win measures often do not appear as realistic options. Rather than being able to exploit synergies, AGE has thus had to make trade-offs between granting construction permits to single municipalities to protect local populations in specific places against flooding and to seek to coordinate more integrated approaches and finding the necessary land to carry out measures. Municipal autonomy in urban water management is often cited as another hindering factor for projects that cross municipal borders.

Taken these factors together, this means that flood protection measures carried out continue to be predominantly technical. Few of the hydromorphological measures planned in the framework of the EU WFD management plan have been implemented (see ASI 3). In practice, a paradigm shift towards nature-based flood protection and adaptive management has not (yet?) emerged.

Formal outcomes:

- National flood risk management plan for Luxembourg (AGE, 2015c)
- Syr River Partnership becomes flood partnership

10.5.2 ASF1: Natura 2000 management plan for Syr valley enters into force

Summary	Based on the EU Habitats Directive and national nature law of 2004, the Natura 2000 management plan for the Syr valley 2016-2026 entered into force. It set ambitious targets for river restorations that were coordinated with the national WFD management plan. The action situation characterises some of its main elements as reflecting a managerial ecological restoration paradigm. At the same time, provisions also allow for habitat destruction for reasons of "overriding public interests".			
Synergies and tensions	Synergies with the objectives of the national WFD management plan as regards the ecological status of aquatic ecosystems, with a focus on water quality and river restorations			
Action situation	Documents	Interviews	Site visits, observations and meetings	Workshop content
ASF1: Natura 2000 management plan for Syr valley enters into force	Natura 2000 management plan, EU Habitats Directive	n°17		-

Based on the EU Habitats Directive, the main objective of Natura 2000 areas is to conserve or restore natural habitats. Unlike national nature reserves, Natura 2000 does not impose prohibitions on human activities. Member states are not legally obliged to improve habitats, but must, however, prevent their deterioration (EEC, 1992; Mémorial A, 2004a). The present thesis has characterised the EU Habitats Directive as based on a managerial ecological restoration paradigm that seeks to attain and preserve particular quantified target states and species (see chapter 7.4.1).

The EU Habitats Directive also prescribes that environmental assessments must be carried out for any project that may affect the attainment of the restoration objectives. Projects whose impact has been assessed negatively may only be carried out "for imperative reasons of overriding public interest, including those of a social or economic nature". EU member states are also obligted to carry out "compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected" (EEC, 1992). Thereby, despite its ecocentric purposes that recognise the intrinsic value of habitats, the EU Habitats Directive thus allows for trade-offs based on the assumption that ecological damage can be compensated.

The Natura 2000 management plan 2016-2026 for the Syr valley between Moutfort and Roodt/Syr, elaborated by the Ministry of Sustainable Development and the Nature and Forest Agency aims for the protection of wild birds depending on wetlands (ANF, 2016b)[269]. The management plan builds on an evaluation of the habitats that has been done in the framework of the mapping of fauna biotope cadastres in the period between 2007 and 2012 and, furthermore, on an evaluation of forest habitats of 2015, both carried out by the Nature and Forest Agency.

The plan has been closely coordinated with the national WFD management plan: In line with EU WFD objectives, its "number 1 priority" is to improve the water quality and the hydromorphology of water bodies. This necessitates the extension of the Uebersyren wastewater treatment plant (ANF, 2016b).

[269] Zone NATURA 2000 LU0002006 « Vallée de la Syre de Moutfort à Roodt/Syre. Période 2016-2026) »

80 % of the Syr river should be restored in the area by 2027 (corresponding to 9,5 km). Furthermore, 100 % of all agricultural land should be extensified via biodiversity contracts with farmers (ANF, 2016b). Similar to the national WFD management plan, Natura 2000 management plans thus include quantifiable long-term objectives and quantified concrete measures to be implemented:

> *"Deswegen biologische Ziele und nachher klare Angaben, zum Beispiel: "so viel Meter eines Wasserlaufs renaturieren", oder "so viel Meter auszäunen". Das muss jeder verstehen können, ist messbar. Es ist auch ein Programm im Aufbau, wo nachher jeder angeben soll, was er macht, plant" (interview n°17)*

While measures are quantified, they do not indicate where exactly they should be implemented, thereby be lessing detailed than the national EU WFD management plan. The underlying assumption of Natura 2000 management plans is not that long-term targets will necessarily be attained, if all measures are implemented. Authorities recognise that many other factors (such as climate change, dynamics of biotic communities, etc.) influence if and how particular species return to and flourish in a given habitat. Rather, concrete measures are to enable authorities and actors such as river partnerships and farm advisors to pass on clear instructions to, for example, farmers on what needs to be done. Quantified plans also make it possible to measure and report on progress. Therefore, even if long-term targets are not reached, at least numbers will convey if measures considered potentially effective have been implemented.

Formal outcome:

- Natura 2000 management plan for the Syr valley between Moutfort and Roodt/Syr (LU0002006) aiming for the improvement of water quality, the restoration of 80 % of the Syr river, and the extensification of 100 % of agriculture in the area

10.5.3 ASF2: New national nature protection plan and law enter into force

Summary	The new national nature protection plan of 2017 and law of 2018 aim to protect one third of the national territory. Coordinated with EU WFD objectives and plans, they also promote river restorations. To enhance coordination between diverse actors, the law provides for the creation of multi-party steering committees for the management of Natura 2000 areas.			
Synergies and tensions	Synergies between environmental and water governance objectives Tensions: national interest in creating more protected areas versus the possibility to destroy biotopes for reasons of overriding public interest (e.g. housing projects).			
Action situations	Documents	Interviews	Observations and meetings	Workshop content
ASF 2: New national nature protection plan and law enter into force	National Nature Protection Plan 2017-2021, Law on the protection of nature and natural resources (2018)	N° 34, 39	-	-

Based on the national nature protection law of 2004 (see chapter 7.4.1), the National Plan for the Protection of Nature entered into force in 2017 (Mémorial A, 2017a)[270]. Among others, it serves to implement measures in the framework of the EU Birds and Habitats Directives, the EU´s Biodiversity Strategy 2020, and the EU WFDe[271]. The overarching objective of the plan is to prevent further biodiversity loss caused by economic and demographic developments, for the sake of human well-being. As regards operational objectives, the plan aims to preserve and restore 15 % of Luxembourg´s ecosystems, with semi-open landscapes and wetlands as priorities (Mémorial A, 2017a). The reference to ecosystem services suggests that the plan pursues broad anthropocentric purposes characteristic of adaptive management (see chapter 4.3). The main means by which to achieve objectives are:

- biodiversity programme and contracts that offer financial incentives for extensive farming (see chapter 7.4.1 and above)
- Public purchasing of land of "high ecological value"
- The declaration of 74 sites located within Natura 2000 zones as national nature reserves, including Schlammwiss-Brill, see ASF 3 below)

Particular attention is devoted to the preservation and restoration of "ecological corridors" in Luxembourg´s fragmented landscapes to ensure that species can circulate between different habitats. Furthermore, the plan aims for river restorations and prescribes quantifiable targets for the restoration of wetlands (Mémorial A, 2017a):

> *"Un programme de renaturation des cours d´eau sera élaboré par l´Administration de la gestion de l´eau (AGE), en collaboration étroite avec l´Administration de la nature et des forêts. Dans ce cadre, plus de 100 ha de forêts alluviales seront renaturées, entrainant des effets bénéfiques pour le potentiel de rétention des eaux en cas de fortes précipitations. […] La restauration des paysages semi-ouverts et de zones humides seront d´autres priorités dans la PNPN".*

These references thus illustrate efforts to integrate environmental and water policies. Furthermore, the plan builds on the principle to "associate actors concerned, such as farmers and municipalities, to measures taken" (own translation), including via the intermunicipal syndicates and biological stations (such as SIAS). Through these measures, a third of Luxembourg´s territory is to be protected (MDDI, 2017b). The government intends to spend up to 100 million euros on the implementation of the five-year plan. The objectives were also inscribed in a new national law on the protection of nature and natural resources that entered into force in 2018 (Mémorial A, 2018a)[272]. Some of the new elements the law brings to environmental policies in Luxembourg include:

- The creation of protected areas of "national interest" in the form of nature reserves, protected landscapes, and ecological corridors (articles 38-39);
- The creation of a national pool of public land (and, potentially, regional pools) used for measures that project leaders (e.g. real-estate agents) are obliged to pay for and carry out to compensate for the destruction of biotopes and protected areas incurred by projects (such as housing) that are carried out "for imperative reasons of major public interest" ("raison

[270] Plan national concernant la protection de la nature. Décision du Gouvernement en Conseil du 13 janvier 2017 relative au plan national concernant la protection de la nature 2017-2021 et ayant trait à sa première partie intitulée « Stratégie nationale Biodiversité ». Mémorial A N°194

[271] In addition, the national plan refers to international conventions on biodiversity (Nagoya, 2010), migratory species and wild fauna (Bonn, 1979), wetlands (Ramsar, 1971), and the European landscape convention (Florence, 2006) (Mémorial A, 2017a).

[272] Loi du 18 juillet 2018 concernant la protection de la nature et des ressources naturelles. Mémorial A N°771

imperatives d´intérêt public majeur"), based on the calculation of "eco-points" that are to reflect the extent of damage (articles 17, 33, 63);

- The creation of steering committees with diverse actors (incl. the administrations in charge of water (AGE), nature (ANF), agriculture (ASTA), municipalities, professional groups such as farmers, infrastructure operators, etc.) to accompany the implementation of Natura 2000 management plans.

The introduction of Natura 2000 steering committees signals a growing awareness for the need of coordination between diverse actors in environmental management. At the same time, the provisions on national nature reserves also provide for far-reaching restrictions of human activities (going further than Natura 2000 rules), thus displaying a more narrow ecocentric character. Finally, tensions (and potential trade-offs to be made) can be discerned between relations between areas protected in the framework of Natura 2000, the EU WFD and/or as part of "national interest" and projects of overriding public interest that are allowed to destroy habitats. The introduction of "eco-points" can be interpreted as a move towards the monetarisation of ecosystems and their services as a way to quantify their values, but also to make them replaceable (see chapter 4.3). The law thereby reflects the attempt to address the significant pressures on land exerted by economic growth and the need for housing. In these cases, national nature protection interests and public social and economic interests stand in direct conflict. Many environmentalists interviewed were critical of compensation measures. In their view, losses of natural habitats were largely irreversible and could not be weighed up in points and "absolved" by money.

> *"Da sind sie dann zehn Meter daneben durch den Orchideen-Trockenrasen gefahren. Und die Kompensierungen, die sind dreimal null. Dann wird irgendwo ein bisschen etwas angepflanzt und dann sind wir fertig. Und das sind einfach so Sachen, deshalb bin ich ein bisschen…ja, man kann es schon ein bisschen desillusioniert nennen" (interview n°34)*

Several also found that compensations created an "illusion" that "something was being done for nature":

> ***"**Also man muss sich ganz klar bewusstmachen, ich schaffe ja keinen Mehrwert durch dieses Kompensationssystem. Ich zerstöre ja auf der einen Seite ein Biotop oder etwas, was seit Jahrzehnten da ist oder vielleicht auch schon länger, und muss das jetzt auf einer neuen Fläche ersetzen. Ich habe ja nicht gleich das, was ich zerstört habe, existiert nicht sofort da. Weil ich bin ja im Konflikt. Ich muss irgendein Schema herausfinden, wo ich jemanden sagen kann: „okay, wenn du da baust, dann kannst du durch diesen Faktor hier irgendetwas kompensieren". Viele Leute denken, jetzt wird da etwas für die Natur gemacht, aber darum geht es ja nicht. Es geht einfach nur um den Status quo zu halten […]. Und dann, der Flächenverbrauch ist da und ich verbrauche auch Flächen für diese Kompensation und da muss immer noch etwas übrigbleiben zusätzlich, um diese ganze Problematik von Artenschwund und was weiß ich, um da noch mal etwas mehr zu machen. Und da wird es irgendwann eng". (interview n°39)*

Furthermore, farmers (especially in the North of Luxembourg) criticised that land purchases meant that more investors have been buying - and driving up prices for - agricultural land that they needed to compensate for constructions (interview n°5, see also Upper Sûre case study). They are countered by policy-makers and other actors who stress that the national land lot pool now addresses this problem effectively. Moreover, several actors emphasised in conversations that the compensation scheme was a compromise that reconciled divergent objectives and interests, and that the environment in Luxembourg was "better off" *with* the scheme than without it.

Formal outcomes:

- National Nature Protection Plan (2017) and National Nature Protection Law (2018) aiming for the protection and restoration of ecosystems, particularly wetlands, in the framework of nature reserves

10.5.4 ASF3: National wetland reserve is prepared in Schlammwiss-Brill

Summary	Schlammwiss-Brill became a nature reserve 37 years after it was first declared a national priority wetland worthy of protection. During prior public participation processes, some citizens and agricultural actors voiced doubts concerning the non-maintenance of drainage systems, prohibitions of mowing, and the alleged risk of infectious mosquitoes. It remains uncertain how the area will be managed in the future.			
Synergies and tensions	Tensions between environmental, agricultural, and local purposes and imaginaries attached to the area			
Action situation	Documents	Interviews	Observations and meetings	Workshop content
ASF3: National wetland reserve is prepared in Schlammwiss-Brill	Law and dossier on the declaration of Schlammwiss-Brill as national reserve area, including statements from the public	N°39, 43, 49, 51, 53	Site visits Schlammwiss-Brill	-

The areas of Schlammwiss and Mensder Brill became a national nature reserve (of approx. 88 hectares) (Mémorial A, 2018b)[273], a few days after the new nature protection law had entered into force. It had been declared a national priority wetland site 37 years earlier (Mémorial B, 1981, see chapter 7.4.1). Ornithologists of the Luxembourg Nature and Birds Protection League (and later the Fondation HfN) had set up a birdringing station and begun to purchase land in Schlammwiss more than 50 years ago (see chapter 7.3.1). In environmentalist narratives, they had thereby "saved" land from other uses, making it possible that habitats could be preserved and protected:

> *"Wenn […] diese Leute da nicht schon die Weitsicht gehabt hätten, wir müssen diese Flächen sichern, gäbe es heute da an den Stellen keine Schutzgebiete, weder national noch international. Also von daher denke ich, haben [die] noch wirklich stellenweise Flächen gerettet" (interview n°37).*

The declaration of Schlammwiss as protected area was a long time in the making. In 1993, the administration for waters and forests (today´s ANF) had commissioned a first dossier from a Luxembourgish consultancy that was revised in 2006. It was only possible to demarcate the area following larger land restructurings. Following the national elections and governmental change of 2013

[273] Règlement grand-ducal du 25 juillet 2018 déclarant zone protégée d'intérêt national sous forme de réserve naturelle la zone humide « Schlammwiss-Brill » sise sur le territoire des communes de Betzdorf, de Niederanven et de Schuttrange. Mémorial A N°763

(with the Green party taking over the Ministry of Sustainable Development and Infrastructure), the consultants had to update the dossier once again. Finalised in 2016, the dossier (ANF, 2016a) included extensive scientific information and data, based on studies that had been carried out in the area:

- a study by Stiftung Öko-Fonds on vegetation and fauna in the area to be restored (2001),
- a study by the Fondation HfN on plant and bird species (2003),
- studies by the University of Freiburg on the impact of the 2003 river restoration and extensive pasturing project on the area (see local context chapter above),
- a study and cartography by the intermunicipal syndicate SIAS on grassland in two of the municipalities concerned (2003-2005),
- cartography done in the framework of the elaboration of the national biotope cadastre (2007-2012).

In addition to information about the climate, hydrology and water quality, geology, and pedology of the area, the dossier also contained extensive documentation of plant and animal species. The dossier also lists existing infrastructures (including canalisation and electricity masts, field paths, etc.) and planned infrastructures (wastewater pipe between the international airport and the Uebersyren wastewater treatment plant). Interestingly, the dossier does not include the birdringing station, perhaps due to its makeshift character.

As the Natura 2000 management plan for the area, the dossier stresses the need to improve water quality (including through the extension of the Uebersyren wastewater treatment plant), to reduce nitrates and pollutants (e.g. from agriculture), and to carry out further river restorations along the Syr and its incoming streams:

> *"Wesentliches Ziel für das Naturschutzgebiet ist der Erhalt und die weitere Entwicklung einer naturnahen, extensiv genutzten Talaue mit ihren typischen Bestandteilen (Fließgewässer, Schilfflächen, Extensivwiesen und –weiden, Seggenriede, Feuchtgebüsche, offene Stillgewässer etc.) und ihrer charakteristischen Tier- und Pflanzenwelt, insbesondere ihrer besonderen Avifauna […] Fließgewässer: die Gewässer Syr, Aalbaach, Bourneschbaach. Für diese Gewässer ist das Ziel, ein naturnahes Gewässerbett sowie eine gute Wasserqualität zu entwickeln. Hierzu sind längerfristig und abschnittsweise Renaturierungsmaßnahmen sowie die Verringerung der direkten und indirekten Nähr- und Schadstoffeinträge notwendig. Entsprechende Ziele und Maßnahmen werden auch im Maßnahmenprogramm der Wasserrahmenrichtlinie bereits geplant. Die Erweiterung der Kläranlage wird hierzu ebenfalls wesentlich beitragen" (ANF, 2016a)*[274].

Moreover, it diagnoses an "unfavourable development tendency" in the restored area of Mensder Brill (ANF, 2016a):

- the Syr river has dug itself deeper into its bed, resulting in its narrowing and deepening,
- degradation of small standing water bodies (ponds) due to overgrowing by plants, algae growth, sinking water levels, mowing of shores bordering private gardens.

On this basis, the dossier recommends the creation of new open ponds. Finally, it recommends prohibitions of drainage systems, and restrictions on agricultural, recreational and economic uses of

[274] The ´exposé de motif´ lists the main species to be protected, including the "phragmite aquatique, le passereau le plus rare de l´Europe continentale […] D´autres espèces d´oiseaux rares roselière et des zones humides {…] telles que le Râle d´eau, la Rousserolle effarvatte, le Phragmite des joncs ou encore le Bruant des roseaux […] Gorgebleu à miroir, la Marouette ponctuée, la Bécassine des marais ou encore la Bécassine sourde. » In addition, it lists a butterfly species (« Grand Cuivre ») and a number of plant species. (Mémorial A, 2018b)

the area. The dossier was presented at the *Conseil Supérieur pour la Protection de la Nature* in February 2016. Its members include representatives of the Ministry of Sustainable Development, environmental organisations (incl. natur&ëmwelt and the Luxembourg Nature and Birds Protection League), the Natural History Museum, the Chamber of Agriculture, and the Ministry of Agriculture. According to interviews, meetings focus on reasons for why a given area should be protected and on future restrictions. Future land-use measures and management are not usually objects of these meetings (interview n°51).

The dossier was sent to the municipalities for approval and for ´public display´("Offenlegung") for a period of 30 days in late summer 2017. It was preceded by public meetings. Some of these meetings sparked heated debates that are also reflected in some of the statements submitted by citizens, farmers, and agricultural organisations during the public consultation. In addition, interviews also point to diverse tensions and synergies between environmental protection, agriculture, and the relations to and uses of nature reserves by local residents.

10.5.4.1 Challenges, divergent perspectives, and imaginaries relating to wetland reserves

Reed areas combined with diverse mosaic landscapes are the main characteristics of the Schlammwiss-Brill area (see figures 10.8, 10.9). The following outlines some of the difficulties associated with the management of wetland areas, as well as different conflicting imaginaries and narratives of different actor groups.

Figure 10.8 - View of a reed area at the Syr in Schlammwiss-Brill

One of the main species to be protected in the nature reserve is the aquatic warbler that depends on reed (German: ´Seggenrohrsänger´, French: ´phragmite aquatique´). For this reason, one environmental objective is to preserve the reed area. However, uncontrolled spreading of reeds needs to be prevented to preserve a *diverse* landscape characterised by a mosaic of habitats. If the area were left unmanaged, a floodplain forest would replace the reed area and semi-open landscape within decades. In terms of Natura 2000, this would constitute a deterioration of the area (which is forbidden), as the habitats would no longer be suitable to host the aquatic warbler and all the other species depending on reed and (semi-)open landscapes.

"Tiere sind angepasst. Das sind entweder Offenarten oder Waldarten. Wenn man das alles wachsen lassen würde, das wäre sicher schon ein Verlust an Artenvielfalt, das ist klar" (interview n°39)

In the reed area of Schlammwiss, the growing of bushes and trees has been prevented by choking them with metal bracelets while still small ("Ringeln"). The traditional way of controlling growth, however, is pasturing (see local context) and mowing. Indeed, among environmentalists there is no doubt that the biodiversity to be preserved has arisen with – and depends on - cultural landscapes extensively managed by farmers (Colling, 2005). In the historical context chapter (see 7.1), these landscapes have been associated with preindustrial times. However, in some places, they have lived on well into contemporary times. Their conservation requires intensive management:

"[das Management der Biotop-Flächen] ist sehr aufwändig, viel Arbeit. Wir kommen nie in ein Gleichgewicht. Kulturland ist immer verbunden mit Eingriff von Menschen […] Deswegen viel Personal, auch für Monitoring" (interview n°14)

Engrained in childhood memories of some, traditional landscapes have also given rise to a particular imaginary of landscapes rich in diverse habitats and species:

"[…] das sind die typischen Zielkonflikte im Naturschutz: Wenn wir all diese besonderen Biotoptypen, die unsere Landschaft heute prägen, wie zum Beispiel Orchideenwiesen, Trockenrasen, oder diese magere Flachlandmähwiesen, das sind ja alles Typen, die erst durch die Bewirtschaftung durch die Landwirte entstanden sind […] Man kann natürlich auch sagen, ich mache gar nichts mehr. […] Das Problem ist halt immer: was will man? Will man diese traditionell enstandenen Biotope erhalten? […] Also, es gibt Argumente dafür und dagegen, aber ich denke, was unsere Kulturlandschaft prägt, ***das hat halt jeder im Kopf****, dass es diese Vielfalt an Offenland und an Waldstandorten hat. Offenland also mit Wiesennutzung, mit Ackernutzung, mit Hecken, mit Bäumen, mit Obstwiesen. Das ist ja eigentlich das, was den Charme von unserer Landschaft ausmacht […] Weil ich in so einer Landschaft aufgewachsen bin, zum Beispiel. Oder vielleicht als Kind Erfahrungen gemacht habe oder auch später im Beruf sehe, wie schön so eine artenreiche Wiese sein kann, oder wie interessant Trockenrasenflächen sind. Und das alles zu verlieren, das wäre schon ein Verlust" (interview n°39, bolds added)*

In this sense, ecological restoration is not only tied to biodiversity objectives and scientific data, but also to particular social and cultural imaginaries closely associated with ´traditional´ agriculture. For this reason, farmers are offered subsidies via biodiversity contracts that provide for mowing; however, at later times of the year (e.g. not before mid-June or even August) than would otherwise be done by farmers. The problem with late mowing in the area, however, is that the grass mown by farmers may not be suitable as cattle forage due to its high share in reed, which is low in nutrients. Furthermore, in wet conditions, farmers may not be able to mow at all, with uncontrolled spreading of reeds and bushes as a consequence. As dates are contractually fixed, they cannot be adapted to the weather (only for following years). Therefore, some farmers who depend on the grass for their livestock may not conclude or prolong such contracts. Others may do so to have at least some income from the land and use the yield as mulch rather than fodder. Due to some of these issues, actors interviewed underlined there were "keine Patentrezepte" as regards the most adequate forms of management for protected habitats.

Statements submitted during the public consultation held in the run-up to the declaration of Schlammwiss-Brill as nature reserve cast light on the perspectives of some farmers. The prohibition of the maintenance of drainage systems (put into place by ancestors) is a key element:

"Dies bedeutet schlussendlich den vollständigen Wertverfall unserer Grünlandflächen, da hier seit Jahrzehnten Drainagen und Entwässerungsgräben von unseren Vorfahren erhalten wurden, um eine Futtergewinnung der Flächen zu ermöglichen […] Ich möchte noch einmal betonen, dass die Natur auf diesen Mähwiesen sich trotz dieser entwässernden Maßnahmen zu dem entwickelt hat, was heute als Schutzgebiet ausgewiesen werden soll. Wir fordern, dass unsere Flächen am Rande des beabsichtigen Schutzgebiets weiter wie bis zum heutigen Zeitpunkt bewirtschaftet und erhalten werden können, und nicht in ein Schilf-Sumpfgebiet degradiert werden" (statement of a local farmer included in the dossier of the law declaring the area a nature reserve, MDDI, 2017a)

The argument that the area had developed into a state considered worthy of protection *despite* existing drainage systems and other agricultural practices has been echoed in several interviews, conversations, and the NEXUS FUTURES workshop (NEXUS FUTURES, 2018, see also annex I). Furthermore, the farmers´ imaginary of landscapes as "Grünlandflächen" is equally widespread. Finally, some actors interviewed underlined that riparian fields were particularly fertile. They asked whether Luxembourg could "really afford" to "lose" productive land to environmental protection (interview n°43). On the other hand (and in contrast to more pronounced scepticism voiced in relation to the Mensder Brill river restoration and pasture project), some agricultural actors stressed they regarded some of the restored areas as "beautiful to look at" (interview n° 51).

Figure 10.9 - Mosaic landscape of the Mensder Brill

Another imaginary has been voiced by local actors. It offers yet another perspective on the landscapes of Schlammwiss-Brill. It puts to the its recreational value and potential contribution in reinvigorating local life:

"Also, wir sehen das ja auch als Naherholungsgebiet; vereinbar mit Naturschutz und Natura 2000, aber als Naherholungsgebiet. […] Also ich finde auf jeden Fall, dass man mehr Leute draußen sieht. Die Gemeinde lebt eigentlich in dem Sinne wieder mehr und es gibt auch Initiativen, wo die Leute sich zusammenfinden, zusammen Rad fahren und so weiter. Das gibt es alles wieder". (interview n° 53)

At the same time, the declaration of Schlammwiss-Brill as nature reserve did not receive wider public attention. Interviews suggest that few local residents are acquainted with the area and that their awareness of its importance for European birdlife is low despite the activities of the Fondation HfN and bird protection league in the area (that also organises guided walks for the public in the area):

> *"[Wir waren] uns auch lange nicht bewusst, wie wichtig dieses Gebiet ist […] auf europäischem Niveau sind da ja die Vogelstudien, die da gemacht werden. Und auch als Überwinterungsplatz und auf der Durchreise als Rastplatz ist das Gebiet ja unheimlich wichtig für die Vogelwelt. Und da war man sich als Einwohner des Syrtals lange nicht bewusst, dass das so ist […] Also ich denke, dass das Gebiet eigentlich von den Einwohnern hier nur wenig bekannt ist und wenig besucht wird. Schlammwiss ist wahrscheinlich ein Begriff, aber was das genau bedeutet, wie das da aussieht, was da gemacht wird, das, glaube ich, ist den meisten Leuten nicht so bewusst". (interview n°53)*

Nonetheless, there had been a few heated local debates ahead of the public consultation. They concerned fears of the Asian Tiger Mosquito that has begun to spread in Europe due to climate change and transmits diseases. One local inhabitant submitted a complaint on this subject, substantiating his/her arguments by reference to a German university study and public campaign[275]. The statement expressed concerns that the proximity of the highway, railways, and the international airport as well as migratory birds from Africa would favour the risk of the Asian Tiger Mosquito appearing as an invasive species and bringing diseases:

> *"Auch wenn die oben beschriebenen Szenarien heute noch nicht spürbar sind, so werden sie doch in der Zukunft mit Sicherheit auf uns zukommen. Daher macht es keinen Sinn heute noch Feuchtbiotope in Siedlungsnähe zu errichten, die morgen schon die Bevölkerung gefährden. Insbesondere möchte ich darauf hinweisen, dass das geplante Feuchtbiotop unmittelbar an die „Spillstuff" (Spielplatz für Kinder) angrenzen soll. Ebenso liegt der Campus „An der Dällt" (Kindergarten, Grundschule, Kindertagesstätte) nur 100m vom geplanten Naturschutzgebiet entfernt. Auch im Hinblick auf die nicht unerheblichen Investitionen in dieses Projekt sollte überlegt werden, ob das Geld nicht besser in Gebiete investiert wird, die einen größeren Abstand zur Wohnbebauung haben. So kann die zukünftige Mückenproblematik für die Bevölkerung reduziert werden und dem Naturschutz ist auch gedient" (statement of local resident included in MDDI, 2017a).*

The concern of mosquitoes and the risk of diseases associated with wetlands is a recurrent theme (see local context chapter above).

Other actors, however, suspected that those stirring fears and opposing the nature reserve had other motives, too: the loss of value of their property caused by Natura 2000 areas (in addition to airport corridors) where constructions were not be permitted:

> *"Das Problem ist ja auch, wir haben ja nicht nur die Schlammwiss, sondern wir haben ja auch Einflugschneisen. Also das Natura-2000-Gebiet, das dehnt sich ja ziemlich weit aus. Und da sind natürlich auch viele Leute, viele Landeigentümer, die sich da mal gedacht haben, irgendwann wird das Bauland. […] wenn man ja weiß, was das Land hier kostet, dass das für viele Leute dann*

[275] Universität Heidelberg: „Asiatische Tigermücke in Heidelberg. Intensive Bekämpfung im Jahresverlauf / Bevölkerung wird um Mithilfe gebeten":
www.heidelberg.de/hd,Lde/7071_34581_34997_35029_213755_520295_988159_1030572_1030224.html

nicht einfach zu verstehen ist, dass der Vogelschutz jetzt da Priorität hat und keine Häuser gebaut werden" (interview n°53).

Despite local concerns, the municipal councils of the three municipalities of the area gave their consent to the declaration of Schlammwiss-Brill as nature reserve. Local debates ebbed off. The law passed. As regards the birdringing station, the law makes motorised access to the station and its power supply more difficult, possibly requiring separate authorisations or a legal revision.

Finally, despite having become a national nature reserve, it remains uncertain if and how the area will attain the ecological objectives formally ascribed to it, or what other prospects the future might hold: Will Schlammwiss-Brill become a managed and diverse mosaic landscape with a controlled reed area hospitable to the aquatic warbler and many other species? Will farmers maintain "Grünlandflächen" to feed their cattle? Will a new pasture project be initiated? Will more river restorations be carried out, and the Syr be flattened again? Or will the area gradually turn into a ´wild´ floodplain forest, becoming a habitat for new biotic communities? Will the area become part of local recreational activities and narratives?

Formal outcome:

- Declaration of Schlammwiss-Brill as national nature reserve with formal restrictions on agriculture, private, and economic activities (Mémorial A, 2018b)

Informal effects:

- Expectations that the state of ecosystems in Schlammwiss-Brill will improve and more river restorations be carried out
- Local hopes that Schlammwiss-Brill will raise environmental awareness among residents and be used for recreation
- Local concerns about loss of property values
- Agricultural concerns about loss of productive lands

10.5.5 ASF b: AGE elaborates concept on aquatic habitat connectivity (2018)

Summary	Together with consultants, AGE prepared a concept in 2018 that serves to prioritise measures aiming to enhance aquatic habitat connectivity. While welcomed by some, other actors have doubts about additional technical requirements applicable to e.g. restoration projects.			
Tensions and synergies	Synergies as regards the need for effectiveness and prioritisation of measures Tensions: Specialised scientific/technical studies – implementation in practice			
Action situation	Documents	Interviews	Observations and meetings	Workshop content
ASF b: AGE elaborates concept on aquatic habitat connectivity	Consultancy study on habitat connectivity, public presentation of the concept (2018)	N° 27, 31, 37	Annual colloquium of river partnerships 2018 devoted to barriers in WFD implementation (see ASI 3)	-

In 2018, the Water Administration Authority (AGE), together with a German consultancy, elaborated a concept ("Strahlwirkungskonzept") to assess the potential effectiveness of management measures in improving the hydromorphology and connectivity of rivers. It was based on the structural quality surveying and mapping ("Strukturgütekartierung") that had been carried out in Luxembourg in the framework of national EU WFD implementation (see chapter 8.4). The concept on aquatic habitat connectivity has become an important assessment tool in granting authorisations and funding for measures such as river restorations. Considering the fact that no water body in Luxembourg had attained good hydromorphological structures by 2015, the concept serves planning and prioritisation purposes (AGE, 2018c).

The basic principle of the concept is that aquatic biotic communities of core river sections with good habitat conditions (e.g. spawning grounds) can "radiate" to and improve other river sections and that, therefore, the restoration of such core habitats should be a priority (Zumbroich, 2018)[276]. The consultancy study defines the target state to be reached for each water body, depending on its specific type, and by which measures it can be achieved.

> *"Die Identifizierung vorhandener bzw. die Planung zusätzlicher notwendiger Lebensräume gibt den hydromorphologischen Zielzustand vor. Durch eine Abschätzung der Wirkung hydromorphologischer Maßnahmen lässt sich prognostizieren, wie nahe man diesem Zielzustand mit dem aktuellen Maßnahmenprogramm LuxMaPro kommen kann. Der zusätzlich notwendige [Lebensraum] dient der vollständigen Realisierung des Strahlwirkungskonzeptes" (Zumbroich, 2018)*

Priority measures for the Syr include the creation of spawning grounds for fish in the Syr itself and in incoming streams (Zumbroich, 2018). In contrast to ´traditional´ approaches to ecological restoration, the concept on aquatic habitat connectivity takes its point of departure in the current riverbed:

> *"und das ist eigentlich egal, ob es da läuft, wo es war vor fünfzig, hundert Jahren… Hauptsache, das Biotop, also Gewässerbiotop, nicht stehendes Gewässer, kann wiederhergestellt werden". (interview n°31)*

The water administration had taken over the concept from German research groups to prioritise and tailor hydromorphological measures to the specific type of a water body ("*Nicht mehr 0815 zu jedem Gewässer*", interview n°31):

> *"Also, jedes Gewässer hat einen Typ und pro Gewässertyp haben die Analysen gemacht: „Wenn wir das machen, wie wirkt sich das auf die Biologie aus?" Und haben im Gewässer auch Proben genommen und das Ganze validiert und haben halt die Funktionselemente wie Kernlebensraum, Aufwertungslebensraum und auch die Durchgangsstrecken genormt, also mit Metern. Das muss so groß sein, damit das die Wirkung erreicht". (interview n°31)*

[276] The functional elements of rivers according to the concept include: core habitats, functional corridors between core habitats, and ´stepping stone habitats´ suitable to enhance the "radiation" of core habitats ("Kernlebensräume", "funktionale Verbindungsstrecken", "Trittsteine bzw. Aufwertungslebensräume") (Zumbroich, 2018)

By seeking to ensure "ecological effectiveness" the concept also serves to invest public funds "responsibly":

> *"Mit den Steuergeldern finde ich auch ein bisschen unverantwortlich, weil jeder zahlt, der Wasser trinkt, unsere ganzen Aktionen. Und ich sehe sehr viele arme Leute hier herum wohnen und ich finde es überhaupt nicht verantwortungsvoll, wie wir momentan mit den Subventionierungen [umgehen]…Das müsste viel zielgerichteter sein". (interview n°31)*

> *"Ja, ein gutes Beispiel, wenn ein Projekt für Subventionen angefragt wird, dann wird eigentlich weniger hinterfragt, was sind wirklich die Zielsetzungen davon, erhalten wir davon effektiv einen besseren Zustand?". (interview n°31)*

At the same time, even consultancies and engineers seem not yet to have become sufficiently acquainted with concepts such as the one on aquatic habitat connectivity and other WFD requirements that have continued to grow:

> *"Man merkt immer mehr, die Anforderungen die werden eigentlich größer, auch mit diesem Strahlwirkungskonzept und den Anforderungen, die die EU auch erwartet, um wirklich den guten Zustand oder das Potenzial zu erreichen. Und man hat den Eindruck, dass die Planungsbüros sich eher schwertun, sich auch mit diesem Thema auseinanderzusetzen […] die kennen sich nicht mit der Thematik genug aus, um eigentlich diese Planung durchführen zu können" (interview n°31)*

Although there had been changes in engineering education, many engineers have continued to treat water management similar to the planning of roads (interview n°31).

Some actors regard the idea underlying the concept of aquatic habitat connectivity as, in principle, useful:

> *"Doch, es ist schon sehr gut und es ist vor allen Dingen eine Fokussierung. […] wir haben also ein großes Gewässernetz oder einen langen Gewässerabschnitt und es ist unrealistisch, auf dem gesamten, von der Quelle bis zur Mündung etwas zu machen. […] Das ist von der Idee her sehr gut". (interview n°37)*

On the other hand, actors interviewed have also pointed out that the concept made the planning of measures and river restorations more "theoretical", and perceived it as contrary to their own more ´intuitive´ approaches:

> *"[…] Und jetzt mit diesem Strahlwirkungskonzept, da muss man sich bewusst sein, dass wird noch mehr Planung. Denn es ist nicht so, dass wir diese Kriterien, die jetzt mit diesem Strahlwirkungskonzept heranwachsen, dass wir die früher nicht angewendet hatten. […] Wir haben immer versucht, so viel wie möglich von dem aktuellen Bett in die Renaturierung zu übernehmen. Aber jetzt ist das alles ein bisschen mehr formalisiert, da werden dann ganz präzise Studien gemacht nach bestimmten Regeln. […] Wir haben vorher viel aus dem Gefühl heraus das gemacht. Und ich gehöre zu den Menschen, die auch der Meinung sind, dass das die richtige Vorgehensweise ist. Aber wir leben nun einmal in einer Zeit, wo alles dokumentiert werden muss. Alles muss im Computer sein". (interview n°27)*

Actors also expressed concerns that the concept of aquatic habitat connectivity might erect additional barriers to the implementation of projects by being too focussed and neglecting issues of feasibility:

> *"Die Gefahr vielleicht, ganz kurz noch, bei solchen Konzepten ist natürlich, wenn man von vornerein zu detailliert rangeht und sich wirklich zu stark fokussiert auf Punkte oder Abschnitte, die wirklich dann laut Konzept die wichtigen sind, dann besteht natürlich die Gefahr, dass man dann zu perfektionistisch schon von vornerein rangeht. Man muss ja auch immer gucken, was ist machbar. Es gibt ja noch andere als jetzt hydromorphologische Fakten. […] Und wenn man sich zu stark auf diese Sachen konzentriert, dann muss ja die Machbarkeit nicht unbedingt gesteigert werden dadurch. Will sagen, man darf auch die Gebiete, die vielleicht nicht ganz perfekt in dieses Raster dann reinfallen, die sollte man nicht vergessen. […] Das hat nichts mit blindem Aktionismus meiner Meinung nach nichts zu tun, sondern einfach auch ein bisschen mit Realismus". (interview n°37, participant I)*

> *"Es geht immer um Kompromisse bei so etwas. Man muss immer Kompromisse finden. Es gibt nie richtig oder falsch". (interview n°37, participant II)*

Formal outcome:

- Concept on aquatic habitat connectivity to improve the hydromorphology of rivers by measures tailored to habitat types

10.6 Informal governance processes

In parallel to some of the formal governance processes discussed above, local actors and the Syr River Partnership undertook efforts to carry out projects and to address barriers in WFD implementation. They are analysed in the following:

- Implementation of further river restorations in the municipality of Betzdorf (ASI A)
- Colloquium of river partnerships of Luxembourg devoted to barriers in WFD implementation (2018) (ASI 3)
- Colloquium of river partnerships devoted to nature-based solutions to flood prevention (2019) (ASI 4)
- River partnership and municipalities address Syr pollution caused by airport wastewater (ASI 5)

10.6.1 ASI A: Municipal river restorations meet administrative requirements

Summary	The municipality of Betzdorf had commissioned a consultancy study to carry out river restorations. The study needed to be updated in 2018 to take into account the concept on aquatic habitat connectivity. A small river restoration has been carried out. However, the administrations for water and nature have adopted divergent approaches to restorations. In general, local actors perceive authorisation procedures for projects as increasingly cumbersome.			
Synergies and tensions	<u>Tensions</u> • interpretations of Natura 2000 - EU WFD requirements to river restorations. • Diverse administrative requirements – implementation of projects			
Action situation	Documents	Interviews	Observations and meetings	Workshop content
ASI 1: Municipal river restorations meet administrative requirements	Formal: Concept on aquatic habitat connectivity, consultancy study	N° 9, 27, 31, 52	Site visit in Olingen in 2019, guided walk in 2020, participation in public meeting on planned river restorations	-

The village of Olingen is part of the municipality of Betzdorf and situated downstream from Schlammwiss-Brill. Due to recurrent floods, there have been plans to carry out a river restoration since before 2011 when the nowadays´ President of the river partnership became mayor. One of his commitments was to restore a historical site in the village that was flood-prone due to its proximity to the Syr and because sand had accumulated in front of a bridge. For this reason, the restoration of the building needed to be preceded by a small river restoration. The municipality commissioned a study from the engineering consultancy Bunusevac for the specific river section.

To be able to obtain authorisation and funding, AGE required the municipality to extend the study to cover the entire course of the Syr within the municipality (i.e. from entry to exit). The mayor argued that if the study were to be extended, it should also include the downstream municipality of Biwer potentially affected by measures implemented upstream. However, this was not required, which he has interpreted as contrary to the the idea of river partnerships at basin-scale:

> *“Nein, partnerschaftlich nicht, denn, wie gesagt, zum Beispiel: die AGE, die schreibt uns vor, eine Studie über den Flusslauf Syr mit Nebenflüssen ab Grenzeintritt und Grenzaustritt aus der Gemeinde zu machen. Da kommt keine Partnerschaft auf. Wenn die jetzt wirklich im Sinne der Flusspartnerschaft handeln würden, dann würden sie sagen: „Okay, kommt wir gucken die Abschnitte, die auch grenzüberschreitend sind“. (interview n°9)*

The Syr River Partnership itself seen itself as unable to rally the municipalities around the common hydrological unit: “*die Flusspartnerschaft wird allerdings für diesen Zweck nicht ernst genug genommen*“ *(interview n°9).*

Once the extended study was finalised, the municipality was required to further extend the study to 50-year flood events. The mayor argued that the main problems concerned 10-years floods and was impatient to start the works.

He thus preferred to carry out the project as originally planned and, if need be, to make changes to it following implementation:

> *"Und wir hatten immer Probleme mit 10jährigem Hochwasser, denn da ist halb Olingen abgesoffen. Wir sagten: „dann können wir das mal durchziehen, und dann weitersehen"". (interview n°9)*

> *"Wie, zum Beispiel, wenn man jetzt einen Abschnitt renaturieren möchte…wir haben ja bereits […] eine Renaturierung [Mensder Brill], und wollen dann etwas flussabwärts noch eine Renaturierung machen, dann wird das wieder davon abhängig gemacht, dass wir das ganze wiederum überprüfen. Anstatt zu sagen: „okay, macht mal Leute und dann nachher sehen wir, ob das Ganze kohärent ist und wenn dann noch Nachbesserungen gemacht werden müssen, dann nehmen wir die halt vor und fertig"". (interview n°9)*

In the end, the municipality consented to a further addition to the study (which also entailed higher costs covered, however, by the water fund) and further delays. The feasibility study of the consultants (who have a longstanding cooperation with ANF) covers five consecutive sections of the Syr from Mensder Brill to Betzdorf (Bunusevac, 2008). Pursuing a ´traditional´ approach to ecological restoration (see chapter 4.4.1), the study is partly based on the historical Syr riverbed deduced from the historical 18th century Ferraris maps (see chapter 7.1.2) and from cadastres of the beginning of the 19th century. It also considers flood events, contains a hydrological model and current riverbed profile (incl. its lowest point, or *thalweg*). On the basis of these various sources of data, the study makes proposals on how the riverbed could be moved, lifted, and widened to restore wetlands. Finally, the study includes maps of publicly owned land (state, municipality, church) along the projected course of the Syr (Bunusevac, 2018).

The feasibility studies was thus close to the ANF approach that, in line with the EU Habitats Directive (EEC, 1992), has tended to seek to restore rivers to as ´natural´ a state as possible (see also local context chapter above). The study was finalised in 2016, just ahead of the municipal elections of Autumn 2017, when a new mayor was elected into office. The new mayor was also eager to proceed on the restoration of the historical site. He introduced some changes to the project (with which he was acquainted as he had been alderman in the municipal council under the former mayor) and prepared the river restoration of the river section (of some hundred meters) at the bridge of Olingen, executed in 2018 (Gemeinde Betzdorf, 2018).

The new concept on aquatic habitat connectivity of the Water Management Authority of 2018, however, has slowed down plans for further river restorations. The municipality – and, hence, the engineering consultancy – was asked to take into account the new concept in its feasibility study of river restorations and identify "core habitats". Moreover, it was asked to consider the new Natura 2000 management plan for the Syr valley 2016-2026, which had been finalised in the meantime (see ASF1).

AGE argues that it has requested municipalities to revise ongoing feasibility studies to include the new concept to ensure the effectiveness of planned measures. Furthermore, the administration questioned the plans of the consultants to lift the riverbed:

> *"Am Beispiel Syr, warum fragen wir das bei der Syr? Weil eben das Büro mit einer Variante […] kommt, wo wir die Sohle heben und das Gewässer eigentlich in die Fläche fließen lassen, wobei sich dann dieses Feuchtgebiet entwickeln kann. Mittlerweile stellen wir das halt infrage und versuchen uns die Frage zu stellen oder zu beweisen: Ist das für diesen Gewässertyp eigentlich verlangt von dem Gewässer? Bringt das etwas?" (interview n°31)*

One possible drawback mentioned was that if a river was allowed to spread out too much it would risk to run dry during the summer. In that case, fish and other species would lose their habitat and it would become impossible to reach the ´good ecological status´.

At the end of 2018, the feasibility study was discussed at an open meeting, in which the consultants, representatives of the municipality of Betzdorf, of AGE, ANF, and a representative of the Syr River Partnership and the author of this study participated. Living in the municipality, the river partnership representative had coincidentally heard about the meeting and joined at own initiative. It was agreed that AGE and ANF should agree on a common approach before the feasibility study was further adapted. Afterwards, landowners, and land tenants were to be identified and contacted in the possible priority sections. Another meeting took place in January 2019. No further developments are known to the author of this study (status: October 2020).

At the same time, some interview partners regard the two different approaches as not necessarily incompatible, but as a matter of how criteria are *interpreted*:

> *"In Wirklichkeit gibt es keine Widersprüche. Sie machen nur Interpretationen ihrer Kriterien, die ein bisschen schwierig sind […] Damit sie einsehen, dass sowohl die europäische Wasserdirektive wie auch die Habitat-Direktive zusammengehen und dass diese Kriterien nicht gegensätzlich sind. Ich höre [aber], dass es in anderen Ländern auch Probleme gibt". (interview n°27)*

Overall, the impression gained by the author was that municipal officials hardly feel in a position to drive forward restoration projects that involve lengthy discussions to convince landowners of the ´re-wetting´ - or selling of swapping - of their land. While many municipal officials were supportive of restoration projects, in principle (and themselves engaged in buying land in protected areas for that purpose), they also argued that it was up to the administrations to agree and take the lead on such projects. Indeed, most actors interviewed underlined the importance of administrations pursuing a common strategy and setting priorities, considering public scepticism and possible opposition.

> *"Wir haben jetzt sehr viele Daten, auch wegen WRRL, auch Natura 2000-Management. Was notwendig ist, starkes Zusammenarbeiten in verschiedenen Gebieten. Ein geeintes Auftreten ist sehr wichtig. Umso geeinter man auftritt und sagt, für dieses Gebiet ist das Priorität, umso besser ist es". (interview n°13)*

In the meantime, the municipality had commissioned another study that was to reinvigorate life in the village. The site encompasses a historical building (the Café de l´Amérique, see historical chapter 7.1.1 and figure 10.10). Plans are to re-convert it into a restaurant and bed-and-breakfast, possibly also including a few affordable apartments. In addition, plans include the building of a playground dedicated to the topic of mills and water, a public barbecue place, and the restoration of approximately 140 meters of an incoming stream to the Syr.

Figure 10.10 – The building of the former Café de l´Amérique of 1900, with a fenced incoming Syr stream to the right

However, in the experience of municipal actors, it can last up to 12 months to receive authorisations for projects such as these from the different administrations involved (including the administrations for water, nature, but also heritage protection). Frequently, there were different – or even conflicting - demands for revisions of projects, which further complicated coordination and delayed planning:

> *"Da kommt man als junger Mensch […] man ist voller Tatendrang und man will vorankommen und dann die Amtsmühle. […] Und dann muss da jede Verwaltung auch mitsprechen. Meine Lieblingsverwaltung: die Denkmalschutzverwaltung. Da müssen wir noch Ausgrabungen machen, damit wir keine Knöpfe von der Französischen Revolution finden. Dann denke ich mir manchmal, was ist jetzt dem Land wichtiger, dass wir jetzt da ein paar Knöpfe finden und diese konservieren, oder bauen wir jetzt Wohnungen für junge Leute?! Und das ist natürlich so wie in der Schule, jeder Professor sagt: „Mein Fach ist das wichtigste." Und so ist das auch dann leider in der Verwaltung. Jeder sieht nur sein Gebiet […] die Diktatur der Ministerien. Dann hat man ein Projekt, das man weitertreiben will, und dann wird das wieder durch ein anderes Ministerium untergraben. Man hat schon den Gegenwind […] im Gemeinderat, und wenn man dann noch viele Hürden von den Ministerien bekommt…" (interview n°52)*

Overall, empirical research thus suggests that procedures for the planning of projects are characterised by rigid and sometimes conflicting sector-specific requirements that do not only slow down implementation, but also discourage some local actors from embarking on projects in the first place. Coordination between different administrations continues to be a challenge.

Informal outcomes:

- Draft feasibility study on further river restorations in the municipality of Betzdorf (in process)

Material outcomes:

- Small restoration at the bridge of Olingen

10.6.2 ASI 3: River partnerships address barriers in EU WFD implementation

Summary	On the occasion of their annual colloquium on World Water Day and the EU WFD midterm review, the river partnerships of Luxembourg addressed barriers in EU WFD implementation, focusing on divergent administrative requirements and coordination, and land availability.			
Synergies and tensions	Tensions in dialogues between river partnerships and public officials			
Action situation	Documents	Interviews	Observations and meetings	Workshop content
ASF 3: River partnerships address barriers in EU WFD implementation	Minutes and presentations of the colloquium	-	Observations during the colloquium on 22.3.2018	-

In March 2018, the Upper Sûre River Contract organised the annual colloquium that the river partnerships of Luxembourg hold on a rotating basis on the occasion of World Water Day. The colloquium gathered representatives of the five river partnerships of Luxembourg (including the Syr River Partnership), municipalities, water syndicates and nature parks, farm advisors, farmers, other local actors, and representatives of the administrations for water (AGE), nature (ANF), and agriculture (ASTA, including their regional branches), and the Secretary-of-State of the Ministry of Sustainable Development and Infrastructure. Representatives of the Water Management Authority (AGE) presented the state of WFD implementation and the new concept on aquatic habitat connectivity (see ASF b). A representative of the environment department of the Ministry of Sustainable Development and Infrastructure informed participants about management plans for Natura 2000 areas and the plan to set up multi-actor steering committees to enhance coordination.

The event was structured along five topics that the river partnerships had identified in advance based on their own experiences and an informal survey conducted among invitees: awareness-raising, implementation of small measures, strategies versus implementation, distribution of tasks and competences, and land availability. The event suggests that WFD implementation faces similar barriers across the country. At the same time, the atmosphere of the event was also influenced by tensions between Upper Sûre and national actors (see Upper Sûre case study).

The implementation of small measures sparked most controversy. AGE presentations had shown that by March 2018 (AGE, 2018a):

- of 913 planned hydromorphological measures, 15 had so far been completed, and 116 were in process of being implemented,
- of 681 planned hydromorphological measures concerning river restorations and the creation, of spawning grounds, seven had been finalised, and 59 were in process.

Public representatives argued that it was important to clarify objectives of measures and set priorities to prevent that measures would be carried out in a short-sighted and hasty manner (“Aktionismus”). River partnerships, on their part, argued that small measures faced disproportionally high administrative hurdles that necessitated significant coordination efforts, time, and money. Several participants pointed out that disagreements between ministries and administrations contributed to hindering implementation. Administrative hurdles and a lack of coordination risked reducing the motivation of landowners, farmers, and other actors to support and participate in projects. Countering

reproaches that some of them were not active enough, some participants of the river partnerships remarked they disposed of too few capacities for implementation, which were further stretched due to the administrative burden. Governmental actors encouraged them to apply for additional funds for planning and coordination.

All participants regarded the future steering committees for Natura 2000 areas and for the drinking water protection zones as an opportunity to improve coordination.

Concerning land availability state representatives advised municipalities and nature parks to purchase land for environmental measures or swap land for other lots to create more space for projects. These lots could become part of possible regional land lot pools for compensatory measures (see ASF2).

Interviews conducted among both local and national actors suggest that the event did not contribute to improving dialogues, interpersonal and inter-organisational relations. Tensions in the Upper Sûre region were certainly an important factor in this regard. At the same time, the author of the present thesis also had an acute sense that public representatives passed on pressure to local actors. An opportunity seems to have been missed.

Informal effects:

- discussions of barriers to the implementation of small measures in the framework of the national WFD management plan
- pressure on the river partnerships to implement more measures

10.6.3 ASI 4: River partnerships address nature-based flood protection

Summary	The 2019 annual colloquium of the river partnerships was dedicated to nature-based protection against flooding caused by torrential rainfalls. It took place in the framework of preparations for the next national flood risk management plan. Organised by the Syr River Partnership and partly moderated by the author of the present thesis, the event suggests that many actors continue to prefer technical ´solutions´.			
Synergies and tensions	Tensions between EU WFD nature-based flood protection objectives and informal preferences for technical solutions			
Action situation	Documents	Interviews	Observations and meetings	Workshop content
ASF 4: River partnerships address nature-based flood protection	Presentations of the colloquium	-	Observations and participation in the colloquium on 22.3.2019, participation in event debrief of river partnerships	-

The 2019 annual colloquium of the six river partnerships[277] was dedicated to the issue of prevention of floods caused by torrential rainfalls ("Starkregen – dezentrale ökologische Überflutungsvorsorge"). It was organised by the Syr River Partnership. The topic had been chosen upon suggestions from the AGE that was working on flood risk maps for the country and the second flood risk management plan (2020-2025). For the first time, the national flood risk plan will encompass protection against flood risks caused by extreme weather events. The reason is that the national climate change strategy and action plan 2018-2023 expects precipitation patterns in Luxembourg to change, resulting in longer drought periods and more intense rainfalls (MDDI, 2018a)[278].

The river partnership had taken on the subject, because it expected the event to provide additional arguments for nature-based approaches to flood protection such as river restorations. The expressed objective of the event was to promote a coordinated approach to - and exchange among stakeholders about - measures in "green zones" (i.e. explicitly not in urban areas).

Figure 10.11 - Topic of the final discussion at the colloquium

More than 60 actors participated, most of them national or municipal officials. AGE was not represented, but had sent a poster on its new programme on floodplain forests. The event was opened by the Minister of the Environment who underlined the importance of water and partnership. Having to leave after the first presentations, she had arrived early to have informal chats with some of the river partnership representatives and other ´early birds´.

In addition to a presentation by the Syr River Partnership, there were two presentations from, respectively, ASTA (their meteorological and pedological services) and AGE. The presentations stressed the unpredictability, violence, and risks of heavy damages caused by torrential rainfalls and possible resulting landslides (affecting buildings, infrastructures, water bodies). Unlike river floods, short and intensive rainfalls are very local events that predominantly hit smaller water bodies, hill slopes, urban areas, and buildings that are not necessarily located close to rivers or lakes. They result in floods when rainfalls exceed the infiltration capacity of the soil and the capacities of canalisation. In the best case, torrential rainfalls can be predicted 40 minutes in advance (compared to 24 hours in case of river

[277] In the beginning of 2019, the river partnership of the Chiers was founded in South-Western Luxembourg.
[278] Strategie und Aktionsplan für die Anpassung an den Klimawandel in Luxemburg 2018-2023

flooding) and can produce floods within minutes, which is why there are no early-warning systems (AGE, 2019).

The measures to be developed will be based on quantitative risk assessments (combining intensities, probabilities with vulnerabilities of particular sites based on their positioning and other characteristics), based on hydrodynamic modelling and simulation. The results will be integrated into maps highlighting particularly exposed areas. They would be discussed with municipal representatives (AGE, 2019). In addition, a number of possible nature-based measures were presented, based on the national WFD management plan:

- land-use practices (e.g. in agriculture) that increase the infiltration capacity of the soil and counteract erosion,
- restoration of rivers and wetlands,
- the creation of riparian boundary strips along rivers.

Following the presentations, the concluding session of the colloquium was moderated by the author of this thesis. She had been invited by the river partnerships who preferred a "neutral" moderator (following 2018 experiences, see ASI 3). The guiding question was: "*How can flood prevention be coordinated and implemented effectively in practice*?" (see figure 10.11). The objective was to stimulate debate on possible decentralised measures in green areas (including changes in land-use practices in agriculture and forestry), and how they could be coordinated and implemented, including by using a concrete example on different measures affecting water retention capacities of the soil.

However, despite efforts of the moderator and river partnerships, participants concentrated almost entirely on technical flood protection measures in *urban* areas. From the municipal side, there were a number of remarks that suggested technical ´solutions´ were the preferred option. Nature-based solutions entailing discussions with landowners about land-use practices (for example, uphill above villages) were hardly considered. Many remarks, including from AGE, suggested that extreme rainfalls were bound to cause damage due to their sheer violence and suddenness, regardless of any measures previously taken in green areas. A participant from the Ministry of the Environment explained that there was little progress on a planned new law on soil. There were only few contributions from agricultural actors.

Moreover, efforts to steer the debate towards the possible role of the river partnerships (some of which are also flood partnerships, as the Syr River Partnership) in nature-based flood protection largely failed. It seemed as if participants were at a loss regarding possible tasks of the river partnerships. The river partnerships themselves made few proposals.

At a joint debriefing, the river partnerships agreed that, overall, the event had been interesting, but had brought few new impulses for their daily work. In their view, concrete guidance and feedback on their work from administrations, municipalities, and agricultural actors had been missing from most of their World Water Day colloquia. Self-reflectively, they also agreed to participate more actively and concertedly in the future. They discussed a possible change in format for future events (e.g. including fewer presentations and more direct questions to participants).

Overall, the World Water Day colloquia of the river partnerships have so far hardly enhanced social learning and the creation of social networks. While most participants know each other well, there have been few dialogues to foster critical self-reflection and reframing about established approaches in water management.

Informal outcomes and effects:

- more knowledge and awareness of increasing risks of extreme weather events caused by climate change
- (few impulses for river restorations and other nature-based approaches to flood protection)

10.6.4 ASI 5: River partnership addresses Syr pollution

Summary	In 2017, the Syr River Partnership and member municipalities decided to address the issue of airport wastewater as major source of pollution. The analysis suggests that the polluter-pays principle and environmental impact assessments are not consistently applied in practice when it comes to activities of "overriding public interest", and that it can be difficult to obtain access to environmental information.			
Main synergies and tensions	Tensions: Legal obligations to restore "good ecological status" of the Syr, to carry out environmental impact assessments and apply polluter-pays principle versus economic and national "overriding public interests"			
Action situation	Documents	Interviews	Site visits, observations and meetings	Workshop content
ASI 5: River partnership addresses Syr pollution	Formal: EU Habitats Directive, legal exchanges Informal: Action plan 2014-2017, minutes of river committee meetings 2017-2018, letters	N° 31, 41	Site visits: Mensder Brill, Schlammwiss, Birelergronn FP river committee meetings 2017-2018	

In 2017, the river committee and municipal members decided to increase pressures as regards airport wastewater by formally addressing a letter to the Ministry of Sustainable Development and Infrastructure. Measures to improve the ecological state of the Syr river could not bear fruit unless the problem was resolved:

> *"Viele der anvisierten Maßnahmen entlang der Gewässer können sich nicht positiv auf die Qualität der Syr auswirken, solange das Problem Findel nicht behoben ist" (FP Syr, 2017a)*

The letter demanded that costs for wastewater treatment be included in any further expansions of the airport from the beginning, and that the airport should pay a share of wastewater treatment in Uebersyren (FP Syr, 2017a). The letter, sent to the minister in charge of infrastructure, was signed by six local mayors, but received no answer. Efforts continued behind the scenes. Interviews suggest that they were motivated by a sense of justice (regarding the issue as one "of principle") and, moreover, rooted in the narrative identities of actors:

> *"Ich bin ja nicht auf die Welt gekommen, um mich beliebt zu machen bei jedem […] Es gibt Leute, die bei Druck nachgeben, ich nicht" (interview n°41)*

After the re-election of the liberal-socialist-green government in 2018, the coordinator and president of the river partnership sent another letter, this time to the re-elected Minister of the Environment. The letter stressed that three Natura 2000 areas in the Syr valley were severely affected, demanding an intermediary solution. Furthermore, it referred to the polluter-pays principle and the law on the prevention and reparation of environmental damage, stating that the enthusiasm of numerous volunteers risked to be exhausted if the problem was not addressed (FP Syr, 2018b; Mémorial A, 2009[279]):

> *"Il est dès lors évident qu´en vertu du principe pollueur-payeur, l´aéroport de Luxembourg devra immédiatement remédier à la situation qui lui est imputable. Sachant que, du fait que le partenariat de cours d´eau Syre ne tombe pas sous la catégorie des personnes auxquelles l´article de la loi modifiée du 20 avril 2009 relative à la responsabilité environnementale en ce qui concerne la prévention et la réparation des dommages environnementaux confère le droit d´exiger qu´une action en ce sens soit prise, nous vous demandons néanmoins, Madame la Ministre, de faire tout ce qui est nécessaire pour remédier vite à cette dégradation grave et permanente de notre environnement. Vous comprendrez sans doute que, sans une amélioration rapide de la situation, l´enthousiasme des nombreux volontaires qui s´engagent depuis des années au sein du partenariat s´amenuisera comme la fameuse peau du chagrin" (FP Syr, 2018b).*

The letter also remained unanswered. Some suspected that this was partly due to the weak legal status of the river partnership that does not itself have the legal right to have access to environmental information, lacking legal personality. The president of the river partnership (an environmental lawyer) decided to pursue the matter further in his private capacity, formally demanding access to information about the extent of the Syr pollution. He also asked if an environmental impact study had been carried out before further airlines had taken up operations at the airport to determine what quantities of effluents the Syr could absorb without negative effects on water quality and natural habitats (Arendt, 2019a).

The letter was answered, including annexes with chemical effluent data for the period 2014-2018 that were difficult to interpret for non-experts. The letter stated that AGE was confident that the extension of the Uebersyren plant (which will include a fourth treatment step to filter out micropollutants) would enable the Syr to reach a good ecological state (MECDD, 2019b). Not having received information concerning environmental impact assessment, first legal steps were undertaken. An additional letter from the ministry clarified that no environmental impact study had been conducted (MECDD, 2019c). It referred to the EU Habitats Directive (article 6.3) that allows for projects whose impact has been assessed negatively to be carried out "for imperative reasons of overriding public interest, including those of a social or economic nature" and if the EU member state takes compensatory measures (EEC, 1992, see also 10.5.2). Legal actions have continued.

The issue had been discussed further at a meeting of the Syr river committee, where examples were cited from other Luxembourgish rivers (the Chiers) that suggested that large quantities of effluents prevented them from being able to reach the EU WFD "good ecological status" (FP Syr, 2018a).

Reflecting a similar perspective, other interview partners also argued that the polluter-pays principle was hardly applied in Luxembourg at all, or if it were then mainly to ´smaller´ actors. In practice, economic and other interests dominated over environmental objectives, both locally and nationally.

[279] Texte coordonné de la loi du 20 avril 2009 relative à la responsabilité environnementale en ce qui concerne la prévention et la réparation des dommages environnementaux. Mémorial A, n°158 du 13 aout 2014.

Interviewer: "dieses Verschmutzer-zahlt-Prinzip, spielt das in irgendeiner Form eine Rolle? "

Participant 3: "Nicht genug. Steht im Gesetz, aber wird nicht angewandt. […]

Participant 2: "Es ist schwer sich durchzusetzen gegen Ökonomie, Wirtschaftswachstum, Rentensicherung" (interview n°31)

On the other hand: *„Also, das Verursacherprinzip wird auf der kleinen Ebene, auf der unteren Ebene, ganz sicher angewandt […] Zum Beispiel, auch Landwirtschaft im Allgemeinen: Wenn ein Bauer, den Fall hatten wir, da läuft die Biogasanlage über, in einen kleinen Wasserlauf. Der kriegt eine Strafe aufgebrummt […] Jeder Bauer muss, wenn er irgendwas machen möchte, eine Studie vorlegen, er muss kompensieren eventuell, einen Antrag stellen. Aber der Flughafen braucht das nicht. Wieso?!" (interview n°41)*

Many actors interviewed perceived the discrepancy between obligations and expectations as regards objectives of water governance, and what happened and seemed feasible in practice, as a source of frustration. Many felt that under current conditions of demographic and economic growth it would be impossible to reach EU WFD objectives, despite ambitious management plans (see also ASF c, d below).

Formal outcome:

- Legal actions undertaken in private capacity

10.7 Interplays between formal and informal governance processes

10.7.1 ASF A: Law paves way for WWTP extension

Summary	In September 2018, a new law entered into force that provides for government funding for the extension and modernisation of the Uebersyren wastewater treatment plant and its connection with the airport. The extension will include new ponds to enhance biodiversity and birdlife in the Syr valley, which may be interpreted as entailing a new approach to – and imaginary of - ecological restoration.			
Action situation	Documents	Interviews	Observations and meetings	Workshop content
ASF A: Law paves way for WWTP extension	Law on the financing of the extension of the Uebersyren WWTP and its connection with the airport	N° 11, 21, 24, 27, 29, 39, 53		-

In Autumn 2018, a new law authorised the government to contribute with roughly 130 mio Euro to the extension and modernisation of the Uebersyren wastewater treatment plant, new pipes from the airport to the plant, and the construction of a retention basin for rainwater on airport territory

(Mémorial A, 2018c)[280]. Engineers had begun to work on extension plans in 2005. However, since then the problem had allegedly passed forth- and-back between the airport society, several ministries and administrations (including the Air Navigation Administration), the wastewater syndicate and plant operator SIDEST, and its member municipalities that demanded more public funding for the extension.

The airport has been in contact with SIDEST to find solutions. It had been considered to construct an on-site wastewater treatment plant at the airport itself. However, the option was not deemed feasible for reasons of space availability and technical competences required (interviews n°11, 21, 53). The 130 mio euros from the government will roughly cover approximately 75 % of the total costs (while the construction of wastewater treatment plants earlier had been subsidised by the state with up to 90 %, interview n° 24).

A first call for tender for the first phase of the construction is set to be launched in Autumn 2019. If works progress as planned, the new treatment plant will be operational by 2028, i.e. 26 years after the problem was first diagnosed. The plant will include a 4th treatment cycle (ozonation and membrane processes) to filter out some of the micropollutants. Some actors expect that the planned new capacity of 122 000 inhabitant-equivalents will be too small considering ongoing demographic and economic growth (interviews n°24, 53). Whether treated or untreated, growing quantities of effluents are expected to flow into the Syr and through the Natura 2000 and national reserve areas.

In addition to the wastewater treatment plant itself, two new ponds are planned in Schlammwiss by natur&ëmwelt Fondation HfN to which effluents will run with a view to creating a new habitat for insects and birds. Different actors interviewed hold that, indeed, the wastewater treatment plant and its effluents and the fauna of Schlammwiss can be complementary (see figure 10.12).

> *"Ich glaube, dass beide – Kläranlage und Naturschutzgebiet – sehr gut zusammenpassen und sogar eine ergänzende Verbesserung auf die Fauna und Flora in diesem Tal der Syr haben". (personal communication n°1)*

> *"Und das ist sogar für die positiv, für diese Vögel und so. Das Wasser ist an sich nicht sehr kalt, die sehen das positiv für die ganzen Vogelarten, die da nisten und auch sich niederlassen im Sommer und vielleicht auch im Winter. Das ist sogar positiv". (interview n° 53)*

[280] Loi du 14 septembre 2018 autorisant le Gouvernement à participer : 1° au financement des travaux nécessaires à l'extension et à la modernisation de la station d'épuration biologique intercommunale du bassin hydrographique de la Syre supérieure à Uebersyren ; [...] 3° au financement des infrastructures de raccordement et de traitement des eaux usées de la zone aéroportuaire à la station d'épuration biologique d'Uebersyren. Mémorial A N°835

Figure 10.12 – Existing effluent pond at the Uebersyren wastewater treatment plant

These views underscore the view voiced by some actors that, in general, urban and ´natural´ areas would increasingly melt into one another (interviews n°27, 29, 39). For example, increasingly, ecological criteria are implemented in the planning of transport infrastructures such as highways and roads, roundabouts, etc. and other urban projects (MDDI, 2013).

> *"Ja, wenn man alle Grünflächen und wie die Deutschen sagen, Freiflächen im urbanen Raum und entlang der Verkehrswege, Eisenbahnen und Straßen, wenn man das alles zusammenzählen würde diese Flächen, dann käme man auf eine größere Fläche als alle Naturschutzgebiete zusammen. Höchst wahrscheinlich auch eine größere Fläche als alle Wälder. Also wenn da etwas geschehen würde, dann hätte das eine große Bedeutung für den Naturschutz auf nationaler Ebene" (interview n°27).*

> *"Je vois cette disparition de cette limite urbaine et naturelle, que cette zone de transition qu'on essaye actuellement d'établir disparaisse et qu'on vit, qu'on bâtit et aménage avec la nature et qu'on lui permet d'entrer dans le milieu urbain […]" (interview n°29)*

Projects such as the ponds at the Uebersyren WWTP, ministerial planning guides such as "Nature et Construction" (MDDI, 2013), and statements such as those mentioned – may possibly herald an emergence of new imaginaries of landscapes. Perhaps, they accompany new adaptive and integrated or ecocentric approaches that imagine human-environment relations as interwoven rather than as separate, focusing less on efforts to preserve ´what has been once´ to ´what may be in the future´. This may entail profound changes in approaches to ecological ´restoration.

Formal outcome:

- Financing law on the extension of the Uebersyren wastewater treatment plant

10.7.2 ASF c: Public consultation is held on 3rd WFD management plan

Summary	In 2019, the Ministry of the Environment and Water Management Authority organised the compulsory public participation on the 3rd national WFD management plan. The river partnerships of the Syr and the Upper Sûre submitted remarks urging priorities for implementation and better coordination between administrations.			
Action situation	Documents	Interviews	Observations and meetings	Workshop content
ASF c: Public consultation is held on 3rd WFD management plan	Draft of the 3rd national WFD management plan, statements submitted by river partnerships			-

The implementation of the third national WFD management plan is to lead to the achievement of the "good state" of all water bodies. In 2015, no water body had reached this state. 95 % of the surface water bodies did not attain the hydromorphological quality criteria concerning water body structures. In conformity with EU WFD obligations, AGE submitted the preliminary schedule, work programme, and key water management questions to a public consultation. It lists the main challenges in reaching the objectives (AGE, 2018d, own translation):

- hydromorphology and connectivity of water bodies,
- nutrient input from point and diffuse sources,
- pollutant input from point and diffuse sources,
- effects of climate change,
- water balance, particularly low water levels,
- demographic and economic development.

The last three aspects were added to those already mentioned in the previous management plans. The Syr River Partnership welcomed all measures proposed (FP Syr, 2019a). It argued, however, that a number of aspects were missing to ensure that measures would actually be carried out. As regards hydromorphology and connectivity, a "consequent application of existing legal instruments when property rights block projects"[281] should be considered (one of the legal instruments available is expropriation). The river partnership also demanded obligatory requirements for agriculture (for example, fencing of rivers and the creation of riparian strips) and a construction stop on floodplains. Concerning nutrients, it asked for information about the quantities of effluents that rivers could endure and about alternatives to wastewater treatment plants. As regards agriculture, it asked for an evaluation of the effectiveness of agri-environmental measures, more measures to reduce nutrient and pollutant inputs from agriculture, more awareness-raising among farmers, and closer cooperation between farm advisors and water managers. Finally, it asked for quicker, more coordinated and flexible authorisation procedures for projects, and for more coordination between the public administrations for water (AGE), nature (ANF), agriculture (ASTA) and roads (P&Ch)[282].

[281] Own translation of: „Konsequente Anwendung bestehender gesetzlicher Instrumente wenn Eigentumsverhältnisse Projekte blockieren" (FP Syr, 2019a)

[282] "Problematik: Anfragen der Genehmigungen bei unterschiedlichen Verwaltungen sind erforderlich. Sie sind nicht aufeinander abgestimmt und komplex. Wird dadurch langsam und kompliziert. Verbesserungsvorschläge: bei den Verwaltungen aufeinander abgestimmte, transparente Genehmigungsprozedur. Verbesserung der

The Upper Sûre River Contract, in concertation with the other river partnerships of Luxembourg, commented on underlying principles, asking for an entirely "new approach" to implementation ("andere Vorgehensweise"). In addition to strengthening the regional branches of public administrations, the "new approach" should include more cooperation between the administrations, more stakeholder involvement, and more "investment" into practical implementation rather than in "theory" to overcome discrepancies:

> *"Abschaffen des strukturellen Defizits zwischen Absichtserklärung und Umsetzung; Verstärkte Investition in die praktische Umsetzung. Geringere Investition in Theorie (Studien, Planung, Analysen). […] Förderung des Umdenkens bei Privateigentümern durch: finanzielle Anreize, echte Kooperation und Kompromissbereitschaft bei den Verwaltungen, Vertrauensaufbau, Sensibilisierungskampagnen" (CRHS, 2019)*

10.7.3 ASF d: EU WFD is declared "fit for purpose" following ´fitness check´

Summary	From 2018 to 2019, the European Commission conducted a two-year ´fitness check´ of the WFD, Floods Directive and other water-related legislation, including a public consultation. As part of an EU-wide campaign of 130 environmental organisations, the political branch of the parent organisation of the Syr River Partnership, natur&ëmwelt, campaigned for the prolongation of WFD objectives beyond 2027.			
Synergies and tensions	Tensions between WFD objectives and progress on water quality in the member states			
Action situations	Documents	Interviews	Observations and meetings	Workshop content
ASF d: EU WFD is declared "fit for purpose" following ´fitness check´	EC fitness check, Press releases of n&ë, personal communication n°2			-

In the period 2017 to 2019, the European Commission conducted an evaluation of the EU WFD and related directives (on environmental quality standards, groundwater, and floods) to assess whether they were "fit for purpose" in terms of their effectiveness, efficiency, coherence, relevance and EU added value[283]. In addition to an evaluation of progress in member states, the Commission organised an online consultation inviting citizens, national authorities, experts, and other stakeholders to provide feedback on the changes the directives had produced in terms of the "sustainable management of water and improvement in the state of water bodies" [284].

Koordinierung der Umsetzungen (AGE, ANF, ASTA, P&Ch): Herausforderung: Höherer Takt an Umsetzungen. Problematik: Hoher Zeitaufwand in Diskussionen. Verbesserungsvorschläge: Arbeitsplan aufstellen, Priorisierung der Maßnahmen, besser zusammenarbeiten und abstimmen" (FP Syr, 2019a)

[283] https://ec.europa.eu/environment/water/fitness_check_of_the_eu_water_legislation/index_en.htm

[284] Public consultation from 17 September 2018 to 12 March 2019 conducted in the framework of the fitness check of the Water Framework Directive and the Floods Directive: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/1155-Fitness-Check-of-the-Water-Framework-Directive-and-the-Floods-Directive/public-consultation

The political branch of the environmental NGO natur&ëmwelt participated in the EU-wide campaign Living Rivers Europe[285]. The campaign had been formed to mobilise environmental organisations and citizens to prevent that the EU WFD and related legislation would be opened for revision and "watered down" (n&ë, 2018)[286]. Natur&ëmwelt expressed itself in favour of an extension of EU WFD objectives beyond 2027, as an alternative to weakening objectives:

> *"Da die gesetzten Ziele aller Wahrscheinlichkeit nach nicht erreicht werden, gibt es 2 Möglichkeiten: entweder wird der zeitliche Rahmen erweitert oder die Ziele werden herabgesetzt. Ersteres wäre dabei definitiv die sinnvollere Variante. So würde verhindert, dass die Mitgliedstaaten, welche ihre Ziele bis 2027 nicht erreichen, vor dem europäischen Gerichtshof angeklagt würden und der Gewässerschutz könnte weiterhin von einem starken gesetzlichen Rahmen profitieren. Die Ziele herabzusetzen hingegen ist der falsche Weg […]" (n&ë, 2019).*

The press release emphasised that, thanks to the EU WFD, knowledge about the state of water bodies had never been as extensive as today and had also resulted in an increase in staff in public water management. Furthermore, more measures had been taken in Luxembourg to enhance water protection and support alternative practices in agriculture since water management had been allocated to the Ministry of Sustainable Development in 2013. Furthermore, the statement referred to exemplary projects such as the Syr restoration in Mensder Brill (see local context chapter above) that showed that the state of water bodies was being taken seriously in Luxembourg (n&ë, 2019).

> *"Die Einsicht, dass unbelastete natürliche Gewässer eine Vielzahl von Funktionen gratis und ohne menschliches Zutun übernehmen, wie Trinkwasserproduktion, Selbstreinigung, Abflussregulierung, Klimaregulierung, Nahrungsmittelproduktion, Vielfalt an Lebensräumen und somit auch einen erheblichen Erholungswert für den Menschen, hat zu diversen Projekten an unseren Flüssen geführt" (n&ë, 2019).*

The campaign supported continuous efforts of the Green-lead Ministry of the Environment and other actors to achieve EU WFD objectives.

It also received attention in the national press. In one article, the Director of the Water Management Authority (AGE) also asked for more time "for member states and ecosystems" to meet objectives. He is cited as stating openly: "*2027 werden die Ziele nicht erreicht […] da brauchen wir uns nichts vorzumachen*." (Tageblatt, 2019) If no additional time were granted, some EU member states (none of which currently met objectives) would seek to lower criteria to avoid fines. As regards efforts in Luxembourg, he referred to the need to improve wastewater treatment (notably, with a view to micropollutants such as from pharmaceuticals), to buy land to obtain more space for river restorations, and to introduce more organic agriculture. At the same time, he also explained that the fact that Luxembourg only had comparatively small water bodies meant that effluents affected river water quality more severely than in other countries (Tageblatt, 2019).

In Luxembourg, the Living Rivers campaign of natur&ëmwelt mobilised 680 of the targeted 1000 supportive signatures for its cause (personal communication n°2). According to the Living Rivers website, roughly 375 000 citizens and 6.000 scientists demanded the EU WFD was maintained in its current form.

[285] www.livingrivers.eu

[286] www.naturemwelt.lu/livingrivers

Based on the fitness check, the European Commission found that the EU WFD, the Floods Directive and other water-related directives were "largely fit for purpose" and would not be opened for revision[287]. The WFD was judged to having been "successful in setting up a governance framework for integrated water management", regardless of the fact that "no substantial progress in water bodies´ overall status has been made between the first and the second river basin management cycles". Less than half of the EU´s 110.000 water bodies had reached a good status (EC, 2019a). According to the European Commission, it had proven more difficult than originally envisaged to establish a framework that took into account "the specific conditions in each member states" (including pressures from the past such as hydromorphological changes) and, at the same time, ensure its enforceability:

> *"There is a trade-off between enabling location-specific water management and enforceability […]: The analysis in this fitness check finds that there is a trade-off between the flexibility of the Directives, which is needed to enable Member States to implement the most cost-effective measures, and the complexity that this flexibility creates, which forms an impediment to enforceability and achieving better results. Many of the pressures on water, and the measures required to mitigate them, are location-specific. […] The complexity of the Water Framework Directive is a consequence of the need for location-specific measures. […] The extensive requirements for the river basin management plans and for public consultation are necessary to keep the policy discretion provided for by the EU WFD in check and provide public transparency about water policy and actions. There is no evidence of excessive administrative burden in terms of monitoring and reporting requirements. Having said that, citizens, Member State representatives, environmental groups and the water sector have indicated there is room for improvement, both in the accessibility of information and in the level of detail. Efforts are being made to address these issues, to simplify the reporting requirements and to lower the administrative burden, for example through improved electronic reporting" (EC, 2019)*

The conclusions suggest that the fitness check has not resulted in a re-framing of objectives and underlying assumptions of the EU WFD:

> *"The fact that the WFD's objectives have not been reached fully yet is largely due to insufficient funding, slow implementation and insufficient integration of environmental objectives in sectoral policies, and not due to a deficiency in the legislation". (EC, 2019)*

[287] European Commission on 19 December 2019: ec.europa.eu/environment/water/fitness_check_of_the_eu_water_legislation/index_en.htm

10.8 Concluding summary and analysis

The following offers a summary of the Syr case study along the main research questions. The research questions asked, firstly, how the EU WFD had contributed to changing approaches and relations among actors, and, secondly, what factors have facilitated or hindered social learning and the emergence of actionable knowledge.

10.8.1 Changes in water and land governance and management (research question 2)

Overall, national implementation of the EU WFD has not fundamentally changed how water and land are governed and managed in the Syr valley. Specialised scientific data and knowledge about habitats and species have greatly increased, including in the framework of the EU Habitats Directive[288]. There is growing awareness among many actors of the importance of giving rivers more space and of improving water quality. WFD objectives have not only introduced a national *obligation*, they have also raised the *expectation* among environmental actors that the necessary measures would be undertaken to ensure that aquatic ecosystems would become cleaner and healthier. However, so far this has not been the case, neither as regards the status of surface water bodies nor biodiversity in general[289]. Governmental actors do not believe that water bodies will be restored to a good state by 2027. Several actors also regard the attainment of objectives as unrealistic in the longer term, not least because of demographic and economic developments.

At the same time, the present case study suggests that coordination in the elaboration of formal environmental and water protection policies and plans has increased. All of those concerning the Syr valley have declared water quality and the restoration of rivers and wetlands a priority. However, as regards concrete projects, there is still a lack of coordination between the administrations involved. While ANF carried out a river restoration in the Syr valley *before* Luxembourg transposed the EU WFD into national law, no larger river restoration has been carried out since. Reconciling WFD and Natura 2000 provisions has beenconsidered a challenge.

The case study suggests that growing technical and administrative requirements, accompanied by diverse contradictions, tensions and barriers, have made the planning and implementation of projects pursuing these objectives more difficult than before. The EU WFD has transferred the managerial ecological restoration paradigm from nature conservation to water management. At the same time, national WFD implementation has resulted in few tangible improvements in the Syr valley. It has not yet been effective in introducing *projects* of adaptive and integrated water management. Several possible river restorations and other projects that aim to improve river structures and biodiversity are stalled in the planning phase, facing higher requirements than in the past and lengthy administrative procedures for authorisations. Requirements elaborated scientifically based on the EU WFD serve prioritisation of measures and apply criteria to ensure their effectiveness in improving the good ecological status of rivers. They have increased the necessity to outsource planning to consultancies (some of which may not yet be competent in applying the new criteria however).

[288] National report on the status of habitats in Luxembourg (2013-2018): „Die Kenntnisse über die Lebensbedingungen der Arten, deren Verbreitung sowie die Qualität des Monitorings haben sich im Vergleich zu 2013 verbessert“ (MECDD, 2020)

[289] The national report on the status of habitats in Luxembourg (MECDD, 2020) concludes that the deterioration of wetlands and open landscape habitats has continued in the period 2013-2018, with none of those monitored found to be in a good condition. Consequently, the populations of almost all species depending on these habitats and on clean water have also decreased, with a total of three quarter of domestic species (excluding birds) and one third of wild birds categorised as threatened. Agriculture, urbanisation, and climate change are cited as main reasons.

Exclusively ecosystem-based, the requirements do not encompass any social criteria. In what has been identified as a managerial ecological restoration paradigm, river restoration projects continue to be treated mainly as technical-administrative and ecological matters isolated from local social contexts. The requirements do not provide for experimental learning-by-doing approaches, a hallmark of adaptive water management. As a result, the Syr case suggests that it has become more difficult for municipalities, river partnerships and environmental actors to seize opportunities for measures as they arise (e.g. when land becomes available and actors have rallied around a common cause). Formal public consultations provide actors with the opportunity to remark on measures listed in the national WFD management plan. However, what has added to this conclusion is the fact that actors (many of whom depend on state funding) are expected to implement measures listed in the national WFD management plan rather than to develop own initiatives.

The post-WFD national regulatory framework, therefore, has not been conducive to network governance and social learning in water governance and management so far. Management has predominantly remained in the hands of municipalities, their syndicates, environmental organisations owning land, the Ministry of the Environment, and its administrations. While cooperation between AGE and local actors has increased, many actors continue to work separately despite the river basin principle. The ending of the pasture project of Mensder Brill and the fact that it has not yet been followed by another project suggests that there there are not yet many examples of how to manage restored and protected areas that are embraced by diverse governmental and nongovernmental actors.

An additional hindering factor faced by the Syr River Partnership when seeking to foster new social networks is the absence of shared organisational structures and narratives linked to the river basin. In the period analysed, a nascent social network has emerged that did not exist pre-WFD. However, it rests mainly on the personal commitment of some municipal members and other individuals, with overall low organisational commitments and cooperation across municipal borders. For many municipalities, water management continues to be mainly a matter of municipal water supply and engineered infrastructures, while pursuing other social and economic priorities. Some municipal officials argued that complex projects such as river restorations involving multiple land-owners exceeded their capacities, even if they welcomed them. Farmers and farm advisors have hardly been involved in the river partnership.

Furthermore, insufficiently treated wastewater and growing quantities of effluents continue to affect the Syr negatively. The Natura 2000 requirement of assessing impacts of projects on ecosystems in protected areas and the polluter-pays principle have not been applied to the airport. This has produced tensions between local environmental and municipal actors, on the one hand, and the Ministry of the Environment on the other.

The most tangible outcome of the governance processes analysed was the passing of the law on state co-funding for the extension of the Uebersyren wastewater treatment plant. The case study suggests that engineered ´solutions´ and technology-driven approaches characteristic of the command-and-control paradigm continue to dominate.

Overall, the Syr case study suggests that the main driver of water and land governance and management in Luxembourg - both before and after the entering into force of the EU WFD and related policies – has been demographic and economic growth. From it also results one of the main barriers facing river restorations: land availability and prices. More generally, the case study suggests that the anthropocentric growth paradigm may be incompatible with the restoration of aquatic ecosystems to a good status and significant improvements in water quality, not least given the relation between quantities of effluents and the size and regeneration capacities of recipient rivers.

This is reflected in narratives of environmental actors. Initially welcomed with a boost of self-organised local activities (e.g. the Interreg project leading to the Syr River Partnership), WFD implementation has given way to sentiments that actors struggle to implement smaller measures, while larger issues are rarely openly discussed. Decision-making and implementation procedures addressing major pollution sources can last several decades, all while ecological deterioration continues. This contrasts with the introduction of the compensation scheme that aims to ensure that any damage incurred to biotopes for reasons of public interest is compensated by measures elsewhere. While the idea of compensation has existed since at least the 1980s in Luxembourg (see chapter 7.3.1), the principle itself has been formally institutionalised via the EU Habitats Directive and subsequent Luxembourgish nature protection policies. It has changed ecocentric narratives of governmental actors who, under pressure of governmental responsibility and socioeconomic ´realities´, have moved away from the principle that biotopes have intrinsic unique values to be protected regardless of other concerns. This ´pragmatic´ attitude (itself controversial within ministries and administrations) has not been well-received by nongovernmental environmentalists contesting the effectiveness and underlying assumptions of compensation.

While contradictions and conflicts between anthropocentric and ecocentric purposes attributed to water and land management have become more pronounced, tensions between ecocentric bottom-up *and* top-down governance also grow. This weakens possibilities of network governance and has resulted in more fragmentation in water and land governance and management in the Syr river basin.

Water governance and management in the Syr valley	***Before* national EU WFD implementation (pre-2008)**	**In the course of national WFD implementation (post-2008/2013)**
Paradigm(s) and purposes	Sectoral command-and-control paradigm (water) and *emerging* ecocentric paradigm (co-existing with economic growth paradigm (e.g. airport), productionist paradigm in agriculture)	Ecocentric paradigm (water, environment) with stronger focus on protected areas and wastewater treatment (co-existing with economic growth paradigm (e.g. airport), productionist paradigm in agriculture)
Main actors	Governmental actors, municipalities and syndicates, engineers and consultants	Governmental actors, municipalities and syndicates, engineers and consultants – in addition: some nongovernmental actors (incl. River Partnership)
Scope	Grey water infrastructures, separate from ecosystems and water bodies	Aquatic ecosystems and grey water infrastructures
Social coordination	Hierarchical multi-level governance between national and municipal levels	Hierarchical governance relying *more strongly* on specialised scientific/technical knowledge, regulation and public funding than before, however, with some public consultations and stakeholder involvement

Management means	Technical infrastructure management and first river restorations	Hydromorphological measures to improve river structures (few carried out), high investments in wastewater treatment infrastructures (e.g. Uebersyren plant)

Table 10.2 – Overview of main changes in water and land governance and management in the Syr valley after the national water law of 2008 and government change in 2013

10.8.2 Facilitating and hindering social learning factors (research question 3)

While interpersonal contacts have increased, the Syr basin has not yet emerged as a widely shared space of social and material engagement among diverse organisations. Water and environmental management are conducted mainly at the municipal level (and intermunicipal level within water syndicates whose borders, however, are not congruent with the river basin). For this reason, the following elaborates mainly on hindering factors for self-organisation and social learning. The main sources of tensions identified are:

- High and rigid administrative and technical requirements based on – and necessitating – specialised scientific/technical studies versus professional and local knowledge of the actors in the river basin;
- Conflicting interpretations of formal institutions and requirements and lack of common priorities and projects between diverse public administrations involved (both as regards funding and authorisations);
- Prevailing *informal* institutions that favour technological ´fixes´ over nature-based and longer-term adaptive projects (such as river restorations);
- Contradictions between the polluter-pays principle, the obligation to carry out environmental impact studies, and public access to environmental information versus ongoing pollution caused by the international airport and the principle of “overriding public interest”.

As there have been few interplays between formal and informal governance processes, the case study has not been able to confirm the assumption that interplays are particularly conducive to social learning (Pahl-Wostl, 2015). However, what it does suggest is that the absence of processes suitable to foster a shared sense of purpose among diverse actors is a hindering factor. The action situations and processes analysed were fragmented. There were several *coordinated* plans (the national EU WFD and Natura 2000 management plans, the national flood risk management plan, and the action programme of the Syr River Partnership) that contained ambitious objectives for river restorations and hydromorphological measures. However, only few have been implemented. Many actors regard ambitious objectives as unrealistic. Furthermore, the end of the Mensder Brill pasture project, the declaration of Schlammwiss-Brill as national nature reserve, the extension of the Uebersyren wastewater treatment plant, and the activities of the Syr River Partnership have largely run independently of one another, seemingly unrelated although they concerned the same area (see figure 10.13).

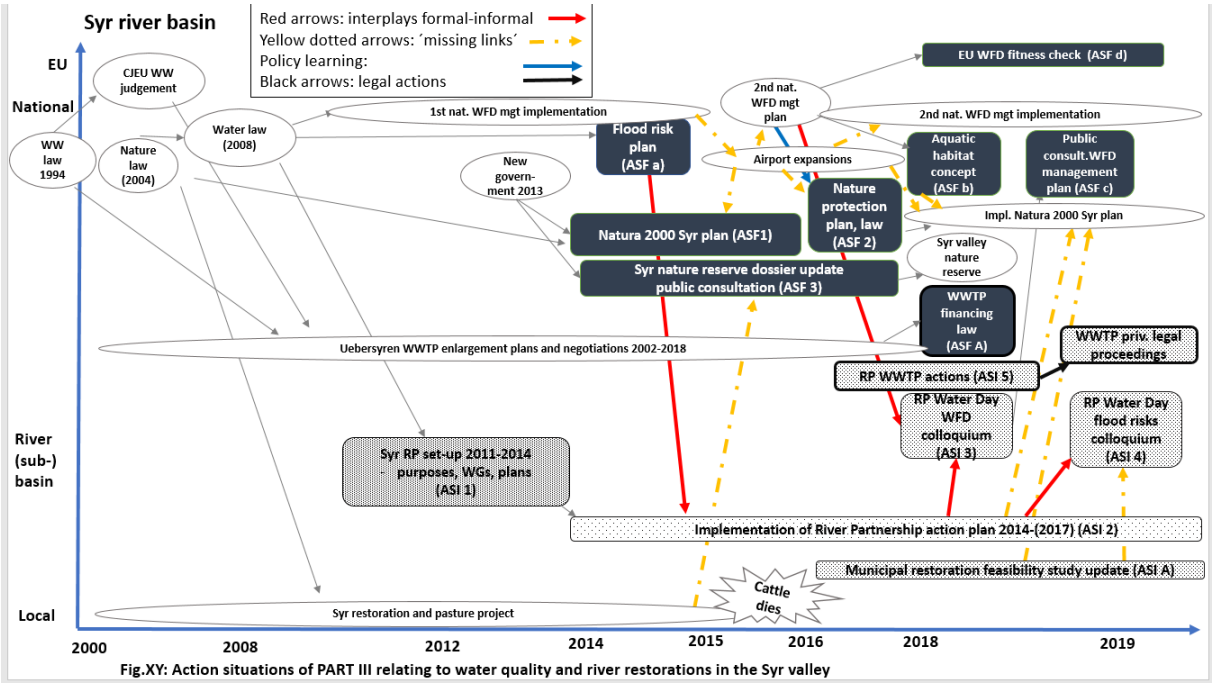


Figure 10.13 – Interplays and ´missing links´ identified in formal and informal governance processes in the Syr valley

Moreover, the Syr case study points towards the importance of organisations in governance processes, providing some evidence that research benefits from distinguishing between and investigating relations between *personal* and *organisational* commitments to collaborative processes (Mostert et al., 2007; Sol et al., 2013; Wenger, 1998). It can contribute to a better understanding of the institutionalisation of social network effects and related factors.

Finally, the present analysis suggests that personal and shared narratives can, indeed, be potent sources of meaning-making and engagement (Chabay et al., 2019). Personal environmentalist and local narratives have been examined. In contrast, the case study has identified the absence of shared narratives in the Syr valley as a hindering factor. Furthermore, it illustrates barriers to self-organisation and personal meaning-making.

10.8.2.1 Actors and relations: network effects?

As potential boundary organisation and starting with its Interreg project, the Syr River Partnership has provided spaces to facilitate networking among municipal and governmental actors. Its river committee regularly brings together representatives of municipalities, intermunicipal syndicates, and of the national administrations for water (AGE), nature (ANF), and agriculture (ASTA). The main reason for why network effects have been characterised as limited is not only that farmers and farm advisors have largely been absent, and that the national railway company and international airport were not engaged. Rather, empirical analysis suggests that actor engagement has rested mainly on the personal commitment of municipal officials (and other actors) dedicated to environmental concerns, and on interpersonal relations. There has been less organisational commitment, illustrated by the fact that municipalities rarely pro-actively involve the river partnership in their activities. Working relations between the Water Management Authority and the Syr River Partnership have been close, but mainly operational. The spaces provided by the accompanying committee of the river partnership and the joint annual colloquia of all the six (formerly five) Luxembourgish river partnerships during the past

years have fostered few reflexive dialogues entailing critical questioning, reframing or joint action strategies.

Why have social network effects in the Syr basin remained limited? Four main hindering factors have crystallised. Firstly, the Syr river basin disposes of no common organisational structures except the recent river partnership itself, of no shared organisational histories. Secondly, municipal autonomy in urban water matters has been another obstacle, as there are no incentives for municipalities to cooperate across municipal borders. The membership fee to the river partnership is very modest, reflecting the low priority municipalities attribute to the river partnership.

These two factors, however, are typical of river basin organisations often situated uneasily between different established formal institutional structures (Huitema & Meijerink, 2017). However, while ´ecosystem-based bioregionalism´ (see chapter 4.3.1) tends to concentrate on formal institutional design and its political aspects, the present case study points to the importance of history and shared narratives in facilitating the emergence of social networks centred on river basins (further elaborated below).

Accordingly, another hindering factor identified is that there has been no common cause around which the members of the river partnership rallied. The aim to improve water quality and river structures alone has not engendered more widespread support. There have been fewer social processes surrounding the implementation of the action plan than during foundational periods. Formal processes and shared environmental concerns could have provided stronger reasons; notably, the Syr pollution caused by wastewater that triggered local complaints and some municipal mobilisation, incl. upon initiative of the river partnership. However, as the river partnership´s letter to the Ministry of Sustainable Development in this matter received no answer, it could not provide an effective channel for local concerns. This relates to the final hindering factor identified: the fact that the river partnership is endowed with no formal competences and legal rights, and disposes of very limited resources. Lacking legal personality, it has no right to obtain to environmental information. Lacking resources and being expected to concentrate on measures estimated to contribute to reaching WFD objectives (incl. its own action programme), the river partnership has little time to initiate other processes.

In conclusion, the Syr River Partnership currently has too few competences and resources to take the role of a boundary organisation to engage a wider spectrum of stakeholders, to build organisational commitment, and inspire a sense of common purposes in the fragmented governance landscape of the Syr basin. Neither are there currently other actors in such a position[290]. So far, the Syr basin exists mainly as a hydrological and administrative unit for national authorities and as a transactional context of individual actors, but has hardly extended to organisational contexts beyond the Syr River Partnership itself.

[290] The future coordinators and steering committees for, respectively, the Natura 2000 areas and the groundwater protection zones might change this. At the same time, they will also be separate structures located in different organisations. The coordinator for measures in drinking water protection zones will be employed by the SIAS syndicate, not the Syr River Partnership, following a mutual understanding between the main actors involved.

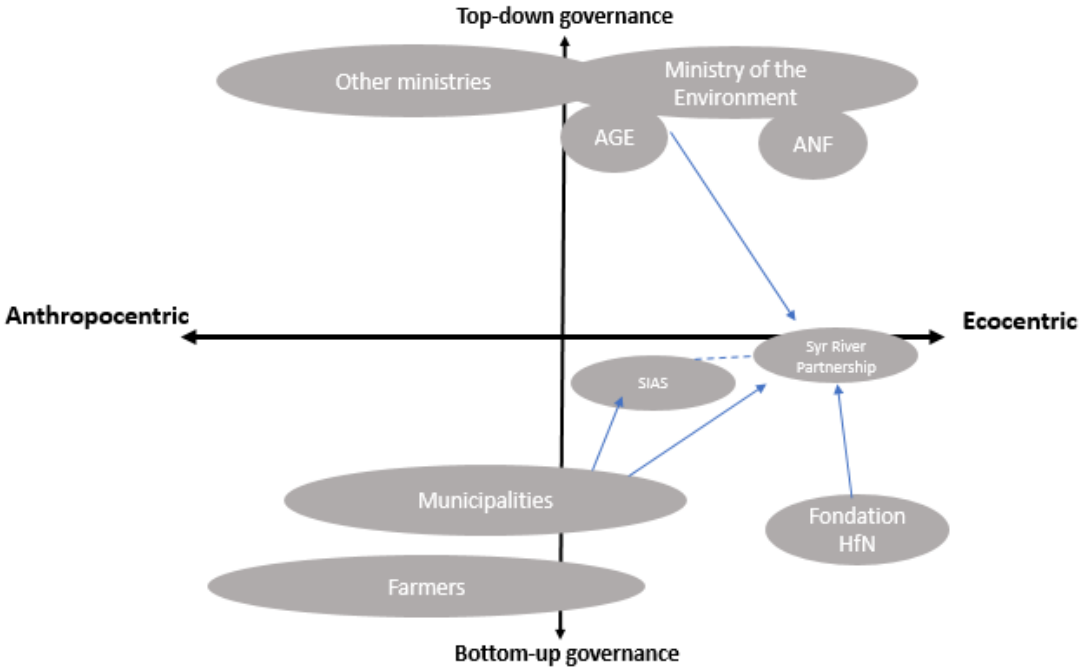


Figure 10.14 – Analytical grid: Mapping selected actors along the governance and management axes

10.8.2.2 (Actionable) knowledge, paradigms, and narratives

In the conceptual framework, self-organisation, and action have been put to the fore as both potentially fostering and fostered *by* social learning and actionable knowledge. In the present case study, the river partnership has implemented a number of technical measures to improve hydromorphological structures of rivers and to prevent cattle from carrying sediments and nutrients into river water. In addition, the SIAS syndicate and Fondation HfN have continued to carry out smaller projects in the Syr valley, such as the creation of new ponds. The river partnership has also supported municipalities in some of their activities. It is appreciated for its professional knowledge of - and commitment to - improving aquatic ecosystems. Some municipalities, however, continue to prefer technical measures serving flood protection and single technical interventions such as fish ladders to restoration measures. At the same time, the small river restoration carried out in the municipality of Betzdorf and other projects planned at municipal level suggest that municipalities tend to carry out ecosystem-based measures as part of wider community development projects serving *integrated* purposes (e.g. ecological, social and cultural, and economic).

With the exception of municipal projects, however, measures rarely seem to be embedded in self-organised processes involving multiple local and professional actors.

Moreover, the case study suggests that even smaller technical measures have required extensive administrative work to obtain funding and authorisations from different public administrations. Due to the administrative burden, many measures remain ´stuck´ in the planning phase for many months, and may require revisions to conform with divergent requirements of, for example, the Water Management Authority and the Nature and Forest Agency. The concept on aquatic habitat connectivity is expected to further complicate administrative processes. An increasing number of projects require professional consultancy input. The river partnership has also had measures rejected, including following financial scrutiny, as they were deemed too expensive. Its impression is that both municipalities and public administrations continue to regard ecosystem-based management measures

more critically than investments in engineered infrastructures, although the latter usually cost significantly more.

The above suggests that, so far, WFD implementation has not fostered a paradigm shift towards adaptive and integrated water management in the Syr valley. Instead, a combination of command-and-control and managerial ecocentric approaches makes self-organisation in the planning and implementation of projects such as river restorations increasingly cumbersome in practice, while anthropogenic pressures on aquatic ecosystems mount. The airport example suggests to local and environmental actors that different standards apply to them than to major "polluters" that jeopardise the attainment of WFD objectives. Some have taken legal action.

The above-mentioned factors hindering social learning have been a source of concern. It has a narrative dimension that links knowledge with action. Interviews suggest that many people engage in local activities in Syr valley out of sense of care. Some have a stronger local narrative identity rooted in the attachment to particular local places and social engagement in their communities. Other have a stronger environmentalist identity, seeking to preserve habitats and cultural landscapes they feel personally connected with. Many actors combine both. Childhood memories, family life, leisure activities, choices of education and profession have been recurrent themes in many interviews and during walks. The case study thus provide some evidence for the claim that many people do what they do, because of their sense of self (Ezzy, 1998; Somers, 1994). It typically included the belief in and drive to "changing something".

Although formal education certainly mattered and scientific data was generally regarded as "useful" and "important", most of professional knowledge (including local knowledge) of environmentalists has been derived from experience. They underlined a particular "sense for nature" as basis for their ecological knowledge and/or a particular knowledge of local people. It enabled them to judge situations, recognise opportunities, chose and develop particular measures or strategies that they deemed most adequate in a specific context, all while stressing there were never any silver bullets ("Patentrezepte", "Wunderlösungen", "Allheilmittel"). All of them underlined that, in order for anything to be done in practice, flexibility and comprises were key, both in relations with diverse actors and ecosystems. This was one of the most frequently mentioned ´lessons´ that actors across scales and sectors had drawn from their experience. It is reminiscent of the Aristotelian concept of "practical wisdom" outlined in the conceptual framework (see chapter 2.1.3.1).

It is in contrast with managerial approaches to ecological restoration and water management. What also united environmental and municipal actors interviewed was an emphasis on the need to prioritise certain projects, coupled with someone taking a lead role to drive them. A few had the vision of the Syr as a national "Vorzeigegewässer". Municipal actors underlined how habitats could be a source of pride and, at the same time, how they contributed to local quality of life by serving as recreational spaces ("Naherholungsgebiete"). There were thus different, and perhaps conflicting, imaginaries of local landscapes. At the same time, municipal and environmental actors felt they did not have the capacities to lead projects. They also emphasised that the different authorities concerned needed to agree on projects to avoid administrative ´stalemates´. Authorities themselves, however, tended to see municipalities in charge, equally feeling their capacities were stretched.

It remains unclear when and how more river restoration projects to improve the health of aquatic ecosystems will be implemented that are suitable to bring together diverse actors.

11 CASE STUDIES (PART V): Comparative analysis

The final part of the case studies compares the formal and informal governance processes analysed in parts III and IV with a view to the main research questions of the thesis:

1. *How can a kind of knowledge be conceptualised that fosters collective action for sustainability?*
2. *How has the EU Water Framework Directive changed water and land governance and management in Luxembourg?*
3. *What factors facilitate or hinder the emergence of social learning and actionable knowledge for sustainability?*

The following summarises and compares the main insights of the case studies. It does so by starting out with the *second* research question. The comparative analysis is followed by an examination of the informal, formal, and material factors that have facilitated and hindered the emergence of social learning and actionable knowledge in the Syr and Upper Sûre river basins (research question 3). The comparison concludes with an analysis of the first research question highlighting the significance of both personal and shared narrative identities among environmentalists, farmers, and municipalities as key elements in what makes knowledge actionable. It focuses on these actor groups, because social learning crucially depends on *that* and *how* individuals and nongovernmental organisations engage in governance processes.

11.1 Changes in water and land governance and management (research question 2)

The case studies suggest that national WFD implementation has not produced a paradigm shift in water and land governance and management in Luxembourg. Instead, water and land governance systems are marked by growing discrepancies between formal environmental objectives and the state of ecosystems.

As a contribution to the literature, the case studies thus suggest that following national WFD transposition, water and land management are no longer dominated by anthropocentric supply- and growth-oriented anthropocentric and sectoral paradigms *alone*. Rather, as noted by some authors in sustainability science (Grunwald, 2016; Maggs & Robinson, 2016; Stirling, 2015a), ecological conservation (Higgs, 1997) and adaptive water management (Ollivier, 2004), a managerial and ecocentric paradigm has emerged alongside established supply- and growth-oriented paradigms. The thesis has interpreted the EU WFD and environmental policies (such as the EU Habitat Directive of 1992) as an expression of this paradigm, even if the EU WFD also encompasses anthropocentric concerns for drinking water protection. The election of the Green Party into government in 2013 (itself an indication of growing public environmental awareness) has contributed to the institutionalisation of the emerging ecocentric paradigm in Luxembourg´s governance system. In the literature, technocratic approaches to water governance are predominantly associated with the incumbent ´command-and-control´ paradigm (see 4.2.1). However, the case studies suggest that the two paradigms share a number of characteristics despite the fact that they pursue overarching objectives that are diametrically opposed (see below). Among others, formal water governance has become more ecocentric, but also more regulated and reliant on scientific/technical expertise and data.

As a result of the EU WFD and environmental policies, water and environmental policies in Luxembourg have become more integrated formally. Furthermore, the case studies also suggest that the

productionist paradigm in agriculture is gradually expanded to include more environmental criteria and to subsidise diverse agricultural services in addition to food production. At the same time, more ecocentric and integrated formal policies have so far produced few changes ´on the ground´. Notably, ecosystem health has not improved significantly.

Therefore, if the EU WFD and environmental policies have been a turning point in water and environmental governance in Luxembourg, it is especially because scientific ´expert´ information on and the awareness of the enormity of environmental challenges and their systemic interconnections have never been as extensive as today. The EU WFD has contributed to growing environmental awareness and enhanced professional systems and ecological knowledge among many public authorities and nongovernmental actors. However, the case studies also suggest that the emphasis on specialised scientific expertise has further consolidated ´expert systems´, while it in comparison has weakened the status of local and professional knowledge in governance and management when it is not substantiated by specialised scientific studies focusing on ecological and physical criteria. While professional and local knowledge increasingly integrate specialised scientific data and information, the gap between knowledge warranted by scientific organisations, on the one hand, and knowledge of non-scientific actors, on the other, therefore widens as regards formal governance procedures deciding on public funding for and authorisations of specific projects. This has posed barriers to self-organised actions of nongovernmental actors who strive to carry out projects to improve ecosystem health. Thereby, the emphasis on scientific studies has also contributed to increasing the gap between formal objectives and action. From these circumstances have resulted in growing contradictions and discrepancies in water and land governance and management.

Furthermore, both the Syr and Upper Sûre cases have been marked by pronounced tensions between anthropocentric and ecocentric purposes attributed to water and land management. Informal governance processes have hardly reduced tensions. In both cases, there are examples of how *national* public interests relating directly to economic and demographic growth have taken precedence over *regional* objectives (Upper Sûre) and over *environmental* obligations and objectives (Syr). In the Upper case, tensions translated into a polarisation between top-down and bottom-up governance processes hindering cross-*scale* network governance. In the Syr case, contradictions between “overriding public interests” relating to the international airport and the obligation to improve the state of aquatic ecosystems have resulted in legal actions. In contrast to the Upper Sûre, however, network governance in the Syr valley has been hampered by the fact that the basin-wide social network has mainly encompassed individual environmentally-minded actors (such as some municipal representatives) whose organisations may be less committed to cooperation at the scale of the river basin. Moreover, the network has encompassed few actors from agriculture. Therefore, there has been less cross-*sectoral* network governance when compared to the Upper Sûre region.

11.1.1 Governance

The case studies suggest that the EU WFD has profoundly changed *formal* water governance and formal and informal organisational landscapes. It is symptomatic of the hybrid character of the EU WFD that it led to the set-up of both a Water Management Authority that centralised competences previously held by the respective public administrations for nature and agriculture and of regional river partnerships that have brought together both governmental and municipal actors at the scale of river basins. This is reminiscent of governance efforts of the 19th and beginning of the 20th century to boost industrialisation and public infrastructures through combined national *and* local efforts. Indeed, the analysis of historical contexts has suggested that governance in Luxembourg has rarely been dominated by one paradigm only.

As regards water governance in the 21st century, the river partnerships received an open mandate that entailed neither a legal personality nor clear competences. However, the mandate included a broad spectrum of possible tasks, including to associate nongovernmental actors and citizens to integrated water management. In this sense, the river partnerships have been well-positioned to act as possible boundary organisation facilitating the emergence of social networks and, thereby, of adaptive resource governance (Folke et al., 2005). The case studies have therefore examined if the creation of river partnerships and the introduction of public consultations could be interpreted as signs of emerging network governance in Luxembourg based on self-organisation across scales and sectors (Pahl-Wostl, 2015).

However, overall, the case studies suggest that the water governance system in Luxembourg continues to be predominantly a hierarchical multi-level system characterised by nested EU, national, and municipal levels endowed with clearly delineated competences (Newig & Koontz, 2014; Pahl-Wostl, 2015). Cross-scale and cross-sectoral coordination around river basins has predominantly been limited to the operational implementation of management plans. Overall, therefore, the case studies have not discerned a paradigm shift towards a polycentric regime held together by network governance to coordinate multiple decision-making centres and issue-specific formal and informal governance processes (Ostrom, 2010; Pahl-Wostl, 2015).

One of the main reason identified in the case studies is that the EU WFD has transferred a managerial approach to water governance that is characteristic of ´traditional´ approaches to environmental conservation (Higgs, 1997) (see chapter 4.4.1). Empirical analysis has traced the roots of managerial approaches in Luxembourg back to 19th century science-oriented environmentalists that fostered both early variants of ´citizen science´ (see chapter 7.1.3) and expert-led efforts such as plans to create a national park around the Upper Sûre lake following the construction of the dam (see chapter 7.2.1). The Syr case study suggests that the public administration closest to this paradigm has been today´s Nature and Forest Agency with its restoration projects (see chapter 10.1). It is therefore somewhat paradoxical that it was the nature administration that lost its formal competences on aquatic ecosystems to the Water Management Authority in the course of national WFD transposition.

The analysis of the EU WFD (see chapter 4.5) and the case studies suggest that the managerial ecological restoration paradigm shares a number of elements with the incumbent command-and-control paradigm:

- technical framings of objectives and challenges,
- the separation of ecological objectives from social criteria (Ollivier, 2004; Waylen et al., 2019),
- static views of ecosystems and social-ecological systems,
- the dominant status of scientific/technical expertise from natural sciences and engineering (e.g. regarding assessments of risks and anthropogenic impacts) combined with a neglect of local and professional knowledge of nongovernmental actors,
- a focus on formal regulation, public funding, and detailed action plans to reach pre-defined objectives.

Therefore, as in the incumbent ´command-and-control´ paradigm, managerial ecocentric approaches in water governance in Luxembourg, too, have relied mainly on scientists first getting "the facts right, then decision-makers decide what to do based on these facts" (Evans, 2012). Overall, EU WFD implementation has thus strengthened hierarchical governance. In the case studies, the elaboration of extensive dossiers and concepts relating to new drinking water protection zones (Upper Sûre) and to aquatic habitat connectivity (Syr) are examples and indications of the technical and *increasingly* scientific and regulated character of water governance. It has contributed to making the elaboration

of plans and laws lengthier and more strongly reliant on specialised scientific data and expertise than before.

Furthermore, managerial top-down approaches to water and environmental protection have found expression in technocratic framings of sustainability challenges and a strong emphasis on formal procedures. The introduction of public consultations, river partnerships, and river basin districts provided *formal* indicators that informal water governance and the role of nongovernmental actors would be strengthened in Luxembourg. It also raised *informal* expectations of active involvement that provided strong impulses for the Interreg projects of the Syr and Upper Sûre river partnerships, and for the efforts of the Upper Sûre River Contract to coordinate regional stakeholder involvement. However, stakeholder involvement in water governance in the two river basins has hardly encouraged the questioning and reframing of overarching purposes, strategic, and operational objectives. The plans published and procedures adopted to solicit public opinion were too technical, legal, and detailed to provide a suitable basis for dialogues, and a stronger consideration of non-scientific knowledge.

The consultations themselves and public meetings held have primarily served information purposes and the revision of technical details. As regards the Upper Sûre case, the technical framing of the process to establish drinking water protection zones contributed to a neglect of the role of historical and local organisational contexts that receive particular attention in adaptive governance and organisational learning (Mostert et al., 2007; Pahl-Wostl, 2015; Wenger, 1998). The neglect of contexts is illustrated by the fact that statements of some governmental actors expressed a certain surprise that a procedure that had ´worked´ in the case of the 51 groundwater protection zones in Luxembourg had sparked significant controversies in the case of the Upper Sûre lake. Statements made during interviews suggest that polarisation could *perhaps* have been avoided if more time and resources had been attributed to conduct dialogues at the local level, and if the political character of the creation of drinking water zones in the Upper Sûre region had been taken into account earlier. Furthermore, the fact that, in general, many actors submitted their statements and objections to formal public consultations with the help of specialised lawyers, consultancies, and farm advisors seems to further substantiate the argument that formal public consultations have, overall, not been tailored to dialogues, but rather to the promotion and negotiation of diverse interests. On the other hand, statements submitted by nongovernmental actors *were* taken into account to revise details and the future protection zones were presented to stakeholders and the public on a number of occasions.

Another indication of the predominance of managerial top-down approaches is that the river partnerships, municipalities, and other nongovernmental actors have primarily been expected to contribute to the implementation of the pre-defined measures of the national WFD and Natura 2000 management plans. Similar to how the command-and-control paradigm relied on administrators passing on clearly defined problems and objectives to engineers for solutions (see chapter 4.2.1), WFD-related and Natura 2000 management now passes pre-defined measures on to nongovernmental actors for one-to-one implementation. Thereby, the managerial ecological restoration paradigm perpetuates an instrumental theory of action characteristic of command-and-control and productionist paradigms. The EU WFD has contributed to its formal and informal institutionalisation in Luxembourg leading to an approach to ecological restoration and sustainability, in which actors are evaluated - and evaluate themselves - based on numbers and box-ticking (i.e. “Aktionspläne abarbeiten”).

Finally, what has further contributed to the managerial character of water governance and management is that river partnerships, municipalities, environmental organisations, farmers, and other nongovernmental actors are strongly encouraged to resort to external advisors and consultancies to be able to fulfil requirements (e.g. to obtain authorisations and public funding). At the

same time, the case studies also suggest that even consultancies themselves may not yet have acquired the necessary expertise to be able to apply new concepts and criteria. One of the main reasons for why consultancy studies and administrative procedures pose a barrier to self-organisation is that (in addition to incurring additional costs that may, however, be covered by the national water fund) the studies can be time-consuming. They often go through several rounds of revisions to meet requirements that may not have been coordinated between different administrations involved and may, therefore, be conflicting (as in the Syr case).

Overall, therefore, the case studies suggest that the national implementation of the EU WFD and environmental policies has not led to a paradigm shifts towards more adaptive and network governance and a greater consideration of the knowledge of practitioners. Rather, it has strengthened the scientific character and technical framings of water and environmental governance, leading to more regulation and detailed and rigid technical requirements, while expectations of stakeholders to be involved more actively in water governance have largely been disappointed. Thereby, EU WFD implementation has increased the divide between specialised scientific expertise and the local and professional knowledge of non-scientific actors (even if they themselves increasingly resort to, use, and produce scientific data).

On this basis, the thesis argues that – compared with pre-2000 decades – the formal shift towards environmental objectives and stronger cross-sectoral integration has not (yet?) enlarged spaces for personal meaning-making, self-organisation, and experimentation (further elaborated in 11.2 below). This may also be the result of a combination of a sense of increasing urgency to address ecological deterioration, coupled with a belief in the relative superiority of specialised scientific expertise. In the past, the dominant governance has also been hierarchical (and in other respects not examined in the thesis probably even more so than today). On the other hand, the historical examples from the Upper Sûre and Syr valleys suggest that there may have been more room to accommodate pioneering self-organised projects and experimentation. Regulatory frameworks were less detailed and may have been handled more flexibly (with interpersonal relations playing a larger role, which also had both advantages and disadvantages).

11.1.2 Management

Via its objectives to restore aquatic ecosystems, the WFD has profoundly changed *formal* purposes of national water governance, and expanded the scope of and preferred means in water management, with river restorations as one example. In addition to formal purposes, the case studies also suggest that nongovernmental actors such as the Syr and Upper Sûre river partnerships, the Upper Sûre Nature Park, environmental NGOs such as the Fondation HfN, etc. strongly supported the re-orientation of water management towards environmental objectives and aquatic ecosystems. However, as along the governance axis, there are growing tensions between anthropocentric and ecocentric objectives and ´realities´. The case studies suggest that formal changes have not yet translated into adaptive and more ecocentric management priorities and means *in practice*, where investments in engineered infrastructures (associated with the command-and-control paradigm) and the productionist agricultural paradigm continue to prevail. The case studies suggest that there is a discrepancy between formal coordination and integration of objectives and plans, and the coordination and implementation of concrete projects. While water and land management have become more *integrated formally*, they have not become more *adaptive*. In the period covered, there has been little progress towards achieving a ´good ecological status´.

National WFD implementation has increased formal coordination between authorities in charge of water and the environment leading to more integrated overarching purposes and operational

objectives and measures adopted for aquatic ecosystems as formally inscribed in the WFD and Natura 2000 management plans. However, the Syr case study suggests that their coordination as regards the implementation of measures is insufficient. A lack of coordination and leadership has contributed to the fact that few plans and studies e.g. relating to river restorations have arrived at the point of implementation. Therefore (and in addition to other factors outlined below), there have been few examples of nature-based ´solutions´ since the pre-WFD river restoration in Mensder Brill in 2003, despite the *formal* obligation to improve river structures and preferences for nature-based solutions in both administrations.

Furthermore, the area of Mensder Brill suggests that the management of protected areas is a challenge. The fact that there as yet are no new project to manage the area in line with Natura 2000 requirements and management plans seems to substantiate arguments that point to shortcomings of ´traditional´ approaches to ecological restoration, notably because they often do not imply community involvement and because they aim to restore and preserve specific target states and species. This is contrary to principles of *adaptive* management. The narrow ecocentric focus on ecological states neglects the social dimension of human engagement with water and land, and related social-ecological feedbacks and social criteria (Waylen et al., 2019). So far, there have hardly been any projects in the Syr valley to involve local communities in processes to address public fears of wetlands.

Furthermore, there are growing contradictions. Firstly, there are growing contradictions between environmental objectives and demographic and economic developments. The principle ´polluter-pays´ and the requirement to carry out environmental impact studies for any projects likely to affect ecosystems have not been applied equally to small and large projects. Furthermore, nongovernmental environmental actors increasingly doubt the ´philosophy´ of compensation, witnessing growing ecological deterioration, losses of biodiversity and decreasing land availability, while major pollution causes are not tackled. In general, pressures on rivers such as the Syr continue to increase due to growing quantities of wastewater, expanding settlements, and other factors. Their impact, however, have not yet been scientifically assessed although some actors suspect that they render the attainment of EU WFD objectives impossible given the small size of rivers in Luxembourg. Changing weather patterns reducing the quantities of freshwater in rivers further increase the share of effluents in drought periods. They thereby aggravate what the Syr River Partnership and the Water Management Authority (AGE) consider to be a major obstacle to reaching a good ecological status. So far, the ´solution´ pursued by AGE, municipalities, and their syndicates perpetuate ´technological fixes´ of the past, namely via investments of extensions of wastewater treatment plants (such as Uebersyren). It remains uncertain if the ecological status of the Syr river will improve in the future.

The introduction of new drinking water protection zones in the Upper Sûre region and across Luxembourg is an example of efforts to *reduce* the need for technical treatment and is, thus, in line with adaptive principles. However, although the protection zones should originally have entered into force in 2015, they had not been introduced by Autumn 2020. Many actors also doubt how effective they will be in improving the water quality in the Upper Sûre lake. The Upper Sûre case suggests that Luxembourg continues to be dominated by conventional agriculture and the productionist paradigm, despite the principle of cross-compliance and agri-environmental-climate measures in the 2nd CAP pillar), national plans for biodiversity, and organic agriculture. The Upper Sûre case study suggests that coordination between the ministries in charge of the environment and agriculture has improved. However, here too, coordination between policy-making and implementation in practice remains complex, including for farm advisors. Moreover, landscape management for the sake of biodiversity continues to be a niche activity of both conventional and organic farmers who rely strongly on production and consumer demand for their incomes (in addition to public subsidies). Efforts for transformative change in agriculture are undermined by other CAP provisions, global competition on

food markets, the behaviour of consumers in Luxembourg (and beyond), and increasing land prices combined with less land availability (see below). One unintended effect of the planned restrictions on farming in Luxembourg is the displacement of agricultural production to the (larger) Belgian part of the Upper Sûre sub-basin. It thus remains uncertain if the future drinking water protection zones in the Upper Sûre basin will contribute to changes in the agricultural regime in Luxembourg and improve water quality.

Finally, in parallel to the governance processes relating to the new drinking water protection zones, a new high-tech treatment plant has been built to secure national drinking water supply in the next decades. As in the case of the wastewater treatment plant at the Syr river, the new plant in the Upper Sûre region suggests that water management *de facto* continues to have a strong focus on infrastructural investments and technological ´fixes´ that perpetuate the command-and-control paradigm. What is perhaps different from before (e.g. when compared to the 1950s and 1960s), however, is that infrastructural projects in water and transport and productivity increases in agriculture seem no longer to be promoted as strongly in collective narratives and imaginaries of progress as before (see case study chapter 7.2.1 on the construction of the Upper Sûre dam for comparison). Supply- and growth-oriented paradigms continue to exist, but their narrative dimension in terms of providing a shared imaginary based on technological progress seems less pronounced when compared to the 19th century and post-WWII reconstruction efforts, especially since the last two national elections.

The case studies thus suggest that the managerial ecological restoration paradigm underlying the EU WFD and environmental policies co-exists with modern-industrial growth paradigms, making the governance system more hybrid and contradictory. Many actors (across scales and sectors) expressed doubts that continuous economic and demographic growth in Luxembourg could be reconciled with environmental protection and sustainability. This also suggests that Luxembourg´s transposition of the EU WFD and other environmental policies are but one factor in much wider systems whose overall patterns are shaped by many other – and often conflicting – drivers. Furthermore, so far few public social processes and dialogues have openly addressed and sought to alleviate tensions and contradictions.

The analytical framework introduced the concept of polycentric governance (see 3.2.3.1). Polycentric governance encompasses a hybrid mix of hierarchical, network- and market-based modes of governance composed of issue-specific centres of decision-making and constellations of actors (Newig & Koontz, 2014; Ostrom, 2010; Pahl-Wostl, 2015). Normatively, the concept of polycentric governance is rooted in the idea that there are no “panaceas” (Pahl-Wostl, 2017) as regards governance modes and management paradigms when addressing environmental problems (Pahl-Wostl, 2015). This echoes the notion that sustainability challenges are “wicked” problems for which there cannot be a ´solution´ (see conceptual positioning 2.1.3) or, alternatively, that any ´solution´ will necessarily be “clumsy” (Verweij et al., 2006). However, what distinguishes a polycentric from a *fragmented* regime is the degree of vertical and horizontal coordination for which cross-scale and cross-sectoral network governance is crucial (Ostrom, 2010; Pahl-Wostl & Knieper, 2014). Furthermore, the main distinguishing factor between an integrated and an *adaptive* and integrated water governance regime is the existence of flexible regulatory frameworks that foster social learning and the capacities to respond to new challenges through institutional adaptations and transformations (Pahl-Wostl, 2015). Based on these definitions, the present thesis argues that the EU WFD has contributed to making water, environmental, and agricultural policies more integrated formally, but that water governance and management have not become more adaptive due to rigid regulatory frameworks and the persistence of infrastructural ´fixes´ to improve the state of aquatic ecosystems. Furthermore, given that network governance remains weak and that contradictions and tensions seem to dominate over

coordination when it comes to certain projects, the case studies also suggest that Luxembourg´s water and land governance systems are fragmented and increasingly contradictory (see figure 11.1). Integrated water governance and management is a balancing-act between diverse governance modes and management paradigms.

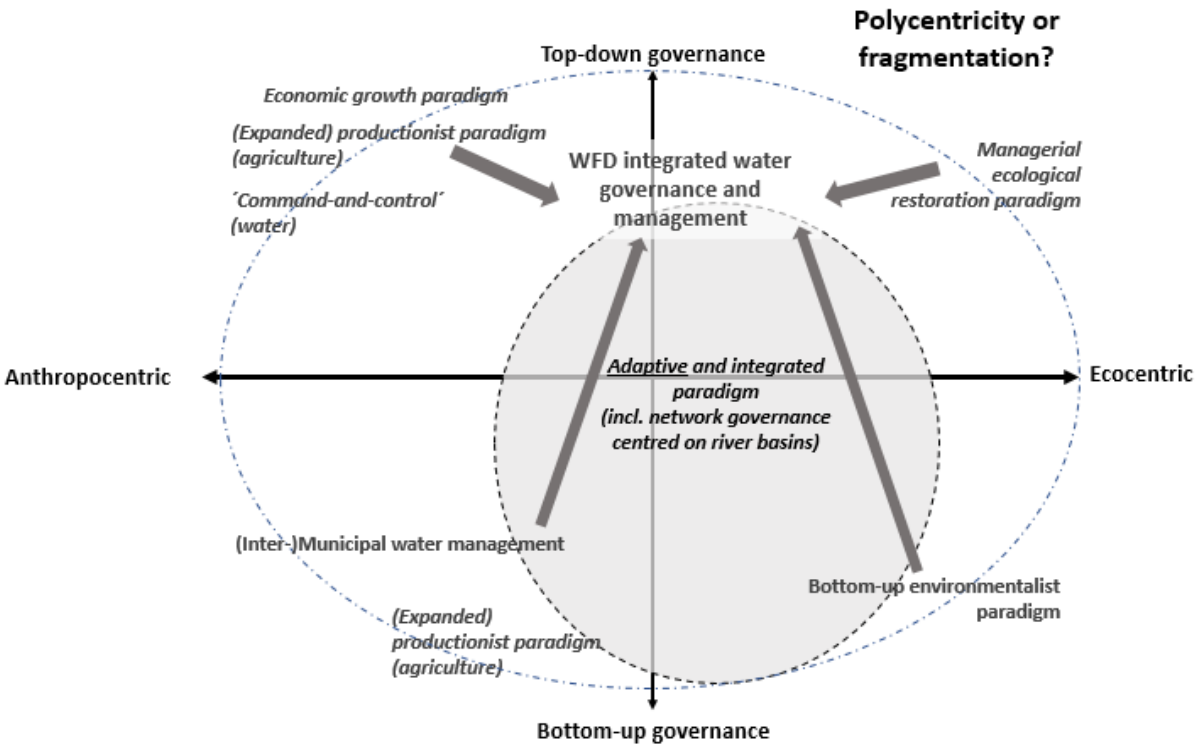


Figure 11.1 – Water governance and management in Luxembourg as balancing-act between diverse approaches and paradigms

11.2 Facilitating and hindering social learning factors (research question 3)

The case studies have served to analyse if and how social learning has emerged in informal governance processes. Social learning is a hallmark of adaptive and network based approaches to water and land governance and management. As discussed above, triple loop learning understood as paradigm shifts in water and land systems has not emerged during the period investigated. Therefore, the following analysis focuses on various informal, formal, and material factors that have either facilitated or hindered *double loop* social learning and actionable knowledge.

In the conceptual and analytical framework, double loop social learning has been defined as entailing profound changes in interpersonal and interorganisational relations and roles, the critical questioning of established purposes and problem framings, and as enhancing collective capacities for actions that depart from established routines and practices. Based on enhanced and reflexive normative and systems knowledge, sustainability learning entails that actors become more aware of and take responsibility for consequences of their practices by adapting and transforming actions and institutions, thereby changing patterns in how they engage with each other, and with water and land. Actionable knowledge for sustainability was understood as entailing profound changes in personal meaning- and action-frames that are often shaped by knowledge shared in specific organisations and

communities and closely related to narratives and paradigms. Therefore, the present thesis has extended social learning to professional and organisational learning and contexts.

In the Syr and Upper Sûre cases, double loop social learning has been limited. Some of the main hindering formal and material macro factors have been outlined above. They manifested themselves in both river basins, albeit differently. Based on the actor-centred multicontextual scheme developed to analyse social learning processes (see figure 11.2), the following compares informal processes in the Syr and Upper Sûre valley, highlighting similarities and differences.

The first sub-chapter compares general dynamics of governance processes and their interplays in the two case studies (11.2.1). The second sub-chapter elaborates on factors that have affected network creation, including interrelations with action and particular outcomes (11.2.2). Informal factors relating to knowledge and its interrelations with narratives are addressed in more detail in relation to research question 1 (11.3)

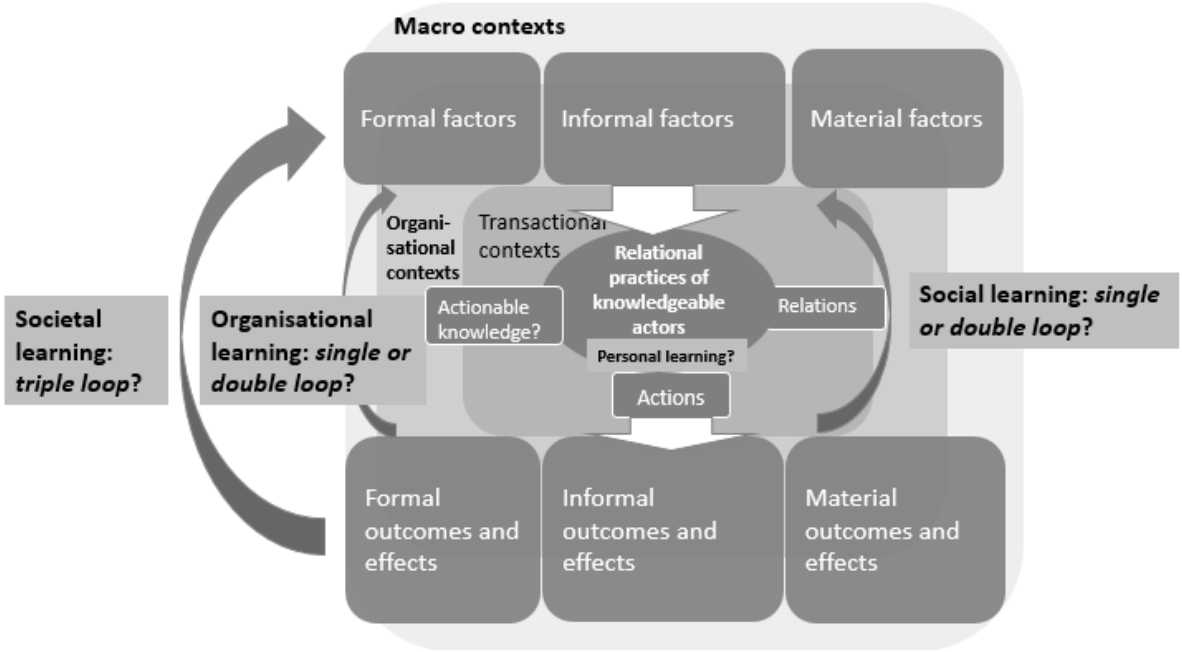


Figure 11.2 – Multicontextual scheme to analyse social learning in governance processes

11.2.1 Comparison of governance processes

The point of departure of the case studies was the assumption that interplays between formal and informal processes and the emergence of social networks are particularly conducive to social learning (Pahl-Wostl, 2015). In order to facilitate the identification of such interplays, the present thesis has developed ideal-typical phases for formal and informal governance processes to which single action situations have been attributed (see figure 11.3).

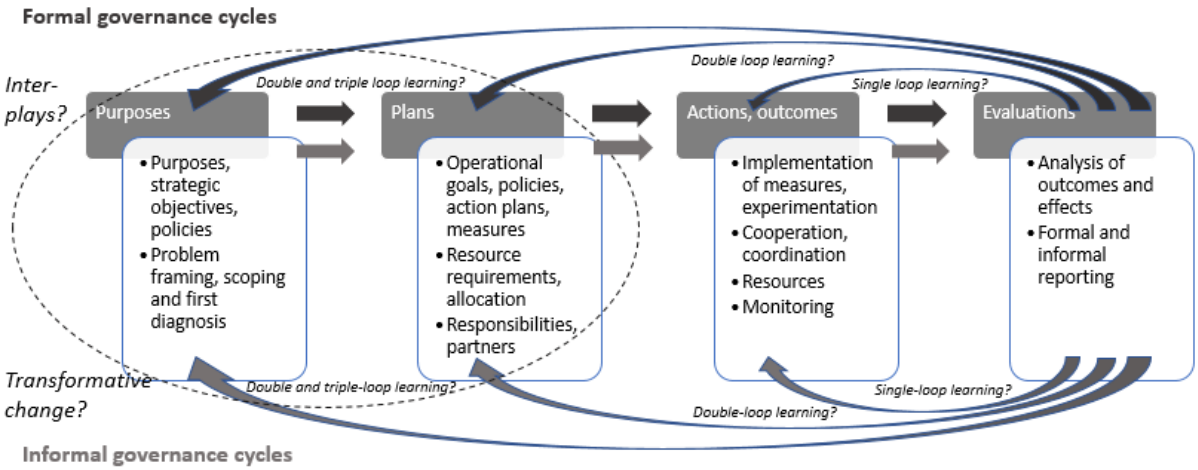


Figure 11.3 – Schematic representation of ideal-typical phases and social learning feedbacks in formal and informal governance cycles

As regards similarities between the Syr and Upper Sûre cases, formal and informal governance processes initiated by the river partnerships have related directly to the EU WFD and the expectation of stakeholder involvement. Overarching purposes to be achieved by formal water governance were prescribed by the EU WFD and had also been adopted by the (Interreg projects of the) river partnerships, even before they were transposed into national law Luxembourg. Hence, overarching objectives were shared between the AGE and the river partnerships. Throughout, they were rarely debated or questioned. Most action situations analysed concerned the planning phase of measures. One of the most significant similarities between the two cases was that most processes analysed concerned the preparation of operational objectives and measures, predominantly based on specialised/technical expertise. As regards formal processes, the planning of new drinking water protection zones in the Upper Sûre Region has so far taken eight years, but they have not yet entered into force (status: Autumn 2020). In the Syr valley, the declaration of Schlammwiss-Brill as a national nature reserve had been 37 years in the making, the necessary decisions to proceed to the extension of the Uebersyren wastewater treatment plant 13 years, and it may take at least another 10 years before the new plant becomes operational. No significant progress has been made on restoring 80 % of the Syr river targeted by the Natura 2000 management plan for the Syr valley around Schlammwiss-Brill. The feasibility study for river restorations in the municipality of Betzdorf continues to be ongoing (status: summer 2020). Only a small percentage of hydromorphological measures of the national WFD management plan have so far been implemented. The Water Management Authority itself and most other actors no longer believe that a good ecological state of a majority of water bodies can be reached by 2027. As regards the river partnerships, they spent most of their time and resources in obtaining funding and authorisations for comparatively small measures (when compared to infrastructural projects), which may take several months or years – or not materialise at all. Municipalities in both river basins have experienced a similar situation. Thus, during the processes analysed few tangible outcomes could be identified**.** A notable exception is LAKU that carried out numerous experiments and field trials (see below).

Despite lagging implementation and doubts about whether objectives can be reached, overarching purposes, objectives, and operational plans have not been revised during the period analysed, neither as regards formal nor informal governance processes. This substantiates the argument that regulatory frameworks may significantly constrain interplays between formal and informal governance processes and, thereby, double loop social learning (Medema et al., 2014; Pahl-Wostl, 2015) (see also chapter 3.2.2.2).

Notable exceptions are incidences of policy learning where policies relating to pesticide restrictions and new funding opportunities for farmers were introduced in the framework of the future drinking water protection zones in the Upper Sûre region, including via SEBES and in support of the LAKU cooperation. Otherwise, however, both formal WFD objectives, Natura 2000 and agricultural objectives and related management and action plans were hardly opened for revision, let alone critical re-examination. The same applies to the objectives and plans of the river partnerships. While most actors (including the European Commission itself, see Syr case study 10.7.3) recognised that implementation was slow and had not yet contributed to substantial improvements, few occasions to critically discuss barriers to implementation, related objectives, plans, and how to improve cooperation and coordination were seized in the processes analysed. As regards formal processes, possible occasions have included the elaboration of progress and status reports of the national EU WFD management plans and the related public consultations. As regards informal processes, possible occasions were offered by the annual colloquia of the Luxembourgish river partnerships, meetings of their river committees, and accompanying committees.

A final similar element is that, in both case studies there were unforeseen events that influenced the state of ecosystems and sparked public debates, thereby influencing governance processes. In the Upper Sûre case, the pesticides accident in the Belgian sub-basin in 2014 had a major impact on water quality and security of drinking water supply leading to controversies about pesticide use in agriculture. The incidence confirms arguments in the literature that point to the significance of hazard events in governance processes (Folke et al., 2005; Medema et al., 2014; Pahl-Wostl, 2015) (see chapter 3.2.5.1). At a much smaller scale (and without comparable impact), the death of Galloway cattle in Mensder Brill and the consequent ending of the pasture project in 2016 raised doubts about what had been a pioneering model for the management of Natura 2000 and nature reserves.

The most significant difference between the two cases is the presence of overarching themes and processes. In the Upper Sûre sub-basin, the new drinking water protection zones planned were a source of local mobilisation and provided an overall point of reference and framework for formal and informal governance processes alike. In contrast, there have been no overarching initiatives or processes in the Syr valley. The airport wastewater problem, death of cattle in the Mensder Brill area, and the declaration of Schlammwiss-Brill as national reserve area attracted *some* more widespread attention among local communities. Despite the formal coordination and integration of management plans and objectives, formal and informal governance analysed in the Syr valley have predominantly been running in parallel to each other, focusing on different single issues and projects. The Syr case study paints a fragmented picture of water and land governance. In the Upper Sûre region, sequences and interplays between formal and informal governance processes that have been identified have been more intense and frequent. The figures 11.4 and 11.5 visualise these differences.

Based on the above assumption, this diagnosis alone would suggest that the Syr processes may have been less conducive to social learning.

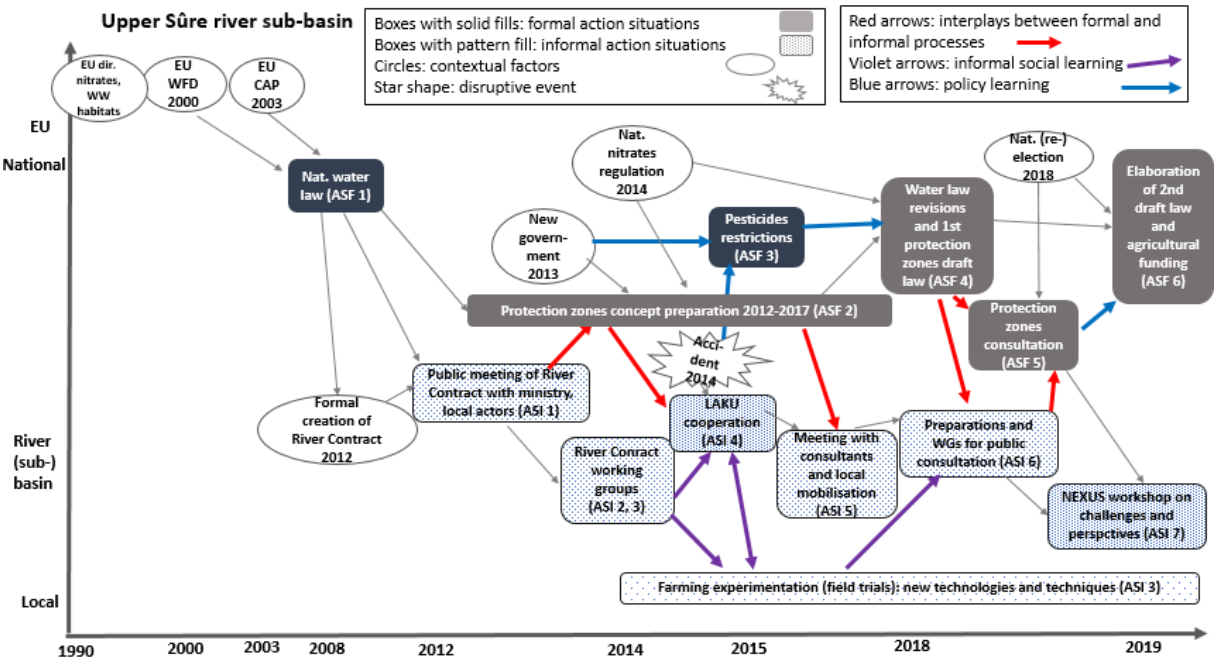


Figure 11.4 – Graphic representation of formal and informal action situations in the Upper Sûre sub-basin

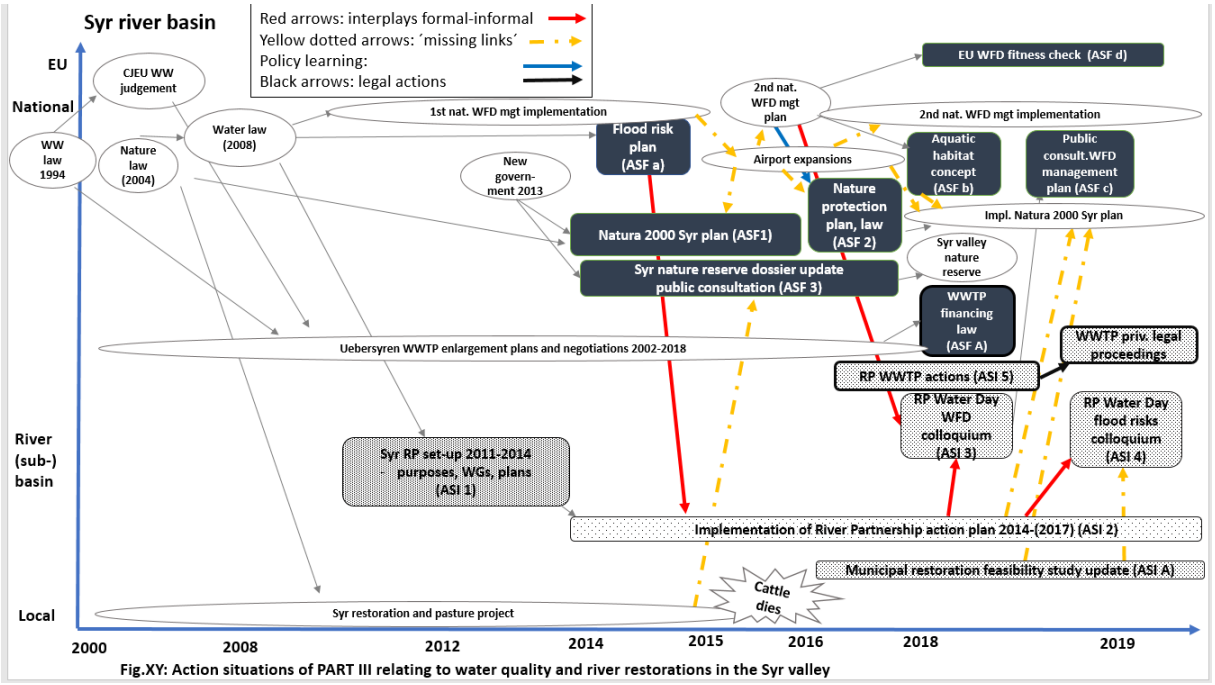


Figure 11.5 - Graphic representation of formal and informal action situations in the Syr basin

11.2.2 Comparison of informal, formal, and material factors

Key indicators of social learning, there have been some network effects, changes in knowledge, and action in both the Upper Sûre and Syr valleys that have produced certain outcomes. The case studies have analysed what factors have facilitated or hindered that the river partnerships could act as boundary organisations and facilitate the creation of multi-actor social networks. In the cases analysed, however, there has been little evidence for the emergence of networks that fostered social learning across scales and sectors, and few examples of actionable knowledge for sustainability.

11.2.2.1 Informal contextual factors: organisations and histories

Network effects in the two river basins have been analysed by reference to the analytical paradigms grid. In the Upper Sûre case, social networks have mainly emerged among local and nongovernmental actors, and have hardly included governmental actors. The analysis of network effects can thus be analysed in terms of tensions between top-down/bottom-up governance, although they also partly reflected tensions between ecocentric/anthropocentric orientations. In contrast, social networks in the Syr valley have centred on like-minded local and national actors committed to environmental objectives, hardly including farmers and other agricultural actors. Network effects can thus be analysed by reference to tensions along the normative anthropocentric/ecocentric axis.

The main factors identified to explain these differences relate to historical and organisational contexts that preceded the processes analysed, and to informal process dynamics unfolding during the period studied (see table 11.1). Both river basins have been defined based on hydrological and administrative WFD criteria. However, the river basin districts of the Upper Sûre have coincided with a region whose identity has grown historically and has offered formal and informal organisational structures and spaces for local self-organisation across municipal and sectoral borders. In this sense, the Upper Sûre region is an example of a community-based "bioregion" that is largely congruent with a hydrologically defined area (McGinnis, 1999). In contrast, the Syr basin is an example of an ecosystem-based "bioregion" where hydrological boundaries hardly reflect local and organisational structures and identities, also referred to as (lack of) ´scalar fit´ or ´mismatch´ (Huitema et al., 2009).

As regards historical and organisational contexts the close affiliation of the river partnerships to the Upper Sûre Nature Park, respectively the environmental organisation Fondation HfN have been highly significant. As part of the Nature Park, the Upper Sûre River Contract has been located at the organisational backbone of a region that has had a decades-long tradition of cooperation between municipalities, farmers, and farm advisors, other agricultural actors, and the environmental staff employed by the Nature Park and its biological station. While the Nature Park is founded on cooperation with and co-funding of ministries, it is perceived (by local and national actors alike) as having predominantly offered a structure for regional activities and marketing originally born out of opposition to centralised government plans. In the processes analysed, tensions between ecocentric purposes of Nature Park staff and anthropocentric purposes of farmers and municipalities have been secondary to the joint objective to make "the voice of the region" heard, which generated high degrees of both personal and organisational commitments in the river basin.

As a project of natur&ëmwelt Fondation HfN, the Syr River Partnership, in contrast, belongs to an organisation that has a decades-long tradition of bringing together environmental activists in the whole of Luxembourg, sometimes in direct opposition to farmers and without necessarily having strong connections to local communities. Furthermore, unlike the River Contract the Syr River Partnership could not build on pre-existing formal cooperation between the 15 municipalities and other local actors in the river basin. Instead, it has been closest to the SIAS syndicate that has provided a common structure of (only) four municipalities. The absence of an overarching challenge with which diverse local actors identified and the absence of common projects have contributed to this. The ´mismatch´ between the river basin scale and contexts and processes of formal and informal social organisation has thus remained. In bioregional approaches, river basin organisations are regarded as well positioned to enhance the ´fit´ between scales of ecosystems and governance (Huitema et al., 2009). However, the Syr case suggests that such a process may meet diverse obstacles, require significant resources and time.

Facilitating (inter-)organisational factors	Hindering (inter-)organisational factors
	History of tense relations between nongovernmental and governmental actors (bottom-up/top-down tensions)
	History of tense relations between environmental and agricultural actors (ecocentric-anthropocentric tensions)
Pre-existing organisational structures and social networks at the scale of river basins (incl. regional identities) (Upper Sûre)	Absence of or weak pre-existing formal organisational structures and social networks at the scale of river basins

Table 11.1 – Overview of facilitating and hindering contextual and (inter-)organisational factors identified in the case studies

11.2.2.2 Informal process factors: Relations and knowledge in action

Despite the above-mentioned differences, two instances of social learning and actionable knowledge were identified in both river basins that entailed discernible network effects and changes in social relations that concerned the river partnerships and the agricultural cooperation LAKU. They also produced tangible outcomes. What they have in common is, firstly, that they flowed from processes of informal self-organisation and, secondly, that they emerged in response to a change in the formal governance context. The former point substantiates the established assumption in transformative sustainability science and adaptive governance that social learning emerges predominantly from self-organisation, transactional engagement, and experimentation (Caniglia et al., 2017; Sipos et al., 2008; Van Poeck et al., 2018). Direct engagement and joint projects was most conducive to building trust and changes in roles and narrative identities (further elaborated below). Place attachment also played an important role (McGinnis, 1999; Singleton, 2015).

As regards the second point, it was the EU Water Framework Directive in combination with public project funding opportunities and the expectation that stakeholders would be actively involved in water management in the future that gave decisive impulses to the foundation of the river partnership. As regards LAKU, it was the prospect of new drinking water protection zones that mobilised local actors, in combination with the expectation to contribute to their elaboration and to, potentially, improve own ´strategic´ positions (i.e. to obtain certain privileges once the protection zones would enter into force). In both cases, (anticipated) changes in the regulative context in combination with expectations of active involvement thus induced actors to seek new social relations.

The instances identified were:

- River partnerships of the Syr and Upper Sûre: Elaboration of inventories from collaborative data collection and problem mappings on the state of hydrographic networks in the river basins as basis for the elaboration of joint charters and action plans during their foundational periods (2005-2012);
- Upper Sûre River Contract agricultural working group and LAKU: development of innovative and more ´water-friendly´ agricultural technologies and techniques developed in the framework of experiments and field trials, including a GPS-based mobile phone app for farmers.

In these examples, common ideas and plans on what to do together emerged from joint dialogues and self-organised activities (namely, in case of the river partnerships from Interreg projects), without pre-defined and external objectives. However, following the formal national institutionalisation of the river partnerships, the implementation of action plan measures encompassed fewer wider collaborative

processes, with all partners predominantly focusing on ´their shares´. The Syr River Partnership has carried out some improvements of river structures of streams, cattle bridges, troughs, and fences. Concrete projects implemented were important as they were the main reason for why municipalities have turned to the river partnership for advice and support.

Overall, however, governance processes brought few changes in the quality of interpersonal and interorganisational relations in the Syr basin, beyond operational contacts with national public administrations and other actors. Compared with the Upper Sûre, municipalities and partners in the Syr river basin seem to have lacked a ´common cause´. The wastewater problem relating to the Uebersyren plant and international airport could perhaps have provided impulses for more self-organisation in the river basin, as insufficiently treated wastewater affected all downstream municipalities and as municipal representatives repeatedly discussed the issue at river committee meetings and took the initiative to write joint letters. However, the fact that the Syr River Partnership received no answer and that it, overall, had not been able to establish contacts to neither national decision-makers in this matter nor the airport itself, meant that it, unlike the Upper Sûre Nature Park and River Contract, could not provide local actors with a platform that increased visibility for local concerns. Actor engagement in the social network rested predominantly on the personal commitment of single individuals, rather than their organisations (e.g. municipalities) whose resource investment in the river partnership has been minimal. On the other hand, the Syr River Partnership has had better relations with, notably, the Water Management Authority than the River Contract, with frequent contacts that, however, were predominantly operational. Therefore, overall, some network effects have emerged in the Syr valley across levels of social organisation, but have in comparison been more limited horizontally across municipalities and sectors.

In contrast, the expected new drinking water protection set into motion a host of social processes in the Upper Sûre river basin when the River Contract (and Nature Park) organised public meetings and working groups. The working group on agriculture differed from the others, because its members were eager to move to ´do things together´ quickly. It produced the most tangible outcomes of the informal processes analysed, including the creation of new formal organisations (LAKU) that institutionalised changing roles (notably, of SEBES), entailed knowledge co-creation, and the development of new technologies and professional practices that have begun to be rolled out across the Grand-Duchy. Although the technologies and practices served primarily single loop learning (i.e. ´business-as-usual´), the case study nonetheless suggests that the emergence of new roles among partners who had hardly had contacts before, knowledge co-creation, and the generation of tangible outcomes may go hand in hand rather than being separate phases of informal processes. A milestone event in this regard was an excursion that the River Contract, farm advisors and farmers organised together with a SEBES representative to members of a cooperation between farmers and a water at a German artificial dam. The excursion fostered first informal contacts between the water supplier and farmers, and the openness and eagerness to ´try out´ something similar. Adding to this were seminars with guest speakers experienced in new agricultural approaches and in cooperation between farmers and water suppliers. They provided inspiration and ´best-practice-examples´ that the Upper Sûre partners adapted to their contexts. SEBES also provided and discussed water quality data with participants, external researchers soil data. A significant element of social learning for sustainability (Tabara & Pahl-Wostl, 2007), participating farmers began to openly acknowledge and actively tackle undesirable effects of their practices on ecosystems and water quality.

In addition to a new formal focus on reducing pollution at source, the engagement of the national water supplier SEBES in the process seems to have initially rested strongly on the *personal* commitment and interpersonal relations of dedicated individuals. Interpersonal relations were followed by organisational commitment of the water supplier in the form of time and resources invested (including

via the national water fund of the Ministry of Sustainable Development). This points to the importance of social networks in bringing together committed individual actors who may generate more *organisational* commitment and, thereby, foster both intra- and inter-organisational learning (Bouwen & Taillieu, 2004; Sol et al., 2013; Wenger, 1998).

Farmers´ commitment was based on expectations that closer cooperation and experimentation would put them into a better position to secure the future of their farms, which they perceived as under threat. The case study suggest that , indeed, a sense of interdependence (rather than, initially, trust) was one of the main factors that facilitated cooperation between SEBES and farmers (Bouwen & Taillieu, 2004; Mostert et al., 2007). It resulted in a high level of both personal and organisational commitment among the parties involved (including the Nature Park, River Contract, and farm advisors). Changes in the role of SEBES have so far been institutionalised in the creation of a new position (the coordinator of the future drinking water protection zones whose job description includes relations with LAKU and other local actors), but not yet (?) in its legal mandate and statutes.

All interview partners underlined how important joint actions had been. Members of the agricultural working group had begun with experiments before formally founding LAKU. The overall objective was to increase farming efficiency by decreasing input (e.g. of manure) while maintaining similar levels of production output (yields) and reducing erosion. The experiments confirm that farming practices seeking to reduce fertilisation, soil erosion and pesticides by being more adapted to local soil conditions, introducing catch crops, mechanical weeding techniques, etc. tend to be more knowledge- and technology-intensive than ´traditional´ conventional approaches (Ingram, 2008; Röling & Wagemakers, 1998) (see also chapter 4.3.2). The experiments necessitated significant *professional* technological learning and mutual support of all participants. The personal professional and technical advice that pioneering LAKU farmers offered to their peers was essential in this regard. On the other hand, leading LAKU farmers themselves were disappointed at the relatively low number of members who engaged actively in experiments. Some attributed this to what they perceived as a widespread preference among colleagues to stick to ´what they know´. Others who had initially participated withdrew again after first experiments had not produced expected results.

Finally, when compared to measures such as river restorations, it is noteworthy that LAKU experiments entailed much fewer administrative requirements compared with river restorations and other measures along rivers as no authorisations were needed for the field trials and as SEBES provided funding.

However, with the exception of LAKU, relations between local and governmental actors hardly improved throughout the processes analysed. Mistrust had existed historically, not least since the construction of the Upper Sûre dam in the mid-20th century. Following initial steps towards one another, political factors began more strongly to influence relations. The national-regional divide re-surfaced following the pesticides accident and during campaigns in the run-up to national elections that not only moved the issue of drinking water protection into arenas of public and political debates, but also lay open *party*-political divides between the Green Party heading the Ministry of Sustainable Development and a predominantly conservative region. This example provides some evidence for the argument that social learning can be seriously hampered when issues discussed become objects of public and political controversies (Pahl-Wostl, 2015). As tensions between local and national actors and discontent with the protection zones process increased, regional “solidarity” also grew. It remains an open question if the situation would have become as polarised as it did if there had been more active stakeholder involvement before. The Nature Park and River Contract were hardly used as fora for dialogue. Without being able to fulfil its “mandate” to coordinate public participation, the River

Contract could hardly assume the role of boundary organisation. Instead, it was caught in-between local actors and national decision-makers. There was no mediator between the two sides.

In both the Syr and Upper Sûre cases, barriers to cross-scale (Upper Sûre) and cross-sectoral networks (Syr) remained (see table 11.2). The colloquia of the five (six as of 2019) Luxembourgish river partnerships have offered an annual informal networking space for the river partnerships, local and national actors from diverse sectors. The events observed in 2018 and 2019, however, hardly fostered new or closer contacts and dialogues. As regards both cases, empirical data suggests that relations between the river partnerships and governmental actors would benefit from more regular in-depth dialogues and common projects.

Facilitating process factors	**Hindering process factors**
(Anticipated) changes in formal regulative contexts in combination with expectations of active involvement and funding opportunities	Limited resources in terms of staff and funding of boundary organisations
Strong *personal* commitment and pioneering spirit of leading and active members seeking new partners and forms of cooperation	Absence of leadership and pioneers
´Leeway´ granted by organisations to members to participate in activities of social networks	Actors sticking to established relations in existing organisations
A ´cause´ creating a sense of interdependence and shared purpose in combination with confidence of being able to ´change something´	Lack of a shared ´cause´ and/or lack of belief that self-organisation can ´change something´
Strong *organisational* commitments of key actors, including of boundary organisations	Weak *organisational* commitment among members and partners
Regular contacts and joint activities, e.g. in the framework of working groups, excursions, problem mapping exercises, etc., building trust, and reducing stereotypes	Lack of time and resources of members and partners to engage in social networks
Collaborative knowledge co-creation based on best-practice examples, seminars, scientific information and data tailored to local contexts	
Collaborative knowledge co-creation via learning-by-doing from experiments	Preference for routines and for implementation of pre-defined recipes that ´work´ regardless of contexts
	Instrumental-strategic attitudes that expect quick desired results
	Lack of trust in network leaders and facilitators (incl. boundary organisations)
	Lack of facilitators/mediators in conflicts
	Political/normative differences among actors that become objects of polarising public and/or political debates
	Events (e.g. hazard events) that trigger accusations and ´blame-games´

Table 11.2 – Overview of facilitating and hindering processual and relational factors identified in the case studies

11.2.2.3 Formal factors

The formal factors compared in this sub-chapter concern both formal overarching governance institutions and formal organisational institutions that have affected processes (see table 11.3).

Despite the processes outlined above, the Syr and Upper Sûre case studies substantiate the argument of adaptive governance scholars that rigid legal requirements reduce spaces for self-organisation and social learning that depend crucially on flexibility (Dietz et al., 2003; Folke et al., 2005; Pahl-Wostl, 2015). Due to the comprehensiveness and degree of detail of national legal prescriptions and requirements, actors were almost inevitably confronted with legal barriers in their professional activities. Legal restrictions are the result of efforts to halt and reduce ecological deterioration. However, the case studies also suggest that they can inhibit self-organised actions that aim to improve water quality and ecosystem health. The case studies thus lend substantial evidence to the assumption that formal regulative institutions may pose barriers to double loop social learning, because they reduce possibilities of critical re-framings of overarching purposes and operational objectives, scopes, and means, notably of actions and experimentation (Medema et al., 2014; Pahl-Wostl, 2015). Few governmental and nongovernmental actors questioned overarching WFD and environmental objectives, several identified with them wholeheartedly. At the same time, the case studies find that legal and technical requirements in many cases have made self-organised actions of actors committed to improvements more difficult than in the 20th century.

The finding is primarily based on the Syr case study (see 10.5.5 and 10.6.1), but has also emerged from interviews with local actors in the Upper Sûre region. Examples from the Syr include how ponds were dug by the Fondation HfN in the 1980s and the (top-down) river restoration of 2003 (pre-WFD transposition) compared with measures along rivers and municipal projects today, many of which have been stalled. In the past, actors could "sin in spontaneity" (as one interview partner put it) and experiment with ecosystem-based measures. Example of the 1980s:

> *"Mit dem Förster: „Ja, ja", sagt er, „das ist in Ordnung", fertig! Heute brauchst du hundertdreißig Gutachten, sechs Genehmigungen und kommst nicht weiter". (interview n° 49)*

In contrast, projects such as river restorations today usually requires ´expert´ studies and authorisations from several public administrations:

> *"Wie, zum Beispiel, wenn man jetzt einen Abschnitt renaturieren möchte…wir haben ja bereits […] eine Renaturierung, und wollen dann etwas flussabwärts noch eine Renaturierung machen, dann wird das wieder davon abhängig gemacht, dass wir das ganze wiederum überprüfen. Anstatt zu sagen: „okay, macht mal Leute und dann nachher sehen wir, ob das Ganze kohärent ist und wenn dann noch Nachbesserungen gemacht werden müssen, dann nehmen wir die halt vor und fertig"". (interview n°9)*

> *"Da kommt man als junger Mensch […] man ist voller Tatendrang und man will vorankommen und dann die Amtsmühle. […] Und dann muss da jede Verwaltung auch mitsprechen. […] Jeder sieht nur sein Gebiet […] Dann hat man ein Projekt, das man weitertreiben will, und dann wird das wieder durch ein anderes Ministerium untergraben. Man hat schon den Gegenwind […] im Gemeinderat, und wenn man dann noch viele Hürden von den Ministerien bekommt…" (interview n°52)*

> *"... man arbeitet viel an Planungen und Vorgaben und Aktionsplänen. […] Dann ist der Text da, da steht dann drin, was man alles tun müsste. Damit ist man eigentlich noch nicht sehr viel weiter. Und wir haben jetzt in den letzten 20 Jahren eine Unmenge von solchen Dingen hergestellt. […]" (interview n°27)*

These quotes are provided here, because they reflect statements made in numerous interviews. The main arguments in favour of ´expert´ studies and technical requirements for projects concern the responsibility of public administrations to handle ´taxpayers´ money´ responsibly by making sure that projects financed would effectively contribute to improving ecosystem health and, thereby, to fulfilling EU obligations (*"Da kann man auch sagen, okay, dann kann man noch mal eher etwas studieren, anstatt Geld zu investieren" n°31)*. Social criteria (such as dedicated actors) and material factors (such as access to land) are not considered. This also means, however, that regulation and scientific expertise reduce spaces for experimentation that, per definition, depends on iterative revisions of objectives and means based on observations – and social learning. Moreover, the Syr case also suggests that administrative requirements do not only hinder experiments, but have also slowed down and prevented several projects, in general, from seeing the light of day.

Technical framings have also dominated public participation on WFD management plans and in the Upper Sûre region. In the Upper Sûre case, the River Contract had a clear expectation to be able to organise and coordinate stakeholder involvement that would be able to contribute actively to the concept on the new drinking water protection zones that would form the basis for the respective law. Government officials, however, did not share this interpretation and regarded the processes, first of all, as technical and science-driven then as political, creating few spaces for substantive dialogues. The analysis of other public consultations (e.g. on WFD management plans or the declaration of wetlands as national nature reserves) also suggest that participatory processes have rarely gone beyond technical details and stakeholder *information* meetings. While governmental actors have recognised that public consultations can contribute to enhancing the quality of laws and formal plans (e.g. by stakeholders identifying inconsistencies, loopholes and gaps, etc.), they have rarely opened spaces for dialogues about underlying principles and overarching objectives.

The fact that overall purposes (e.g. reaching a ´good ecological status´ of water bodies) are legally prescribed and that there is an increasing sense of urgency of needing to halt environmental deterioration has contributed to reducing perceived ´rooms of manoeuvre´ of governmental actors, too. In addition to the widespread impression among policy-makers that stakeholder involvement often is not fruitful, because actors involved tend to only re-affirm own positions and defend own interests (another *informal* factor hindering social learning), interviews have also suggested that the capacities of public administrations and ministries themselves are strained. National authorities do not seem to have grown proportionally with the EU and national requirements they need to manage. This has frequently been cited as a reason for why public authorities prefer ´expert´ studies, why administrative procedures are often lengthy, and for why there is little time to engage more intensely with stakeholders (and other administrations).

At the same time, as outlined above, the fact that the WFD promotes preventive principles to pollution to reduce the need for water treatment *did* contribute to changing roles of the national water syndicate SEBES and farmers in the Upper Sûre region.

In addition to these formal factors, the case studies have also identified a number of other formal organisational factors that have influenced the Syr River Partnership and Upper Sûre River Contract in their efforts to create social networks. On the one hand, legal provisions (laid out in the national water law and their contracts with the government and member municipalities) have, in principle, facilitated the emergence of social networks and, therefore, network governance. They have done so by providing for multi-actor river committees, an accompanying committee encompassing national governmental actors, and by attributing the formal role to river partnerships to raise awareness for and associate actors with integrated water management. Formal provisions also included the opportunity to contribute to river basin management and the attainment of WFD objectives via the participation in

formal public consultations and the implementation of technical measures. On the other hand, the close association with WFD management has also meant that national co-funding of the river partnership has been tied to the expectation that they would concentrate on implementing national WFD management plans, leaving little room for other activities and self-organisation (also considering limited resources). Furthermore, the capacity to act as boundary organisations has been hampered by the fact that the river partnerships have not been endowed with formal competences and rights, and municipalities continue to hold autonomy in urban water management.

In the case of the Syr, the River Partnership has thus met with difficulties in associating municipalities to their activities and in encouraging them to plan projects across municipal borders. Furthermore, the fact that the Syr River Partnership itself (as the Upper Sûre River Contract) is not equipped with any formal right to access environmental information has meant that it has had less ´leverage´ towards national decision-makers than individual citizens and formal organisations *with* legal personality (as e.g. in the airport case). As a result of these and other factors, water management in the Syr valley has continued to rest predominantly on municipalities (with national co-funding) rather than on the scale of the river basin.

Finally, it is noteworthy that the river partnerships will not be in charge of the future coordination of measures in the drinking water protection zones in their river basins (the issue has not been covered in the Syr case study, however). Instead, it will be SEBES that will coordinate the new management plans and measures in the Upper Sûre region and SIAS in the Syr basin.

Facilitating factors relating to formal institutions	**Hindering factors relating to formal institutions**
Existence of boundary organisations at the scale of river basins with multi-actor statutory bodies (such as river committees, accompanying committees, etc.), legally anchored	Legally prescribed/fixed overarching purposes and objectives not open for discussion
´Open legal mandate´ of boundary organisations encouraging self-organisation	Lack of legal personality, formal competences, and rights, e.g. of access to environmental information
Institutional (´moral´ and administrative) support of governmental and nongovernmental actors for ´open´ bottom-up self-organisation and experimentation	Expectation that river partnerships, municipalities, and other actors primarily help to "work off" WFD management plans
Governmental, municipal and/or other funding for nongovernmental organisations and activities of social networks in and beyond river basins	Difficult access to funding for organisations and projects
Lean and swift administrative procedures	Conflicting and/or rigid (interpretations of) regulatory frameworks and administrative requirements
	Slow administrative procedures and lack of coordination among administrations
	Lack of common priorities among public administrations and other actors (including municipalities)
	Lack of sufficient capacities in public administrations

	Lack of incentives for municipalities to cooperate across municipal borders
	Weak consideration of local and professional knowledge in formal national procedures
	Weak consideration of other than legal and ecological criteria in authorisation and funding procedures for projects
	Technical framings in public consultation and stakeholder involvement (not going beyond legal requirements)
	Discrepancies in interpretations and expectations as regards stakeholder involvement not openly addressed/managed

Table 11.3 – Overview of facilitating and hindering processual formal factors identified in the case studies

11.2.2.4 Material factors

In addition to the informal and formal factors compared above, the case studies have also identified a number of material factors that have hindered the emergence of social learning and knowledge producing actions that depart from established practices (see table 11.4). In both river basins, the most prominent has been land availability.

Already one of the most fragmented countries of the EU (MDDI, 2009), Luxembourg strives to match ongoing demographic and economic growth with the construction of housing and infrastructures. As a result, land availability for both agriculture and nature-based ´solutions´ decreases. Access to (affordable) land is a precondition for river restorations (Schindler et al., 2014) and agricultural extensification (Windt & Swart, 2018). However, in Luxembourg, competition for land between diverse actors has intensified (farmers, real-estate agents, companies, governmental actors, nongovernmental organisations, municipalities, private citizens, etc.). The Syr case study points to land availability as one of the most significant barriers to river restorations.

The Upper Sûre case study suggests that many agricultural actors perceive protected areas (covering 27 % of the country (MDDI, 2017b) and public purchases of agricultural land and subsequent leases to farmers prescribing extensive farming as a way to push out food production and full-time farmers of water and land systems. Other agricultural actors argue in favour of state acquisitions by reference to the rising number of foreign investors (and speculators) who buy farming land across Luxembourg (SER, 2018) and the EU (Heubuch, 2015). Nonetheless, increasing land competition and prices have negatively affected relations between farmers and the Ministry of the Environment, in particular, and also the perceived room of manoeuvre for farmers to extensify production. Some farmers increasingly extend (or shift) their production to the Belgian part of the Upper Sûre basin.

During the entire period covered by the case studies (i.e. since the 19th century), structural changes in agriculture towards larger and more specialised high-investment farms cultivating more land and producing larger quantities have continued. This has contributed to increasing farm debts and path dependencies. Furthermore, only roughly 5 % of agriculture has ´gone organic´ despite an ambitious action plan[291]. Despite intensification, farms have hardly seen increases in profits (on average roughly

[291] In the period 2009-2019 the number of organic farms in Luxembourg increased from 88 to 146, representing 5,6 % of all farms and 4,4 % of agricultural land. A large majority is specialised on milk and meat production (ASTA, 2020).

42 500 EUR/year) (SER, 2018). Instead, the gap between average and farming incomes in Luxembourg widens, with farmers on average earning less than the minimum salary in Luxembourg (SER, 2016). In addition to higher investments in farm infrastructures, land prices are one of the significant factors. The dependence of farmers on leased land has increased to 60 % since 2000, with leases also on the rise (SER, 2018). Some farmers interviewed had sold some of their land (that had become construction ground) to be able to compete in agricultural land purchases. Some doubted their children would one day be able to take over their farms and that Luxembourgish agriculture would continue to be carried by family farms in the future.

Finally, a frequently mentioned material factor is climate change. Changing weather patterns (incl. extreme weather events) pose major challenges to both water quality in rivers and to agriculture. Changing weather patterns contribute to altering flora and fauna in Luxembourg (MDDI, 2018a). Prolonged drought periods reduce the quantity of freshwater in surface and groundwater bodies. Furthermore, droughts and torrential rainfalls decrease agricultural yields, with some farmers (including organic farmers) experiencing climate change as serious existential threat.

In general, climatic changes increasingly cast doubt on regulation and management that build on fixed deadlines and on specific target states and species. The Syr case suggests that climate change may contribute to jeopardise the attainment of WFD objectives, because of too high proportions of effluents in rivers. Environmental conservation efforts may no longer be able to repopulate habitats with some of the ´traditional´ plant and animal species. In agriculture, several actors remarked that legal periods for manure application and pasturing (e.g. in protected areas) no longer corresponded to growth periods of crops and grass (which, in some years, have continued to grow until Christmas).

These examples alone seem to provide substantial arguments in favour of a paradigm shift away from rigid regulatory frameworks towards *adaptive* approaches. Furthermore, uncertainties, perceived existential threats, and frustrations about growing barriers to the attainment of legal objectives and/or the implementation of projects and activities considered appropriate by stakeholders have been significant factors that have hindered actor engagement in informal governance processes (see also 11.3.2 below).

Facilitating factors relating to the material sphere	**Facilitating factors relating to the material sphere**
Shared ICT infrastructures (e.g. databases, tools) that facilitate cooperation and provide common information and data sources	Decreasing land availability, increasing prices making access to land for river restorations or extensive farming more difficult
Technologies that decrease soil erosion, use of fertilisers, pesticides, etc. tailored to local contexts	Stagnant farm incomes combined with higher production costs and debts, reducing financial rooms for manoeuvre
Technologies (such as milk robots) that free up time of users for social activities and reduce ´stress´	Changing weather patterns (i.e. climate change) and more extreme weather events that increase variability and unpredictability making experiments less ´transferable´
Ecological self-regeneration and water retention capacities in restored rivers	Large financial investment requirements in water infrastructures (e.g. drinking and wastewater treatment plants), path dependencies
Soil quality increasing water retention capacities, decreasing need for use of chemical substances	Increasing quantities of wastewater effluents in rivers that reduce the impact of other measures to improve water quality

	Technologies that contribute to increasing the distance between humans and ecosystems (´dis-connect´)

Table 11.4 – Overview of facilitating and hindering material factors identified in the case studies

11.2.2.5 Comparison of outcomes and effects

The below briefly compares the main outcomes and effects of the governance processes analysed, focusing on social learning in the informal governance processes analysed from 2000 to 2019 (see table 11.5). Multiloop social learning has been understood as entailing feedbacks that change not only interpersonal relations, but also *contexts* of governance. When compared to water governance before national transposition of the EU WFD, the following changes in contexts of water and land governance are particularly significant:

- **Organisational contexts**: With the creation of the Water Management Authority and the river partnerships organisations have been introduced that are entirely dedicated to ecosystem-based water governance and management (for the first time in Luxembourg´s history) that is based on cooperation with municipalities, while municipalities have retained their autonomy; with the creation of LAKU a first *formal* cooperation between farmers and a water supplier emerged (including the Upper Sûre Nature Park and farm advisors);
- **Transactional contexts** (place-based): LAKU experiments have changed *some* professional practices of and technologies used by farmers in the Upper Sûre region (and beyond), smaller measures of the river partnerships have led to *some* improvements of river structures, but overall, ecosystem health has hardly improved due to ongoing nutrient input and pollution.

Particularly within LAKU, first timid signs of double loop learning and re-framing of challenges have been identified, notably, because farmers actively involved openly acknowledged and sought to tackle environmental impacts of their practices. However, overall, there have been few tangible *physical* changes, despite significant increase in water quality and environmental data. Moreover, narrative identities (personal meaning-making) have not changed significantly (see below). Therefore, few signs of transformative change are as yet manifest in Luxembourg´s water and land systems.

In addition, the Upper Sûre case study has also identified a number of incidences of *policy* learning (incl. pesticides restrictions in 2015, revisions of the national water law in 2017 and of the 1st protection zones draft of 2018 coordinated with the Ministry of Agriculture, see 9.14.1) that have changed the formal governance context (notably, towards more formal integration). The new drinking water protection zones have not yet entered into force (status: October 2020). Furthermore, there are ongoing infrastructural projects as regards the national SEBES drinking water treatment plant in the Upper Sûre region and the Uebersyren wastewater treatment plant in the Syr valley that change material transactional contexts. However, policy learning and infrastructural projects are not covered here.

Informal processes in the Upper Sûre and Syr basins	**Informal outcomes and effects**	**Formal outcomes and effects**	**Material outcomes and effects**
Organisational contexts: ***intended outcomes*** (incl. formal organisations, professional and local communities)	• Some network effects around the Upper Sûre and Syr river partnerships (with changing actor roles around LAKU, SEBES) • Shared knowledge, information, data as regards ecosystems in the river basins • Quality of some inter-organisational relations enhanced • Stronger organisational commitment of SEBES (Upper Sûre)	• Formal public consultations intensified some exchanges • New formal organisation (Upper Sûre /LAKU) • New positions and job descriptions (Upper Sûre/SEBES)	• New shared resources and inventories (Upper Sûre, Syr) • Enhanced professional practices and skills (Upper Sûre/LAKU) • New technologies (Upper Sûre/LAKU)
Organisational contexts: ***unintended and/or (side-) effects***	• Expectations of more active stakeholder involvement have been disappointed (Upper Sûre) • Remaining inter-organisational divides (Upper Sûre, Syr) • Remaining weak organisational commitments of some organisations/communities (Upper Sûre, Syr)	• Formal public consultations rarely occasions for dialogues • No strengthening of formal roles, rights, and competences of river partnerships • High admin-istrative burdens • Legal actions taken or considered by a few single actors (Syr, Upper Sûre)	
Transactional contexts: ***intended outcomes***	• Quality of some interpersonal relations enhanced (e.g. trust) (Syr, Upper Sûre)		Place-based: • Experiments and new practices enacted (Upper Sûre/LAKU) • New ´water-friendlier´ technologies used (LAKU) • Some measures along rivers implemented (Syr)

Transactional contexts: ***<u>Un</u>intended and/or (side-) effects***	• Quality of some interpersonal relations *not* enhanced (e.g. lack of trust) (Upper Sûre, Syr) • Few occasions for cross-scale and cross-sectoral dialogues (Upper Sûre, Syr)		• Displacement of agriculture to Belgium (Upper Sûre) • Few common projects carried out (Syr) • Few improvements in water quality and aquatic ecosystem health (Syr, Upper Sûre)

Table 11.5 – Overview of informal, formal, and material outcomes and effects of governance processes analysed

11.3 Actionable knowledge and narrative identities (research question 1)

This final chapter is dedicated to the role of narratives and narrative identities in the governance processes analysed. It returns to the initial assumption outlined in the conceptual and analytical framework (see 3.1.1) that narratives provide a promising approach to analyse interrelations between knowledge, action, and organisations. Notably, narratives can serve as a point of departure to analyse what knowledge may be actionable in both resonating with and challenging established understandings and practices.

The case studies have analysed governmental organisations, professional and local communities (farmers, municipalities), river basin organisations, environmental NGOs, and syndicates, including water facility operators. Empirical analysis has provided evidence that it is illuminating to inquire into their specific organisational and professional contexts to better understand why individuals act and know as they do. Narratives can cast light on personal and collective identities and on process dynamics. Narratives may reveal shared assumptions and paradigms, and cast light on tensions and synergies with other actors. They may be integral elements of local, professional, and organisational knowledge. The case studies suggest that narratives and paradigms have been significant informal factors in the governance processes analysed. This applies particularly to some of the actors involved most actively. They can also help to explain why others have *not* participated actively in governance processes or have done so mainly through opposition.

Based on the case studies, it is possible to identify and group shared elements into the following ideal-typical categories of narrative identities:

- **Environmentalist narrative identities** of staff of river partnerships, environmental syndicates and organisations (relating closely to a bottom-up ecocentric paradigm)
- **Farming narrative identities** of farmers (relating closely to a bottom-up anthropocentric and *expanded* productionist paradigm)
- **Municipal narrative identities** of municipal officials (relating closely to an integrated community paradigm)

Relations between personal knowledge and organisations are necessarily complex. Individuals identities are shaped by multiple contexts and affiliations, identities are fluid, and how they manifest themselves crucially depends on specific situations (Chabay et al., 2019; Ezzy, 1998; Wenger, 2010) (see chapter 3.1.1.1). Ascribing specific environmentalist, farming or local identities to individual

actors is therefore delicate and all but straightforward. For example, in the case studies environmentalist and farming identities have often overlapped significantly with local identities. While explicitly defining themselves as food-producing farmers, some organic farmers´ identities also reflected *some* elements of environmentalist narratives. In other words, despite the fact that few convergences have been identified between farming and environmentalist identities, there may be overlaps between all of them. And, of course, the identities of all actors encompassed elements not covered within this thesis (e.g. relating to age, gender, lifestyle, etc.). The categorisation, therefore, is inevitably reductionist.

In addition to the narrative identities mentioned, processes were also shaped by other narratives, particularly those of governmental actors and water facility operators. Some of them were explicit about their environmentalist or farming identities (e.g. within the ministries of environment, respectively, of agriculture), others expressed more ´managerial´ or ´technocratic" identities´ relating e.g. to the command-and-control paradigm. However, in general, interviews conducted do not provide a strong empirical basis for further exploration, as national actors tended to be more reserved about their personal commitments and identifications. Furthermore, the present thesis has predominantly been concerned with the question how actionable knowledge can emerge among *non*governmental actors. For these reasons, the following two sub-chapters mainly concern narratives of (nongovernmental) environmentalists, farmers, and municipalities. The first sub-chapter is dedicated to the role of personal meaning-making and narrative identities in how individual actors engaged in governance and social learning processes. The second elaborates on the significance of narratives shared in organisation with regard to what constitutes actionable knowledge. Both sub-chapters summarise more general insights derived from the case studies, as only few instances of re-framing were identified in the processes analysed.

11.3.1 Personal meaning-making and narrative identities

Empirical analysis has substantiated findings from other case studies that suggest that the leadership and personal commitment exerted by key individuals who seize and create opportunities in social networks may initially be more important for the emergence of social networks than organisational structures (Folke et al., 2005; Hahn et al., 2006). The concept of narrative identity rests on the assumption that how individuals act may often be strongly related to their sense of ´who they are´ (Ezzy, 1998; Somers, 1994). Based on the case studies, the thesis posits that narrative identities provide a fruitful empirical path into exploring why and how leading individuals engage in governance processes. Conversely, narrative identities can also cast some light on why some actors have mainly participated through opposition or why they have not participated actively at all.

A general insight offered by the case studies is that the personal commitment of *all* actors who were particularly active in building networks rooted in a combination of care for what they did and the belief that they could contribute to ´changing things´. In interviews, they displayed a strong sense of self-efficacy and an urge to take fate in own hands rather than being passive objects of change. The sense of self-efficacy is in strong contrast with *observing* individuals, some of whom felt they had "no influence" on processes. At the same time, among both actor groups there were individuals who retained the option to take legal actions as a possible ´last resort´ means to ´defend´ their cause.

Interviews suggest that narrative identities provide actors with a source of both ´*positive*´ action to initiate and promote a cause perceived as worthwhile and of *opposition* to defend what were precious elements of their sense of self and personal lives. In many narratives, childhood memories, family life and what to pass on to children played an important role. Furthermore, in all cases, their professions (and often their choice of education) and local engagement reflected an integral element of their

personal narrative identities. Narratives of a majority of actors (be they environmentalists, farmers or municipal officials) reflected a strong attachment to local communities and/or nature, particular animals or plants, landscapes or places. This seems to substantiate arguments that point to the significance of place attachment (Cresswell, 2004; McGinnis, 1999; Singleton, 2015) and/or nature attachment (or nature "connection") for actor engagement (Amel et al., 2017; Ives et al., 2018).

As regards environmentalists, nature attachment has been a recurrent element in their personal narratives. Their hobbies frequently encompassed diverse outdoor activities. For all of them, being in nature and experiencing it as ´intact´ was an important factor of their personal well-being and quality of life. Imaginaries for the future centred on ´saving´ or recreating healthy and diverse landscapes populated by endangered species that have traditionally been at home in Luxembourgish landscapes. They regarded active landscape preservation and management as crucial to preserve certain species What contributed to this was that hardly any believed that it would be possible to restore a ´natural equilibrium´. In exceptional cases, landscape imaginaries also included a longing for more ´wild nature´ unmanaged and ´left alone´ by humans. The strong personal commitment of environmentalists to contribute to the attainment of formal water and environmental protection objectives can thus be interpreted as driven and inspired by "protecting" an integral part of themselves that they also wished to preserve for their children and future generations.

In agriculture, all farmers interviewed had chosen their profession out of a vocation and passion for their job that also included continuing family traditions: "Die Landwirte arbeiten aus Überzeugung und mit dem Hauptziel, den Betrieb irgendwie zukunftsfähig zu übergeben" (interview n°5). Hardly any could imagine *not* working independently (e.g. as "Freiberufler", "freischaffender Landwirt" or "Betriebsleiter") and outside with their hands, animals, and machines. All farmers stressed they were not farmers "for money", but that being economically viable was necessary to make a living for themselves and their families. The metaphor of "Selbstbestimmung versus Fremdbestimmung" was a quasi-omnipresent reference (in different variations). Thus, farmers actively involved in the processes analysed did so to seek to contribute to determining their own future and to *resist* being "marionettes". The insistence on self-determination also served to explain their reluctance to switch to more extensive business models that, in their view, would make them even more dependent on public subsidies than they already were. Furthermore, both particularly active conventional and organic farmers portrayed themselves as "modern" (or "fortschrittlich") continuously trying to learn to ´do things better´. Being progressive implied being ready to openly discuss environmental impacts of farming and seeking technologically innovative and efficient ways of minimising impact, while keeping productivity at same levels. For several conventional farmers interviewed, this had included reflections about ´going organic´. Reasons for why they had not chosen that path were not only practical and financial, but also ´psychological´. They feared organic production would aggravate daily stress (e.g. due to potentially higher exposure to pests) already experienced as high. Many farmers conversed with emphasised they cared for and did their best to engage "responsibly" with soil, water, and animals. They stressed the importance of having healthy animals (also referred to as performance athletes/"Hochleistungssportler"). Nulltoleranz" of citizens and policy-makers to environmental impacts of farming would, however, make farming in Luxembourg impossible. Many hoped for the development of new technologies and of effective but biodegradable products for plant protection. All farmers interviewed felt under high pressure due to multiple factors and a general lack of time.

Pressure seemed particularly strong among farmers who engaged in diversified and alternative activities, but hardly participated in the governance processes analysed. The author of the present thesis had made efforts to interview farmers who do direct marketing (i.e. via own farm shops), had diversified their business model by starting vegetable cultivation or by offering farm holidays. However, the farmers contacted apologised on the phone for not having any time for an interview,

referring to high season, respectively, of being alone with their work due to ill parents or staff. Another farmer had just had a burnout. One organic farmer told the interviewer he had been on the brink of quitting several times.

High pressure and lack of time of those interviewed certainly seemed to affect their personal well-being and health, their family and social lives. With parents growing old, wives working elsewhere (if existing), children at school most of the day (if existing), automatisation and difficulties to find external manpower, farms increasingly become "one-man shows" (interview n°12, 45). This was also reflected in statements made by farm advisors who stressed that too high pressures and increasing social isolation contributed to making it more difficult for farmers to question and change their business models. All agreed (including those who *had* converted) that the decision to switch to organic, in addition to requiring appropriate market conditions and land availability around their farms (for pasturing), also necessitated a personal learning process that could not be induced from the ´outside´.

Finally, as regards municipal officials interviewed in the Syr and Upper Sûre valleys, they had all been active in their local communities since their childhoods (e.g. as scouts, in local fire brigades, music groups, etc.) and felt strongly attached to and embedded in local contexts and places. Their municipal engagement centred on efforts to improve the quality of local life and social cohesion ("sozialer Zusammenhalt").

Analysing narrative identities directs attention to the affective dimension of actor engagement. For all actors interviewed, administrative burdens posed not only barriers to projects, but affected their personal well-being and enthusiasm for their occupations. All actors particularly active gained personal fulfilment from what they ´achieved´, be it in terms of agricultural production, nature protection, or local life – or in their efforts to bring all of them together. All of them emphasised they were continuously ´learning-by-doing´, underlining the importance of context-specific approaches, intuitive (i.e. tacit) knowledge and that there were no silver bullets ("keine Patentrezepte"). They all deplored having to spend increasing amounts of time on administrative work and in the office, and having to comply with external requirements (and expectations). Some felt patronised by too detailed requirements in general (e.g. treated as "Kleinkinder"), and, in particular, by those rules that did not make ´any sense´ to them. One felt authorities were reducing him to a number ("ich bin Nummer XY, die sollen mal rauskommen auf den Betrieb", n°23). Others felt victims of decisions of authorities concerning stable authorisations that did not make any sense to them and for which they did not receive any explanations despite repeated questions. These examples seem to indicate that meaning-making and finding personal fulfilment may become increasingly difficult in a highly regulated world.

What is more, engaging in the informal governance processes analysed has been emotionally intensive for many. Some felt personally affected by being misperceived and –represented by others and by worsening and tense interpersonal relations. Some explicitly explained that emotional implications had been a reason for becoming less active or for withdrawing from some of the processes analysed.

Furthermore, administrative work has not only reduced the time available for physically implementing specific projects, but also for engaging with others (e.g. in social networks). Many actors felt they hardly had time to step outside – and, thus, occasions to look beyond - their daily routines, established communities in spite of recognising how important it was.

For others again, doing things ´their own way´ (incl. in legal grey zones) and/or considering legal actions not only served a particular practical or normative end, but was also a reaction to defend their sense of self.

Finally, some of the individuals from governmental and national organisations most actively involved in the governance processes analysed seem equally to have done so based on personal narrative

identities, some of which also reflected environmentalist, farming, or local identities. Their personal identities, however, did not *necessarily* reflect the organisation they formally represented. As the above, this would also point to the importance of informal spaces and social networks, as those individuals may serve as important mediators and ´change agents´. Others explicitly drew a border between their work and private live: "Ich versuche das zu trennen" (interview n°17) or "Ich mache jetzt keinen Wassersport oder so. Leitungswasser habe ich schon immer getrunken" (interview n°10). For them, participating in the activities analysed was primarily part of their job.

Although empirical evidence on these points is not very strong and although the interviewer also had the impression that governance processes had been emotionally intense for some of the individuals representing governmental authorities, this would suggest that informal governance processes may not only be characterised by asymmetries of power, but also by asymmetries in *personal* commitment and affective implications.

11.3.2 (Actionable) Knowledge and narratives in organisations

Prior research in sustainability science has sought to understand what makes knowledge actionable for sustainability (see chapter 2.1.3).

Extensive scientific work has been done in sustainability science to better understand what may make knowledge actionable for sustainability. The present thesis, however, has addressed two main shortcomings that merit further research: understanding meaning-making not only as essential, but as related to diverse contexts, and as closely intertwined with collective narratives and paradigmatic assumptions. Formal and informal organisations (incl. professional and local communities) are "environments for knowledge" providing "action frames" (Argyris & Schön, 1996). Different professions are based on an "epistemology of practice" that denotes a certain way of "*seeing a*s and *doing as*" (Schön, 1983). Knowledge cultures and practices of such "epistemic communities" may flow from shared paradigms (Knorr Cetina, 1991, 2007; Pahl-Wostl et al., 2011) and may be articulated in common narratives (Tsoukas, 2005). Belonging to specific organisations and professions and shared narratives may be important sources of narrative identities, knowledge, and action (Ellett, 2012; Ezzy, 1998; Knorr Cetina, 2007; Tsoukas, 2005). For this reason, it is difficult to ´tease apart´ personal meaning-making and collective meaning- and action-frames.

In the case studies, the individuals interviewed have been embedded in organisations whose narratives, knowledge, and paradigms have evolved over decades if not centuries. The Upper Sûre case as well as the analysis of relations between the Water Management Authority and the Nature and Forest Agency suggest that the significance of organisational narratives and how organisations have evolved historically cannot be underestimated (Ellett, 2012; Tsoukas, 2005). Histories of their inter-organisational relations find expression in narratives that have been found to have strongly influenced both interorganisational and interpersonal relations today because narratives have contributed to shaping actions and mutual *perceptions*.

Relations between individual actors and their organisations are multi-layered. Some actors seemed to wholeheartedly identify with organisation(s) they were members of. More frequently, however, actors also adopted a certain ´critical distance´, both towards their organisation as a whole and/or towards other members. They also reflected on internal tensions as regards, for example, diverse purposes and priorities pursued, different action strategies, and difficult interpersonal relations. Clearly, none of the collective actor groups analysed were monolithic and ´harmonious´ entities. They were themselves diverse composed of different sub-groups and diverse individuals. All organisations have been

characterised by evolving dynamics, many of which remained impenetrable or entirely unknown to the author of the thesis.

Nonetheless, the inquiry into shared narratives has cast light on interrelations between individuals, organisational and professional assumptions and approaches, or paradigms. Most notably, the case studies substantiate the assumption that any knowledge that is to foster actions that go beyond prevailing practices needs to both resonate with and, at the same time, challenge established narratives. The thesis therefore seems to confirm the argument that regulation, information and social/public expectations alone are unlikely to produce behaviour change (Chabay et al., 2019; Maggs & Robinson, 2016).

The contribution of the present thesis, however, is that it points to the significance of organisational affiliations and professional occupations in what makes knowledge actionable for individuals. A large majority of research has focused entirely on individuals without much consideration for their organisational contexts. Furthermore, as "affective narrative expressions" (Chabay et al., 2019), different landscape imaginaries engrained in these narratives have been found to be particularly illuminating as regards how actors envisage human-environment interaction, what they act on and how.

The following elaborates on farming, environmentalist, and local narrative identities and their interrelations with knowledge and particular paradigms based on the three dimensions of actionable knowledge (see figure 11.6):

- Normative dimension: purposes and values, framing of challenges, of past, present and futures,
- Systems dimension: systems and ecological knowledge and related uncertainties,
- Transformation dimension: preferred strategies and means relating to social coordination and management of/engagement with material environments.

The elaboration of all three dimensions also include relations with other actors and perspectives as integral elements of narrative identities and knowledge.

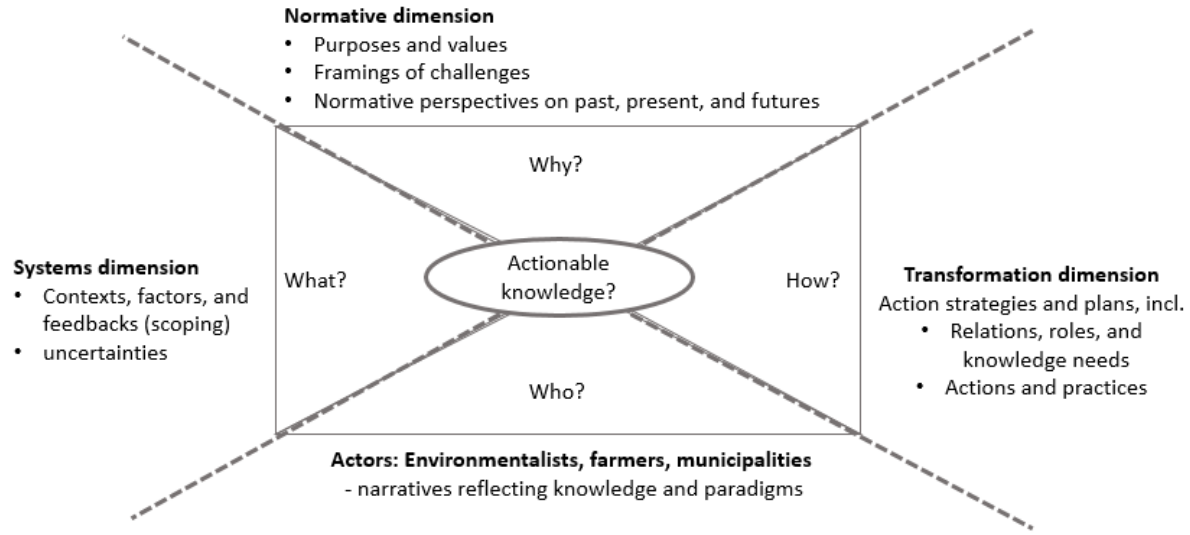


Figure 11.6 – Dimensions of actionable knowledge

11.3.2.1 Farming narrative identities and knowledge

Normative dimension

Purposes: The narrative identities of farmers were closely related to their professional practices and reflected their self-understanding as independently working food producers that needed to be economically viable. Narratives were closely related to the productionist agricultural paradigm and shared by both conventional and organic farmers. At the same time, the case studies have also found evidence that many farmers increasingly consider environmental aspects in their work. Most notably, several farmers mentioned (even if sometimes half-jokingly) that ´water production´ was also a service they rendered to society for which they could be paid. Several farmers interviewed were convinced that what they perceived as an "ideological" divide between conventional and organic farmers would gradually disappear, partly as a result of both market demands and regulation. For these reasons, the thesis suggests that there are emerging signs of an *expanded* productionist paradigm that continues to be centred on – but no longer necessarily limited to - food production. Hence, this may serve as a point of departure for more extensive re-framings.

Normative perspectives on past, present, and futures: As regards the past, there were two main themes, both tied to the notion of progress. One was the dismissal of agriculture preceding the "scientific-technical revolution" in agriculture of the mid-20th century (see paradigms chapter 4.2.3) as "primitive". Farmers felt that many policy-makers and the public had clung to an outdated and romanticised view of agriculture ("Heidi agriculture"). In their view, traditional agriculture had not been able to produce enough food and had not been better in terms of animal welfare either (e.g. because cows stood tied in stables during winter months).

The second frequently mentioned theme were critical references to farming practices in the 1960s to 1970s which were characterised by a strong intensification and the use of highly toxic pesticides. Compared to those days, farmers felt their practices and knowledge relating to pesticides had much improved. On the other hand, they all deplored structural changes, underlining that they had grown larger out of necessity directly linked with competitive markets and consumer behaviour, but also with subsidy schemes and bank loans that incentivised high investments into larger stables and more sophisticated machinery. All farmers stressed they were subsidy recipients out of necessity and would much prefer to be paid fair prices by consumers. Subsidies, however, were a ´necessary evil´, because they could hardly compete on the world market and domestic consumer behaviour offered few perspectives that were economically viable. The specialisation on milk and meat production was the result of a combination of local soil conditions, market and land prices, and the fact that agricultural production (as well as regional or direct marketing) required increasingly specialised knowledge. For these reasons, most did not regard diversification of production and own initiatives in alternative marketing as viable options. They would strongly welcome viable domestic and regional schemes and new products, but felt they had neither sufficient time nor professional knowledge to develop own marketing channels themselves.

Most were worried about future perspectives seeing few alternatives to continuously investing in modernisation and expansion although they preferred not to grow any further. Several farmers (and farm advisors) argued that many organic and extensive farms were primarily "hobby farms" and/or part of an "exit strategy" of farmers who were either not competent enough professionally (and therefore needed to resort to more public subsidies) or about to retire. Widespread scepticism towards converting entirely to non-food production and (extensive) landscape management was reflected in a statement by an elderly farmer who in dialogue with his grown-up child (who participated in the interview) said:

"Wie lange mache ich das noch? Wie lange hält mein Vater noch da? Wie lange wollen wir das jetzt machen? Ich kann jetzt nicht sagen, „mach das nicht mehr" oder so. Dann bin ich ja nur nachher vielleicht der Böse […] Aber für die nächsten 20 Jahre…Man kann auch jetzt sagen, wir sind hier im Naturpark […] so lange wie ich die Kühe melke, melke ich sie und helfe dir. Das kann noch sieben, acht Jahre sein. Und dann nachher machst du hier im Naturpark noch Blumen, setzt noch Blumen und ziehst die Prämien ein, die es gibt" (interview n°46)

The statement also reflects the concern of many farmers whose parents begin to be too old to continue helping on the farm. On the other hand, several conventional farmers, farm advisors, and other actors expressed admiration for those organic farmers who, in their eyes, were particularly skilled and successful in organic production, referring to them as "elites".

Finally, farmers in general and organic dairy farmers in particular were not only concerned about increasing regulation, but also about the ´vegan trend´ in society, which contribute to making them re-think if and how to invest in new stables.

Many landscape imaginaries centred on Luxembourg (and the Upper Sûre region in particular) as dominated by pastures ("Grünlandstandort").

Systems dimension

All farmers interviewed displayed a high degree of systems knowledge interconnecting multiple factors and scales. Their professional knowledge and narratives centred on interconnections between local life and production, global and national markets, agricultural policies, demographic, economic and technological developments, increasingly difficult access to affordable land, consumer behaviour and societal debates about farming, and changing weather patterns (i.e. climate change).

Many farmers and farm advisors emphasised that holding cattle for milk and/or meat production was the most viable option for Luxembourgish agriculture, given soil (and weather) characteristics:

"Die Ökosysteme: wir sind eine Grünlandgegend, wir sind ein Grünlandstandort. Vom Acker kann man hier nicht leben. Das heißt, wir werden immer Wiederkäuer brauchen, um dieses Gras auch zu verwerten. Und Gras ist ja auch von Vorteil, immer grün, nimmt Stickstoff raus, kaum Überschüsse, kaum Herbizidbehandlungen. Das hat für mich nur Vorteile" (n°45)

On the other hand, some also criticised that other farmers worked ´at the limit´ of intensity by holding too much cattle in relation to the amount of land they cultivated (resulting in surplus manure), which, however, had been incentivised and/or made necessary by ´the system´.

Overall, several farmers and farm advisors found that there was not yet enough awareness and ecological knowledge of the importance of soil characteristics and dynamics (e.g. humus), which are important elements of agroecological practices (see paradigms chapter 4.3.2). LAKU members stressed that their seminars served to enhance ecological knowledge of interconnections between soil quality, plant health, agricultural practices, and productivity. Furthermore, they saw their seminars as a contribution to getting farmers to acknowledge and learn more about ecological consequences of their practices, including by the use (and production) of scientific data and studies.

Narratives also suggested that systems and ecological knowledge (in connection with attempts to reduce the use of fertilisers, pesticides, invasive ploughing techniques, etc.) also contributed to making farming a lot more demanding; firstly, because it implied the necessity to tailor approaches to local ecological conditions instead of uniformly applying standard techniques. In general, all farmers

highlighted that their practices were highly variable, because they dependent on a host of factors such as not only soil but also weather conditions. All of them emphasised that there was no generally applicable "Schema X" that did not have drawbacks. The second (and related) reason cited for why systems knowledge made farming more demanding was that it increased their awareness of multiple systemic constraints and pressures. Statements of farm advisors reflected this:

> *"Für die Landwirte ist das einfach von allem ein stückweit zu viel, ob es jetzt Naturschutz ist, Wasserschutz, Klimaschutz, Ammoniak-Emissionen, und was auch immer. Es kommt so vieles auf so kurzem Zeitintervall zusammen, und es wird von den Landwirten erwartet, dass sie für jedes einzelne Problem eine Lösung haben und am besten eine Lösung, die alles irgendwie bedient, und das geht nicht" (interview n°12)*

This perspective also applies to organic farmers interviewed. For example, an organic farmer interviewed had faced ploughing restrictions in a Natura 2000 area that he regarded as "nonsensical", because they "forced" him to use less invasive techniques that, however, increased the growth of weeds (that neighbouring conventional farmers unlike himself were allowed to combat with pesticides).

The statement above confirms the diagnosis that agroecological and/or "sustainable" farming tends to be significantly more knowledge-and learning-intensive (Ingram, 2008; Ingram & Morris, 2007; Röling & Jiggins, 1998). All farmers were particularly concerned about nutrient cycles on their farms, preferring the use of own manure to other forms of fertilisation. One organic farmer interviewed also adhered strongly to the principle of "feed autonomy" (i.e. feeding his animals only own grass and crops), but experienced that prolonged drought periods made this increasingly difficult (to the point of decreasing milk production).

These aspects also highlight the unifying theme identified in all farming narratives centred on the sentiment of being "at the limit" as a result of multiple pressures. All farmers felt they were going into not only an uncertain but also an increasingly insecure future (lack of "Planungssicherheit").

Transformation dimension

Management: All farmers stressed the importance of learning-by-doing for their professional knowledge. Technology use was the area where narrative identities differed most. Some farmers pinned their hopes on high-precision farming (e.g. for weeding), milk robots, the development of biologically degradable pesticides (pesticides regarded as problematic by all), and regarded technologies such as manure injection as progress. They also found that resorting to external machine contractors was an advantage, as it meant they did not have to buy large machines themselves. Technologies helped farmers become both more efficient and to be more flexible time-wise (allowing them, for example, to spend more time with family and other farmers). Others rejected the use of bigger and more expensive machines, both because of high investment needs and for their understanding of what it meant to be a farmer.

Social coordination and relations: The general sentiment conveyed was that farmers (both conventional and organic) generally felt "fremdbestimmt", misunderstood, and wrongly portrayed by "the public" and policy-makers (e.g. as "scapegoats" of society). They wished their work and products were appreciated more in society and by policy-makers.

In general, farmers preferred self-organisation. All farmers interviewed were upset about the amount of rigid regulation and, in some cases, the fines they had received (e.g. for bringing out manure on fields with restrictions):

> *"Aber die ganze Bürokratie, der Aufwand, man steht ja morgens schon mit einem Bein im Gefängnis, weil man gegen irgendeine Regel verstoßen hat oder riskiert zu verstoßen" (n°16).*

Some felt they were being punished for "mistakes" of others. Several perceived many of the provisions they had to comply with as ´nonsensical´, counterproductive, and/or patronising. An object of much controversy was the issue of agricultural land purchase by the state. Some went as far as speaking of a "Enteignung durch die Hintertür" (n°35), particularly in combination with water and environmental protection restrictions. Frustrations about regulation typically went hand-in-hand with the perception that public administrations (all of them) were not close enough to them, that civil servants were ´remote office people´ with comfortable lives, many of them without ´any clue´ about farming. Some farmers and farm advisors remarked that, in the past, civil servants had been more understanding and flexible, perhaps because more of them had had family connections to farmers and workers. Some portrayed environmental governmental authorities as "ideologised". Farmers and farm advisors stressed the importance of "talking to each other" and "being actively involved":

> *"Man müsste zumindest mal mit den Leuten reden […] Wenn man irgendjemanden irgendwo hin mitnehmen will, dann muss man den auch motivieren" (n°16).*

Furthermore, all farmers were deeply concerned about their bad image in society and the lack of understanding and appreciation for their professions by consumers and neighbours:

> *"Die Leute wissen nicht, wo kommen ihre Lebensmittel her?! Sie sehen das in den Ferien, aber wenn´s hier vor Ort geschieht, bist du der, der immer meckert" (interview n°20).*

Some farmers had experienced being insulted on the streets (e.g. when passing on their tractors), observed and reported to authorities or the press (e.g. when someone had seen them parking calves on a trailer somewhere or spraying), some also had legal disputes with neighbours (e.g. about noise and odours) when planning to extend their stables. Therefore, all farmers felt that more needed to be done to improve their image, to raise awareness of the origins of food, and of ´realities´ on a farm. At the same time, many felt helpless about what they themselves could do to change their image given the lack of time.

11.3.2.2 Environmentalist narrative identities and knowledge

Normative dimension

Purposes: Core elements of environmentalist identities centred on being "Naturschützer" with a mission to "protect nature". They are closely related to a bottom-up ecocentric paradigm. Their main *raison d´être:*

> *"Unsere Daseinsberechtigung ist wirklich zu zeigen, wie kann es aussehen, wenn die Fläche nicht bis zum letzten Meter intensiv genutzt wird" (n°37).*

While stressing common overarching purposes, environmentalists interviewed frequently made distinctions between various kinds of ´nature protectors´ (including "Artenschützer", "Gewässerschützer", "Klimaschützer").

Normative perspectives on past, present, and futures: Most environmentalists referred to ”traditional” cultural landscapes when regretting the loss of biodiversity. Many inscribed themselves in the pioneering traditions of environmentalist movements starting in the 1970s (one referring to the 19th century). If environmentalists in the second half of the 20th century had not begun to restore and purchase land, there would be significantly fewer biotopes left in Luxembourg today. Furthermore, more generally, they had ´stood up´ for nature at a time when environmental awareness in the public and among policy-makers had hardly existed.

Some remembered that EU environmental legislation and the EU WFD had sparked a certain enthusiasm (“Aufbruchsstimmung”) among environmentalists in Luxembourg convinced that Luxembourg on its own would hardly have taken environmental measures. Several expressed similar sentiments as regards the governmental change of 2013 when a liberal-socialist-green government ended the decades-long ´reign´ of conservatives. At the same time, when asked about changes in their professional lives during the past two decades some were somewhat nostalgic about the past. Many of the older interview partners said that they, until the beginning of the 21st century, had been able to spend more time outside carrying out projects and collecting data:

> *“[Wir haben] damals eigentlich noch viel mehr Geländearbeit gemacht […] wo es dann nachher vom Ministerium hieß: „Nein, das muss schneller vorangehen“, und dann wurden irgendwelche Studienbüros auch aus dem Ausland eingeflogen, die das dann gemacht haben. Und wie gesagt, das war alles noch irgendwie viel praxisbezogener. […] heute sitzt man fast nur noch im Büro. Das ist wirklich das, was sich über die 17 Jahre so geändert hat“(n°34).*

In general, the past two decades have not met expectations. In addition to increased administrative work, environmentalists are confronted with what they perceive as growing environmental problems caused by an “intensification in all directions” (n°13) as a result of ongoing demographic and economic growth. Witnessing “dramatic losses” (n°39) in biodiversity and few improvements in water quality, nearly all were pessimistic as regards the future of ecosystems in Luxembourg: “Visionen habe ich definitiv keine mehr” (n°34), “da hat man manchmal das Gefühl, dass man so auf verlorenem Posten sitzt […] da wird es langsam eng“ (n°39), or “das spitzt sich zu, die Situation“ (n°13).

None believed that habitat destruction could be halted via compensatory measures. Without profound societal and economic transformations, several believed that only marginal areas would be “left over” for environmental protection:

> *”Und was dann für den Naturschutz vielleicht noch übrigbleibt sind eben diese Grenzertragsstandorte, Hangflächen, Obstwiesen und so weiter“ (n°39).*

As regards landscape imaginaries most adhered to the ideal of “diverse mosaic landscapes”, one to “letting nature be nature” with more “wild” forests. At the same time, they gained fulfilment in their work from measures such as creating “islands”, “ecological corridors” or “stepping stones” for certain species in increasingly fragmented landscapes.

Systems dimension

All environmentalists had a high level of systems and ecological knowledge derived from a combination of professional experience and education (e.g. as biologists). Ecological knowledge centred in particular on the awareness of ecological dynamics and the importance of strengthening self-regeneration capacities. In environmentalist narratives, local ecological restoration and preservation were part of *global* environmental protection efforts to fight effects of economic and demographic

developments, including climate change. Many were acutely aware of diverse contradictions in policies and societal ´realities´, and how "small" their own measures were when compared to "major problems". Despite all legislation and compensatory measures, they perceived habitat destruction and environmental pollution as ongoing, feeling particularly bitter that environmental requirements and the ´polluter-pays´ principle were apparently not applied to large "polluters". All of them were also deeply concerned about what they perceived as a growing "disconnect" from nature in the population, consumerist lifestyles and widespread beliefs that problems could be tackled via ´technological fixes´ (see below).

Transformation dimension

Management: ´Learning-by-doing´ was one of the most important sources of the professional knowledge of environmentalists. Thanks to hands-on professional experience in habitats they developed a sense of ecological dynamics: "Gefühl dafür, wie steht es um unsere Gewässer" (n°13). All environmentalists stressed the importance of managing ecosystems by certain interventions, as they did not believe that a ´natural equilibrium´ could be restored in Luxembourg´s fragmented and cultural landscapes: „wir kommen nie in ein Gleichgewicht. Kulturland ist immer verbunden mit Eingriff von Menschen" (n°13). This also entailed mimicking traditional land uses to preserve certain species:

> *"Normalerweise hätten wir hier überall Wald […] Wir haben eben die Auen genutzt und durch diese Nutzung sind dann andere Lebensräume entstanden und wir versuchen die dann eben durch dieses Management auch ein bisschen nachzuahmen, wo dann verschiedene Arten auch darauf angewiesen sind, weil sie ansonsten gar nicht vorkommen können […] künstliche Aufrechterhaltung durch eine gewisse Nutzungsweise" (n°39)*

River restorations were also cited as one example. They had little to do with nature herself, but were described as interventions that aimed to imitate nature as much as possible to strengthen regeneration capacities (n°37). However, there were limits to the power of human interventions. For example, several environmentalists stressed that they could, for example, not bring back certain species that had disappeared:

> *"Da sind auch gewisse Sachen, die können wir überhaupt nicht mehr steuern [e.g. Steinkauz] dass es auch unrealistische Ansätze gibt, Sachen, die einfach nicht gehen" (n°34).*

While most referred to traditional cultural landscapes, some environmentalists had also developed an interest in how new species began to appear in non-traditional ´artificial´ environments such as around the Upper Sûre dam and the Uebersyren wastewater treatment plant (its effluent ponds).

In their professional activities, they often experienced conflicts between different operational objectives of, for example, nature and water protection ("Zielkonflikte"); for example, between the mowing of fields along rivers (or extensive pasturing) to protect specific plant or bird species and letting vegetation grow ´freely´ to provide shade to river water and life or build fences.

Social coordination and role of science: All environmentalists interviewed stressed the need for flexibility, pragmatism, "realism", compromise (not only "Naturschutzbrille") and "concerted action" with clear priorities to make environmental protection work in practice ("keine Patentrezepte", "wo ein Wille ist, ist ein Weg" (n°37)). Many cited this as the main lesson they had learned throughout their professional lives.

As regards governance modes, they favoured a combination of (top-down) regulation and community- and network-based self-organisation. None of them questioned regulation in general or environmental policies in particular. At the same time, they all stressed they increasingly suffered from too rigid regulation and administrative burdens. One referred to an increasingly tight "corset", including by legal provisions and demands from authorities perceived as contrary to common sense and as lacking "Praxisbezug". Some perceived civil servants as behaving as if they had a "Wissensmonopol" (n°9). Some also felt that many public funders and municipalities continued to prefer measures involving engineered infrastructures and technologies and put nature-based solutions under more intense scrutiny. They criticised that public funding for nature-based solutions was "ridiculously small" compared with expenditures for engineered water infrastructures.

Many wished there would be more direct exchange between themselves and public authorities. Some felt that pressure and expectations on them were increasing due to EU-related objectives:

> *"Das heißt wir haben uns so Ziele gesetzt, die so enorm sind und die wir auch einhalten müssen, weil uns ja die EU im Nacken sitzt […] Und dann kriegt man so einen Druck […] von politischer Seite […] Wir machen halt viele so kleinere Sachen. Das reicht dem Ministerium eigentlich nicht, weil die ja gegenüber der EU halt ganz andere Ziele angegeben haben. Und das ist dieser Druck, der dann auch da ist" (n°34).*

Some experienced growing workloads and demands from ´outside´ as demotivating and as exceeding their capacities, stressing that they did many extra working hours during evenings and weekends out of personal commitment:

> *"Bis auf einige Ausnahmen macht hier jeder viel mehr als er müsste, und teilweise auch als er kann" (n°34).*

Furthermore, as regards science, nearly all environmentalists interviewed stressed the importance of and need for scientific studies and "facts" (some of which they contributed to producing). For this reason, some regretted that not all scientific data and information was made available to them. Furthermore, some were dissatisfied that some studies had not been granted public funding (e.g. as regards environmental impact studies on wastewater, the use of pesticides on train embankments or certain soil sampling projects in forests and fields). On the other hand, many also felt that studies, in general, needed to be taken ´with a grain of salt´, as some lacked ´common sense´, could be interpreted in many different ways or were used "out of context". Some pointed out that collecting monitoring data needed to have a specific purposes and be interpreted. The fact that there were growing amounts of data that were hardly used also showed that environmental awareness (or, more specifically, appreciation of water) had not increased proportionally with science:

> *"Es gibt viele Informationen, die abrufbar sind, aber es wird nicht abgerufen dieses Wissen. Es wird sich nicht beschäftigt, weil die Wertschätzung meiner Meinung nach zu gering ist, von Wasser z.B. Da muss sich was ändern" (n°13, participant I)*

> *"Wir haben jetzt sehr viel Daten, auch wegen WRRL [EU WFD], auch NATURA 2000-Management. Was notwendig ist, starkes Zusammenarbeiten in verschiedenen Gebieten. Ein geeintes Auftreten ist sehr wichtig. Umso geeinter man auftritt und sagt, „für dieses Gebiet ist das die Priorität!" umso besser ist es" (n°13, participant II)*

In addition to the need for concerted action based on common priorities, they all emphasised that direct interpersonal relations were vital, whether with farmers, citizens, municipal or national authorities. As regards farmers, in particular, several stressed: "man muss bei denen in der Küche

sitzen“(n°34, n°49). In general, environmentalists perceived relations with farmers as the most difficult. They had a sense that most farmers did not understand and support environmental protection measures, were reluctant to change any of their practices and mainly participated in certain environmental programmes for financial reasons. At the same time, many farmers had not yet understood that environmental protection was a service that they could make an integral part of their business models. In order to show farmers that extensive farming practices could be rewarded financially and to fulfil own targets set by public authorities, environmentalists also encouraged farmers to participate in programmes with land plots they hardly used anyway (“Grenzertragsflächen”).

In accordance with the points made above, many environmental actors interviewed diagnosed a widening ´disconnect´ between people and ´nature´ that also extended to inhabitants of rural areas (“Naturferne”). Not only did they feel that people and children, in general, spent less time outside, some had also been confronted with fears of inhabitants relating to mosquitoes in wetlands and to ordinary (and harmless) insects and plants. Others also associated public fears of ´nature´ with the evolution of humankind as always having striven for control. Adding aesthetic standards, they diagnosed a low acceptance of weeds and other ´messy´ phenomena in public spaces among residents, many of whom complained about any signs of “neglect”. Environmentalists thus emphasised the importance of their pedagogical work with, for example, children and youth. Some experienced that there was growing public interest in hands-on seminars such as on urban gardening. Other environmentalists, on the other hand, felt it was rather difficult to mobilise non-retired adults for activities such as guided tours through protected areas.

11.3.2.3 Municipal narrative identities and knowledge

Normative dimension

Purposes: All municipal officials interviewed underlined that their main purpose was to serve their citizens by improving local life. Their narratives can be identified with a bottom-up integrated community paradigm. In the Upper Sûre region, municipal officials often referred to the region and the Nature Park (e.g. as a kind of regional “Solidargemeinschaft”). In contrast, inter-municipal activities in the Syr valley were predominantly mentioned in relation to the SIAS syndicate, if at all. Thus, while a regional identity has been identified around the Upper Sûre lake, identities at the Syr were mainly local, with the Syr river itself hardly playing any role (see above).

Normative perspectives on past, present, and future: Local narratives conveyed by municipal officials centred on how social life and the ´fabric´ in the municipalities had profoundly changed during the past decades. Growing numbers of inhabitants and their increasingly diverse origins were central concerns. Population growth had changed proportions between “Ureinwohner” and “newcomers” and the languages used (e.g. Luxembourgish, Portuguese, French, German) in increasingly diverse local communities (see also chapter 6.1.2.2 and 7.5). In the Upper Sûre region, structural changes in agriculture (i.e. fewer farmers) and the arrival of new residents who had no connections with farming also played a role. Furthermore, in the Upper Sûre region, the “pioneering times” of the 1980s and 1990s with their numerous regional projects and cultural activities were recalled with a certain nostalgia. Another important difference between the two river basins is that municipalities in the Syr valley situated close to Luxembourg City have become increasingly prosperous, experiencing few financial concerns. In contrast, the Upper Sûre municipalities expressed concerns about their difficult financial situation and how they struggled to keep the region attractive for young people.

Municipal officials shared imaginaries of vibrant local social and cultural life carried by actively engaged residents (as opposed to being merely "Schlafgemeinden"). An important difference, however, could be discerned as regards imaginaries of landscapes. Municipal officials in Syr municipalities particularly valued green areas as contributing to local quality of life by offering recreational spaces ("Naherholungsgebiete"). In the Upper Sûre region, in contrast, the term "Naherholungsgebiet" had very different and more ambiguous connotations. They originate in the perception that the protection zones around the lake had partly served to offer a recreational space for stressed and well-off city-dwellers and one-day bathing tourists from the South of the country. Nonetheless, tourism being important for regional development, they hoped to be able to develop attractive offers for "slow tourism", including "wellness" and cultural activities, despite restrictions (see Upper Sûre case study 9.13).

Systems dimension

Municipal narratives centred on interconnections between national demographic and economic developments and local community life, with housing and land availability and prices as well as infrastructures among their major concerns. In the Upper Sûre region, reflections on the local economic future, including the future of agriculture, played a significant role. A few municipal representatives were 'proud' of living in the vicinity of habitats of European and international importance and wished they were appreciated more by local inhabitants.

Transformation dimension

Management: Being in charge of local infrastructures of growing local populations, the focus of municipalities has been to meet local needs (and wants) in terms of housing, transport, childcare and schools, sports and cultural centres, and water sources and wastewater treatment. Securing drinking water supply and improving wastewater treatment (often via inter-municipal syndicates) had significantly higher priority than river restorations and other ecological projects. An exception was those municipalities who had experienced flooding events and believed river restoration could be effective in reducing floods, and had access to the necessary land. Overall, however, these seemed to be in a minority, with technical ´command-and-control´ approaches to flooding continuing to prevail.

The projects analysed in the Syr case study suggest that river restorations tend to be one element of broader projects encompassing social, cultural, economic, *and* ecological aspects (see chapter 10.6.1). Energy-efficient buildings, the use and production of renewable energies, and green public spaces designed to be maintained without ´necessitating´ the use of pesticides were sources of local pride. Several municipal officials expressed the hope that some of their projects would contribute to residents engaging more in social life and appreciating local landscapes more. As regards ecological restoration, many municipal officials (especially in the Syr valley) expressed their willingness (or even eagerness) to cooperate with authorities if there was a concrete project that public administrations had agreed on. In that case, the municipalities would do their share, including convincing local landowners and farmers to support and participate in the project. At the same time, they did not feel in a position to drive any projects themselves, as river restoration projects were too complex and time-consuming. In the meantime, they would, however, continue to purchase local land whenever an opportunity offered itself (usually thanks to personal contacts) and were willing to put some of it ´at the disposal´ of the state for restoration projects. Many of the municipal officials interviewed recognised positive effects on flood protection (using e.g. the river restoration in the Mensder Brill as

an example). At the same time, they also showed some understanding for residents and farmers concerned about loss of land values and productivity.

Social coordination and relations: All municipal official interviewed adhered to municipal and inter-municipal self-organisation as their preferred mode of governance. As analysed in the Upper Sûre case study, scepticism towards governmental interventions has been particularly pronounced among the Northern municipalities. Here, commissioning expert advice in relation to the planned new drinking water protection zones has been a means to substantiate their arguments and defend their interests in the framework of public consultations.

However, some misgivings about interventions of national authorities in local affairs could also be felt in the Syr valley. Notably, all municipalities expressed criticism of growing administrative burdens resulting from legal and technical requirements and lengthy and inflexible funding and authorisation procedures. As a general rule, they used consultants for the planning of any projects, but cited examples of how contradictory requirements from different national administrations had stalled projects (e.g. in housing). On this basis, some referred ironically to what they perceived as a "Diktatur der Ministerien" (n°52). Municipal officials, too, felt increasingly stretched: "Heute ist so viel zu machen in einer Gemeinde, das kriegt man nicht mehr hin" (n°53). For some, this significantly reduced enthusiasm for their work.

As regards social life, all municipal officials interviewed stressed how important it was to engage directly with citizens, to involve them in projects, and to keep them informed (e.g. via municipal bulletins). At the same time, many interview partners regretted what they perceived as decreasing local solidarity and a weaker "sense of community". Municipal infrastructural projects faced more resistance among local residents when compared with the past, which added to lengthy procedures. Municipal officials ascribed this, notably, to widespread "not-in-my-backyard" attitudes. For one interview partner, growing "egoism" was a reason for why he considered not running for office again. In contrast, another interview partner felt that social life was beginning to re-flourish, with more residents engaging in common social activities, including in municipal ´citizens committees´.

11.3.3 Summary

Analysing effects of formal institutions such as drinking water protection zones and nature reserves from a narrative perspective directs attention to identities and sentiments. The case studies have provided evidence for the argument that what is perceived as meaningful – and, hence, actionable - to individual actors engaged with water and land is closely interrelated with their embeddedness in specific organisations, professions and communities, often locally anchored. This means that what scholars refer to as the need for reframing or "conceptual change" in (double) social learning (Bouwen & Taillieu, 2004, Pahl-Wostl, 2015, Scholz et al., 2014) may need to go hand in hand with changes in not only knowledge, but in narrative identities themselves.

The analysis of elements of narratives has contributed to illuminating personal and diverse types of community-based knowledge (local, professional, organisational) about what *ought to* be, what *is, has been* and *will be,* and *how things ought to be done.* In other words, it helped to enhance understanding of why actors framed challenges and acted on them as they did. Shared narratives and paradigms were integral elements of local, professional and organisational knowledge. The analysis of narratives casts light on how different and partly conflicting the purposes, ´stories´, and imaginaries are that environmentalists, farmers, and municipalities attach to their engagement with others and their material environments. As different as narrative identities among environmentalists, farmers, and

municipalities particularly engaged in governance processes may be, they have shared a number elements:

- an identification with and care for specific environments and activities,
- a sense of self-efficacy and desire for some self-determination,
- a drive towards ´getting things done´ via self-organisation,
- a recognition of the need to tailor projects to social and ecological local contexts based on local, professional, and organisational knowledge and on social multi-party processes that foster common understandings and compromise,
- an awareness of how engagement is embedded in complex and uncertain systems dynamics that encompass diverse formal and informal social factors as well as ecological and technological factors,
- the perception that administrative barriers for projects are increasing,
- the perception that diversity and fragmentation in society are growing,
- the perception that individuals in society are increasingly disconnected from material environments and processes,
- the need for future perspectives and hope.

Governance processes crucially depend on the engagement of committed individuals and organisations. They also depend on being perceived as legitimate (Lebel et al., 2010; Mostert et al., 2007; Pahl-Wostl, 2015; Reed, 2008).

The EU WFD has not only created legal *obligations*, but also enthusiasm among environmentalists coupled with *expectations*. In general, discrepancies between obligations and expectations (*what ought to be*), on the one hand, and what *is* and *can* be done, on the other, has been experienced as frustrating and disconcerting by nearly all actors interviewed. Feeling ´blocked´ or powerless in the face of major barriers has negatively affected the enthusiasm of numerous actors towards activities and causes they have dedicated parts of their professional and private lives to. It has also been a reason for legal actions. The fact that actors continue to strive in what many of them perceive as ´against all odds´ may count as evidence for the argument that narrative identities (i.e. rather than expected ´rewards´) are a decisive element in why actors act as they do.

This also applies to those for whom environmental regulation and projects have been causes for anxiety and perceived as threats to their professional and/or local lives. The argument that has been made in the case studies is that some local and professional actors have reacted so strongly not only because of possible economic consequences or because they did not ´care for the environment´, but because some regulations and requirements violated their sense of ´common sense´, of self, and of autonomy. The question if reasons for these sentiments have been well-founded is perhaps less important than addressing the sentiments themselves. They have inscribed themselves in – and have been influenced by – specific personal and shared narratives. It is in this way, that narratives have contributed to shaping – and perpetuating - mutual perceptions and relations, both interpersonal and interorganisational. Thereby, they have been major informal factors in the governance processes analysed.

On the basis of the above analysis and tentative answers to the research questions, several paradigms have been identified in the Luxembourgish water and land governance systems (see figure 11.6).

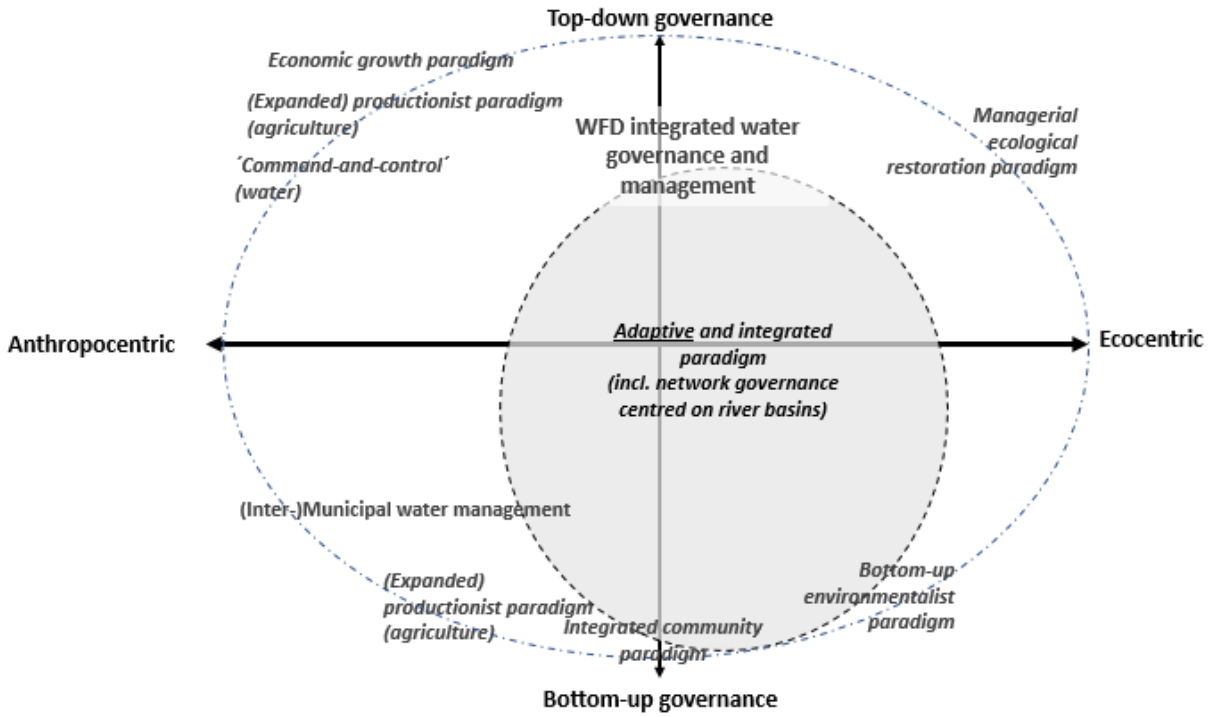


Figure 11.7 – Diverse paradigms identified in water and land governance in Luxembourg based on narratives

The question remains what factors facilitate that actors from diverse nongovernmental and governmental organisations come together in social networks, develop a sense of 'shared purpose' and converge on some understandings of the ´nature´ of the challenges and what to do together to tackle them, while questioning prevailing assumptions and practices (double loop learning, see also chapters 2.1.3.1 and 3.1.1.2):. Tentative insights based on the inquiry into narratives are summarised below along the main dimensions of actionable knowledge.

11.3.3.1 Normative dimension

Fostering some shared understandings of challenges between diverse actors and a sense of shared purpose requires normative reflexivity that enables actors to see challenges with others´ eyes. This may, most of all, require that actors *get to know* each other to begin to *understand* each other better and develop empathy. This may entail seeing not only the *present* with others´ eyes, but also the *past*, anticipated, and desired *futures*.

Some systems approaches in transformative sustainability science focus on the importance of ´futures knowledge´, either as an element of systems knowledge or a ´knowledge type´ on its own (Grunwald, 2016; König, 2018). Adaptive governance scholars have stressed the importance of social memory (Folke et al., 2005). The current thesis embraces both (see also 2.1.3.1). However, in contradistinction to these scientific stances and based on empirical insights, the thesis argues that perspectives on pasts (´*where we come from*´) and on both *anticipated* and *desired* futures (´*where we are heading or ought to be going´)* are highly normative and difficult to separate from one another; precisely because they are closely intertwined with personal and shared narratives.

Some of the most significant reasons identified for tensions between environmentalists and farmers have been divergent perspectives on past-present-futures. Not only have they sometimes been

diametrically opposed, they have also had intense affective implications. Both within academia (see chapter 4.1) as outside, our imaginaries of *pre-industrial* and *pre-CAP* life and landscapes have been found to be highly significant for how we relate to present and future. This has been the main reason for why the case studies have ventured back into the 19th century. Furthermore, the case studies suggest that mutual perceptions, inter-organisational and -personal tensions today often have roots in events years and decades ago. In processes involving diverse organisations, this may be the rule rather than an exception.

Therefore, ´getting to know´ each other and developing common understandings and framings entails questioning not only own personal and organisational purposes and values but also being able to see past, present, and future with other eyes – including past inter-organisational relations. Finally, views on the past are inextricably interlinked with how we judge our own place and actions ´in the world´ as well as those of the formal organisations and informal communities of which we are a part. Sustainability learning requires an acknowledgement of how actions have contributed to, for example, pollution of rivers, to climate change, poverty, etc. This may cast past personal life and actions as well as activities in our organisations in an entirely new light – and go to the heart of personal and collective identities. Making this part of not only personal but also of collective processes is bound to be uncomfortable, but perhaps also liberating. For these reasons, normative reflexivity and re-framing are ongoing processes that require significant time and ´safe spaces´ for reflection, dialogues, and joint action (see below). The present thesis has placed such processes as elements of professional and organisational learning.

In the end, the depth of social sustainability learning and transformative change (i.e. paradigm shifts) may depend on – and be accompanied by - the emergence of new narratives and imaginaries, partly shared. As suggested above, narratives have cast light on identities and ways of knowing and doing of diverse actors. Diverse landscape imaginaries have been identified. STS scholars have investigated how collective "sociotechnical imaginaries" have served modern societies as sources of imagination and action, and their legitimisation (Jasanoff & Kim, 2009) (see chapter 3.1.2.4). The present thesis has identified imaginaries of landscapes that merge human activities, natural environments, rivers and lakes, animals, built environments, and people into assemblages. They have surfaced in narratives in the form of fond memories, memorable experiences, a status quo to be maintained or overcome and/or as visions for the future. Landscape imaginaries have been found to be sources of identification, meaning, and action, in the sense of "affective narrative expressions" (Chabay et al., 2019). Landscape imaginaries have also illustrated conflicts between communities: diverse traditional mosaic landscapes and habitats *versus* grassland and fields used for ´modern´ food production *versus* recreational areas *versus* ´wilderness´. Although exceptions, the landscape imaginaries of a few actors have embraced ´non-traditional´ interconnections between engineered infrastructures and built environments and particular wild plant and animal species, such as around effluent ponds and artificial dams. Projects on how to create green spaces in urban environments also point in this direction (MDDI, 2013). These imaginaries and projects seem significant, because the case studies suggest that it becomes increasingly difficult to restore and maintain traditional landscapes. The author of the thesis proposes that exploring diverse ´ecocultural landscape imaginaries´ may contribute to re-imagining human-environment relations and, thereby, to opening new collective and future-oriented narrative paths in minds and actions[292].

[292] In coining the term ´ecocultural landscape imaginaries´ the author of the present thesis has been inspired by both the STS concept and the "ecocultural community metaphor" developed by Raymond et al. (2013) (see paradigms chapter 4.4.2). Ecocultural landscape imaginaries may be "sociotechnical" in the STS sense of denoting public visions of desirable futures that serve certain political projects and ends (Jasanoff & Kim, 2015). In contrast,

11.3.3.2 Systems dimension

Scholars located in sustainability science and adaptive governance stress the need for systems knowledge to tackle sustainability challenges (see chapter 2.1.3). Adopting an actor-centred perspective the present thesis has framed the systems dimension in terms of *contexts* of actor engagement encompassing diverse factors, scales, and flows. Furthermore, it has enlarged an understanding of context as ´webs of meanings´ to also include ´webs of implications´ of human action (see chapter 3.1.2). The case studies and above analysis of narrative identities suggest that a large majority of actors interviewed (governmental and nongovernmental) have developed an acute knowledge of systemic interconnections that places their own actions, transactional, and organisational contexts into a maze of diverse and complex cause-effect relations encompassing personal, social, and material spheres. How actors delineate systems and what challenges and interconnections they perceive as particularly important depends crucially on their organisational contexts (local and professional). At the same time, there have been many common denominators among diverse actors; for example, as regards effects of ongoing demographic and economic growth that many actors across sectors and scales thought was "unsustainable". The case studies, however, also suggest that systems knowledge can seem paralysing as it enhances awareness of diverse constraints, responsibilities, uncertainties, and contradictions and may, therefore, weaken the sense of self-efficacy and agency of actors. This underscores the need to connect systems knowledge with the transformation and action dimension (see below).

Furthermore, the systems knowledge of actors contrasts with sectoral regulatory frameworks and the plethora of specialised scientific studies and data used in water and land governance and management. While they have contributed to enhancing understandings of ecosystem dynamics, the case studies also suggest that ecological systems are still predominantly treated as separate from social systems. The fact that water and environmental policies and studies hardly consider social factors and social-ecological interdependencies (beyond anthropogenic pressures) has been identified as a major weakness of prevailing approaches in formal water and land governance. Notably, approaches tailored exclusively to ecosystems have neglected the human and social dimensions of sustainability challenges – the need for engaging actors in social processes that respond to their need for future perspectives and self-determination. Integrated approaches that treat ecological and social regeneration as interdependent continue to be an exception. This may also be one explanation for why the gap between the status of scientific ´expertise´ in formal governance vis-à-vis local and professional knowledge widens. On the other hand, the examples of the river partnerships and LAKU suggest that nongovernmental and non-scientific actors increasingly use (and produce) scientific studies and data when planning measures and experiments. The notable difference is that these actors have tailored studies and data to their local contexts and purposes by making them elements of (learning) processes that are inherently social.

Based on these insights (and in line with many other scholars, see chapter 2.1.3), the present thesis argues that social processes are indispensable to counteract both the growing gap between scientific ´expert´ data and action and the growing fragmentation between ever-more specialised fields of knowledge (scientific and non-scientific). Paradoxically, the more specialised knowledge becomes, the

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however, the term ecocultural imaginary puts more emphasis on ways of imagining and narrating human-environment relations. In the current case studies, landscape imaginaries have been affective narrative expressions of particular community-based narratives and paradigms, often flowing from particular images of the past derived from personal and communal memories. But they may also be sociotechnical imaginaries in the STS sense by inscribing themselves in societal projects, by being technology-centred, and future-oriented.

greater is the need for cooperation. To dissolve this apparent paradox seems to be a pre-condition for sustainability transformations.

11.3.3.3 Transformation dimension

´Knowledge-for-action´ is the crucial dimension of actionable knowledge (Caniglia et al., 2020; König, 2018; Wiek et al., 2012). Human agency manifests itself in the capacity to *re*-interpret contexts of engagement, particularly institutional constraints and opportunities, and to act on these re-interpretations (Giddens, 1984; Pahl-Wostl, 2015). Thus understood, agency is in contrast with the mere reproduction of established routines and practices. In the present thesis, the transformation dimension has been analysed in relation to how actors engage with each other (social engagement and coordination/governance) and with water and land (material engagement and management). Social learning for sustainability rests on the notion that transformations of modes of social and material engagement are needed to fundamentally change patterns in human-environment interaction. As interfaces between individuals, society, and material environments, organisations have a crucial role to play in this regard.

The examples of the founding periods of the river partnerships and of LAKU suggest that few factors may be as effective in fostering ´knowledge-for-action´ as ´knowledge-*in*-action´. In these examples, a sense of shared purpose and trust among actors emerged from action-oriented and experimental social processes driven by committed self-organising individuals. The processes analysed have entailed knowledge co-creation tailored to contexts based on non-scientific and scientific professional, local, and organisational knowledge that also included technological experimentation. They have required strategic, operational, and financial support of diverse organisations. Governmental actors have had an important role in facilitating such processes.

At the same time, the present thesis also argues that spaces for self-organised actions are shrinking. The argument is rooted in the diagnosis that national EU WFD implementation has contributed to strengthening hierarchical governance in Luxembourg´s water and land systems due to detailed and rigid regulatory frameworks that are often difficult to reconcile, that necessitate extensive administrative capacities, and are predominantly based on specialised scientific expertise. Furthermore, diverse material constraints to nature-based solutions and experiments in water and agriculture also grow, with increasingly difficult access to (affordable) land as just one factor among several (see above). Taken together, these and other factors have manifested themselves in widespread sentiments among nongovernmental and governmental actors alike of being ´at the limit´.

Paradoxically, the more detailed and inconsistent formal institutions are, the greater is the need that actors develop agency by interpreting and applying institutions flexibly and creatively. Even more generally, the more insurmountable barriers may seem, the more is collective action of diverse actors called for. To tackle this second paradox may be yet another precondition for transformative change.

A belief in – and the strengthening of - human agency in and via social processes may be necessary to tackle these formidable challenges. This may take significant powers of narration and imagination.

CONCLUSIONS

12 FINAL CONCLUSIONS

The following conclusions are evidence-based and normative. They offer insights and thoughts as an invitation to further scientific and societal dialogues.

With a point of departure in sustainability science and adaptive governance, the thesis set out to examine how knowledge and action in diverse organisations that are professionally engaged in Luxembourg´s water and land systems may contribute to regenerating human-environment *and* human-human interaction. They are inextricably interlinked. Environmental problems are *societal* problems (Ravetz, 2006). In order to move towards sustainability, societies need to devise ways to address interdependencies between ecological and social systems. It is in this sense that the thesis has investigated sustainability challenges at the water-land nexus as part of wider societal transformations. Societies need to strengthen their adaptive and transformative capacities to meet sustainability challenges (König, 2018; Pahl-Wostl, 2015). Adaptive capacities denote the ability of societies to cope with unpredictable change in their social and material environments. Self-organisation and social learning enable actors to adapt their institutions and practices (see chapter 2.2.1).

The emphasis scholars place on *transformative* capacities rests on the argument that it is not sufficient to *adapt* current systems reactively to changes. Humanity faces the prospect of irreversible large-scale changes (so-called "tipping points") that may undermine the ecological foundations on which human life depends (Folke, 2006; Holling, 2001; Rockström et al., 2009a). Therefore, capacities of human actors need to be cultivated that are suitable to *transform* current social and material arrangements in a manner that makes societies more responsive to turbulence, enables ecological regeneration, and creates new opportunities for human flourishing[293]. Social-ecological system dynamics are complex, uncertain, and contingent on contexts. Furthermore, sustainability is a highly normative concept. The present thesis has therefore taken its point of departure in the concept of *double loop* social learning that underscores the need to enhance reflexive capacities of actors that enable them to question established purposes and practices, deal with uncertainty and normative ambiguities from diverse perspectives, and to devise sustainability pathways that are tailored to *adapt* and *transform* interactions between humans and material environments in their specific contexts. In the conceptualisation of the thesis, any learning depends on (changes in) personal meaning-making and experiential engagement.

Human knowledge, agency, and learning have thus been at the heart of the thesis. Moreover, while most scholarship on actionable knowledge focuses on researcher-led processes, the present thesis has

[293] The concept of resilience is closely related to adaptive and transformative capacities of governance systems (see 2.2.1).

aimed to cast light on what knowledge actors act upon in their *professional* lives. The findings of the thesis thereby contribute to enhance understandings of:

- what makes knowledge actionable for sustainability, with a focus on the role of organisations and professions (including related paradigms and narratives) in shaping actor engagement and vice versa (research question 1);
- how EU and national regulation (e.g. on water, environment, agriculture) contribute to shaping societal capacities to meet sustainability challenges, notably by changing structures and processes of how actors (self-)organise themselves, and the purposes and knowledge they pursue in their organisations and professions (research question 2);
- factors that facilitate or hinder the emergence of social learning, actionable knowledge, and transformative change in governance processes (research question 3).

Insights have emerged from case studies in the Syr and Upper Sûre river basins that have analysed formal and informal governance processes that concerned different aspects of the EU Water Framework Directive (WFD), the Birds and Habitats´ Directives, Common Agricultural Policy (CAP), and related national policies.

The conclusions begin with a summary of the main findings on changes in Luxembourg´s water and land governance systems (research question 2), before elaborating on the main research contributions concerning actionable knowledge and social learning (research questions 1 and 3).

12.1 Summary of overarching findings

Have governance processes in the Upper Sûre and Syr basins fostered social learning and actionable knowledge, thereby enhancing adaptive and transformative capacities in Luxembourg´s water and land systems? What were the main hindering and facilitating factors?

The first decades of the 21st century marked a watershed for formal policies and actors professionally engaged in Luxembourg´s water and land systems. The EU Water Framework Directive resulted in profound re-framing of formal purposes and operational objectives pursued in water governance and management, not only in Luxembourg but across EU member states (see chapter 4.5). While water management throughout the centuries had served anthropocentric drinking water supply and flood protection, water management following the millennial turn was to be re-directed towards restoring water bodies to a "good ecological status", thereby covering entire aquatic ecosystems such as wetlands. Consequently, water management has become more ecosystem-based (river basins), an integral element of *environmental* governance, and was also to be integrated more strongly with agricultural, regional and other sectoral policies. Moreover, based on WFD provisions, Luxembourg, for the first time in its history, introduced public consultations to involve stakeholders in formal governance and river basin management.

The thesis finds that EU regulation has led to a normative reframing of water-related challenges in Luxembourg and a significant extension of the scope and means attributed to water management. Re-framing and re-scoping have had profound implications for governance processes, organisational landscapes, and knowledge and data production (e.g. in relation to water quality), particularly as regards the status of specialised scientific/technical knowledge and the role of nongovernmental actors. As regards organisations, the thesis deals, in particular, with the creation and roles of the Water Management Authority (AGE) and the Syr and Upper Sûre river partnerships.

However, the thesis also finds that 20 years after the entering into force of the EU WFD changes in water management practices have remained modest. Aquatic ecosystem health falls far short of the

legally binding WFD objectives. Patterns in human engagement with water and land in Luxembourg have not changed fundamentally. Adaptive and transformative capacities in Luxembourg to meet sustainability challenges at the water-land nexus have therefore not yet been significantly enhanced. The thesis argues that this is the result of a combination of characteristics of the EU WFD itself (transposed by the national water law of 2008) and of diverse other formal, informal, and material factors. Formal environmental regulation is but one driver of change in a much larger and complex system, and, hence, unlikely to produce sustainability transformations by itself.

The main reason for this diagnosis is that social learning has overall remained limited in the governance processes analysed in the case studies. There are, however, a few exceptions relating to the river partnerships and to the agricultural cooperation LAKU that do provide evidence that social learning and actionable knowledge are most likely to emerge from self-organisation and knowledge co-creation.

Overall, however, contradictions in Luxembourg´s water and land systems grow, while spaces for self-organisation and meaning-making shrink. A growing number of organisations are in place to improve the state of ecosystems and enhance cross-scale and cross-sectoral cooperation. At the same time, as many actors sense that their "rooms for manoeuvre" (*what can be done*) become smaller, gaps between environmental objectives (*what ought to be)* and ´realities´ on the ground (*what is)* widen. ´Limits to growth´ may manifest themselves earlier here than in larger countries. It would thus seem that Luxembourg finds itself at a crossroads, with actors across scales and sectors facing tough choices between partly conflicting paths towards increasingly uncertain futures.

Empirical analysis has identified several sets of contradictions that have posed barriers to the emergence of social learning and actionable knowledge for sustainability:

1. between environmental objectives and social and material ´realities´,
2. between a continuously strong supply- and productivity-orientation in the economy (incl. agriculture) and environmental objectives,
3. between environmental objectives and widespread scepticism towards ecosystem-based management,
4. between managerial top-down approaches to environmental protection and self-organisation.

As regards the first, the case studies suggest that demographic and economic developments continue to be the main drivers of change in Luxembourg´s water and land systems. Pressures on water bodies and ecosystems grow. Technologies serve as dominant means to make demographic and economic growth as well as agricultural production more compatible with environmental objectives. Pressures include landscape fragmentation and soil sealing resulting from expanding settlements and infrastructures. Growing quantities of drinking water are extracted from the Upper Sûre lake and local sources. Growing quantities of effluents flow into Luxembourg´s small rivers such as the Syr, making the attainment of a good ecological state increasingly doubtful. The construction of a new high-tech drinking water treatment for the Upper Sûre lake, the expansion and modernisation of the Uebersyren wastewater treatment plan (incl. a 4th treatment step) and of airport infrastructures seem symptomatic of the strategy to use technologies rather than preventive measures to fulfil environmental objectives. Adding to this are decreasing land availability and increasing fragmentation that reduce physical spaces available for river restorations and other ´nature-based solutions´. Hikes in land prices combined with strong competitive pressures on domestic and global food markets have contributed to stagnant or even falling incomes among farmers. This has reduced their possibilities to switch to more extensive farming models. Finally, climatic changes add to strains on water bodies (dropping water levels), flora and fauna, and agriculture (see chapter 11.2.2.4).

Secondly, these developments suggest that contradictions between supply-oriented paradigms and environmental objectives do not only persist but also exacerbate. EU regulation and national environmental policies (having become more ambitious since the election of the liberal-socialist-green government in 2013) have contributed to a stronger institutionalisation of an environmentalist paradigm that has contributed to normative re-framings in formal governance. At the same time, environmental objectives and approaches co-exist with productivity- and supply-oriented paradigms. This has made Luxembourg´s governance landscape more hybrid and contradictory. For example, there is a stark contradiction between the introduction of new protection zones for drinking water and natural habitats of "national interest" and ongoing pollution and destruction of biotopes on the grounds of "imperative reasons of overriding public interest" allowed by water and environmental regulation if damage is compensated by other measures (see chapter 10.5.2). "Major problems" such as pollution of the Syr river caused by wastewater from the international airport have weakened the credibility of environmental policies, impaired the attainment of environmental objectives (although legally-binding), and has produced suspicions among nongovernmental actors of double standards. The case studies show how such contradictions may negatively affect the engagement of actors in governance processes.

An emphasis on technological innovation in areas such as water management or agriculture seems to be the main common denominator that serves to bridge apparent contradictions. The case studies, however, suggest that with demographic and economic developments continuing unabatedly, beliefs in the omnipotence of technological remedies may turn out to be illusory. The thesis thus makes the point that it is unlikely that regulation, scientific and technological advances will move Luxembourg closer to sustainability without wider societal and economic transformations.

As regards the third contradiction, empirical analysis suggests that support of ecosystem-based and adaptive management is not yet widespread among the population and stakeholders. Since national WFD transposition and the creation of the Water Management Authority and river partnerships, more actors (e.g. some municipalities) have begun to support river restorations. The Syr case study, however, also suggests that many local inhabitants, landowners, and agricultural actors have strong misgiving about wetlands, notably for fears of insects and infectious diseases. In addition to economic reasons (e.g. fears of land price losses), the case studies suggest that scepticism results from aesthetic preferences for ´controlled´ and ´orderly´ landscapes, agricultural narratives in which wetland drainage done by ancestors features as pre-condition for modern agriculture, and a widening "nature dis-connect" (or "Naturferne") in the population. Interviews and observations also suggest there continues to be a widespread preference for control-oriented technological ´solutions´ among municipalities and public authorities rather than for dynamic ecosystem-based approaches (see Syr case study). Moreover, for multiple reasons (see Upper Sûre case study), only a small minority of farmers have so far converted to alternative organic and/or extensive production. The main factor identified is a lack of demand of Luxembourgish products (organic or not) among domestic consumers who prefer cheaper non-organic and organic imports. These examples suggest that societal (or triple loop) learning in the form of paradigm shifts in the minds, hearts, and hands of a majority of actors in Luxembourg have not yet taken place.

At both collaborative NEXUS workshops conducted in framework of the thesis, a closer cooperation between farmers and consumers emerged as one of the key ´action fields´ to ´re-connect´ citizens with local food production and to open new perspectives for farmers (see recommendations below).

Finally, the thesis suggests that contradictions in the Luxembourgish governance system between technocratic-managerial approaches to ecological restoration and self-organisation (network governance) grow, despite the introduction of public consultations and river basin organisations. The

case studies find that the EU has significantly boosted hierarchical environmental governance based on specialised scientific knowledge and data that have fed into extensive management plans and new administrative requirements for projects. This applies not only to Luxembourg, but has also been found in other EU countries (see chapter 4.5.3). As a result of EU requirements, professional and scientific knowledge of ecosystem dynamics and water quality has increased significantly within many governmental and nongovernmental organisations. At the same time, natural science-based administrative requirements have contributed to making it more complex and lengthy for nongovernmental actors (including municipalities) to obtain authorisations and funding for projects. This has led to a consolidation and expansion of ´expert systems´.

To fulfil both EU and administrative requirements, governmental and nongovernmental actors alike have increasingly resorted to specialised researchers and consultants to prepare and evaluate plans and projects to ensure that they are effective in contributing to reaching ecological objectives. The concept on aquatic habitat connectivity that demands that hydromorphological measures to improve river structures be targeted at core habitats is one example of the "scientification"[294] of water and environmental management (see 10.5.5). It has added to difficulties in the coordination between the public administrations in charge of water management (WFD-based), respectively, of environmental protection (based on EU Habitats Directive) that work with different sets of criteria. Furthermore, because of complex requirements and insufficient coordination, the planning of several hydromorphological measures (incl. river restorations) has been stalled, others have been rejected because they did not fulfil requirements and/or deemed ecologically ineffective. Actors have experienced this as a setback, especially in those cases where they had managed to get farmers on board.

Rigid and partly conflicting requirements have thus limited spaces for adaptive management that is based on experiments and learning-by-doing among diverse actors. The only major river restoration analysed in the Syr basin was carried out *before* the national water law transposing the EU WFD and Floods Directive entered into force. Nation-wide, a large majority of hydromorphological measures from the national WFD management plan have not yet been implemented (see chapter 10.6.2). Given limited space availability and the reluctance of many landowners, some actors do not expect significant progress.

Overall, the case studies suggest that hierarchical approaches and the emphasis on expert studies have come at the expense of the consideration of professional and local knowledge of practitioners and self-organisation. The analysis of public consultation procedures in the river basins points to how numerous organisations (e.g. municipalities) and individual actors (e.g. farmers) have resorted to expert advice and studies to give more weight to their objections and arguments. Those who do not substantiate their judgements scientifically fear to lose influence and credibility. Furthermore, some public debates analysed in the Upper Sûre basin have centred on conflicts between expert studies. Overall, the public consultations analysed have mainly served the revision of technical details of draft laws rather than having been used as opportunities to foster dialogues and more active involvement of actors.

Finally, the river partnerships (partly state-financed) and their municipal members have been expected to focus on implementation measures (pre-)defined in the national WFD management plans, further reducing spaces for self-organisation. In this sense, governmental and nongovernmental actors alike have struggled to "work off" management plans in what resembles a ´box-ticking´ exercise, while few believe that the good ecological state required by the EU WFD can actually be reached by the latest legal deadline in 2027 or, for that matter, at all. It is based on these findings that the thesis diagnoses

[294] Or "scientization", as Beck puts it (Beck et al., 1994)

that Luxembourg´s water and land system is characterised by growing contradictions and shrinking spaces for self-organisation that severely constrain opportunities for social learning.

At the same time, the case studies also provide some evidence that actors across scales and sectors begin to move towards more integrated understandings of (positive and negative) interrelations between water quality and land use practices, and increasingly recognise the need for cooperation. One example is the agricultural cooperation LAKU (outlined in more detail below). The empirical analysis of LAKU also points towards some factors that facilitate social learning and contributes to a better understanding of what makes knowledge actionable. The case study confirms the established view in transformative sustainability science and adaptive governance and management that self-organisation in cross-sectoral social networks is one of the most important factors (or even precondition) to facilitate social learning and actionable knowledge. Moreover, the Syr and Upper Sûre case studies have allowed the author to provide novel insights into their relations with organisational and professional knowledge and narratives.

Sustainability challenges at the water-land nexus are formidable. They are interwoven with wider systems in deep need of transformative change. The more insurmountable barriers and contradictions seem, the greater the need to leverage the marvellous capacities of humans for knowledge, learning, and action (e.g. Chabay, 2020; Maggs & Robinson, 2016; Stirling, 2015a). Knowledge that is to be actionable for sustainability may need to re-imagine and foster new ways on how to understand and address interrelations between ecological and social challenges. 19th century industrialisation and 20th century post-WWII reconstructions were societal projects that mobilised and inspired people across organisations and levels of society. The 21st century presents us with the challenge of how we can continue to develop democracy further to join forces with each other *and* with Earth´s life-support systems.

The following is divided into three parts, discussing, first, the main research contributions, secondly, the limitations of the thesis and questions for further research. Thirdly, it outlines recommendations for policy and practice. The recommendations propose ways forward on how cooperation and experimental projects in Luxembourg could be strengthened to better enable actors to address water-land nexus challenges in local contexts. They rest on the main insight that dominant approaches alone are unlikely to pave the way for sustainability. The thesis concludes with an outlook for transformative sustainability research in Luxembourg

12.2 Research contributions

The Luxembourgish context is particular; not all insights about challenges, barriers, and opportunities can be generalised. The empirical basis is necessarily limited. Nonetheless, the case studies also suggest that Luxembourg is firmly embedded in global, Western, and European contexts, notably within the EU and with regard to its Belgian, French, and German neighbours. Therefore, this chapter dares to draw some general conclusions.

Actionable knowledge is a concept that reflects efforts of researchers to close gaps between science and society, and between knowledge and action. It has emerged from the widespread diagnosis that sustainability requires knowledge and ways of knowing that are more conducive to behavioural changes and action than information (e.g. about scientific ´facts´) and regulation by themselves. The

thesis makes three main contributions to scientific understandings of actionable knowledge and how it may contribute to transformative changes:

1. the role of organisations and diverse knowledge types in transformative change,
2. the role of paradigms and narratives shared in organisations (incl. professional and local communities),
3. the role of self-organisation, knowledge co-creation and collaborative experiments.

Based on established scholarship (Grunwald, 2016; König, 2018; Pohl & Hirsch Hadorn, 2007; Wiek & Lang, 2016), the thesis has developed an analytical framework that is suitable to structure investigations into knowledge and learning along three dimensions (see figure 12.1):

- Normative dimension (why)
- Systems dimension (what)
- Transformation dimension (how)

The thesis offers these dimensions (or ´meta-knowledge types´) to juxtapose and analyse changes in diverse types of *community*-based knowledge: organisational, professional (including scientific), and local. The framework thus brings together those scientific discourses that centre on the importance of normative or target knowledge, systems knowledge and transformation or action knowledge for sustainability and those that stress the need to integrate different knowledge types such as scientific and local (see chapter 2.3.2.2). The thesis adds organisational and professional knowledge and links these knowledge types to organisational and professional *learning* (as sub-types of *social* learning). The framework thus allows for a systematic analysis of different knowledge types, of tensions and synergies between different actors, and how they evolve as a result of social learning.

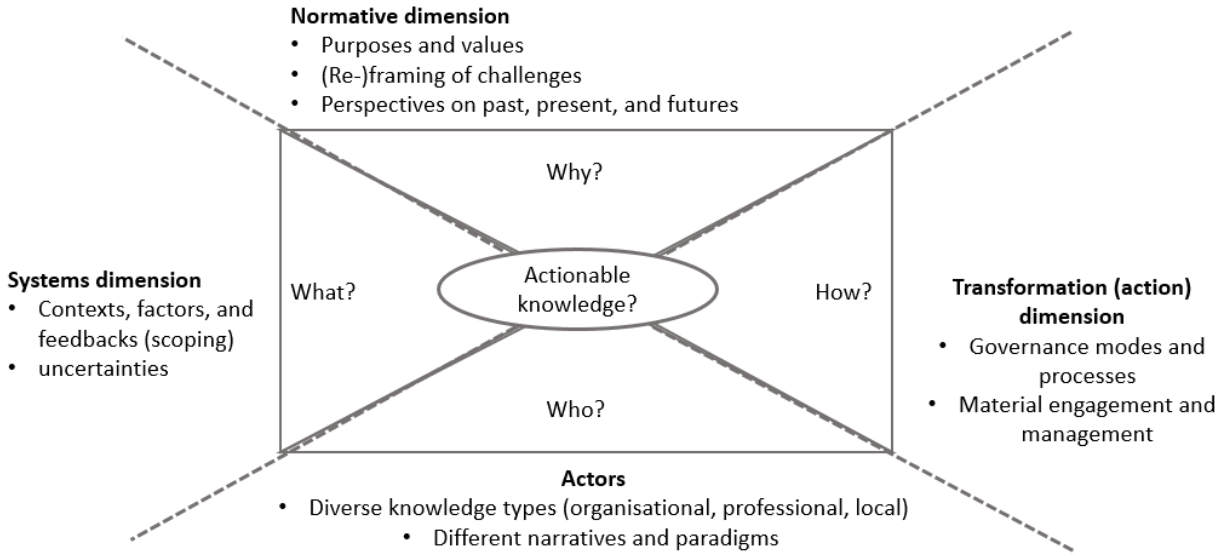

Figure 12.1 - Analytical framework on actionable knowledge developed by the thesis

One of the main advantages of differentiating between these knowledge types is that they direct attention to organisational and professional factors that facilitate or hinder the emergence of social networks and social learning and sustainability actions. Additionally, the case studies suggest that the analysis of interrelations between organisational and professional contexts (including their histories) and how individual professionals (such as farmers, environmentalists, municipal or national officials)

choose to engage in water and land systems generates interesting insights into what makes knowledge actionable.

More concretely, on the basis of the empirical evidence, the thesis concludes that knowledge that is to be actionable in the service of sustainability needs to resonate with and cultivate organisational, professional (incl. scientific), and local knowledge of actors. In the course of social learning processes, knowledge of diverse actors may converge along the normative, systems, and transformation dimensions, fostering adjustments in preferred means and processes (single-loop learning) or more profound re-framings and re-scoping of challenges (double-loop learning) that enhance shared understandings.

Furthermore, the thesis links these knowledge types with narratives, suggesting that personal and collectively held narratives (and related narrative identities) shape what purposes actors pursue, how they understand (frame) challenges, engage with others, and how they address challenges. Finally, empirical analysis shows how narratives may cast light on paradigms that underlie collective (epistemic) cultures and practices, e.g. in organisations. Accordingly, *changes* in narratives of individuals and organisations lend themselves as indicators of emerging social learning and possible paradigm shifts in organisational cultures and professional practices. The analytical framework developed, therefore, is also suitable to structure inquiries into narratives and paradigms.

By analysing interrelations between knowledge, action, and narratives, the thesis provides some empirical groundwork and arguments in favour of those approaches in transformative sustainability science that seek to leverage the powers of narratives as a way to encourage collective and individual behaviour change (e.g. Chabay, 2020; Chabay et al., 2019; Jones, 2014). At the same time, the thesis also points out that narratives may be sources of inaction and division.

Finally, elaborated from the Management Transition Framework (Pahl-Wostl et al., 2010), MTF, the thesis has developed a scheme to analyse the role of diverse informal, formal, and material factors in facilitating or hindering the emergence of social learning and actionable knowledge in governance processes. These factors are associated with transactional (incl. local) contexts of direct social and material engagement, organisational and macro-contexts. The thesis has defined social learning as entailing changes in social relations, knowledge, and action that enhance the capacities of actor groups to address sustainability challenges. Social learning serves as a generic category to denote learning among diverse stakeholders (e.g. in social networks), learning in their home organisations and professions (*organisational* and/or *professional* learning), and in society at large (*societal* learning), e.g. in the form of wider paradigm shifts (see below). All professions are considered to be embedded in formal or informal organisational contexts.

Outcomes and effects of social learning also change *contexts* of actor engagement. In single loop learning, actors mainly adapt the means (how) employed to achieve established purposes, with limited changes in contexts. Double loop learning entails a reflexive questioning and re-framing of purposes and challenges (why) that is typically accompanied by changes in understandings of what factors and systems dynamics (what) are taken into account when addressing a particular challenge (or re-scoping), also leading to changes in strategies and means on how to address them (e.g. in governance modes and management practices). Thereby, double loop social learning changes personal contexts of meaning-making, transactional contexts of actor engagement as well as organisational and professional contexts. Furthermore, it is through actionable knowledge emerging with double loop social learning that actors may contribute to transformations of patterns in human-environment interactions in societal and physical macro contexts. While much of the literature focuses on *intended* outcomes and effects of social learning, the case studies also explicitly analyse *unintended* effects and feedbacks in relation to the different contexts (see figure 12.2).

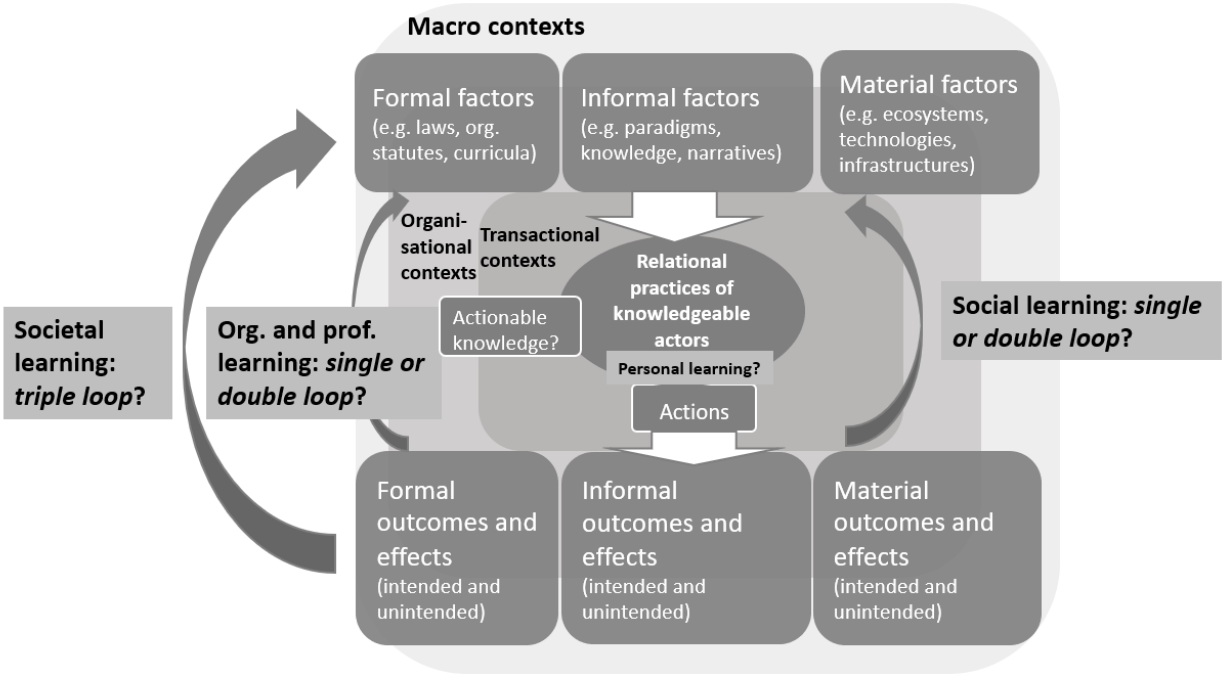

Figure 12.2 – Social learning scheme developed by the thesis based on the Management and Transition Framework

The following conclusions summarise the main insights concerning, first, interrelations between organisations and paradigm shifts in society (triple loop learning); secondly, the role of different knowledge types in organisations and how EU directives have contributed to changes in knowledge cultures and hierarchies. Thirdly, the conclusions discuss the role of narratives in the case studies and conceptualise interrelations between narratives, knowledge, and paradigms. Finally, the thesis summarises key factors facilitating the emergence of social learning and actionable knowledge, using the agricultural cooperation LAKU as an example.

12.2.1 The role of organisations and diverse knowledge types in societal transformations

The thesis contributes to understandings of the role of organisations and diverse knowledge types in societal transformations. Based on empirical evidence, the main insights are:

- as possible ´carriers´ of paradigms, organisations can be vehicles of wider societal paradigm shifts, with changes in organisational landscapes serving as possible indicators of such paradigm shifts,
- organisations bring together diverse knowledge types: organisational, professional (practice-oriented and scientific), and local,
- actionable knowledge for sustainability emerges from social learning that enhances organisational, professional, and local knowledge (e.g. via organisational and professional learning),
- regulation may shape knowledge cultures and hierarchies in organisations and influence the sense of agency among actors.

The thesis provides evidence that organisations (governmental and nongovernmental) may serve as promising entry-point to better understand how transformations in society (triple loop learning) emerge. Notably, changes in organisational landscapes and knowledge have been found to be possible

indicators of new emerging paradigms and paradigmatic shifts. This finding underscores arguments that organisations may be potential vehicles of transformative changes (Amel et al., 2017) and that transformations may necessitate organisational changes (Hahn et al., 2006). However, few scholars have examined interrelations between organisations, paradigms, and knowledge in governance and social learning processes.

With a point of departure in the 19th century, the thesis has investigated changes in organisations in Luxembourg across different scales and levels of social organisation (local, river basins/regions, (trans-)national, EU). Based on Science & Technology Studies (STS), the inquiry provides an account of how organisational and material environments have mutually influenced and shaped each other. To structure the analysis into paradigms and approaches of organisations (and policies), the thesis has developed an analytical grid composed of a vertical axis (hierarchical, network-, and community-based governance modes) and a horizontal axis that allows for the mapping of purposes that organisations (or policies) attribute to human engagement (or management) with ecosystems (anthropocentric-integrated-ecocentric). In particular, the grid has served to map historical trajectories of organisations, and (inter-)organisational tensions and synergies. It is based on the insight that understandings of organisations and how actors engage with each other today greatly benefit from inquiries into organisational histories, starting with e.g. narratives supplemented by organisational documents.

Based on interrelations between paradigms and organisations, a distinction can be made between:

- **dominant paradigm(s**) that shape formal frameworks, cultures, infrastructures, and technologies across organisations and society,
- **emerging paradigms** underlying organisations that pursue alternative (non-dominant) purposes and, possibly, transformative change,
- **waning paradigms** that begin to lose traction among individual actors, organisations, in formal regulation, and cultures.

Societal transformations happen when new paradigms emerge and become dominant, and once-dominant paradigms wither. Whilst this may seem abstract at first glance, the thesis shows how the waxing and waning of paradigms may be usefully analysed and understood by reference to organisations. The historical context chapter of the case studies thus shows how major transformations in 19th and 20th century Luxembourg went hand in hand with the creation of new organisations and changes within and between existing organisations and professions. These changes encompassed inter-organisational cooperation, knowledge generation (e.g. professional and scientific), and use of new technologies (among others). Some of the new organisations were formally founded as a result of pioneering bottom-up self-organisation (e.g. environmental NGOs), others by formal government initiative (e.g. new ministries, administrations), others again as a combination of the two. Notably, the boundary organisations analysed in Luxembourg (river partnerships, Upper Sûre Nature Park, and LAKU) were all founded as a result of a cooperation between nongovernmental and governmental actors.

Empirical analysis suggests that *emerging* paradigms (e.g. environmentalist), in history, have been highly depended on (and emerged with) organisations of pioneering groups and individuals that carried seeds of transformation. At the same time, history and contemporary processes also provide evidence that governmental initiatives to set up new ministries, administrations, syndicates or similar also served to strengthen – or respond to - emerging paradigms. Thus, the set-up of the national water supplier (together with the Upper Sûre dam) consolidated command-and-control approaches to water management, while the founding of the Water Management Authority following the entering into force of the WFD heralded a paradigm shift towards new ecocentric and integrated approaches to water management.

Based on empirical analysis and the conceptualisation of paradigms, the history of Luxembourg´s water and land governance systems has been divided into four phases (see table 12.1) that are closely intertwined with European and global contexts (see chapter 4.2.3):

1. Industrial revolution (19th century to beg. 20th century)
2. Post-WWII reconstructions (1945-1968)
3. Pioneering times (1968-1999)
4. Integrative and hybrid times (2000-today)

Within each of these phases, new governmental and nongovernmental organisations were created for particular purposes and existing organisations re-oriented themselves towards new ´missions´ as a result of organisational learning and/or formal regulation. This often went hand in hand with inter- and intra-organisational tensions and coordination challenges that, in many cases, could be directly related to differences in paradigms (dominant and emerging) and (often ensuing) competence re-distributions and struggles.

Most notably, historical inquiry suggest that major societal transformations such as the 19th century ´industrial revolution´ and post-WWII reconstructions were made possible by complex cross-scale and cross-sectoral cooperation between many different organisations that shared beliefs in modern-industrial paradigms (e.g. command-and-control in water management and productionist paradigm in agriculture) and related narratives that centred on progress. They were challenged in the "pioneering times" of the second half of the 20th century, when new environmental and regional movements and first sectoral environmental policies emerged.

Phases	**Formal governance** (Lux., EU, international)	**Informal governance: organisations** (Luxembourg)	**Material environments** (Luxembourg)
19th century to WWII: "industrial revolution"	**National administrations** of emerging Luxembourg nation-state, incl. for • forestry (today´s ANF) • roads (P&Ch) • agriculture (today´s ASTA)	**Existing:** farmers, municipalities **New:** • env. organisations (e.g. Natural History Museum, SNL, LNVL) • intermunicipal syndicates (e.g. DEA) • agricultural advisors (CONVIS, LWK)	**Infrastructures**: • heavy industry • transport, drinking water **Ecosystems & agriculture**: • river regulations, draining of wetlands • new ploughs, live-stock, fertilisers, etc.
***Emerging*:** command-and-control and supply-oriented paradigms & bottom-up ecocentric paradigm ***Waning**:* pre-industrial local community paradigm			
1945-1968: reconstructions ("public works era" and "scientific-technical revolution" in agriculture)	**Internat.:** Marshall plan **EC:** Common Agricultural Policy (CAP) **New national ministries** (incl. for agriculture, today´s MAVDR) and **administrations** (incl. for land consolidation, ONR)	*In addition*: • national water supplier SEBES • Luxair	*In addition* : **Infrastructures:** • Upper Sûre dam • airport extensions **Agriculture:** • inten-sification • structural changes **Ecol. deterioration**
Dominant*:** command-and-control paradigms ***Emerging: productionist paradigm (agriculture) ***Waning**:* pre-industrial local community and farming paradigms			

1968-1999: pioneering times	**EC, Lux.:** water and env. policies (incl. Wild Birds, Wastewater, Nitrates, Habitats directives) **Internat.:** UNESCO Ramsar wetland convention, WCED Brundtland commission	*In addition*: • syndicates for wastewater, environment (e.g. SIAS, SIDEN, Nature Park Upper Sûre) • env. organisations (e.g. Fondation HfN) • (public research centres)[295]	*In addition*: **Ecosystems:** • (river) restorations **Agriculture:** • regional products (Upper Sûre) **Infrastructures:** • WWTP (e.g. Uebersyren) • finance industry
***Dominant*:** command-and-control and productionist paradigms (water, agriculture) **Emerging**: ecological restoration paradigms, integrated local community paradigm, organic agriculture			
2000 – today: Integrative and hybrid times	**EU:** WFD, CAP reform **Lux.:** water administration (AGE), public access & liability, environmental and water laws **Internat.:** UN 2030 Agenda for Sust.Dev.	*In addition*: • river partnerships • env. organisations (e.g. natur&ëmwelt) • wastewater syndicate SIDEST • agricultural cooperation LAKU, organic advisors IBLA • coordinators for drinking water and Natura2000 areas • (University of Luxembourg)[296]	*In addition*: **Ecosystems:** • protected areas restricting human activities • nature-based ´solutions´ **Agriculture**: • experiments with extensive and organic farming **Infrastructures:** • new plants (e.g. SEBES, Uebersyren)
Dominant*:** (expanded) command-and-control and productionist paradigms **Co-existing**: managerial ecological restoration paradigms ***Emerging: integrated community paradigms, organic and extensive agricultural production			

Table 12.1 – Four phases in the history of water and land governance in Luxembourg showing the main actors, paradigms, and material factors analysed

The case studies have focused on the period starting in 2000 when the EU WFD entered into force. Since then both top-down managerial approaches to ecological restoration have consolidated as well as integrated and more adaptive network-based approaches to water and land management. This hybridity is reflected in the set-up of the central Water Management Authority, the river partnerships of the Syr and Upper Sûre basins, and LAKU that were created in response to the WFD and the respective national water law. As regards the creation of the river partnerships (initially as *self-organised* Interreg projects that were later institutionalised based on the new national water law) and LAKU, they resulted from the expectation that nongovernmental actors would henceforth be involved more actively in water governance and management in river basins. At the same time, municipalities kept their autonomy in urban water management. Furthermore, since 2019 new coordinators for

[295] The first public research centres in Luxembourg were set up in the 1980s (see also www.innovation.public.lu/en/decouvrir/acteurs/recherche-publique/index.html), including the forerunners of today´s Luxembourg Institute of Science and Technology (LIST) mentioned in the case studies (website: www.list.lu).

[296] The University of Luxembourg was founded in 2003 (website: www.uni.lu)

(future) drinking water protection zones have been introduced to coordinate measures with diverse actors.

Since the 19th century, organisations active in Luxembourg´s water and land management have thus multiplied. Accordingly, the thesis shows how organisational landscapes and inter-organisational (governance) processes have grown in complexity and diversity in purposes pursued, problem framings, systems knowledge, and problem-solving strategies. The creation of river partnerships and other coordinating actors provide some evidence that Luxembourg moves towards more integrated water and land management. At the same time, coordination has become an increasing challenge; organisations have not only multiplied, but some of them also have overlapping, unclear, and contested competences. This greatly adds to the need for informal social processes that are conducive to foster shared understandings, priorities, and sense of purpose among these diverse actors through social learning. It seems unlikely that formal coordination requirements and formal governance processes alone will be sufficient (see recommendations).

12.2.1.1 Organisations as contexts for learning and diverse knowledge types

The thesis set out to investigate what makes knowledge actionable for sustainability. The case studies provide evidence that sustainability researchers and policy-makers alike would benefit from recognising and cultivating diverse types of knowledge in organisations and professions more strongly to foster actions for sustainability (see recommendations). Devoting more attention to organisational and professional knowledge – and, accordingly, to organisational and professional learning - may significantly enhance understandings of what is actionable for whom and of how processes could be designed (in science and governance) to be conducive to its emergence.

The thesis has defined organisations broadly as entities whose members share certain rules (institutions) and tasks. This definition has encompassed formal organisations (governmental and nongovernmental), but also groups such that may predominantly be organised in an informal manner, for example, farmers and local communities. Professional and local activities will thus tend to take place in some kind of formal or informal organisational context. Organisational contexts encompass diverse formal, informal, and material factors: e.g. formal organisational mandates and statutes, purposes and informal institutions, social relations and roles, particular resources, practices, and technologies.

Furthermore, as contexts that simultaneously structure and are shaped by actor engagement, organisations bring together *diverse* knowledge types (see figure 12.4 below). The thesis has thus gone beyond the widely established distinction between scientific/expert and local (or experiential) knowledge. Considering organisational and professional knowledge types in their own right implies a greater recognition of the importance and specificities of how organisational and professional contexts may reflect different epistemic cultures and, indeed, paradigms.

How organisations and actors mutually shape each other

The thesis finds that how actors have understood and sought to address sustainability challenges in the governance processes analysed has been inextricably wound up with their organisational and professional contexts, notably by shaping what actors *personally* perceived as *meaningful* (e.g. desirable), *appropriate,* and *possible* in terms of how to engage with others and with water and land in specific situations in transactional contexts (see figure 12.3 & table 12.2).

At the same time, the case studies also suggest that interrelations between organisational contexts, personal meaning-making (personal contexts), and social and material engagement in transactional

contexts have not been unidirectional. In informal governance processes, in particular, organisations and actor engagement have mutually shaped each other. Thus, *individuals* who have stepped *beyond* ways of knowing and doing (incl. in social relations) established in their organisational and professional contexts have been important drivers of social networks and contributed to changing organisational contexts. Likewise, new trustful relations and innovative action have sometimes emerged from specific *situations* of direct place-based engagement (e.g. in experiments), contributing to changes in both personal meaning-making and organisational contexts. Organisational learning effects have included stronger organisational commitments to social networks and boundary organisations, and the institutionalisation of new mandates, jobs, and job descriptions, to name but a few (see LAKU example below).

It is worthwhile noting that these effects have been observed in relation to *informal* action situations. In formal governance processes, actor engagement was shaped more strongly by legal mandates, formal capacities of participating actors, etc. This finding substantiates arguments that underline the importance of informal self-organisation for sustainability learning and, furthermore, of engagement in transactional contexts where actors enter into direct interaction with each other, water, land, and soil (e.g. Singleton, 2015; Van Poeck et al., 2018).

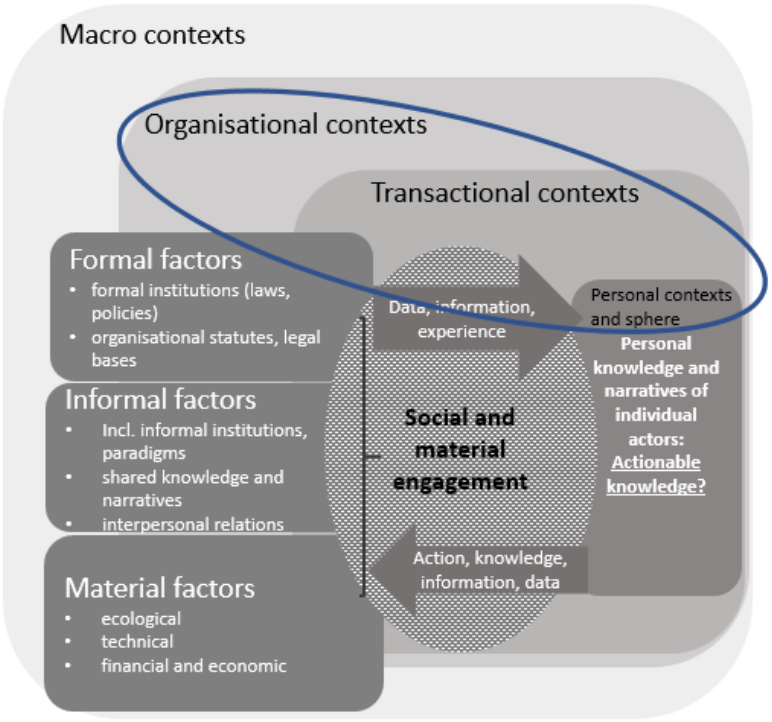

Figure 12.3 – Empirical focus on interrelations between organisational, transactional, and personal contexts and related factors

Interrelated contexts and factors	**Organisational contexts**	**Personal contexts**	**Transactional contexts** *(of a specific place-based situation)*
Informal	Purposes, shared narratives, paradigms, quality of (inter-)organisational relations, shared knowledge, repositories of information, data	Meaning-making: personal purposes, knowledge, narratives, sense of self (narrative identity)	(interpretations of) situations and people in terms of what are appropriate, meaningful, and possible means of *social* engagement
Formal	Legal mandate, statutes, job descriptions, formal roles, formal education	Interpretations of formal institutions, professional standards, roles, etc.	(interpretations of) formal roles and ´rooms of manoeuver´ in a situation
Material	Physical spaces, tools, (material) practices	e.g. place and/or nature attachment, routines	(interpretations of) situations in terms of appropriate, meaningful and possible means of *material* engagement, e.g. as regards technology use, ecosystem interventions

Table 12.2 - Table of factors in how organisational, personal, and transactional contexts mutually shape each other

Consequently, to neglect the affiliation of actors to particular organisations and professions risks limiting understandings of actionable knowledge and of facilitating and hindering factors.

The thesis thus seeks to contribute to an approach that analyses social networks and boundary organisations as (organisational) contexts that provide informal spaces and processes to facilitate organisational and professional learning within their member and partner organisations. The case studies show how actions that are tailored to local contexts – be they in agriculture or water management – require significant professional knowledge among practitioners. Local knowledge is an important element, however, rarely sufficient when it comes to the design and implementation of specific interventions that often are knowledge- and technology-intensive. For this reason, the thesis has introduced organisational and professional learning as sub-types of social learning.

Actionable knowledge as emerging from diverse knowledge types in organisational contexts

Based on the case studies and with a view to what makes knowledge actionable, relations between organisational, professional and local knowledge can now be clarified more systematically.

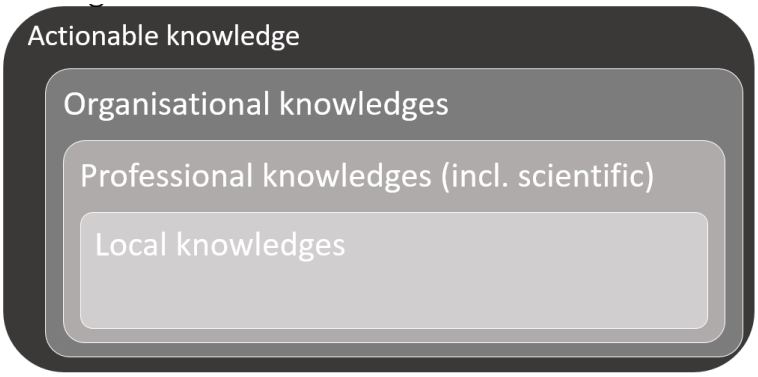

Figure 12.4 – Actionable knowledge as emerging from diverse organisational, professional, and local knowledge

The case studies show how members of organisations (be they public administrations, environmental organisations, municipalities or farmers) typically draw on *multiple* types of knowledge: organisational, professional (both science- and practice-oriented) and local, albeit to different degrees. In the understanding of the thesis, knowledge encompasses particular understandings and skills that are rooted in personal meaning-making and experiences, but also rest on formal education and vocational training (see chapter 3.1.3.). Furthermore, knowledge encompasses interpretations and enactments of formal institutions (such as laws and organisational statutes), informal institutions and social relations, and specific ways of engaging with material environments, e.g. via specific tools and technologies.

For the purposes of the thesis, *organisational* knowledge has been defined as pertaining primarily to the functioning of organisations, objectives, action strategies, task, and role distributions (within and between organisations), material environments that provide physical spaces, knowledge repositories and resources (e.g. infrastructures, technologies, etc.), and may be rooted in particular paradigms. As understood here, organisational knowledge thus relates to how actors choose to organise – and self-organise – themselves. The case studies analyses several examples of how (epistemic) culture and practices of an organisation shape how individual members engage with others, how they frame and seek to tackle sustainability challenges.

For present purposes, *organisational learning* then denotes a kind of social learning through which members change an organisation´s functioning (single loop), purposes and problem framings (double loop). Bringing together diverse organisations, boundary organisations may pursue purposes and action strategies that are close to priorities of their members or conflicting. The examples of the Upper Sûre Nature Park and River Contract, the Syr River Partnership, and LAKU suggest that the need of organisational learning required within boundary organisations to reconcile different purposes and ways of functioning of member organisations and for common priorities and strategies to emerge is particularly high. Furthermore, for *organisational commitments* to boundary organisations to emerge it may be necessary that intra-organisational learning takes place within member organisations. The Syr case study, in particular, suggests that while personal commitment of individual members is crucial, it may not itself be sufficient to overcome structural constraints, and leverage new opportunities.

Furthermore, organisations are typically composed of members with *different* professions and occupations (be they engineers, farmers, farm advisors, conservationists or other). How professionals carry out their activities is itself rooted in particular institutionalised purposes, knowledge, practices and disciplines. Unlike other approaches, the present thesis does not make a clear-cut distinction between scientific and professional (or practice-based) knowledge. For the purposes of the thesis, *professional* knowledge has been defined as encompassing both specialised scientific/technical knowledge (e.g. of researchers, consultants, public administrators) that is warranted by particular

scientific institutions and professional knowledge that is occupation-based and practice-oriented. Both are typically formally anchored in particular scientific disciplines and educational curricula (be it in universities or vocational schools), but they depend on professional experience. As will be argued below, professionals across the board are increasingly engaged in the use and production of scientific data.

Typically, organisations thus provide a super-structure for diverse professions and professional specialisations. Thus, purposes pursued by organisations, problem framings, scopes and factors considered and means to achieve purposes may converge – or be complementary - with established missions of particular professions (e.g. water supply, food production). But there may also be tensions and conflicts. The example of the national Water Management Authority shows how there can be significant differences in how younger and older-generation engineers address water management issues, as a result of both different professional experiences (made in different regulatory macro-contexts) as well as of differences in formal education. Several farmers and farm advisors stressed that they have largely acquired knowledge of e.g. soil and water quality by themselves (i.e. informally), as these issues were largely neglected by agricultural schools (this, however, may gradually change, too).

Addressing professional knowledge as a category in its own right thus directs attention to formal education, regulatory frameworks, and to professional experience as important factors for action and transformative change. Notably, the case studies suggest that adaptive ecosystem-based management in the water sector and agriculture, in particular, requires significant *professional* learning, notably as regards ecological systems knowledge and the use of sophisticated technologies (see LAKU example below). Organisations thus offer contexts for professional learning via the spaces for interaction, incentive structures, and resources they provide.

The case studies also suggest that new formal institutions – such as the EU WFD – can have significant impact on not only how actors organise themselves formally and informally, but also on the professional knowledge that is fostered and privileged (incl. via recruitment, job descriptions, task distributions, and promotions). For example, interviewees in water organisations emphasised the advantage of assigning colleagues with family and/or professional backgrounds in farming to governance processes analysed; conversely, agricultural organisations have increasingly employed people with professional knowledge of water (be they hydrologists or other). Several actors interviewed in water organisations regarded their privately acquired professional farming knowledge as an advantage in relation to agriculture-related governance processes.

Finally, professionals within organisations also drew on *local* (or place-based) knowledge acquired by experiential immersion in local social and material contexts. For the purposes of the thesis, local contexts have been defined as those setting in which actors engage directly with water bodies and ecosystems. The work of farmers, environmentalists, and municipal officials necessitates close engagement with and thorough knowledge of local ecosystems and communities (e.g. knowing who to talk to and how). But the case studies have also encountered public administrators who emphasised that the fact that they themselves (or colleagues or family members) lived in a particular community and region meant they engaged with local inhabitants differently, were able to better assess local reactions and action options, and that this enhanced their professional judgements (notwithstanding, that personal and private ties could also make engagement more complex and difficult).

On this basis, the thesis concludes by conceptualising organisations as entities that provide structures and processes for cultivating and bringing together *various* knowledge types (see table 12.3). In cross-scale and cross-sectoral social networks and boundary organisations epistemic diversity is typically particularly pronounced, adding multiple organisational knowledges to the professional and local knowledge of their members. Intimate knowledge of the functioning of member organisations has thus

been a particularly significant element in devising strategies on how to (self-)organise, strengthen organisational commitments, and launch joint initiatives.

Actionable knowledge can thus be conceptualised as emerging from – and necessitating – social learning that engages diverse actors along with their respective organisational, professional, and local knowledges.

Organisations	**Normative dimension (why): purposes**	**Systems dimension (what): factors**	**Transformation dimension (how): means**
National actors			
Water Management Authority (AGE) Related paradigms: • managerial ecological restoration • adaptive and integrated • command-and-control	Drinking water supply & ´good state´ of aquatic ecosystems Main reference policies: relating to EU WFD & Floods Directive	Weather, water bodies and aquatic ecosystems in river basins Anthropogenic pressures Technical water infrastructures	**Governance:** mainly hierarchical, but some network governance **Management**: formal preference for nature-based solutions, but focus on technical infrastructures
Knowledge types	**Organisational knowledge** of institutions, strategies, relations, roles, resources **Specialised scientific/technical professional knowledge (dominant)** (related disciplines: natural and engineering sciences, e.g. hydrology) **Practice-based professional knowledge** (incl. farming knowledge of some civil servants) **Local knowledge** of some civil servants of river basins		
Administration of Technical Agricultural Services (ASTA) Related paradigm: • (expanded) productionist paradigm	Food supply, economic competitiveness and survival of farms, rural development and environmental protection Main reference policies: relating to EU CAP	Climate, weather Plants, livestock, soil Technologies Markets	**Governance:** mainly hierarchical, but some network governance **Management**: mainly productivity- and technology-oriented, but also supporting other ecosystem services
Knowledge types	**Organisational knowledge** of institutions, strategies, relations, roles, resources **Specialised scientific/technical professional knowledge (dominant)** **Practice-based professional farming knowledge** of some civil servants (related disciplines: agricultural, natural and engineering sciences) **Local knowledge** of some civil servants of specific rural communities		
Nature & Forest Agency (ANF) Related paradigm: • managerial ecological restoration	Environmental protection Main reference policies: relating to EU Wild Birds and Habitats´ Directives	Ecosystems in protected areas (e.g. Natura2000) and beyond Anthropogenic pressures	**Governance:** mainly hierarchical, but some network governance **Management**: preference for nature-based ´solutions´
Knowledge types	**Organisational knowledge** of institutions, strategies, relations, roles, resources **Specialised scientific/technical professional knowledge (dominant)** (related disciplines: natural sciences, e.g. biology) **Practice-based professional conservation knowledge** of some civil servants (incl. via environmentalist grassroots activities)		

	Local knowledge of some civil servants of local communities and ecosystems		
National water operator (SEBES) Related paradigms: • command-and-control • adaptive and integrated	Drinking water supply expanded to include pollution prevention Main reference policies: relating to EU WFD and Drinking Water Directive	Water dynamics and quality in Upper Sûre dam and river basin Technical infrastructures Anthropogenic pressures	**Governance**: mainly hierarchical, but some network governance **Management**: mainly technical, but some preventive approaches
Knowledge types	**Organisational knowledge** of institutions, strategies, relations, roles, resources **Specialised scientific and practice-based technical knowledge (dominant)** (related disciplines: natural and engineering sciences) **Local knowledge** of some staff members of Upper Sûre river basin		
natur&ëmwelt Fondation Hëllef fir d´Natur Related paradigms: • bottom-up environmentalist • adaptive and integrated	Nature protection Main reference policies: relating to EU Wild Birds and Habitats´ Directives, WFD	Ecosystems, biodiversity Anthropogenic pressures	**Governance:** mainly bottom-up and network, but some support for managerial ecological restoration **Management:** nature-based solutions (learning-by-doing)
Knowledge types	**Organisational knowledge** of institutions, strategies, relations, roles, resources **Practice-based professional conservation knowledge (dominant)** **Specialised scientific/technical knowledge** (related disciplines: natural sciences, e.g. biology) **Local knowledge** of staff members of ecosystems and communities		
Bridging organisations			
Syr River Partnership Related paradigms: • adaptive and integrated • bottom-up environmentalist	Good state of aquatic ecosystems Main reference policies: relating to EU WFD, Wild Birds and Habitats´ Directives	Water bodies and aquatic ecosystems in river basins Anthropogenic pressures	**Governance:** mainly network, but some support for hierarchical env. governance **Management:** nature-based solutions (learning-by-doing), implementation of action plan measures
Knowledge types	**Organisational knowledge** of institutions, strategies, relations, roles, resources (including of members) **Practice-based professional conservation knowledge (dominant)** **Specialised scientific/technical knowledge** (related disciplines: natural sciences, e.g. biology, geography) **Local knowledge** of Syr basin		
Upper Sûre Nature Park Related paradigms: • adaptive and integrated • community-based	Regional development & nature protection Main reference policies: relating to Wild Birds and Habitats Directives, CAP, WFD	Regional development, incl.: ecosystems (incl. water bodies), agriculture (incl. markets for regional products), tourism, culture, regulation	**Governance**: network and community-based **Management**: adaptive and integrated
Knowledge types	**Organisational knowledge** of institutions, strategies, relations, roles, resources (including of member organisations) **Practice-based professional conservation knowledge (dominant)**		

	Specialised scientific/technical knowledge (related disciplines: natural and agricultural sciences) **Local knowledge** of Upper Sûre region		
Upper Sûre River Contract Related paradigms: • adaptive and integrated • community-based	Good state of aquatic ecosystems Main reference policies: relating to EU WFD, Wild Birds and Habitats Directives, CAP	Aquatic ecosystems Regulation Agriculture (incl. markets for regional products) Tourism	**Governance**: network and community-based **Management**: adaptive and integrated
Knowledge types	**Organisational knowledge** of institutions, strategies, relations, roles, resources (including of member organisations) **Practice-based professional conservation and farming knowledge (dominant)** **Specialised scientific/technical knowledge** (related disciplines: natural sciences, e.g. geography) **Local knowledge** of staff members of Upper Sûre basin		
Agricultural Cooperation LAKU Related paradigms: • productionist (expanded) • command-and-control (expanded) • adaptive and integrated	Economic survival & competitiveness based on food production expanded to include delivery of (other) ecosystem services, pollution prevention	Agricultural production Regulation Food markets Soil and water quality	**Governance:** network and community-based **Management**: efficiency- and productivity-oriented with adaptive elements (learning-by-doing via experiments)
Knowledge types	**Organisational knowledge** of institutions, strategies, relations, roles, resources (including of member organisations) **Professional (farming and technical) knowledge (dominant)** **Specialised scientific/technical knowledge** (related disciplines: natural, agricultural and engineering sciences) **Local knowledge** of Upper Sûre river basin of active members		
Local actors			
Municipalities Related paradigm: • integrated and community-based	Quality of local life	Local populations Regulation Local infrastructures Economy, agriculture Environment	**Governance**: community- and network-based **Management**: integrated with adaptive elements (learning-by-doing)
Knowledge types	**Organisational knowledge** of institutions, strategies, relations, roles, resources **Practice-based professional & local knowledge (dominant)** **Specialised scientific/technical knowledge** (related disciplines: various)		

Table 12.3 – Overview of actors and respective knowledge types analysed in the case studies

12.2.1.2 Effects of formal governance on knowledge hierarchies in organisations

While all organisations unite diverse types of knowledge, the case studies have identified significant differences in epistemic cultures and practices in terms of what type of knowledge is valued, cultivated, and prioritised (see table 12.3). Empirical analysis suggests that knowledge hierarchies within organisations can often be directly linked to paradigms and, moreover, to formal institutions. More specifically, the case studies have found that EU regulation has contributed to significantly consolidating and expanding the status and role of specialised scientific/technical knowledge across

governmental *and* nongovernmental organisations, reaching far beyond formal water and land governance. The case studies thereby confirm the widespread diagnosis that we live in a knowledge society, in which regulation and science have driven specialisations within organisations and professions that increasingly use and produce specialised studies and data, usually rooted in natural and engineering sciences (e.g. Beck et al., 1994, Knorr Cetina, 2007). Science is not confined to universities, research institutes and consultancies – and governmental bodies. Clear-cut boundaries between science and society, scientific and non-scientific organisations, and between scientific and professional and local knowledge increasingly melt away. In general, human activities become more knowledge- and technology-intensive, be it in water and environmental management, agriculture or other.

As regards ministries and public administrations, EU directives have resulted in a "scientification" of water and environmental governance, leading to a strong intermarriage between (natural and engineering) sciences, on the one hand, and national regulation, management plans, and administrative requirements on the other. Furthermore, "scientification" has driven specialisations within public authorities and increased dependencies on research institutes and consultancies that themselves have had to specialise more. The case studies have analysed how specialists in public administrations, consultancies, and research bodies have worked out data-intensive models and studies on a wide range of issues such as surface water run-off, physico-chemical water quality, algae growth, anthropogenic pressures, to name but a few (see chapters 8.8, 9.5 & 10.5.4).

In their turn, scientific requirements in public funding and authorisation procedures have obliged farmers, conservationists, and municipalities to increasingly use and produce scientific knowledge themselves, often resorting to external consultants and researchers. Even *local* knowledge, e.g. in municipalities, is increasingly nurtured by – and itself nurtures – scientific knowledge, information, and data when planning projects to take into account complex interrelations between local phenomena and wider processes.

This has contributed to a "professionalization" (that has also progressed *independently* of formal regulation) that enables practitioners to regard their own practices and projects as part of complex causal interlinkages, usually ecological, that may otherwise be unknown and invisible to them. As a consequence, the ecological systems knowledge (professional and local) has significantly increased among many actors professionally engaged in Luxembourg´s water and land systems and enabled them to tailor their actions more strongly to specific ecological dynamics.

The case studies also suggest, however, that the increasing dominance of natural science-based knowledge in water and land governance comes at a price. Its impact is not neutral, but highly normative. By setting criteria applied to projects in funding and authorisation procedures, it creates a bias towards specialised scientific knowledge that drives specialisations within organisations and professions and increases dependencies of nongovernmental actors on advisory and consultancy services. Even smaller restoration projects now require expert planning to be authorised and publicly funded. Accordingly, the status of professional and local knowledge that is tacit and/or not backed up by scientific evidence weakens and is often subordinated to expert studies. Those who cannot or do not substantiate their judgements and projects scientifically, fear to lose influence and credibility. For this reason, even statements of nongovernmental actors and citizens to public consultations are often based on – or refer to – scientific studies. Partly as a result, some public debates have centred on controversies about ´true´ scientific ´facts´ rather than to address normative issues at stake.

Moreover, the thesis suggests that the dominant status of scientific knowledge adds to asymmetrical (power) relations between policy-makers (and researchers), on the one hand, and nongovernmental actors, on the other. Beliefs in the superiority of science vis-à-vis other knowledge types may imply

that governmental (and scientific) actors attribute less importance and resources to engaging in social processes and with local actors. Nongovernmental actors have perceived the relative neglect of practical professional and local knowledge among governmental actors as resulting in requirements and expectations remote from professional and local practice ("Praxisferne", or as lacking "Praxisbezug").

Among other effects identified are that the production of scientific data and expert advice can be costly and lengthy, thereby creating imbalances in the time and resources dedicated to scientific studies when compared to, for example, public participation processes (see Upper Sûre case study). Moreover, despite detailed studies of specific local ecological dynamics, their outcomes (including resulting legal or administrative requirements) have often been criticised as "non-sensical", contrary to common sense or lacking practical feasibility by local and professional actors. Furthermore, regulatory and administrative requirements and expert studies examined have almost entirely neglected social factors (except anthropogenic pressures), thereby strengthening technocratic approaches to sustainability issues and possibly hampering experimental and social learning processes.

Finally, on this basis, the thesis argues that the above-mentioned knowledge-action widens partly (but certainly not only) as a result of managerial approaches to ecological restoration. The accumulation of more scientific studies and data has not yet been matched by a corresponding uptake in restoration activities and improvements in ecosystem health.

As a consequence of all of the above, the thesis also finds that the dominant status of specialised scientific knowledge in governance processes contributes to weakening the sense of agency among actors. Sentiments among nongovernmental actors of being "patronised", stuck in a "corset" or "treadmill of bureaucracy", reduced to "marionettes" or similar seem to have become stronger. These sentiments have entered – and been fuelled by – personal and shared narratives (see below).

In the light of the above, the thesis provides evidence that ways may need to be explored as a matter of urgency on how to consider and cultivate action-oriented non-expert knowledge in governance and how scientific and other knowledge types may mutually enrich each other. Boundary organisations can play important roles in this regard.

12.2.2 The role of narratives in the emergence of actionable knowledge and social learning

The thesis contributes to understandings of the role of narratives in actionable knowledge and social learning. Based on empirical evidence, the main insights concern:

- how actors engage with each other and water and land is closely related to personal and collective narratives as sources of meaning, narrative identities, of action/inaction and mobilisation/division,
- to be actionable for sustainability, knowledge needs to both resonate with and challenge personal and historically grown collective narratives,
- a strong sense of agency (engrained in narrative identities) is a precondition of social learning and actionable knowledge,
- narratives, knowledge, and paradigms are different concepts, but closely interrelated,
- changes in narratives can serve as indicators of the extent and depth of social learning (incl. possible paradigm shifts in organisations and professions and society).

The thesis set out to investigate how actionable knowledge and social learning relate to personal meaning-making. Building on American Pragmatism, the thesis rests on the assumption that meaning-making in transactional encounters with the world is the source and fountain from which knowledge and learning spring. Taking a narrative approach, the thesis provides evidence that how actors act and know is intertwined with life stories through which actors provide their selves and lives with meaning, continuity, and coherence (narrative identity). Narratives therefore hold significant explanatory power as regards the analysis of actor engagement, including tensions and synergies in social relations.

The thesis has examined narrative elements in relation to formal organisations, particular professional groups and local communities, comparing the Syr and Upper Sûre basins, triangulating them with workshops, documents, and observations. It has done so with a view to identifying and comparing purposes, the self-understanding and problem framings of actors (normative dimension), factors and scopes of challenges considered (systems dimension) and preferred means and strategies of social and material engagement, e.g. in water management (transformation dimension) (see table 12.4). The thesis argues that changes along these dimensions may serve as indicators of social learning and the extent to which actors question and go beyond established paradigms (double loop social learning).

Narratives of professional groups	**Farmers**	**Environmentalists**	**Municipal officials**
Related organisations	**Members of:** farming communities, LAKU **Related to**: farm advisory services, Ministry of Agriculture	**Members of:** environmental syndicates and NGOs, river partnerships **Related to:** Ministry of the Environment	**Members of**: municipalities and inter-municipal syndicates **Related to** diverse organisations
Dominant narrative identities: sense of purpose (normative dimension)	"Modern food producers", "out of conviction, not for money", "we are all farmers" (beyond conventional-organic)	"Nature protectors"	"Serving citizens", "improving local life"
Dominant narrative identities: sense of agency	Generally low: sense of having "no" or "little" influence **Exceptions:** "better to be pro-active than to be cornered"	Generally, low to medium: "fighting a lost cause", "big problems persist", "no more visions" **Exceptions**: "to show what nature can look like when not intensively exploited"	Generally, medium: "caught in treadmill of bureaucracy" ("corset"), but "still possible to do something"
Perceptions of formal governance	Farmers as "marionettes", "children", "scapegoats of society", "I am number XY"	"pressure handed downwards", many "unrealistic" objectives and approaches, feeling "blocked"	"knowledge monopoly" of public authorities
Normative dimension (pasts): • **pre-industrial** • **20th century**	**Pre-industrial times:** "primitive" farming (vs. idealised "Heidi agriculture"), human life unhealthy, poor	**Pre-industrial times**: mosaic landscapes with rich biodiversity thanks to extensive farming	**1950s-1980s** (Upper Sûre): • Fears of being turned into "indian reserve" (Upper Sûre)

	1962-1970s: growing public prosperity and health (progress), but "damaging" pesticide use, strong emphasis on machines	**Second half of 20th century:** • "intensification in all directions" causing ecological regress • environmentalists as "saving biotopes" for future generations	**1980-1990s:** • "pioneering times" (Upper Sûre) • Municipalities turning "Schlafgemeinden" (Syr, Upper Sûre)
Present (2000-2019)	Growing environmental awareness among farmers, but also growing pressures	Initial "spirit of optimism" post-2000 and -2013 (national elections) ebbing off	Environmental awareness in municipalities grows
Systems dimension (what): dominant factors	Land price hikes and ´landgrabbing´, growing restrictions and requirements (red tape), some environmental impact of farming is inevitable Public: "people no longer know where their food comes from"	Demographic growth, economic and agricultural activities driving ecological deterioration Public: growing "nature dis-connect"	Demographic growth, less "native Luxembourgers" in relation to "newcomers" Public: growing "not-in-my-backyard attitudes"
Anticipated futures and uncertainties (timeframe ~2045)	*Anticipated*: "pressures grow", "more of everything", "more restrictions and subsidies for ecosystem services" *Uncertainties*: • *Will there be any family farms left?* • *"farmers mainly as landscape managers depending on public subsidies" ("planting flowers", "hobby agriculture")?*	*Anticipated*: continuing ecological deterioration *Uncertainties*: • *"how many measures planned will have been implemented, how many environmental objectives reached?"* • *"will there be any healthy habitats left?"* • *Will threatened/extinct species return?*	*Anticipated*: growing egoism, fragmentation, <u>exception</u> (some Syr municipalities: reinvigorated community life) *Uncertainties*: • *will population growth, urbanisation continue?* • *Will there be enough affordable housing?* • *Will social fragmentation continue?*
Desired futures	*Desired*: consumers pay fair prices, farmers as appreciated partners who have a say, farming more environmentally-friendly thanks to scientific & technological progress	*Desired*: preservation and regeneration of biotopes, Syr as "national exemplary river" *Tensions among environmentalists:* • nature ´wild´ or ´managed´ for mainly	*Desired*: more local social cohesion and "community spirit", stronger appreciation of local landscapes and place-based engagement *Tensions*: e.g. housing and infrastructural

	Tensions among farmers: • level of technology-optimism • production for global or domestic markets?	ecological or social purposes? • "nature-culture boundaries vanishing"?	needs vs. nature protection
Dominant landscape imaginaries	Grassland for dairy and meat production	Diverse extensively managed cultural mosaic landscapes (exception: "letting nature be nature")	"Naherholungsgebiete" (Syr), "Kulturlandschaften" (Upper Sûre)
Transformation dimension (how): preferred means to foster change	**Governance:** "we have to talk with each other", farmers should be "involved" **Management:** "no patents", ongoing learning, experience *and* science, flexible (experiments), technologies	**Governance:** "we have to talk with each other, find compromises and cooperate", need for learning, but also clear political priorities **Management:** "feeling for nature" *and* science, adaptive	**Governance**: "we have to talk with each other" **Management**: "we cannot drive complex projects ourselves", "adapted to context", flexible, innovative technologies
Related paradigm(s) and learning effects	*Expanding* productionist paradigm?	*Expanding* environmentalist paradigm?	*Expanding* community paradigm (*stronger environmental focus?)*

Table 12.4 – Overview of narrative elements and related paradigms analysed of farmers, environmentalists, and municipal officials

The thesis shows how inquiries into (narratives relating to) organisational, professional, and local *histories* may be crucial to understand factors that influence the engagement of individual actors, mutual perceptions, and interpersonal relations today. One significant way in which narratives have been found to influence actor engagement is by shaping *perceptions* of others. Narratives that have been passed on to colleagues offer some explanation for why interorganisational relations (whether trustful or tense) have been constant over longer stretches of time even when individual actors changed. Often, tensions seemed to have had their origins in events or developments from years or decades ago. Via narratives, inter*organisational* relations have thus influenced or even shaped inter*personal* relations.

On this basis, the case studies suggest that knowledge that is to serve sustainability actions needs to both resonate with and challenge historically grown narratives and narrative identities of actors, both personal and shared. On the one hand, personal and shared narratives may inspire actors to become actively engaged in governance processes and self-organise with others. On the other hand, narratives may also be hindering factors for the emergence of social networks and learning. Narratives thus contribute to a better understanding of actionable knowledge and how it may be fostered in governance processes. Furthermore, narratives cast light on how life stories, knowledge, and collective paradigms mutually shape each other. The following summarises the main conclusions on these points.

12.2.2.1 Narratives as sources of action and inaction

Narratives have a *performative* dimension. They contribute to shaping the world that we encounter in imagination and action. The case studies suggest that if and how nongovernmental actors choose to engage in governance processes inscribes itself in their life stories. In particular, empirical analysis provides evidence that network governance crucially depends on actors who have a strong sense of agency and purpose that are integral elements of their narrative identities and make their engagement meaningful. Their sense of agency and purpose is expressed in personal narratives. Furthermore, the thesis shows how *collective* narratives and identities may engender a *shared* sense of purpose that strengthens individual engagement, knowledge co-creation, organisational commitments and collective action. Finally, narratives helped to explain affective implications that some of the processes analysed had on actors involved. Some collective narrative identities were more closely interrelated (integral parts of) personal identities than others. This seems to be the main reason for why engagement has been particularly emotionally intense for some actors.

The thesis has focused on narratives and narrative identities of environmentalists, farmers, and municipal officials (see table 12.4). Similar elements in narratives among those actors who engaged particularly actively in processes (such as in leading roles) cast light on key driving factors for active engagement and self-organisation:

- an acute sense of purpose in relation to specific environments and activities tied to professional vocations, place and/or nature attachment (be it as “food producers”, “nature protectors” or “servants of citizens”),
- a strong sense of agency and self-efficacy resting on the belief in the possibility to “change things” and a drive to “take fate in own hands”,
- an awareness of and strive to better understand complex systemic interconnections expressing itself in self-portrayals as “lifelong learners”,
- a conviction that improvements depend on context-specific approaches that necessitate compromise and cooperation.

These narrative elements have been in striking contrast to those actors who felt they had “little” or “no influence” on governance and who, therefore, engaged less actively or not at all. Strengthening a sense of agency among those actors would thus appear to be a precondition for social learning and actionable knowledge. This insight adds a narrative dimension to findings of scholars who argue that agency of single individuals are key to network governance and transformative change (e.g. Folke et al., 2005; Hahn et al., 2006, Pahl-Wostl, 2015).

The thesis provides evidence that hierarchical governance (whether anthropocentric or ecocentric) combined with mounting ecological and/or market strains weaken the sense of agency among some nongovernmental and local actors. In narratives, a weak sense of agency – sometimes coupled with defiant attitudes – expressed itself in dismay at “not being listened to”, being treated “in an arrogant manner”, or statements on “no longer having visions”, etc. Some actors explicitly decided to step down their engagement or even to entirely withdraw from some of the governance processes analysed as a result of feeling misperceived or not taken seriously. Such setbacks risk to fuel narratives of “powerlessness” and thereby to weaken network governance, reducing opportunities for social learning, and the emergence of actionable knowledge.

While most research rightly emphasises the need to empower and engage disadvantaged actors in governance processes, the present thesis argues that ways to strengthen agency across professions and organisations in and through governance may become an increasing challenge despite growing environmental awareness.

12.2.2.2 Mobilising and divisive powers of collective narratives

The thesis offers some insights on the potential of collective narratives to facilitate and foster engagement among diverse actor groups in water and land governance and to enable them to transcend differences in purposes and approaches (Upper Sûre case study). At the same time, it also points to narratives as possible hindering factors.

In the Upper Sûre basin, regional narratives rooted in long-standing strives for more self-determination supported cross-sectoral local self-organisation. Self-organisation of the Upper Sûre Nature Park and River Contract, municipalities, and farmers was triggered by the launch of the formal governance process to prepare new drinking water protection zones. Provisions of the EU WFD and national water law raised local expectations of being actively involved. Farmers and municipalities, in particular, perceived the protection zones as potential threat to the region. The process awakened memories and strong sentiments of how the government in the past had intervened in the region (e.g. by the construction of the Upper Sûre dam and plans for a government-led nature park) and how regional self-organisation had been successful in giving a more prominent role to local actors. Self-organisation and concrete projects (such as the launch of regional products) had been based on a study that municipalities had commissioned in the 1980s, which outlined a common vision and ideas of how the nature park could be turned into an "opportunity for the region". Narratives about these "pioneering times" have become part of communal memory and continue to inspire action until today. In the processes analysed, regional narratives thus contributed to the forming of an informal "crisis" or "solidarity community" that was endowed with a shared sense of purposes and resolve that hardened with suspicions of not being able to "have a say" after all.

At the same time, the Upper Sûre case study also contains examples of drawbacks of such unifying narratives. In the processes analysed they contributed to barriers and polarisation in relations with governmental actors (that one interviewee half-jokingly described as "Gauls against Romans"). Conversely, governmental actors interviewed depicted and perceived actors in the Upper Sûre region as primarily defending local and economic interests without consideration of environmental concerns. These narratives and mutual perceptions that displayed and consolidated a high degree of distrust have been a major hindering factor for the emergence of cross-scale networks and social learning. During the governance processes analysed, actors ´on both sides´ felt confirmed in their narratives. This has provided a strong indication that and why network and social learning effects have overall remained limited. A notable exception, however, concerns changes in local relations with the national water supplier SEBES who had still figured as remote actor (or even "lord of the castle"/"Burgherr") in regional narratives when the processes to demarcate new protection zones began. However, when the water supplier supported the creation of LAKU, local perceptions of SEBES began to change (see below).

As regards the Syr River Partnership, narrative identities of *individual* actors also provided sources for active engagement in governance processes. Environmentalists have been driven by "saving nature", municipal officials by "serving their citizens" and "caring for the environment". The "charter for a clean Syr" of the Syr River Partnership of 2008 provided a basis for later joint charters and action plans. However, a shared unifying narrative and purpose has been largely missing in the Syr valley, where only few actors felt attached to (or were even aware of) the small river at all. The Syr basin thus provided few local actors with a frame of reference and it lacked a common history of cross-sectoral cooperation. Farmers have been almost entirely absent and *organisational* commitments of municipalities have overall been comparatively weak. On the other hand, working relations with public water and environmental authorities have not been obstructed by polarising narratives. Nonetheless,

the Syr case suggests that social processes that foster shared narratives may be needed to strengthen organisational and personal commitments and attachments of diverse actors to the river basin for actionable knowledge to emerge. Without a doubt, such processes may take many years.

On a more general note, among the actors interviewed and documents consulted, the thesis has not been able to identify ´unifying´ narratives and imaginaries that are shared by actors across different scales and sectors of society. This seems to confirm the hybridity and fragmentation of current times. While societal narratives and imaginaries in the past supported and boosted transformations such as industrialisation or post-war reconstructions, it would appear that sustainability (or any other endeavour) has not (yet?) become a collective societal mission that sparks new hopes and dreams.

12.2.2.3 Narratives, knowledge, and paradigms: differences and interrelations

The thesis has investigated narratives in relation to action, knowledge, and paradigms. It shows how narrative approaches and methods (i.e. narrative interviewing) may be useful in casting light on knowledge and paradigms that shape how actors understand (or frame) and address sustainability challenges. Furthermore, inquiries into narratives render interesting insights into how actionable knowledge emerging from (double loop) social learning may contribute to changing *paradigms* that underlie organisations and professions (see below). The following seeks to clarify differences and interrelations between narratives, knowledge, and paradigms.

For purposes of empirical inquiry, one of the main advantages that narrative approaches offer is that narratives can be articulated and shared as ´stories´, while epistemic processes and paradigms often remain tacit. This is why narratives seem to lend themselves particularly well as indicators of transformative change. Through interpretation, narratives may reveal tacit meanings and paradigmatic assumptions: e.g. purposes and problem framings (normative dimension), drivers of change and uncertainties (systems dimension), and preferred modes of social and material engagement (transformation dimension). Interpretations of the past, anticipated, and desired futures and landscape imaginaries have crystallised as particularly ´telling´ in terms of purposes pursued and perceptions of human-environment and social relations. In fact, it was based on narratives encountered during interviews that the author of the thesis began to construct knowledge types and paradigms in the first place. Furthermore, structured around significant episodes and events, their narrative accounts provided the basis for the construction and analysis of governance processes and their various contexts (thus turning the case studies into ´second-order narratives´ that revealed a multiplicity of perspectives on ´what had happened´ and ´why´).

In addition to their form of expression (tacit and/or articulated), the main differences identified between narratives, knowledge, and paradigms are the degree of their institutionalisation and actor-dependence, relating directly to their changeability over time (see table 12.5). Paradigms distinguish themselves from knowledge and narratives by being more firmly institutionalised. As informal belief systems, (epistemic) cultures and via formal legal frameworks paradigms manifest themselves as ´ordering principles´ or ´rules´ that structure human knowledge and behaviour and render it patterned (see chapter 2.1). Material embodiments such as infrastructures and technologies add to their *relative* independence of individual actors and a certain ´resistance´ to change. The most prominent examples examined in the case studies were command-and-control and productionist paradigms that emerged some 150 years ago and continue to shape societies, organisations, and narrative identities today, even if they begin to change.

	Articulation	Changeability over time
Paradigms	Mainly tacit	Low
Knowledge	Articulated and tacit	High
Narratives	Articulated as stories	Moderate

Table 12.5 comparing characteristics of paradigms, knowledge, and narratives

Paradigms in society and organisations may shape knowledge and narratives (see figure 12.5). The case studies have correlated the productionist paradigm with narratives of progress that centre on farmers as food producers and with professional knowledge serving to increase productivity and efficiency focusing on technologies, fertilisation and (chemical) plant protection. The command-and-control paradigm was correlated with narratives of (societal) progress relating to drinking water supply and flood protection, with specialised engineering knowledge serving infrastructural improvements. Finally, environmentalist paradigms found expression in narratives of (ecological) regress and the mission to protect and restore habitats that was either based on specialised scientific/technical knowledge (managerial restoration approaches in administrations), professional learning-by-doing or a combination of the two (especially in environmental NGOs and river partnerships). The creation of new formal organisations has contributed to institutionalising such new emerging paradigms providing them with more leverage and permanence.

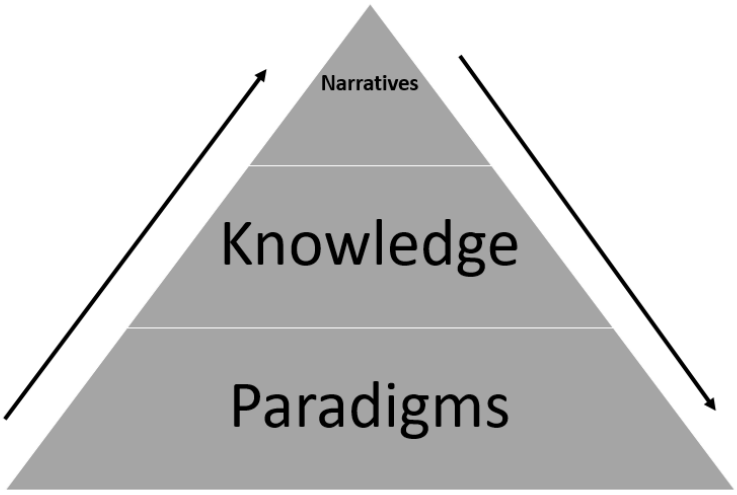

Figure 12.5 - Paradigms, knowledge, and narratives presented as pyramid

Both knowledge and narratives are more actor- and context-depended than paradigms. They emerge in social engagement and may be shared, becoming the glue that holds some organisations and communities together. Knowledge may be formally institutionalised in the form of educational curricula, expert studies that support formal regulation, or publications and standards warranted by scientific communities or other organisations. When detached from meaning-making and engagement, however, the present thesis has preferred to refer to such ´formalised knowledge´ as resources, information or data. In this understanding, knowledge is always informal, rests on interpretations and engagement in specific contexts. As human knowing is embedded in ongoing learning processes, personal knowledge is the most changeable over time when compared to both narratives and paradigms.

Similarly, in the definition developed for the purposes of the thesis, narratives depend on being told and re-told. They are typically more concrete than both paradigms and knowledge, structured around identifiable people, places and events that are weaved into a plot. It is in this sense that narratives have an ordering function and provide actors with orientation and guidance in concrete situations. While human knowing is infinite, narratives chart some of its journeys and territories, put up signposts, mark high- and low-points and contain certain key messages and ´lessons learned´ that are closely interwoven with personal and collective identities, memories, sentiments, and imagination. Their structure and core elements may reflect a particular – or several – paradigm(s), but they may also go beyond and herald a new emerging paradigm.

Narratives (similar to knowledge) will necessarily vary from one actor to another and may change depending on the context, and evolve over time with new experiences, knowledge, and events. However, as narratives serve to provide individual actors and organisations with continuity and coherence, they change more slowly than knowledge, but more quickly than paradigms. In the social learning processes analysed, some actors sought new knowledge of, for example, interrelations between farming practices and water and soil quality (farmers) or between water quality, water body structures and biodiversity (e.g. public administrators, engineers, municipal officials), including via (pilot) projects and experiments. As a result, many became more reflexive. However, there is some evidence to suggest that it takes time (and further learning) before changes in narratives and narrative identities follow suit, let alone until paradigms are questioned and altered. However, farmers referring to themselves as “drinking water producers” (even if half-jokingly) can be interpreted as signs of changing narratives and a possible broadening of the scope of the productionist paradigm, e.g. to include other services than food production.

The case studies thus provide some examples of how human knowledge and agency enable actors to question established assumptions and paradigms. As loci of reflexivity, imagination and creativity, human knowledge and agency are emancipatory, enabling humans to question and distance themselves from paradigms – and to self-organise to explore and promote alternatives. These capacities are a precondition for actionable knowledge for sustainability. Through (double-loop) learning, human knowing and doing may thus venture into spheres unchartered by established collective narratives and paradigms – and contribute to the emergence of new ones. Examples from the case studies include bottom-up environmentalism that was nurtured by not only scientific but also lay (local) knowledge of the deterioration of habitats enhanced by learning-by-doing approaches to restoration. Emerging adaptive and integrated paradigms have been fuelled by new modes of knowledge production and application in boundary organisations such as the Upper Sûre Nature Park and the river partnerships (including their municipal and agricultural members) that have brought together (or *integrated*) professional conservation and farming knowledge, local knowledge and scientific knowledge in self-organised experiments and projects. As the case studies suggest, the pursuit of such knowledge has, furthermore, often been inspired by projects, emerging new narratives and paradigms from elsewhere (especially neighbouring countries and EU policies).

Based on the analysis of narratives, there are some signs of changes in (purposes and scopes attributed to) knowledge generation and in narratives among actor groups that point towards an expansion of established command-and-control, productionist, and environmentalist paradigms towards adaptive and integrated paradigms (see table 12.6).

Paradigms	**Command-and-control - *expanding***	**Productionist - *expanding***	**Environmentalist – *expanding***	**Adaptive and integrated**
Actors and identities	Some water syndicates and municipalities (“public service providers”)	Farmers (“food producers”)	Environmentalists (“nature protectors”)	Boundary organisations (“intermediaries”)
Knowledge (and actions)	Serving drinking water supply and flood protection, primarily via technologies	Serving productivity and efficiency of food production, e.g. via technologies, fertilisation, plant protection	Serving effectiveness of interventions in terms of protecting certain species and improving water quality	Learning-by-doing from ecosystem interventions integrating scientific knowledge, serves ecological restoration
Expanding to:	Considering nature-based solutions to enhance flood protection and adaptive approaches pollution prevention and regeneration of water bodies	Knowledge about soil, water run-off, alternative crops and livestock breeds to reduce anthropogenic inputs in farming and conform with environmental requirements	knowledge of how biodiversity and water quality depend on specific forms of land use (e.g. agriculture) and need to be reconciled with them (e.g. recreation)	Knowledge of local actors and communities, contributions to local quality of life
Narratives	Water needs to be controlled and treated for human purposes. Thanks to science and technologies, Lux. has reached high standards of human water security.	Agriculture serves food production to satisfy demands. Due to scientific and technological advances, there has been significant progress in terms of productivity and environmental impact.	Demographic and economic developments have produced ecological deterioration. If environmentalists had not purchased land and without EU regulation, there would be few biotopes left today.	Compromises, learning and experiments between diverse actors are necessary to find ways to improve water quality and biodiversity. There are no “silver bullets”. The future is uncertain.
Expanding to:	There are limits to human control, especially with climate change. More ´natural´ retention capacities are necessary to avoid floods. Some water pollution should be reduced at source to bring down treatment costs.	Agriculture can also deliver other services to society (such as cleaner water, biodiversity), if consumers and/or authorities are willing to pay for them.	Compromises with land owners and users and engagement of populations are necessary to “protect nature”.	

Table 12.6 – Expansions of knowledge and narratives of actors as possible signs of emerging adaptive and integrated approaches

12.2.3 Co-creation of actionable knowledge through self-organisation and experiments

How can social learning and actionable knowledge for sustainability be fostered in water and land governance? What are facilitating factors? The main contemporary example provided by the thesis is the agricultural cooperation LAKU that points to a number of informal, formal, and material facilitating factors (the historical context chapter provides other examples from the Syr and Upper Sûre river basins that suggest there were fewer barriers to self-organisation pre-2000).

The cooperation emerged from a self-organised working group that the Upper Sûre River Contract had organised in response to the obligation of Luxembourg to set up new drinking water protection zones in line with WFD requirements and the expectation that local actors would be actively involved. In contrast to the Syr basin, the upcoming protection zones were to be elaborated by a formal processes that directly concerned a wide range of different actors affected by future restrictions and, hence, provided them with manifest reasons to self-organise. This finding lends evidence to the hypothesis that social learning may benefit from close interplays between informal and formal governance processes (Folke et al., 2005, Pahl-Wostl, 2015).

The narrative dimension of regional cooperation and the importance of a strong sense of agency among committed individuals who share a common purpose has been highlighted above. Furthermore, the LAKU case provides evidence in favour of the argument that knowledge that is to be actionable for practitioners is best co-created in collaborative action-oriented and experimental processes. The example suggests that self-organisation thrives particularly well without pre-defined objectives, action plans, and formal obligations or administrative burdens. However, it does require funding and, in addition, can be boosted by political support from ministries. Boundary organisations that are trusted by participating actors, offer resources and experience in supporting multi-stakeholder processes (organisational knowledge) may serve as drivers and facilitators, in the case the Upper Sûre Nature Park and River Contract. Furthermore, the case study points to the importance of organisational flexibility and commitments of members. It was essential that a representative of the water supplier was granted sufficient leeway to participate and support LAKU activities, despite the fact that organisational statutes provided no explicit mandate for such engagement. Organisational and personal commitments were strengthened by political support of the Ministry of Sustainable Development. Crucial for the emergence of actionable knowledge, however, were activities and experiments organised by farmers and farm advisors themselves that rested on learning-by-doing. Joint excursions to similar projects abroad provided inspiration and contributed to building trust, notably between farmers and the national water supplier who had hardly had contacts before.

Interviews suggest that joint excursions have become part of personal and shared narratives about how “LAKU was conceived on the back bench of a bus”. This suggests that joint activities and experiences may be particularly effective in (if not preconditions for) fostering social learning, because they may feed into new shared narratives that provide a glue for multi-actor relations in emerging organisations and social networks.

Knowledge co-creation brought together professional agricultural knowledge, diverse specialised scientific knowledge and data (incl. on water and soil quality), and organisational knowledge of members (how to organise the cooperation). It was fostered by joint seminars and field trials with new machines, farming techniques, and crops. Experiments enhanced professional ecological and technological knowledge among practitioners, and delivered scientific data to researchers. Participating farmers and farm advisors provided mutual support to each other in the implementation and handling of new technologies and crops. The cooperation entailed significant professional and organisational learning, particularly among farmers and farm advisors, but also the water supplier. One of the main motivations for farmers to participate was the prospect of enjoying more flexibility and

certain benefits when the drinking water protection zones would be in place. At the same time, active farmers interviewed also underlined that they were “always trying to learn” and to “do things better”, this being integral elements of their identities as “progressive” farmers.

Thus, LAKU provides an example of a number of informal, formal, and material factors that may facilitate social learning and the emergence of actionable knowledge based on diverse knowledge types (see figure 12.6), with a special emphasis on self-organisation, joint experiments, and their narrative aspects and effects. Based on the analytical framework on actionable knowledge outlined above, social learning effects can be structured as follows:

- **normative dimension (why):** emergence of shared sense of purpose in improving water quality, some re-framing of food production in terms of effects on water quality, and of drinking water supply in terms of pollution prevention,
- **systems dimension (what):** co-creation of knowledge and emerging shared understandings of interconnections between agricultural practices, soil and water quality in the river basin,
- **transformation dimension (how):** self-organised partnership between farmers and water supplier that enhanced trust and enjoyed some ministerial political and financial support (network governance) and field experiments with new technologies, techniques, etc. (management).

As regards outcomes, the most notable social learning effect of the LAKU cooperation was, firstly, that farmers critically addressed the environmental impact of agriculture leading to some changes in practices. Secondly, in line with integrated and adaptive approaches, the role of SEBES changed from focusing entirely on water treatment and supply to actively engaging with local actors to prevent and reduce water pollution ´at source´. This role has been formally institutionalised, as SEBES now hosts the coordinator of the future drinking water protection zones. Both effects implied a *partial* departure of established narratives and paradigms or, perhaps, the expansion of command-and-control and productionist paradigms to encompass adaptive elements. In addition to being “food producers”, some farmers began to also portray themselves as “drinking water producers”; SEBES enlarged its mission as “drinking water supplier” to “regional coordinator”, building on LAKU measures. LAKU also produced a number of tangible outcomes, such as new technologies and techniques, some of which are now rolled out across the country. Finally, the LAKU cooperation fostered some *policy* learning, notably that the national water law was revised to allow for (additional) funding for farmers in water protection zones (see figure 12.6).

LAKU, however, is a controversial example. Social learning did not extend to changes in conventional farming business models but, on the contrary, served their maintenance (leading to suspicions of “greenwashing”). Overall, therefore, double-loop social learning has remained limited. Among the hindering factors were financial (bank loans) and market (lack of consumer demand for e.g. organic products) constraints. Furthermore, only a minority of farmers participated actively. Empirical analysis confirms the finding of other scholars that farming practices that aim to reduce fertilisation, soil erosion, and pesticide use in a manner tailored to local conditions are knowledge- and technology-intensive. Increasingly volatile weather and diverse soil conditions mean that techniques and crops that have ´worked´ in one place and year cannot simply be transferred. The need for ongoing learning and adaptations increases strains on farmers, many of whom already feel “at the limit” and that “everything is too much”. This seems to have been one reason for why there were not more farmers who participated actively in field trials over longer periods.

Finally, in 2020, farmers collectively resigned from the LAKU board due to tense and distrustful relations with public authorities. Until other farmers join, the future of LAKU remains uncertain. This

also suggests that even when formally institutionalised, multi-actor cooperation and social learning outcomes may continue to be fragile.

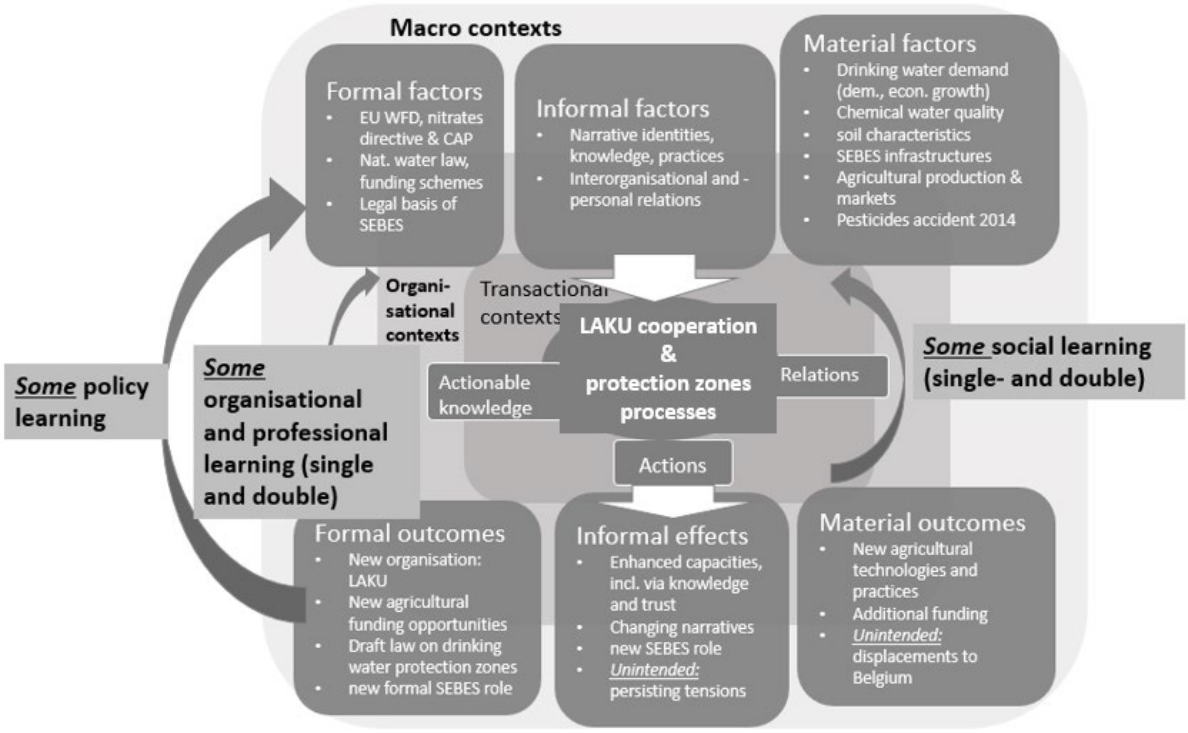

Figure 12.6 – Illustration of diverse factors, outcomes, and effects of LAKU cooperation and protection zones processes

12.3 Limitations and questions for further research

Reflections on process: The thesis is the result of an iterative spiral. It unfolded centrifugal forces that the author only partly managed to tame. The research continued to grow in terms of breadth of concepts and empirical scope, with new empirical insights calling for additional concepts, and vice versa. The volume of the thesis reflects the attempt of the author to be as close as possible to – and to learn from - the complex and multi-faceted ´realities´ encountered, perspectives voiced, etc. of the *broad* range of actors (and issues) she engaged with. The PhD has been an open research project; only the focus on actionable knowledge in the Syr and Upper Sûre basins had been pre-defined. While extensive reading preceded the case studies, the extent of the conceptual framework and the methods employed and adapted is a direct result of an approach that, in hindsight, could be characterised as partly inspired by grounded theory.

Some of the main limitations of the thesis can be ascribed to this. One of the main challenges faced was to combine an analysis of governance processes with an in-depth inquiry into personal meaning-making that ended up to centre on the concept of narratives, combined with the concept of paradigms in organisations and formal governance. The balancing act between a process analysis that sought to consider all major organisations and factors involved (inspired by systems approaches) and the inquiry into narratives and meaning-making of specific actors was one of the most difficult. It was only partly achieved. One of several shortcomings is that the thesis has not analysed and compared entire personal and shared narratives (incl. their interrelations), but has rather focused on certain narrative *elements*.

Another shortcoming is that while the Management and Transition Framework has been adapted to the purposes and scope of the thesis (for the analysis of governance processes), the adaptations and extensions have not been systematically discussed and reflected on.

Without a doubt, in terms of analytical depth, coherence, and consistency, methodological rigour and reflections, the thesis would have benefited from a stronger focus, be it in terms of relations of actionable knowledge with meaning-making and transactional engagement, with organisations and narratives, or other (see below).

Reflections on transdisciplinary research: The transdisciplinary and transformative ambitions of the thesis have added to conceptual and empirical challenges. One the one hand, the thesis has greatly benefited from the willingness of actors (such as the members of the NEXUS FUTURES reference group) to provide feedback, to help guide the researcher through the maze of the water and land governance landscape in Luxembourg. This support has been indispensable and immensely rewarding. On the other hand, transformative research necessarily creates close interpersonal relations between researchers and participating actors and creates *different* personal and organisational expectations towards the project on the part of the project partners. Some of the actors involved had tense and partly conflictual relations that were not so much interpersonal, but rather inter-organisational, political, and even legal. Some harboured hopes the thesis would bolster their own position. Transformative research, therefore, is inescapably political in nature. For the author, it has been an ongoing effort to stay clear of bias, to be perceived as neutral, and to reflect all perspectives as truthfully as possible. At the same time, the focus on what makes knowledge actionable implied almost per definition that perspectives of nongovernmental actors had particular weight. The author can only hope that her research contributes to enhancing mutual understanding and dialogues. She is certainly grateful that all actors have continued to engage actively with her and the NEXUS FUTURES project.

Finally, transformative research ambitiously aims to contribute to action and societal changes. The author organised two collaborative workshops. Their expressed objective was to identify ´action fields´ to be pursued in the river basins. One workshop could only take place towards the end of empirical inquiry, the other was organised at the beginning. To pursue the action fields that emerged further has been beyond the capacities of the author and the scope of the thesis. However, they *do* provide a possible basis for follow-up research conducted by the sustainability science team at the university (see below).

Furthermore, the thesis has used and adapted several methods from transformative research and other scientific strands: collaborative systems mapping and use of timelines at workshops, narrative and ´walking´ interviewing (see below).

Reflections on empirical basis in relation to main findings: It is hardly ever possible to generalise or transfer findings without doing injustice to specific contexts. The thesis does not lay claim to general validity. Focusing on Luxembourg only, it has a limited empirical scope. Furthermore, empirical analysis has rested on subjective interpretations that were, however, triangulated with data generated from different sources and via different methods. The thesis covers two of six river basin districts in Luxembourg that have different characteristics. At the same time, both being predominantly rural, some of the insights gained on challenges here are probably less valid in urban areas - or even more acute, for example, as regards anthropogenic pressures on ecosystems and the diversity of local populations.

At the same time, all governance processes analysed related directly to EU directives and related policies that member states implement across the European Union. As regards formal governance, EU regulation provides member states with common legal frameworks and references. The scientific

literature used suggests that many of the challenges encountered in Luxembourg have been similar in other member states and beyond. This has been supported by direct exchanges with researchers across Europe (e.g. at scientific conferences), especially with researchers of the University of Osnabrück who have conducted a host of national, European, and international projects on some of the governance aspects examined by the thesis. Notably, the contributions the author made to the validation study of a comparative case study of the international STEER project suggest that water governance entails significant coordination challenges that have comparable features across countries[297]. The author has chosen the Management and Transition Framework to be able to build on the knowledge of dedicated international research teams and to ensure that her findings could, in principle, be compared with other countries, both in Europe and globally.

Furthermore, the case studies shows how many dynamics of not only formal but especially also informal governance in Luxembourg have been interlinked with – and often inspired by – neighbouring countries (Belgium, France, Germany). Cross-border projects (e.g. within EU Interreg programmes) have contributed and consolidated such links. Researchers of the University of Luxembourg and neighbouring universities have extensively studied such interrelations[298].

Certainly, the findings of the present thesis would greatly benefit from being compared with, validated, and qualified in the framework of comparative case studies.

Questions for further research: Being as broad as it is, the thesis opens up for a host of questions that merit further research. In particular, they concern (conceptual and empirical) interrelations between actionable knowledge and:

1. personal narratives and meaning-making in transactional social and material engagement, including cognitive and behaviour changes,
2. organisational and professional knowledge, including with a particular view to scientific,
3. collective narratives and paradigms in organisations and society,
4. formal governance (regulatory frameworks), notably with a view to spaces of self-organisation and the sense of agency of actors,
5. knowledge co-creation in transformative research: with a view to all of the above aspects, how can the findings of the thesis inform the further development of methods of transformative research?

As the thesis has examined actionable knowledge for sustainability as outcome of social learning in informal governance processes, it seems particularly interesting to investigate further how *changes* along these aspects (narratives, knowledge, paradigms, regulation) relate to self-organisation and to behaviour, practices, and patterns in human-environment interaction.

Actionable knowledge, personal narratives, and meaning-making in action: Research into these interrelations (including personal narrative identities) could complement and enrich scientific research such as on mental models, transactional engagement and behaviour change, place and nature attachment (e.g. in human geography), environmental psychology and cognition. In sustainability science, narrative dimensions of actor engagement and meaning-making offer much unexplored potential (including beyond researcher-led collaborative processes).

[297] Website: www.steer.uni-osnabrueck.de

[298] For example, the Centre for Border Studies (UNIGR-CBS) of the universities of the Greater Region (Kaiserslautern, Lorraine, Liège, Luxembourg, Saarland, and Trier) brings brings together 80 researchers to this end (website: cbs.uni-gr.eu). Before joining the NEXUS FUTURES project, the researcher had worked for the University of the Greater Region network (website: www.uni-gr.eu)

Actionable knowledge, organisational, and professional knowledge: The present thesis has developed a framework to compare organisational, professional (incl. scientific), and local knowledge along the three ´meta-knowledge types´ for sustainability developed in transdisciplinary research. The addition of organisational and professional knowledge to the established distinction between scientific and local knowledge potentially opens a broad field of study that calls for further investigations (conceptually and empirically) and links sustainability more strongly with organisational and professional learning (see chapter 2.3.2.2). It would be particularly interesting to further investigate, firstly, how knowledge cultures and ´hierarchies´ in organisations are shaped by formal governance contexts, and, secondly, how scientific knowledge contributes to changing professional and local knowledge and their respective contexts. In scientific fields such as Science & Technology Studies (STS), such interrelations have been studied for decades (see chapter 2.3.2.3). In sustainability science, attention to them has been less widespread.

Actionable knowledge, collective narratives, and paradigms: The thesis has only begun to touch upon interrelations between paradigms and collective narratives, how they relate to and may mutually influence each other as regards human-environment relations and sustainability. Here, too, significant research has been conducted in STS, notably in inquiries into co-production and imaginaries, however, rarely with an explicit focus on sustainability. Some research (see chapter 2.3.2.1) has examined the (potential) role of narratives in local and social transformative changes pointing, in particular, to the insufficiency of ´information-deficit´ approaches to foster behavioural changes; however, usually in the framework of the use of specific ´stories´ in collaborative processes and particular governance contexts (e.g. climate change). The case studies suggest that narratives can be sources of action *and* inaction, of mobilisation *and* division (see above). Sustainability science could benefit from more conceptual clarifications and broader empirical inquiries that could also help refine the analysis of roles of different narratives in societal transformations, and how narratives of inaction or division can soften and change to become narratives of action and (non-polarising) engagement.

Furthermore, the thesis has identified what it has termed ´ecocultural landscape imaginaries´ has significant elements of narratives, building on "sociotechnical imaginaries" from STS (Jasanoff & Kim, 2015) and "narrative affective expressions" from transformation research (Chabay et al., 2019). The use and affective dimensions of landscape imaginaries (that also serve as metaphors and may be closely related to ´nature myths´, Holling et al., 2002; Raymond et al., 2013) in narratives have remained unexplored in depth. They offer a promising path for future research.

Actionable knowledge, formal governance, and agency: Extensive research has been conducted on the need to empower marginalised actor groups to participate in governance, on public participation, on self-organisation, and transformative agency. An emphasis on flexible frameworks is a hallmark of adaptive governance and management, particularly with a view to social learning (see chapter 2.2.1). Interplays between formal and informal governance processes are at the heart of the Management and Transition Framework. However, much less research has been carried out on the question how regulation and dominant roles of scientific knowledge in governance affect actor engagement and, in particular, their sense of agency and (narrative) identities. The thesis suggests that actors willing and eager to self-organise in social networks and engaging in informal governance tend to have a strong sense of agency that this sense may, however, be weakened by exacerbating contradictions, increasingly detailed science-based regulation, and administrative rigidity. Further research may be important to enhance understanding of hindering factors for social learning, of why some actors engage in network governance while others do not, and how governance can contribute to strengthening agency (i.e. to empower actors).

Actionable knowledge in transformative sustainability research: The thesis thus opens up diverse potential research paths for sustainability science and transformation research, conceptually and empirically. A dimension neglected by the thesis is what the concepts and empirical findings imply as regards how transformative research methods can contribute to fostering actionable knowledge. How can the thesis contribute to further developing collaborative methods, e.g. as regards conceptual mapping at stakeholder workshops, the use of narratives and imaginaries in systems, scenario and visioning approaches, the use of timelines, approaches to citizen science, narrative and walking interviewing, etc.? The methods chapter contain some reflections (see part 5). All of them merit extensive further reflections and experiments.

12.4 Recommendations for policy and practice

Social learning is a prerequisite for sustainability. The thesis provides evidence that regulation, science, and technologies alone are not sufficient on their own to bring about more profound changes in how actors engage with water and land. Furthermore, the need to cooperate across organisational and professional boundaries has grown stronger and more urgent. This adds to the learning challenge.

The thesis has investigated what makes actors take collective action to improve water quality and ecosystem health in their professional and local contexts in a manner that takes into account complexity and uncertainties. The case studies suggest that actionable knowledge tends to emerge from self-organised and experimental social learning processes that engage actors from diverse organisations and professions. Engagement in such processes greatly depends on that actors are confident that they can actually ´change things´ and that they are heard. These findings, therefore, underscore the social and governance dimensions of sustainability.

The following outlines arguments and recommendations on how social processes and factors can be given a more prominent role in water and land governance. They are meant as contributions to further dialogues.

Addressing contradictions and uncertainties

Contradictions in Luxembourg´s water and land systems grow. It seems increasingly uncertain if environmental objectives to improve water quality and halt ecological deterioration can be met. The author argues that addressing discrepancies and barriers more openly could contribute to counteracting divides among governmental and nongovernmental actors. There are no solutions to complex problems. But recognising sustainability challenges in their complexities raises fundamental normative questions about possible and desirable futures for Luxembourg, might be a precondition for more mutual understanding, and calls for creative approaches on how to work together.

Flexible frameworks and one-stop-shops

The case studies have identified a number of “rigidity traps” (Gunderson & Holling, 2002) in regulative frameworks and administrative procedures. Legal and administrative requirements have resulted in lengthy and complex procedures to get projects authorised and funded. They have also increased dependencies on expert advice and administrative burdens. Some projects have been stalled due to rigid and conflicting requirements, others struggle with their practical feasibility, for some authorised projects it is doubtful if they will produce the intended ecological improvements.

This points to the need for leaner procedures, more coordination, and flexible interpretations of requirements in public administrations to take into account context-specific social and practical

constraints and opportunities. More flexibility would make it easier to get more actors on board and foster enthusiasm and commitments for common projects.

A one-stop-shop (´guichet unique´) for project authorisation and funding application could also help alleviate the situation.

Collaborative and participatory processes

The thesis recommends that social factors and processes be considered more strongly in environmental and water governance. This implies a stronger recognition of knowledge that practitioners have gained from their professional experiences in specific organisational and local contexts. Earlier and more active involvement of stakeholders in public consultation processes could be one way of doing so; especially when designed to allow for more far-reaching dialogues about - and revisions of - draft plans and laws.

Secondly, it seems worthwhile to experiment with how collaborative processes could accompany and help prepare regulatory processes such as for the creation of new protection zones, management and action plans or similar. One objective could be to stimulate dialogues with local and professional communities about how political plans and legal initiatives could be designed to leave room for and *create* new possibilities.

Such collaborative governance processes could also aim at developing concrete projects or shared visions for particular areas. To do so, would move the current emphasis on restrictions and ecological target states towards an understanding of environmental governance as opening ecological *and* social opportunities. This might necessitate more flexibility as regards environmental objectives and administrative requirements, but would hold the promise of generating innovative new ideas and projects tailored to contexts and more widespread support for and involvement in implementation (i.e. make them socially and perhaps also ecologically more ´robust´).

Organisations as learning environments

Governmental and nongovernmental organisations bring together people with diverse professions and experiences. Many of their tasks are knowledge-intensive and highly specialised. Sustainability challenges are complex and require innovative ´solutions´. This increases the need for continuous learning and cooperation.

The thesis recommends that organisations encourage their members to work closely with colleagues across departmental structures (e.g. in multi-disciplinary and project-specific teams) and to engage with actors outside their own organisations, from local to national and across sectors (e.g. water, environment, agriculture). This may necessitate that organisations grant more leeway for - and dedicate more resources to – collaborative processes and experimental projects that do not have pre-defined objectives. There is evidence to suggest that organisations benefit from fostering professional learning among their members in this manner. Engagement outside formal procedures can strengthen dedication, build trust with others, contribute to more differentiated and shared understandings of cross-cutting sustainability challenges, and pave the way for novel and context-specific approaches on how to address them. Notably, governmental actors could enhance their knowledge of local contexts, and nongovernmental actors of legal constraints and opportunities.

To this end, the thesis proposes to consider introducing inter- and intra-organisational ´mobility periods´ or ´exchange programmes´.

Boundary organisations

River partnerships, nature parks, farm advisory services, and other cooperative and coordinating organisations provide spaces for self-organisation and social learning that facilitate multi-actor cooperation, knowledge co-creation, and measures tailored to improve ecosystem health. Boundary organisations build bridges between – and provide repositories for - scientific, professional, and local knowledge. To bring organisations with different purposes and strategies together around specific causes usually requires compromises. These may not always fulfil expectations, formal plans and objectives, but are often necessary to get actors on board and ´to get things done´. Moreover, there are rarely clear-cut one-size-fits-all solutions to sustainability challenges. In addition to mediating compromises, the case studies also suggest that boundary organisations have contributed to enhancing environmental awareness (i.e. knowledge of aquatic ecosystem dynamics) within their networks and the public.

The thesis therefore recommends that boundary organisations be strengthened. Multi-stakeholder cooperation in the river basins would benefit from a stronger organisational commitment of funders, members, and partners (from local to national). Stronger commitment could consist in more active participation in and contributions to decision-making bodies and processes, activities, and events. Boundary organisations would also benefit from more resources, visibility, and stronger mandates.

Experimental priority projects

The case studies suggest that joint action and projects are among the most effective measures for fostering trust, a shared sense of purpose, and changes in established ways of thinking and doing (i.e. learning). Collective projects can be sources of shared experiences, identification, and pride that become inscribed in the lives of individuals and organisations. Ambitious joint projects can demonstrate *that* and *how* alternative ways of organising human-environment interactions are possible in Luxembourg and its river basins.

Two action fields have emerged in the framework of the thesis (incl. NEXUS FUTURES workshops). The first is to launch new agricultural products and regional marketing initiatives that bring farmers and consumer closer together and provide more economic incentives for farming to live up to high environmental standards. In Luxembourg, many actors regard regional food production and consumption as the most promising pathway (or even “last hope”) for a future for agriculture that is economically and environmentally sustainable. A number of initiatives and products are already in place or underway (see annex II)[299]. To be successful on a larger scale, a wide range of different actors need to rally around particular projects, with broad support from consumers.

The second action field is the restoration of rivers (and other habitats). The case studies suggest that environmental governance would benefit from more examples on how biodiversity in protected biotopes can be preserved and enriched in cooperation with agricultural actors and strong local involvement. How can restorations become part of collective projects, communal life and imaginaries, serving both ecological and social regeneration? As a possible way forward, the thesis recommends that local actors, farmers and farm advisors, river partnerships, national authorities and others channel some of their energies and efforts into a few priority projects to explore this challenge.

[299] At the University of Luxembourg, there is also a research team dedicated to sustainable food practices in Luxembourg and the Greater Region (website: food.uni.lu).

12.4.1 Transformative sustainability research in Luxembourg: an outlook

The thesis has been conducted in the framework of the transdisciplinary NEXUS FUTURES project of the sustainability science team of the University of Luxembourg[300]. In close cooperation with societal actors, it seeks to contribute to refiguring interfaces between, policy, practice, and science to accompany and facilitate transformative change. The team offers a wide range of systems, scenario, and citizen science approaches and methods, combined with a collaborative platform[301]. Building on the research of the past years, the sustainability science team seeks to develop these approaches and methods further to enlarge and enrich spaces for collaboration, imagination, and experiments in Luxembourg.

The project shows ways of how science and society alike can benefit from researchers who leave the confines of their establishments to engage actively in society. In its research, the sustainability team of the university has met with open doors, keen interest, reflexive thinking, and invaluable advice. Working in such as hospitable and stimulating environment has been a real privilege and great opportunity. There are few other places where the local and the national and diverse sectors are so close to one another. In addition, the Grand Duchy is a (wealthy) microcosm of diverse trends and challenges given its linguistic and cultural diversity and embeddedness in transboundary contexts with Belgium, France, and Germany. Where if not here can we hope to conduct projects through which we can learn *that* and *how* it is possible to make societies more sustainable?!

The creation of a transformation laboratory will be a next step. Transformation laboratories (similarly to real-world or living laboratories, König, 2013) serve the co-creation of knowledge that helps actors understand complex challenges that arise in their professional and local lives from diverse and systemic perspectives and develop ways of addressing them in their contexts. Transformation laboratories nurture practice-oriented professional and local knowledge enriched by scientific expert knowledge and accompanied by innovative technologies (McCrory et al., 2020). They bring together actors from local communities, agriculture, environmental organisations, public authorities, and science (to name but a few) around experiments and pioneering projects that actors themselves develop, with facilitation by experienced researchers. Projects and experiments may accompany or provide impulses for formal policy processes. Thereby, such laboratories can enhance the capacities of diverse actors and of society at large to address nexus challenges in a future-oriented and imaginative manner.

Transformation laboratories (or t-labs) contribute to making the pursuit of sustainability meaningful and tangible. Designed as structures that run permanently or at least over many years, t-labs aim to make sustainability an integral element of the life of everyone, of identities, and lifestyles. This is a long-term endeavour, but the time to embark on it may be now.

[300] Website: sustainabilityscience.uni.lu

[301] Collaborative platform ´Aktioun Nohaltegkeet´ initiated in cooperation with the Conseil Supérieur pour un Développement Durable (website: www.aktioun-nohaltegkeet.lu).

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Annexes

Annex I: Bericht vom NEXUS FUTURES-Workshop im Einzugsgebiet der Syr (2. März 2018)

„Wasser, Natur und Land im Einzugsgebiet der Syr:

Perspektiven auf Zusammenhänge, Problem- und Handlungsfelder“

Webseite: sustainabilityscience.uni.lu/nexus-futures_/syr/

(sämtliche Dokumente, einschl. Einflussdiagramme und Feedback)

Inhalt

1. Hintergrund, Zielsetzung und Methoden der Veranstaltungen

Die Veranstaltungen am 1. und 2. März 2018 in der Gemeinde Niederanven trugen zur Entwicklung neuer Ansätze für einen nachhaltigen Umgang mit Wasser und Land im Einzugsgebiet der Syr bei. Im Vordergrund stand der Austausch zwischen Bürgern und Akteuren (aus Gemeinden, Verwaltungen und Ministerien, Syndikaten, Landwirtschaft und Industrie) über Herausforderungen, Problemfelder und Handlungsmöglichkeiten in Bezug auf Wasser, Natur und Land.

Die Veranstaltungen sind Teil des Projekts *„NEXUS FUTURES – Herausforderungen im Umgang mit Wasser und Land in Luxemburg“* (gefördert durch das MDDI und die Universität Luxemburg), in dessen Rahmen das Forscherteam partizipative, praxis- und zukunftsorientierte Methoden zur gemeinsamen Arbeit an Nachhaltigkeitsthemen entwickelt. Die Veranstaltungen bildeten den Startschuss für weitere Treffen und Aktivitäten, die im Rahmen des Projekts im Einzugsgebiet der Syr stattfinden sollen. Sie wurden in Zusammenarbeit mit der Flusspartnerschaft Syr organisiert. Der Info-Abend am 1. März (siehe Webseite) bot den cirka 30 Teilnehmern einen Überblick über den Zustand der Gewässer sowie über bestehende und geplante Maßnahmen im Bereich Wasser- und Naturschutz (u.a. im Rahmen von Natura 2000). Auch wurden „typische“ Herausforderungen im Bereich Nachhaltigkeit anhand dreier Fallbeispiele aus dem Einzugsgebiet veranschaulicht.

Beim Workshop am 2. März erarbeiteten 21 Teilnehmer Einflussdiagramme, die zentrale Zusammenhänge, Ursachen und Folgen im Bereich Wasser und Land aus ihrer Sicht darstellten. Der kollaborative Ansatz zur Systemanalyse, der hierzu angewandt wurde, diente dem Dialog und einem besseren gegenseitigen Verständnis.

Zentrale Fragestellungen für die Gruppenarbeit waren:

- *Welche Zusammenhänge und Wechselwirkungen in den Bereichen Wasser, Natur und Land sind aus Perspektive der Teilnehmer wichtig? Durch welche Faktoren und Bedingungen werden diese beeinflusst?*
- *Mit welchen Anforderungen, Herausforderungen, Barrieren und Problemen sind Akteure konfrontiert?*

- *Wie kann mit unterschiedlichen Interessen, Konflikten und Widersprüchen umgegangen werden?*
- *Welchen Veränderungsbedarf und welche Handlungsmöglichkeiten sehen die Teilnehmer in Bezug auf Wasser- und Naturschutz im Einzugsgebiet?*

Den Teilnehmern wurden eine Reihe von „Faktorkarten" (welche aufbauend auf Recherchen sowie 26 vorbereitenden Interviews mit Akteuren erstellt worden waren) zur möglichen Auswahl für die Erstellung der Einflussdiagramme angeboten.

2. Zusammenfassung des Workshops: Perspektiven auf Herausforderungen in Bezug auf Wasser, Natur und Land

Während des Workshops erstellten die Teilnehmer in Gruppen insgesamt sieben Systemdiagramme (siehe Webseite). Diese stellen u.a. zentrale Herausforderungen, Faktoren und Zusammenhänge aus Sicht mehrerer oder einzelner Teilnehmer dar:

Wasserqualität (in Grundwasser und Oberflächengewässern) – *wurde in 4 Diagrammen in den Mittelpunkt gestellt*:

- **Bevölkerungs- und Wirtschaftswachstum sowie Abwasser:** Es bestehe die dringende Notwendigkeit des Ausbaus des Abwassernetzes im Einzugsgebiet angesichts steigender Abwassermengen (u.a. aus Gemeinden und vom Flughafen), die die Wasserqualität in den Flüssen belasten und dadurch andere Bemühungen teilweise untergraben würden.
- **Kohärenz politischer Ziele und Strategien**: Es wurde ein Widerspruch festgestellt zwischen einer Subventionspolitik, die auf Wachstum und Konsum ausgerichtet ist (z.B. in der Landwirtschaft), und einer Nachhaltigkeitspolitik, die sich dem Schutz begrenzter natürlicher Ressourcen verschreibt.
- **Landwirtschaft sowie Verhalten von Bürgern und Verbrauchern:** Es wurde ein Zusammenhang zwischen einem intensiven Einsatz von Pflanzenschutz- und Düngemitteln in der Landwirtschaft sowie dem in der Gesellschaft verbreiteten Konsum- und Ernährungsverhalten (welches mehr auf Quantität statt Qualität setzt) festgestellt.
- **Umsetzung von Schutzgebieten** (u.a. Natura 2000) und mehr naturnahe Gewässerabschnitte im Einzugsgebiet würden zur Verbesserung der Biodiversität und Stärkung der Selbstreinigungskraft von Gewässern beitragen. Gleichzeitig äußerte jemand Zweifel an der Sinnhaftigkeit der kategorischen Ablehnung von Drainagesystemen in Feldern (siehe Annex I, Diagramm 5).
- **Lebensqualität, Gesundheit und Erholung:** Wasserqualität sowie naturnahe Gewässer wirkten sich positiv auf das Wohlbefinden von Menschen aus.

Sicherheit der Trinkwasserversorgung (Quantität und Qualität) – *wurde in 1 Diagramm in den Mittelpunkt gestellt:*

- **Wasserpreise (Kostendeckung) und guter Zustand der Infrastruktur**: Mit steigenden Ausgaben für die Wasserinfrastruktur müssten auch die Preise in den Gemeinden für die Wasserverbraucher steigen, um Kostendeckung zu erreichen.
- **Ressourceneffizienz**: Höhere Wasserpreise könnten zu mehr Einsatz ressourcensparender Installationen und Geräte führen.
- **Freiheit der Bürger versus Maßnahmen zur Einschränkung des Wasserverbrauchs**: Eine sichere Trinkwasserversorgung wurde als Voraussetzung für Freiheit und Gesundheit der

Bürger betrachtet. Bürger dürften ihre Freiheit jedoch nicht zu ´verschwenderisch´ nutzen, da dies sonst Maßnahmen zur Einschränkung des Wasserverbrauchs zur Folge haben könnte.

- **Wasserverfügbarkeit, Landnutzung und Klima**: Eine ausreichende Wasserverfügbarkeit müsse auch über eine zugunsten von Quellen- und Wasserschutz verbesserten Landnutzung sowie über die Berücksichtigung der zunehmenden „Variabilität" von Niederschlagsmengen sichergestellt werden.
- **Nutzung von Regenwasser, lokale Aufbereitung von Brauchwasser und Umsetzung der Kreislaufwirtschaft**: Die verstärkte lokale Nutzung und Aufbereitung von Regen- und Brauchwasser (z.B. als Elemente der Umsetzung der Kreislaufwirtschaft) und der (evtl. über Zuschüsse unterstützte) Einsatz entsprechender Technologien würden sich positiv auf die Versorgungssicherheit auswirken.

Wertschätzung von Wasser und Boden sowie **Verbraucherverhalten** – *wurde in 2 Diagrammen in den Mittelpunkt gestellt:*

- **Sensibilisierung, Wissen und Einbindung von Bürgern und Kooperationen**: Die Einbindung von Bürgern und Landwirten (auch als „Landschaftspfleger") wurde als wichtige Möglichkeit gesehen, diese mehr für ökologische und ökonomische Zusammenhänge zu sensibilisieren. Wünschenswert seien eine höhere Wertschätzung der Umwelt sowie Veränderungen des Verhaltens der Bürger in Bezug auf Wasser- und Landnutzung, Konsum und Ernährung. Sensibilisierung und Wertschätzung könnten langfristiger wirksamer sein als finanzielle Anreize.
- **Berichterstattung in Medien & sachliche Diskussionen**: Medien würden in Bezug auf Wissen und Sensibilisierung eine wichtige Rolle spielen, Diskussionen würden jedoch oftmals zu emotional geführt. Werbung habe einen (zu) großen Einfluss auf Verbraucherverhalten.
- **Mut zu Verantwortung und Veränderung sowie Offenheit für Neues**: Diese hänge eng mit der Freiheit der Bürger sowie mit sozialem Zusammenhalt und Vertrauen zusammen.

Darüber hinaus haben die Gruppen die folgenden möglichen Interventionspunkte und Handlungsfelder erörtert und vorgeschlagen:

- **„Medien beeinflussen":** Mehr sachliche Informationen und Diskussionen sowie mehr Berichte (´good news stories´) über innovative Nachhaltigkeitsprojekte (z.B. Regenwasseranlagen in neuen Siedlungen) in den Medien
- **Einbindung von Bürgern und Kooperationen sowie Sensibilisierungsmaßnahmen**, u.a. damit Bürger sich für andere Gesetze und Formen der Landwirtschaft einsetzen.
- **Bewusstseinsbildung und Sensibilisierung bei Verbrauchern** für mehr Eigenverantwortung und „kritischen" Konsum

3. Weiteres Vorgehen (Anregungen und Vorschläge)

Es wird vorgeschlagen, dass das Nexus-Team allen Teilnehmern einen Entwurf der Zusammenfassung zur Ergänzung schickt. Darüber hinaus wird vorgeschlagen, dass im Mai zu einem **2-stündigen Treffen zur Nachbereitung des Workshops** eingeladen wird (Terminfindung über ´Doodle´). Zweck des Treffens ist die gemeinsame Besprechung von Handlungsfeldern und möglichen nächsten Schritten in Bezug auf das Einzugsgebiet der Syr.

Anregungen zum weiteren Verlauf aus Workshop und Feedback-Bögen (siehe Webseite):

- Teilnehmer: (mehr) Teilnehmer aus Landwirtschaft, Medien (z.B. Silicon Luxembourg – Startup Magazin), Gemeinden (einschl. Förster), Industrie und Transport
- Mehr Fokus auf das Einzugsgebiet der Syr

Darüber hinaus möchte das Nexus-Team die Methoden des Workshops kritisch reflektieren, um sie für weitere Veranstaltungen ggf. zu überarbeiten und verbessern. Ergänzungen und Anregungen bitte an: kristina.hondrila@uni.lu

ENDE

Annex II: Bericht des Nachbereitungstreffens des NEXUS FUTURES-Workshops im Einzugsgebiet der Syr (28. Mai 2018)

Lokale Problem- und Handlungsfelder: Aktionspunkte und –vorschläge für das Einzugsgebiet der Syr

1. **Zusammenfassung der Handlungsfelder**

a) Direkt- und Regionalvermarktung: Mehr Kontakt und Zusammenarbeit zwischen Landwirten und Verbrauchern im Einzugsgebiet im gesamten Flusseinzugsgebiet fördern

Vorschlag: Eine Veranstaltung mit Akteuren vor Ort zur (Weiter-)Entwicklung von Initiativen und Ansätzen zur Diversifizierung regionaler Produktion und Direktvermarktung zu organisieren (mit wissenschaftlichen Methoden und wissenschaftlicher Begleitung durch das Nexus-Team sowie in Zusammenarbeit mit der Flusspartnerschaft Syr). Das Ziel der Veranstaltung, Vorbereitung und Folgearbeit wird darin bestehen, konkrete Maßnahmen - auch im Hinblick auf Wasserschutz – gemeinsam mit Akteuren auszuarbeiten und auf den Weg zu bringen. Das Demonstrationsprojekt in Schuttrange, das Gemüseanbau mit Aquaponie verbindet, schien besonders interessant.

Vorbereitung: Das Nexus-Team wird einen Überblick über bestehende Initiativen und Ansätze, Erfolge und Hürden erstellen (z.B. zu bestehenden Direktvermarktern, Vereinigungen und Anbietern von Regionalprodukten wie Oikopolis/Naturata, Projekten innerhalb der Gemeinde Schuttrange und anderen Gemeinden, Kantinen und Großküchen…). Wir bitten alle Teilnehmer und Akteure um weiterführende Hinweise und Kontakte!

b) Die Umsetzung von Renaturierungen im Einzugsgebiet voranbringen

Vorschlag: Workshop mit Landwirten, Gemeinden, Bürgern, Landwirtschaftsberatern, verantwortlichen Verwaltungen und weiteren Akteuren zur Umsetzung von Renaturierungsmaßnahmen im Einzugsgebiet – und Abschnitten, die prioritär für Renaturierungen in Frage kommen (in enger Zusammenarbeit mit der Flusspartnerschaft Syr, evtl. auch als anerkannte Fortbildung für Landwirte), mit wissenschaftlichen Methoden und wissenschaftlicher Begleitung durch das Nexus-Team

Vorbereitung (in enger Zusammenarbeit mit der Flusspartnerschaft Syr): Gespräche mit Vertretern aus den Verwaltungen (AGE, ANF, SER, ASTA), mit Landwirtschaftsberatern, Gemeinden und Landwirten (sowie Wald- oder Mühlenbesitzern?), um heraus zu finden, in welchen prioritären Gebieten rund um die Syr Bemühungen zu Renaturierungen bereits (an-)laufen oder besonders sinnvoll wären, und welche Hürden ausgeräumt werden müssen, damit die Projekte vorangehen können. Hierzu gehört

auch, mit Gemeinden, Landwirten und über das nationale Amt für Flurbereinigung (ONR) Möglichkeiten des Flächentauschs auszuloten.

Wir bitten alle Teilnehmer und Akteure um weiterführende Hinweise und Kontakte!

Wir sind auf Ihre Mithilfe angewiesen. Wir wären Ihnen sehr dankbar für jegliche Informationen, Tipps und Ideen (**möglichst bis zum 1. September**), gerne auch in persönlichen Gesprächen. **Ansprechpartnerin:** Kristina Hondrila, kristina.hondrila@uni.lu, Universität Luxemburg

2. Zusammenfassung des Treffens: Lokale Handlungsfelder

Diese Vorschläge für die nächsten Schritte entstanden aus dem Workshop vom 2. März, der half Handlungsfelder aus verschiedenen Perspektiven zu identifizieren, sowie aus den Gesprächen vom 28. Mai, bei dem diese von den Teilnehmern im Hinblick auf den lokalen Kontext weiterentwickelt wurden:

Welche Ideen und Ansätze aus dem Nexus-Workshop vom 2. März 2018 wollen wir zur Verbesserung des Umgangs mit Wasser, Natur und Land rund um die Syr und ihre Zuflüsse gemeinsam weiter verfolgen?

Die Teilnehmer waren sich einig, dass **Landwirte (auch landwirtschaftliche Berater), Gemeinden und Bürger** bei den nächsten Schritten im Einzugsgebiet der Syr im Vordergrund stehen sollten.

Übergreifend wurde angemerkt, dass Änderungen von **Verhaltens-, Konsum- und Produktionsweisen** im Umgang mit Wasser und Land (z.B. in Haushalten und landwirtschaftlichen Betrieben) **aus eigener Motivation, d.h. „von Innen“,** kommen müsse. Die zentrale Frage war, wie auch im Rahmen der Arbeit der Flusspartnerschaft Bürger und Arbeitgeber erreicht werden können, die sich bis heute noch nicht mit dem Thema ‚Wasser - eine kostbare Ressource, die es zu schützen gilt' auseinandergesetzt haben. Mehr Leute müssten für Nachhaltigkeit sensibilisiert und begeistert werden. Nicht Mangel an finanziellen Anreizen und Möglichkeiten seien ausschlaggebend für Zurückhaltung und Widerstand, sondern vielmehr praktische und persönliche Aspekte (z.B. Zeitgründe und Überforderung durch die Vielzahl an – teilweise widersprüchlichen - Informationen und Anforderungen, es fehlten positive emotionale Anreize). Im Folgenden werden die oben genannten Handlungsfelder, die den Teilnehmern besonders wichtig waren, erläutert.

a) Die Annäherung zwischen Landwirten und Verbrauchern im Einzugsgebiet fördern (Direkt- und Regionalvermarktung)

Dieses Handlungsfeld wurde intensiv diskutiert. Viele Teilnehmer sahen die **Ernährung** als besonders wichtiges Element der **Entwicklung der landwirtschaftlichen Produktion** in Richtung von Nachhaltigkeit und Wasserschutz (sowie „Lebensmittelautarkie"). Wünschenswert sei es, dass Landwirte zu besseren Konditionen für ihre Region produzieren könnten anstatt dem Wettbewerbsdruck des Weltmarkts ausgeliefert zu sein. Dies setze allerdings voraus, dass die Verbraucher **regionale Produkte** wertschätzten und auch entsprechend bereit seien, **höhere Preise** für Lebensmittel zu zahlen.

Dies gehe Hand in Hand mit einer **höheren Wertschätzung und Anerkennung** der Landwirte durch die Verbraucher, die über die reine Lebensmittelproduktion hinausgehe. Denn Landwirte tragen als **„Landschaftspfleger"** entscheidend zu Natur und Land in der Region bei. Eine extensive Bewirtschaftung der Flächen im Sinne des Gewässerschutzes hat jedoch einen Preis, der nicht nur über staatliche Subventionen abgefedert werde sollte, sondern auch über **neue Absatzmöglichkeiten.** Somit seien sowohl Landwirte als auch Verbraucher aufgerufen, neue Wege zu suchen. Von einer

direkteren Vermarktung regionaler Produkte (auch über Nahrungsmittel hinaus) würden letztlich beide Seiten profitieren.

Auch erscheint es wünschenswert, dass mehr Bürger einen **Einblick erhalten, wie auf modernen Höfen** heutzutage gewirtschaftet und Tiere gehalten würden. Doch in beiderlei Hinsicht gibt es im Einzugsgebiet der Syr bislang nur punktuelle Ansätze und Pilotprojekte, die über die Gemeindegrenzen hinaus kaum bekannt sind. Genannt wurden u.a. die folgenden:

- Pilotprojekt zur Kombination von Bio-Gemüseanbau und Fischzucht (Aquaponie) in Munsbach (www.aquaponie.lu)
- Hofladen in Munsbach mit Biogemüse und regionalen Produkten (www.lespaniersdesandrine.lu)
- Hofladen in Lellig (www.buttek-umhaff.lu)
- Regionaler Wochenmarkt von Roodt-Syre, Weiler-La-Tour, Contern…(anscheinend aufgrund von Schwierigkeiten aufgegeben)
- …weitere ?

Übergreifend wurde zu bedenken gegeben, dass es für Landwirte schwer sei, die **zusätzliche Arbeit, die durch Direktvermarktung** für sie entsteht, zu stemmen. Dies gelte auch für die **hohen rechtlichen Anforderungen und Auflagen** zu Hygiene, Buchhaltung usw. Deswegen erörterten die Teilnehmer den **Aufbau neuer Strukturen**, die die Vermarktung, evtl. die Belieferung von Kunden und andere Dienstleistungen für die Landwirte übernehmen könnten. Als Vergleich wurden **Winzergenossenschaften,** die hierfür eine lange Tradition haben, angeführt. Es gebe einige Ansätze, die zumindest in diese Richtung gehen würden:

- **Vereinigung der luxemburger landwirtschaftlichen Direktvermarkter** (www.bauerenhaff.lu): bietet (derzeit 26) Direktvermarktern die Möglichkeit, sich gegenseitig zu unterstützen, gemeinsam Werbung zu machen und Kontakt mit den Verbrauchern zu pflegen - bislang nur 1-2 Produzenten aus dem Einzugsgebiet Syr
- Neue **Online-Plattform Letzshop** von u.a. Handelskammer, Wirtschaftsministerium und CLC mit Online-Bestellkatalogen von Einzelhändlern und Lieferservice an Kunden (www.letzshop.lu – Lancierung im Frühherbst 2018) – interessant auch für landwirtschaftliche Direktvermarkter?
- **Tag des Bauernhofs** am 17.6.2018 (Tag der Offenen Tür einiger Betriebe)
- **L´Association pour la promotion des fermes d´accueil et pédagogiques** (APFAPL, www.fermepedagogique.lu): Kinder- und Schülergruppen werden Hofbesichtigungen angeboten (u.a. in Schuttrange).
- **Oikopolis-Gruppe,** einschl. der genossenschaftlichen **BIOG-Molkerei und Naturata-Lebensmittelgeschäfte,** in Munsbach (www.oikopolis.lu): Initiative für nationale und regionale Bioproduktion und -vermarktung
- **Mëllerdaler Produzenten** (www.produzenten-mullerthal.lu): Gemeinsame Plattform von Anbietern lokaler Produkte sowie von Restaurants, Unterkünften und Sehenswürdigkeiten, die auf Lokales ausgerichtet sind
- **Initiative zum Anbau von Miscanthus** (Chinaschilf) und zur Regionalvermarktung von Miscanthus-Produkten (u.a. Einstreu, Mulch) in Wasserschutzgebieten (www.miscanthus.lu)
- Initiative der Luxemburger Landjungend und Jungbaueren (http://fro-de-bauer.lu): Öffentlichkeitsarbeit und Informationen für Verbraucher, einschl. zu regionalen Produkten
- Petition "**Lëtzebuerger Produkter an der ëffentlecher Restauratioun**" (2017) wurde von 7.900 Bürgern unterschrieben – auch gibt es Ansätze hierzu in Gemeinden, deren

Lastenhefte den Einkauf regionaler Produkte durch Kantinen (etwa in Schulen oder *Maisons relais*) ausdrücklich erlaubten.

- …weitere?

Es erschien den Teilnehmern interessant, auf einige dieser – oder anderer – Ansätze und Beispiele aufzubauen und das Thema weiterzuverfolgen.

b) Die Umsetzung von Renaturierungen im Einzugsgebiet fördern

Der **Handlungs- und Nachholbedarf** im Bereich Gewässerschutz und Renaturierungsmaßnahmen ist groß, nicht zuletzt aufgrund der schleppenden Umsetzung von Maßnahmen im Rahmen der Wasserrahmenrichtlinie (bislang wurden landesweit lediglich 6 der 800 vorgesehenen Maßnahmen vollständig umgesetzt). Zwar seien die Gewässerabschnitte, an denen Maßnahmen tatsächlich auch umgesetzt werden könnten, begrenzt. Aber gerade am Oberlauf der Syr bestehe weiterhin **erhebliche „Luft nach oben".**

Im Blickpunkt war besonders der Bedarf von Maßnahmen zur Renaturierung von bestimmten Flussabschnitten, auch um Hochwasserschäden zu vermeiden. Dies könne nur über eine höhere Akzeptanz von Renaturierungen unter Landwirten, Bürgern und Gemeinden sowie durch eine stärkere Mobilisierung und partnerschaftliche Zusammenarbeit seitens der Gemeinden, Landwirte, Flusspartnerschaften, Verwaltungen und Berater erreicht werden. Oft scheitere die Umsetzung an **unterschiedlichen Interessen und Widerstand** vor Ort, z.B. bei Landwirten. Als mögliche Gründe hierfür werden angesprochen: zum einen, die prinzipielle Ablehnung von etwas, was ihnen „von Außen" auferlegt werde (ob Viehtränken, Fischtreppen oder Zäune); zum anderen die Tatsache, dass einige Landwirte sich in vielerlei Hinsicht „am Limit" fühlten, auf eine intensive Nutzung ihres gesamten Landes angewiesen seien und unter Bürokratie-Druck litten.

Gleichzeitig berichten die Teilnehmer jedoch auch von Landwirten, die zu Maßnahmen auf ihrem Land bereit waren, dann aber aufgrund **widersprüchlicher Beratungen und Aussagen** seitens von **Verwaltungs- und Beratungsstellen** abgesprungen seien.

Verwaltungs- und Beraterebene

Wünschenswert sei eine stärkere Zusammenarbeit, Priorisierung und Abstimmung der beteiligten Verwaltungen (AGE, ANF, SER und Asta) sowie der landwirtschaftlichen Beraterstrukturen (Landwirtschaftskammer, Convis, Ibla und unabhängige Berater) im Rahmen der Umsetzung des nationalen Bewirtschaftungsplans der EU-Wasserrahmenrichtlinie, der Managementpläne von NATURA 2000 sowie der Agrar-Umwelt-Klimamaßnahmen (AUK).

In Bezug auf das Einzugsgebiet wurde deswegen empfohlen, dass sich die Verwaltungen zunächst auf gemeinsame Prioritäten in Bezug auf Gewässer- und Naturschutz einigen sollten. Die landwirtschaftlichen Berater, die in Bezug auf das Engagement der Landwirte eine Schlüsselrolle spielen, müssten entsprechend einbezogen und informiert werden.

Dies sollte im Rahmen der jeweiligen regionalen Comités de pilotage, welche sowohl im Rahmen der Trinkwasserschutzzonen als auch im Rahmen von NATURA 2000 in 7 Gebieten in Luxemburg eingesetzt werden sollen, geschehen. Weitere Bemühungen in punkto Priorisierung, Abstimmung und Zusammenarbeit seien jedoch erforderlich.

Landwirtschaft

Insgesamt würden gesamtbetriebliche Beratungen und Ansätze durch die fehlende Abstimmung und Zusammenarbeit zwischen landwirtschaftlichen Beratern erschwert (einschl. Teilumstellungen von Landwirten auf Bio-Produktion). Dies sei zum einen auf die durch die EU vorgegebene Modulstruktur der Beratung zurückzuführen, aber auch auf die unterschiedlichen „Philosophien“ und Ansätze der Verwaltungen.

Es sei wichtig, positive Beispiele und Auswirkungen von Renaturierungen und extensiver Landwirtschaft aufzuzeigen. Immer mehr Landwirte würden beispielsweise an Agrar-Umwelt-Klima-Maßnahmen (AUK) teilnehmen und Landschaftspflegeprämien erhalten. Landwirte, welche eine Landschaftspflegeprämie beziehen, sind verpflichtet, 10 theoretische und praktische Fortbildungsstunden zu absolvieren. Diese werden über den SER anerkannt.

Außerdem wäre es interessant in Erfahrung zu bringen, ob es möglich wäre zusammen mit dem nationalen Amt für Flurbereinigung (ONR) zu ermitteln, ob landwirtschaftliche Flächen (vom Staat, Gemeindeflächen oder von Landwirten) an Fließgewässern im Einzugsgebiet getauscht werden können, um ihnen mehr Raum für ihre natürliche Entwicklung zu geben.

Von der Gemeinde Schuttrange wurde berichtet, dass dort neben der Bürger-Umweltkommission auch eine Landwirtschaftskommission eingerichtet wurde. Diese sei derzeit sehr aktiv, da sich Landwirte mit Vorschlägen und Initiativen einbringen würden. Am 28. Juni hat dort ein Quellen-Tag mit Führung zu den Quellen der Gemeinde stattgefunden.

Übergreifend wurde angemerkt, dass der Anteil der Biolandwirtschaft in Luxemburg mit etwa 4 % im europäischen Vergleich „miserabel“ sei, es gleichzeitig aber ein „enormes Potential“ gebe (bis zu 20-25 %?). Ein möglicher Weg, mehr Landwirte für Bio zu begeistern, sei über Technikbegeisterung, da auch die moderne Biolandwirtschaft technikintensiv sei (z.B. Präzisionstechniken bei der Unkrautbekämpfung). In 10 Jahren werde es voraussichtlich automatische selbstfahrende Traktoren geben. Es wurde allerdings zu bedenken gegeben, dass kleinteilige Felder mit Hecken nicht mit großen Maschinen vereinbar seien.

Weitere Fragen, die aufgeworfen wurden, betrafen auch die anstehende Reform der Agrarsubventionen auf EU und nationaler Ebene (bei der mehr auf gesellschaftlichen Mehrwert anstatt auf Massenproduktion für globale Märkte abgezielt werden sollte).

ENDE

Annex III: Bericht des NEXUS FUTURES-Workshops in der Obersauerregion (14. Februar 2019)

„Was bewegt Sie in Sachen Wasser, Boden und Natur in der Obersauerregion? Welche Veränderungen, welche Zukunft?“

Webseite: sustainabilityscience.uni.lu/nexus-futures_/obersauer/

(sämtliche Dokumente, einschl. Einflussdiagramme, Feedback und Ergänzungen der Teilnehmer)

Hintergrund und Zielsetzung

Das Ziel des Austauschs bei den Veranstaltungen am 13. und 14.2.2018 in der Gemeinde Bauschleiden bestand darin, Veränderungen und Herausforderungen im Alltag aus verschiedenen Perspektiven zu beleuchten sowie zukunftsorientierte Handlungsansätze für Zusammenarbeit und Nachhaltigkeit im Umgang mit Wasser, Boden und Natur in der Obersauerregion zu erarbeiten.

Teilnehmer kamen aus dem Naturpark (einschl. Gewässervertrag und biologische Station), aus Land- und Forstwirtschaft, Anglervereinen, Gemeinden, Wassersyndikaten, Verwaltungen und Ministerien oder waren Privatleute. Die Veranstaltungen wurden in Zusammenarbeit mit dem Gewässervertrag Obersauer organisiert.

Die Veranstaltungen sind Teil des Projekts *„Nexus Futures – Herausforderungen im Umgang mit Wasser und Boden in Luxemburg“* (gefördert durch das Umweltministerium und die Universität Luxemburg), in dessen Rahmen das Forscherteam partizipative, praxis- und zukunftsorientierte Methoden zur gemeinsamen Arbeit an Nachhaltigkeitsthemen entwickelt. Webseite: https://sustainabilityscience.uni.lu/nexus-futures/

Synthese des Workshops: Die Obersauerregion heute und in Zukunft: Handlungsfelder und Akteure

Während des Workshops am 14. Februar erarbeiteten 33 Teilnehmer in Gruppen gemeinsame Einflussdiagramme. Diese stellten zentrale Herausforderungen und Zusammenhänge dar, die den Umgang mit Wasser und Boden aus Sicht der Teilnehmer in der Region jetzt und in Zukunft prägen. Impulse lieferten zwei Zeitleisten sowie nationale Szenarien-Skizzen zu möglichen Herausforderungen im Umgang mit Wasser und Boden in Luxemburg im Jahr 2045. Ziel des Austauschs war es, das Wassersystem und Herausforderungen aus unterschiedlichen Perspektiven besser zu verstehen und zukunftsweisende Handlungsansätze zu arbeiten. Zentrale Fragen:

Wie kann der Umgang mit Wasser und Boden verbessert werden? Was sind zentrale Herausforderungen in Bezug auf die Zukunft? Wo kann angesetzt werden, um Zukunft zu gestalten?

Die Diskussionen beim Workshop waren lebhaft und reichhaltig. Im Vordergrund stand der Bedarf an Perspektiven und Alternativen für die Region und ihre Menschen. Hieraus gingen die folgenden Ansätze und Vorschläge hervor:

Regionale Produkte: mehr „vum Séi“

Landwirte in der Region wollen wasser- und bodenschonender arbeiten, weiterhin Nahrungsmittel produzieren und nicht nur von Weltmarkt und Subventionen abhängig sein. Verbraucher wollen gute Produkte, sauberes Wasser und schöne Landschaften. Wären regionale und nach strengen Kriterien

produzierte Produkte erfolgreich, wären alle glücklich. Um Wasser, Böden und Natur stünde es besser. Die Landwirte hätten mehr Perspektiven, die Region wäre attraktiver.

Aber wie kann Verbrauchern dieser Zusammenhang bewusstgemacht werden? Wie können regionale Produkte und Absatzmöglichkeiten aufgebaut werden, ausgehend von den „vum Séi"-Produkten?

Handlungsfeld: Vorgeschlagen wurden von einem Ministerium finanzierte Anlaufstellen und „Produkt-Animateure" für die Region. Diese wären für den Aufbau solcher Produkte zuständig. Ideen gibt es genug (z.B. eine Käserei, siehe unten). Was fehlt, sind konkrete Initiativen und Strukturen. Die Landwirte selber können das nicht stemmen. Der Naturpark Öewersauer, der sich bereits mit den anderen Naturparks eine Beauftragte für „Regionale Produkte" teilt, sollte eine wichtige Rolle spielen.

Tourismus in der „Wasserregion" wiederbeleben

Infrastrukturen und Angebote für Urlauber müssen verbessert werden. Der Tages- und Badetourismus reicht nicht. Er ist ohnehin durch die alljährlichen ´Blaualgen´ und Badeverbote beeinträchtigt und führt lokal auch zu Problemen (Parkplätze, Müll…). „Slow tourism" bzw. Agro-Tourismus könnten Alternativen sein. Insgesamt sollte das Image der „Wasserregion" verbessert werden. Einige nationalen Tourismusvorgaben passen jedoch nicht gut zu der Region. Mehr Selbstbestimmung und Eigenverwaltung wären nötig.

Aber welche Art von Tourismus wollen die Gemeinden und ihre Bürger eigentlich? Dies muss geklärt werden.

Handlungsfeld: Vorgeschlagen wurde, dass Gemeinden „Kurtaxen" einführen könnten, über die lokale „syndicats d´initiative" unterstützt würden, z.B. um Wanderwege zu sanieren.

Regionale Akteure: mehr Zusammenarbeit und Mitbestimmung

Landwirtschaft und LAKU: Landwirte wollen ein anerkannter Teil gesellschaftlicher und politischer Prozesse sein. Viele fordern ein „Vorkaufs-" bzw. „Vornutzungsrecht" für Landwirte, um die Konkurrenz um Flächen abzumildern. Die LAKU wurde als Best Practice-Beispiel dargestellt, das weiter gestärkt werden sollte; u.a. als Ansprechpartner im Rahmen der neuen Trinkwasserschutzzonen. Es sollten mehr Landwirte bei der Umsetzung von Wasserschutzmaßnahmen mitmachen.

Trinkwasser und SEBES: In Zukunft wird die Rolle der SEBES in der Region wichtiger. Die Koordination und Umsetzung von Wasserschutzmaßnahmen im Einzugsgebiet gehören zu den Aufgaben des neuen „Animateurs". Der SEBES unterstützt die LAKU bereits. Doch sollte das nationale Syndikat seinen Bezug zur Region stärker unter Beweis stellen, u.a. indem es auch mit anderen Akteuren enger zusammenarbeitet und mehr Trinkwasser-Einnahmen zurück in die Region fließen lässt.

Gemeinden, Naturpark und Sensibilisierung: Viele wünschen sich mehr Selbstbestimmung für die Gemeinden (u.a. bei den PAGs). Die Gemeinden sollten stärker an einem Strang ziehen, um das Gewicht der Region im Land zu verstärken und das lokale Leben attraktiver zu machen. Eine gemeinsame „Gemeinde Obersauer" wurde von einigen vorgeschlagen. Der Naturpark könnte als „Regionalentwicklungsakteur" bei der „Eigenverwaltung" eine zentrale Rolle spielen.

Immer wieder wurde auch die Wichtigkeit von Umweltbildung und Sensibilisierung betont. Die Wertschätzung von Wasser und natürlichen Lebensräumen sind eine Voraussetzung für Nachhaltigkeit. Die Aktivitäten des Naturparks (u.a. *Naturparkschoul*) sind in Zukunft noch wichtiger.

Zusammenarbeit mit Belgien: Immer wieder wurde betont, dass alle Akteure ihre Zusammenarbeit mit belgischen Partnern ausbauen sollten. 2/3 des Einzugsgebiets befinden sich schließlich in Belgien. Die neue Konvention der Regierung mit Belgien wird hoffentlich einen guten Rahmen für grenzüberschreitende Schutzzonen, landwirtschaftliche Kooperation sowie Produktions-, Verarbeitungs- und Vermarktungsstrategien bieten.

Weiter unten sind Hauptpunkte aus den Diskussionen und Einflussdiagrammen der Teilnehmer thematisch zusammengefasst.

Wie geht es weiter?

Der Gesprächs- und Handlungsbedarf ist groß. Die Teilnehmer wünschten sich, dass die Ergebnisse und Ideen aus dem Workshop von den Akteuren regional und national aufgegriffen und weiterverfolgt werden, u.a. vom Gewässervertrag Obersauer.

Im Rahmen des Projekts NEXUS FUTURES (Universität Luxemburg) werden Elemente aus dem Workshop in die Erstellung nationaler Szenarien zu Herausforderungen im Umgang mit Wasser und Boden einfließen. Kristina Hondrila untersucht im Rahmen ihrer Fallstudie im Einzugsgebiet der Obersauer einige der Themen ausführlich und wird in der zweiten Jahreshälfte 2019 vorläufige Ergebnisse an die Teilnehmer sowie andere Akteure zurückspielen, um diese in Gesprächen zu vertiefen und verfeinern.

Darüber hinaus können weitere Handlungsempfehlungen, Projekte und Initiativen entstehen. Das gesamte Team von NEXUS FUTURES greift Anregungen und Vorschläge für weitere gemeinsame Aktivitäten gerne auf. Anmerkungen bitte an kristina.hondrila@uni.lu

Thematische Zusammenfassung

1. Wasser, Natur und Sensibilisierung

In den Einflussdiagrammen veranschaulichten die Teilnehmer viele Zusammenhänge und Herausforderungen rund um Gewässer, Boden und Natur. In vielen Diagrammen stand der ökologische Zustand im Vordergrund, in anderen die Trinkwasserversorgung (mitsamt Infrastrukturen), das Bevölkerungswachstum oder auch die Einstellungen und Motivation von Bevölkerungsgruppen, bei Wasser- und Umweltschutz mitzumachen.

Wie kann der Zustand von Gewässern, Boden und Natur verbessert werden? Die Teilnehmer verwiesen auf Einstellungen, Mentalitäten und Verhaltensweisen, die ein Ausdruck von (geringer) Wertschätzung seien. Jedem Einzelnen muss bewusst sein, dass das, was er die Toilette runterspült, was er einkauft, was er im Garten einsetzt, wie er als Landwirt den Boden bearbeitet oder als Unternehmen Ressourcen nutzt, sich direkt auf die Natur auswirkt. Jeder Einzelne muss seinen Umgang mit Wasser und Boden überdenken und ändern. Am Beispiel der Bodenbearbeitung in der Landwirtschaft wurde deutlich gemacht, dass dies auch Abwägungen und Kompromisse erfordert. Einfache Lösungen gibt es nicht. Sensibilisierung und Bildung in Schulen und im Naturpark (*Naturparkschoul*) können entscheidend dazu beitragen, Einstellungen und Verhaltensweisen zu ändern.

Welche Rolle spielen politische Rahmenbedingungen und Mitbestimmung? Einige Teilnehmer warben für Verständnis dafür, dass Verhaltensweisen und Praktiken historisch gewachsen und durch politische Ziele und Förderprogramme gezielt „gesteuert“ worden seien. Ein Landwirt stehe morgens nicht mit dem Gedanken auf, wie er das Wasser verschmutzen, sondern ob er von seiner Milch leben kann. Die Art der Produktion spiegele die Politik der letzten Jahrzehnte wider. Auch hier muss also angesetzt werden. Wichtig war den Teilnehmern, dass Landwirte und Bürger in den Veränderungsprozessen

mitgenommen werden und mitreden können. Letztlich müssen die Akteure Kompromisse zwischen der lokalen und nationalen Ebene sowie zwischen verschiedenen Sektoren aushandeln. Eine perfekte Lösung gibt es nicht.

In welche Richtung bewegt sich Gewässer- und Naturschutz an der Obersauer? Biodiversitätsverträge sind ein wichtiger Baustein des Schutzes der natürlichen Lebensräume rund um die Obersauer. Landwirte verpflichten sich vertraglich über die biologische Station und ANF zu extensiven Arbeitsweisen, um Artenvielfalt zu erhalten. Es wurde vorgeschlagen, Biodiversitätsverträge auf vermehrt in Trinkwasserschutzgebieten zu bewerben und hier die Konditionen, wie in Natura 2000, Ramsar und Naturschutzgebiete zu vereinfachen.

Immer mehr Beachtung findet die Einsicht, dass Tiere und Pflanzen im Wasser, Boden und Wald die Regeneration der Natur unterstützen. Aufgrund menschlicher Aktivitäten und klimatischer Veränderungen stehen Lebensräume immer mehr unter Stress. So laufen derzeit z.B. Projekte mit Bachmuscheln, die Gewässer auf natürliche Weise reinigen.

Natur auch mal „Natur sein lassen"? Einzelne Teilnehmer fragten, ob Natur nicht auch in Ruhe gelassen werden und sich „frei" entwickeln könnte. Zumindest aus Sicht des Wasserschutzes wäre eine „Verbuschung" und Bewaldung von Ufern durchaus positiv (u.a. durch Beschattung der Gewässer). Aber oft sei dies nicht im Sinne des botanisch ausgerichteten Naturschutzes. Sein Ziel ist die Erhaltung oder Wiederansiedlung bestimmter Pflanzenarten, die an ganz bestimmte Lebensräume geknüpft sind.

Kommt der Wald zu kurz? Der Bedeutung des Waldes müsse mehr Aufmerksamkeit geschenkt werden. Der Wald speichert Wasser, filtert CO2, produziert Sauerstoff– und alles „ganz gratis". Nach Landwirtschaft und Kläranlagen könnte dies nach Einschätzung einiger Teilnehmer das nächste große Thema werden. Der angestrebte „Waldumbau" (mehr Laubbäume) müsse langsam und schonend vonstattengehen („kein Kahlschlag"). Akteure in der Region wurden ermutigt, eng mit der nationalen „Arbeitsgruppe Forst" zusammenarbeiten.

2. Trinkwasser

Talsperre und Einzugsgebiet: *Welche Rolle hat der SEBES?*

Die Teilnehmer waren sich einig: der SEBES wird in Zukunft eine zentrale Rolle in der Region spielen. Es kommen neue Aufgaben dazu. Das Syndikat wird nicht nur die Talsperre managen und sich um die Trinkwasseraufbereitung und -versorgung kümmern. Es wird das gesamte Einzugsgebiet managen und dafür sorgen müssen, dass Maßnahmen im Rahmen der neuen Trinkwasserschutzzonen koordiniert und umgesetzt werden. Dies wird Hauptaufgabe des neuen „Animateur de captage" sein.

Aber welchen Bezug hat der SEBES eigentlich zur Region? So fragten einige Teilnehmer. Es sei wichtig, dass der neue „Animateur" auch auf bestehende Strukturen innerhalb und zwischen den Gemeinden wie Naturpark und Gewässervertrag zurückgreife. Nicht zuletzt seit SEBES die LAKU unterstützt, habe das nationale Syndikat „eine große Entwicklung hingelegt". Dennoch stelle sich im Hinblick auf die Zukunft verstärkt die Frage, in welcher Form Geld vom SEBES an die Region und in die lokale Wirtschaft zurückfließt.

Kommunale Zuständigkeiten, nationaler Wasserpreis?

Die Gemeinden sind für Wasser zuständig. Einige beklagten hohe Infrastruktur- und Instandhaltungskosten. Jedoch erhalten die Gemeinden einen großen Anteil der Kosten über den

Wasserfonds zurück. Einnahmen über die „taxe d´eau“ sollten die Gemeinden auch wirklich für die Infrastruktur ausgeben, „nicht für ein neues *Centre culturel“*.

Als ungerecht wurde von vielen empfunden, dass das Trinkwasser im Süden des Landes – wovon ein Großteil aus dem Stausee kommt - günstiger ist als im Norden, wo Gemeinden und Landwirte Einschränkungen hinnehmen müssen. Der Wasserpreis hat unter anderem mit der höheren Bevölkerungsdichte und damit mit den geringeren Infrastrukturkosten (pro Einwohner) im Süden zu tun. *Könnte ein „nationaler Wasserpreis“, wie er vor Jahrzehnten schon einmal vorgeschlagen wurde, Abhilfe schaffen? Was wären Konsequenzen und Erfolgsaussichten einer solchen Idee?*

Wasserversorgung diversifizieren: Quellen schützen, Regen- und Grauwasser nutzen

Einige Teilnehmer betonten, wie wichtig es sei, dass Gemeinden landesweit ihre Quellen schützten und Quellfassungen sanierten, so teuer dies auch sein mag - zur Diversifizierung der Trinkwasserversorgung (mehr Sicherheit) und als Alternative zum SEBES. Sie forderten mehr „politische Courage“. Es werden derzeit jedoch auch über 50 neue Schutzgebiete für Quellen ausgewiesen. Doch wird es Jahrzehnte dauern, bis (z.B. mit Pestiziden) belastete Quellen sauberes Trinkwasser liefern können.

Wird es in Zukunft überhaupt genug Trinkwasser in Luxemburg geben? Laut einiger Teilnehmer sei die Versorgung selbst mit der neuen SEBES-Anlage in Eschdorf nur mittelfristig gesichert (für 10 Jahre?). Wenn es immer mehr Menschen in Luxemburg gibt (sogar 2 Mio. bis 2045?), dann brauche das Land eine zweite große Trinkwasserquelle, die 40-60 000 Kubikmeter/Tag bringt. Als mögliche Lösungen wurde die Mosel erwähnt - oder aber Grundwasser. Im Ausland würde man Wasser in Regenzeiten bereits im Boden versickern lassen, um es dann bei Bedarf „anzuzapfen“. Einige Teilnehmer befürchteten sinkende Grundwasserspiegel.

Da man sich auf Engpässe gefasst machen müsse, sollte der Verbrauch an Trinkwasser unbedingt sinken. *Welche innovativen Möglichkeiten gibt es hierfür*? Regenwasser und Grauwasser (kaum verschmutztes Abwasser) wurde als ein Weg nach vorn gesehen, ob für Toiletten oder zur Kühlung in der Industrie.

3. Landwirtschaft

Zentrale Themen und Ungewissheiten für die Zukunft sind die neuen Trinkwasserschutzzonen, der Zugang zu Produktionsflächen und inländische Absatzmöglichkeiten für landwirtschaftliche Produkte zu ´fairen´ Preisen.

Mitbestimmung, Rolle der LAKU, neue Geschäftsmodelle?

Vor dem Hintergrund der neuen Trinkwasserschutzzonen mahnten Teilnehmer aus der Landwirtschaft mehr Mitbestimmung an. Sie wollten nicht „Subventionsempfänger“ sein, müssten aber wirtschaftlich arbeiten. Derzeit diktiere der Weltmarkt die Bedingungen. Daher müsse Wasserschutz als Dienstleistung honoriert werden - wenn nicht durch die Verbraucher, dann durch den Staat.

Wird LAKU mitreden und Zusatzkosten tragen können? In punkto Trinkwasserschutzzonen wurde die Hoffnung geäußert, dass das künftige Maßnahmenprogramm flexibel und in Rücksprache mit LAKU und den Landwirten anpassbar sei. Wünschenswert sei, dass Zusatzkosten (etwa für eine schonendere Bodenbearbeitung) über die LAKU gedeckt werden könnten. Zu hoffen sei aber auch, dass mehr Landwirte bei der Umsetzung von Wasserschutzmaßnahmen, etwa der CULTAN-Düngung, überhaupt mitmachen. In Bezug auf die Zukunft regten einige Teilnehmer die Ausweitung der LAKU auf den belgischen Teil des Einzugsgebiets an.

Welche (anderen) Alternativen gibt es zur Flächenprämie? Einige Teilnehmer stellten ein Prämien- und Punktesystem vor, in welchem sich Landwirte freiwillig für Natur- und Wasserschutz entscheiden und dafür mehr Akzeptanz und höhere Preise für ihre Produkte erzielen könnten.

Dreh- und Angelpunkt der Diskussion war das Verhalten der Verbraucher. *Werden Verbraucher in Zukunft regionale Produkte kaufen und hierfür auch mehr bezahlen (siehe unten)?*

….alles bio oder was…?

Die Regierungsziele zum Ausbau der Biolandwirtschaft wurden für unrealistisch gehalten. Bereits jetzt gingen 50 % der Milch aus 12 luxemburgischen Bio-Betrieben unverarbeitet ins Ausland. Offenbar kaufen heimische Verbraucher lieber billigere ausländische Biomilch. Auf geändertes Verbraucherverhalten zu hoffen sei laut einiger Teilnehmer reines „Wunschdenken". Daher untersuchen einige Bio-Landwirte derzeit - trotz aller Bedenken - die Möglichkeit, ihre Milch über deutsche Discounter zu vermarkten. Grundsätzlich müsse die Bio-Umstellung (eine „Kopfsache") freiwillig sein.

Strukturwandel und Zugang zu Flächen – ein „Vorkaufs"- oder „Vornutzungsrecht"?

Einige Teilnehmer hielten es für wahrscheinlich, dass die Entwicklung hin zu immer wenigeren und größeren technologieintensiven Betrieben anhält. Digitalisierung und Präzisionslandwirtschaft gehörten die Zukunft. Dies wird sich auch auf die Möglichkeiten bei der Bodenbearbeitung auswirken. Der „Kampf um die Flächen" mit den vielen Akteuren, einschließlich dem Staat, wurde von vielen als problematisch empfunden. Ein Vorkaufsrecht oder zumindest ein „Vornutzungsrecht" für Landwirte könnte die Situation verbessern. Gleichzeitig wurde angemerkt, dass mehr Einwohner nicht unbedingt mit mehr Flächenverlust in der Landwirtschaft einhergehe. Es könnten auch andere Flächen genutzt bzw. „höher gebaut" werden.

Landschaftspflege und Energieproduktion als realistische Zukunft – oder „vom Bock zum Gärtner"?

Viele Teilnehmer stellten eine Tendenz weg von der ´klassischen´ landwirtschaftlichen Produktion hin zu Umweltschutz und ländlicher Entwicklung fest, die sich auch in den (zukünftigen) Förderprogrammen verstärkt wiederspiegeln werde.

In einer der Gruppen wurde eine mögliche Zukunft der Landwirte in der Region als „Landschaftsgärtner im Naturpark" gesehen. Sie würden vielleicht noch „etwas mulchen und Heu machen", jedoch kaum noch Kühe halten (trotz des vielen Grünlands). Energieproduktion wäre eine weitere Möglichkeit (etwa für Miscanthus-Heizungen oder Biogasanlagen). Als Pächter staatlicher Flächen würden Landwirte laut einzelner Teilnehmer zu „Hampelmännern der Gesellschaft". Sie befürchteten das „Aus" für die klassische Landwirtschaft und Familienbetriebe. Fremdarbeiter würden die Arbeit erledigen. Die Lebensmittel in Luxemburg kämen – evtl. abgesehen von einigen Nischenprodukten (siehe unten) - aus dem Ausland.

4. Gemeinden, Naturpark, regionale Produkte und Tourismus

Die Obersauerregion braucht Perspektiven für die Zukunft und eigene Einnahmequellen. Dies ging deutlich aus den Gesprächen hervor. *Was macht das Leben in der Region lebenswert? Welches Leben und welche Arbeitsplätze kann die Region auch jungen Leuten bieten?* Mehr Selbstbestimmung und Eigenverwaltung der Gemeinden wurden als Weg nach vorn gesehen. Der Verkauf von Trinkwasser an den Rest des Landes wurde erwähnt, aber nicht weiter thematisiert.

Mehr Produkte aus dem Naturpark

Der Wunsch nach mehr regionalen Produkten „vum Séi“ und Absatzmöglichkeiten (etwa nach dem Vorbild von Basel) einte die Teilnehmer. Folgende Ideen wurden geäußert:

- Eine „Riesenkäserei“, die ein Großteil der Milch aus der Region verarbeiten würde
- (Neuauflage der) Braugerste, „Spelz vum Séi“, für regionale Brauerei
- Mühle und Bäckerei (nach belgischem Vorbild, erfolgreicher Absatz von Spelz-Brot in Boulaide)
- Hanfproduktion (dann sollten 10 % Hanffasern in Baublöcken aus Luxemburg obligatorisch sein)
- Mobile Schlachthöfe für besseres Fleisch („stressfrei geschlachtet“)
- „Solidarische Landwirtschaft“ mit direkten Wegen zwischen Landwirten und Verbrauchern

Regionalvermarktung könne nicht „aus dem Ärmel geschüttelt“ werden. Nötig sei eine zentrale Anlaufstelle für Produkt- und Vermarktungsideen, ob im Naturpark (wo es derzeit eine einzige Beauftragte für sämtliche Naturparks gibt) oder Landwirtschaftsministerium. Man kämpfe schließlich gegen Weltmarkt-Konzerne an. Vorgeschlagen wurden staatlich finanzierte „Animateure“ für jeweils zwei Naturpark-Produkte, die nach strengen Wasserschutzkriterien finanziert würden. Verbrauchern in Luxemburg müsste bewusst werden, dass sie - wenn sie sauberes Wasser und schöne Landschaften wollten - regionale Produkte kaufen sollten.

Tourismus wiederbeleben – aber welchen?

Der Tourismus in der Region „liegt danieder“. Der Tages- und Badetourismus allein reiche nicht aus, nicht nur wegen der ´Blaualgen´ und wochen- oder monatelangen Badeverboten. Es fehle an Infrastruktur und Angeboten für „slow tourism“ und Agro-Tourismus, der mehrtätige Aufenthalte für etwa Familien attraktiv mache. Nationale Vorgaben, etwa zur Größe von Hotelzimmern, seien nicht hilfreich. Vorgeschlagen wurde, dass die Gemeinden eine „Kurtaxe“ einführen, die etwa an die lokalen „syndicats d´initiative“ fließen, damit diese z.B. die Wanderwege sanieren können. Mehr Tourismus und ein besseres Image als „Wasserregion“ würden sich auch positiv auf die Regionalvermarktung auswirken.

Gewässer- und Naturschutz und die Rolle von Naturpark und Gewässervertrag

Je sauberer die Natur, desto attraktiver die Region. Die Bedeutung von Gewässer- und Naturschutz im Naturpark und Einzugsgebiet wird zunehmen – und damit könnte auch die Rolle des Naturparks (einschl. Gewässervertrag) wichtiger werden. *Könnte der Naturpark als „Regionalentwicklungsakteur“ Eigenverwaltung und Koordination vorantreiben, so dass alle an einem Strang ziehen?* Einige Teilnehmer hielten dies für wünschenswert. Hierfür müsse der Naturpark jedoch von lokalen und nationalen Akteuren – auch in Bezug auf Ressourcen – stärker unterstützt werden.

Wirtschaft, Leben in den Gemeinden, Eigenverwaltung einer „Gemeinde Obersauer“?

In einer der Gruppen wurde der Zusammenschluss zu einer „Gemeinde Obersauer“ als wünschenswerte Zukunft anvisiert. Es gelte Kräfte und Ressourcen zu bündeln, damit Gemeinden „überhaupt noch funktionieren“ und Aufgaben wie die Abwasserklärung stemmen könnten. Vor allem aber sollte dies der Obersauerregion mehr Gewicht im Land verleihen und jungen Leuten mehr Vielfalt und Aktivitäten bieten können. Das Vereinswesen (u.a. freiwillige Feuerwehr) und kulturelle Ereignisse wie die „Séibühn“ wurden genannt. Ein „Mehrgenerationenhaus“ könnte das Zusammenleben stärken. Einige hofften, dass mehr Leute, u.a. dank *télétravail*, wieder in der Region arbeiten und auch mehr (Frei-)Zeit hier verbringen könnten.

Wiltz und Redange seien für die wirtschaftliche Entwicklung ganz besonders wichtig. Benötigt werde aber unbedingt „schnelles Internet“ und entsprechende sektorielle Leitpläne, die es möglich machten, neue Unternehmen anzuziehen (ob ein „kleines Google“ oder andere). Wünschenswert erschien einigen eine regionale „Kreislaufwirtschaft“.

In der Frage, ob mehr oder weniger Menschen in der Obersauerregion leben würden und wie sich das auf die PAGs auswirken würde, gingen die Meinungen auseinander. Wieviel „Entscheidungsgewalt“ hätten die Gemeinden überhaupt? Wenn es – auch im Zuge des landesweiten Bevölkerungswachstums – mehr Einwohner in der Region geben würde (evtl. auch mehr Flüchtlinge, die einige für 2045 erwarteten), befürchteten einige ein „kulturelles Disconnect“.

Andere glaubten, dass Leute aus den ländlichen Gebieten eher wegziehen würden und dass die regionale Wirtschaft und Bevölkerung stark davon abhängig sei, ob der Wohlstand in Luxemburg auch gesichert ist. Die Abhängigkeit vom Finanzsektor mache Luxemburg - und dadurch die Region - jedoch anfällig.

Abschließend einte die Teilnehmer das Gefühl, dass konkreter, zielorientierter Handlungsbedarf groß ist. Die vielen unterschiedlichen Perspektiven und Interessen müssten weiter ausgetauscht, Kompromisse ausgehandelt und stärker zusammengearbeitet werden, und zwar auf allen Ebenen. Nur so können die Herausforderungen der Zukunft in Bezug auf den Zustand von und den Umgang mit Wasser und Boden angegangen werden.

ENDE

Annex IV: Gesprächsgrundlage für das Treffen der NEXUS FUTURES-Referenzgruppe zur Auswahl von "Handlungssituationen" für die Fallstudien in den Einzugsgebieten der Obersauer und Syr (1 April 2019)

Kurzbeschreibung der vergleichenden Fallstudien in den Einzugsgebieten von Obersauer und Syr

& Auswahl von „Handlungssituationen"

(Ergänzte Gesprächsgrundlage für das Treffen der Referenzgruppe am 1.April 2019)

Zweck des Dokuments: Beschreibung der Fallstudien und gemeinsame Festlegung von „**Handlungssituationen**" für die Untersuchungen zu Trinkwasserschutz und Renaturierungen in den Einzugsgebieten von Obersauer und Syr.

Hintergrund und Zielsetzung der These:

Im Rahmen der EU-Wasserrahmenrichtlinie (WRRL) und des nationalen Wassergesetzes hat sich Luxemburg zu einer Verbesserung des Zustands der Gewässer (insbesondere der Wasserqualität) verpflichtet. Hierzu bedarf es Engagement, Koordination und Zusammenarbeit in vielen Bereichen von Politik und Praxis. Wasser-, Umwelt- und Landwirtschaftspolitik müssen auf nationaler Ebene abgestimmt werden (formale Governance). Für die Umsetzung von etwa Trinkwasserschutz und Renaturierungen sind Veränderungen in der täglichen Praxis und Zusammenarbeit zwischen einer Vielzahl von Akteuren entscheidend, u.a. damit Maßnahmen an lokale Gegebenheiten angepasst sind. Die WRRL sieht die öffentliche Beteiligung und Einbeziehung von Akteuren im Wasser-Management vor, um damit soziale Lernprozesse und Ansätze auf Flussgebietsebene zu fördern. Abhängig von ihrem beruflichen Umfeld und ihren persönlichen Erfahrungen verfolgen Akteure jedoch unterschiedliche Ziele, verfügen über unterschiedliche Lösungsansätze, Selbst- und Rollenverständnisse, Sachkenntnisse und Perspektiven. Dies führt zu Barrieren bei der Abstimmung und Zusammenarbeit, die über Austausch und soziales Lernen abgebaut werden können, in denen sich Akteure und Ansätze annähern und sich Denk- und Handlungsweisen ändern.

Die vergleichende Fallstudie verspricht Erkenntnisse darüber, welche Faktoren und Paradigmen derzeitige Ansätze in Wasser-Governance und -Management prägen und soziale Lernprozesse fördern und behindern. Berücksichtigt werden formal-politische, informell-soziale und materiell-ökologische Faktoren und ihr Wechselspiel.

Struktur und Inhalte:

1.Übergreifende Ausrichtung und Fragestellung der Fallstudie
2. Ansatz und Methoden: Management and Transition Framework (MTF)
3. Auswahl von „Handlungssituationen" für die Fallstudien an Obersauer und Syr

1. Übergreifende Ausrichtung und Fragestellung der Fallstudie*:*

Welche Faktoren fördern bzw. behindern soziale Lernprozesse und transformative Veränderungen in Richtung Nachhaltigkeit in Governance-Prozessen und etablierten Praktiken im Umgang mit Wasser und Boden?

Inwiefern trägt Wasser-Management auf Einzugsgebietsebene (u.a. über die Flusspartnerschaften) und mehr öffentliche Beteiligung zu Lern- und Transformationsprozessen on Obersauer und Syr bei?

Schwerpunkte:

- Einzugsgebiet Obersauer: Trinkwasserschutz an Schnittstellen zwischen Gewässer- und Naturschutz, Landwirtschaft und Regionalentwicklung
- Einzugsgebiet Syr: Renaturierungen an Schnittstellen zwischen Gewässer- und Naturschutz, Landwirtschaft und Wirtschaft

Spezifische Fragen:

- *Wie haben sich die Umsetzung der WRRL und andere politische Ziele und Pläne auf die Koordination zwischen den Akteuren in Bezug auf die Zielsetzung, Planung, Umsetzung und Evaluierung von Maßnahmen ausgewirkt?*
- *Welche Lernprozesse finden zwischen den Akteuren in Bezug auf Koordination, Umsetzung und Praktiken im Umgang mit Wasser und Boden statt?*
- *Wie haben sich die Rollen der Akteure und ihre Ansätze verändert?*
- *Welche Faktoren fördern bzw. behindern Lernprozesse, Koordination und Umsetzung?*
- *Welche Arten von Wissen können dazu beitragen, dass Akteure handeln und dass sich Praktiken im Umgang mit beteiligten Akteuren, Wasser und Boden verändern?*

2. Ansatz und Methoden: Management and Transition Framework (MTF)

Die Fallstudie baut auf einem etablierten Rahmen zur interdisziplinären Analyse von Transformationsprozessen in Wassersystemen auf, das Zusammenhänge zwischen sozialen und ökologischen Umständen untersucht: dem Management and Transition Framework (MTF) von Prof. Dr. Claudia Pahl-Wostl (Universität Osnabrück)[302]. NEXUS FUTURES baut derzeit eine Zusammenarbeit mit Frau Prof. Pahl-Wostl und ihrem Team auf und wird die MTF-Datenbank für die Fallstudie nutzen und anpassen.

Der Schwerpunkt des MTF-Ansatzes liegt auf Wechselwirkungen zwischen ***formalen politischen Prozessen*** auf der einen, und ***informellen*** **Aktivitäten und Abstimmungsprozessen** zwischen beteiligten Akteuren auf der anderen Seite.

Bei der Analyse werden **ökologische, technisch-infrastrukturelle und gesellschaftliche** Faktoren und Zusammenhänge berücksichtigt. Zweck der Forschung ist es, Menschen und Gesellschaften dabei zu unterstützen, Herausforderungen – etwa im Wassermanagement – zu bewältigen.

Ein Augenmerk des Ansatzes richtet sich auf unterschiedliche Formen der **Wasser-Governance**, die von **Staat** („Hierarchie"), **Wettbewerb** („Markt") oder der **Beteiligung von Akteuren** und Öffentlichkeit („Netzwerk") geprägt sein können. Die WRRL sieht mehr **Netzwerk-Governance** vor.

[302] Siehe Pahl-Wostl, Claudia, 2015, *Water Governance in the Face of Global Change*, Springer
und Pahl-Wostl, C., Becker, G., Knieper, C., Sendzimir, J. 2013, *How Multilevel Societal Learning Processes Facilitate Transformative Change: A Comparative Case Study Analysis on Flood Management,* Ecology and Society

Außerdem spielt sich Wasser-Governance auf und zwischen verschiedenen Ebenen ab (´multi-level governance´). Aus diesem Grund wird der **Koordination zwischen Ebenen und Akteuren** im MTF-Ansatz besondere Beachtung geschenkt.

Ausgangspunkt ist die Hypothese, dass im Wechselspiel zwischen formalen und informellen Prozessen **soziales und gesellschaftliches Lernen** stattfindet, das gesellschaftliche **Transformationsprozesse** und **systemischen Wandel** hervorbringen kann, in denen Annahmen, Strukturen, Prozesse und Praktiken neu ausgerichtet werden (z.B. vom Massiv- zum naturnahen Wasserbau oder von intensiver zu extensiver Landwirtschaft). Eine wichtige Voraussetzung hierfür ist, dass sich verschiedene Ebenen abstimmen und Akteure zusammenarbeiten.

Handlungssituationen (´action situations´)

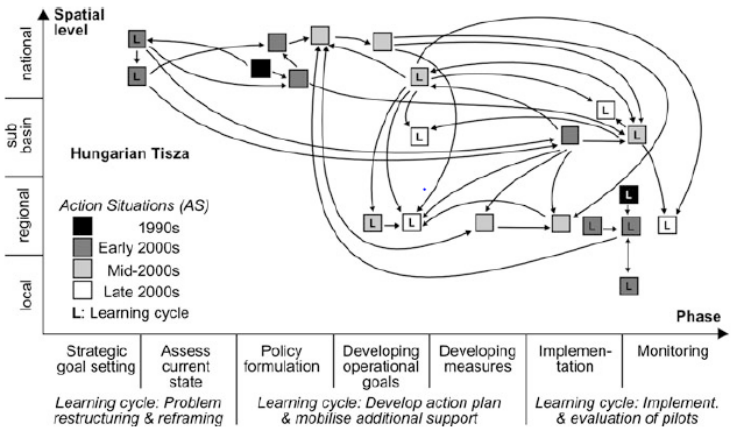
Eckpfeiler der Analysen sind so genannte ´action situations´ oder „Handlungssituationen". Hierbei handelt es sich um ***Schritte oder Etappen*** in Prozessen, die sich auf nachfolgende Aktivitäten auswirken. Handlungssituationen können z.B. bestimmte **Schlüsselereignisse**, **Meilensteine oder Wendepunkte** sein, die Handlungskontexte nachhaltig verändern – entweder in Form **einzelner Ereignisse** oder als **Teilprozesse**.

Handlungssituationen	**Formal-politisch**	**Informell**
Typische Merkmale	Gebunden an rechtlich vorgegebene Prozedere und Mandate, oft rechtlich bindende Ergebnisse	Teilnehmer, Ziele, Aufgaben, Regeln und Rollen werden selbstorganisiert ausgehandelt, entwickeln sich dynamisch, sind unverbindlich
Modus der Akteure	Einhaltung, Anpassung	Soziales Lernen
Beispiele	Neue Gesetze oder Managementpläne	Bildung neuer Netzwerke oder Arbeitsgruppen, lokale Initiativen, Treffen und Experimente

Die Handlungssituationen werden bestimmten Phasen zugeordnet:

Formaler politischer Zyklus (vereinfachte Phasen)	**Informeller sozialer Lernzyklus**
Ausarbeitung strategischer übergreifender Ziele	*Formulierung und Umdeutung von Problemen aus Perspektive beteiligter Akteure*
Entwicklung operationeller Ziele und Maßnahmen	*Entwicklung von Aktionsplänen und Mobilisierung zusätzlicher Unterstützung*
Umsetzung & Monitoring von Maßnahmen	*Umsetzung & Evaluierung von Aktivitäten, z.B. Pilotprojekten oder Experimenten*

Mithilfe der MTF-Datenbank und anhand der Handlungssituationen kann das Wechselspiel zwischen Politik- und Lernprozessen visualisiert werden (Beispiel, Pahl-Wostl et al., 2013):



Quelle: Pahl-Wostl et al., 2013

Für jede Handlungssituation werden in der MTF-Datenbank Daten zu folgenden Aspekten erfasst (siehe Anhang mit Beispielen):

- Beteiligte **Akteure** (*staatlich/nicht-staatlich*) und ihre **Rollen** *(´lead´, aktiv*, *passiv*)
- **Ebene** (*lokal, Einzugsgebiet, national, grenzüberschreitend, EU*)
- **Phase** der formalen oder informellen Prozesse
- **Governance-Modus** (*Hierarchie, Markt* oder *Netzwerk*)
- **„Institutionen“:** verbindliche oder informelle Regeln (z.B. Gesetze, Praktiken, ´Paradigmen´, soziale Normen)
- **Wissen,** das eingebracht oder erzeugt wird (z.B. Experten- oder Erfahrungswissen, System- und Zukunftswissen)
- **Ergebnisse** bzw. **Auswirkungen:** z.B. Veränderungen von Regeln, Wissen, Bewusstsein, Beziehungen oder Durchführung von Maßnahmen, die sich z.B. auf Wasserqualität auswirken

Die Daten werden aus rund 50 qualitativen Interviews, Dokumentenrecherchen, Beobachtungsstudien und Workshops, die im Rahmen des Projekts NEXUS FUTURES organisiert wurden, erhoben.

In der Analyse werden außerdem **kontextuelle Ereignisse und Faktoren** berücksichtigt, welche die Handlungssituationen beeinflussen: **ökologische** (z.B. Zustand der Gewässer, ´Blaualgen´ oder Hochwasserereignisse), **technisch-infrastrukturelle** (z.B. neue Aufbereitungsanlagen oder Flächenkonkurrenz) und **gesellschaftliche Faktoren** (z.B. Wahlen, demographische und wirtschaftliche Entwicklungen, Medienberichte, Gerichtsurteile, Wertewandel).

Darüber hinaus wird die Analyse durch **Faktoren aus der persönlichen Sphäre** der Interviewpartner bereichert: ihre Annahmen und Einschätzungen, Einstellungen, Werte, Absichten und ihr Selbst- und Rollenverständnis.

Die qualitative Fallstudie zu den Einzugsgebieten Obersauer und Syr untersucht, **welche Faktoren Lernprozesse, Koordination und Umsetzung von Maßnahmen im Bereich Wasserqualität und Renaturierungen fördern bzw. behindern** und inwiefern grundlegende Veränderungen in der Wasser-Governance und im Umgang mit Wasser, Boden und Natur in Luxemburg stattfinden.

3. Auswahl von „Handlungssituationen“ für die Fallstudie zu den Einzugsgebieten von Obersauer und Syr

Da die Fallstudie entlang der „Handlungssituationen“ strukturiert wird, ist deren Auswahl für die Qualität und Ergebnisse der Analysen äußerst wichtig. Deswegen möchten wir in Zusammenarbeit mit unseren Partnern bis zu **20 Handlungssituationen pro Einzugsgebiet** festlegen. ***Welche Situationen oder Teilprozesse waren Schlüsselereignisse, Meilensteine oder Wendepunkte in Sachen Wasserschutz und Beziehungen zwischen Akteuren?***

Situationen, die letztlich nicht Teil der Endauswahl sind, werden als kontextuelle Faktoren berücksichtigt.

Während der Schwerpunkt der Untersuchungen in den beiden Einzugsgebieten unterschiedlich ist (Trinkwasserschutz bzw. Renaturierungen), geht es in beiden Fällen um zentrale Elemente des luxemburgischen Bewirtschaftungsplans der EU-Wasserrahmenrichtlinie: dem **Zustand der Gewässer** sowie die **Rolle der Flusspartnerschaften und anderer Akteure**.

Gegenstand der Forschung sind darüber hinaus unterschiedliche Ansätze und Bewertungen von Herausforderungen im Wasserbau („massiv“/„naturnah“), in Wasserschutz und Naturschutz sowie in der Landwirtschaft („intensiv“/ „extensiv“), aus denen sich Konflikte und Widersprüche ergeben können.

Darüber hinaus werden die **NEXUS-Workshops**, welche in beiden Einzugsgebieten organisiert wurden, als Teil informeller Lernprozesse ausgewertet.

a) Einzugsgebiet Obersauer: Ausrichtung der Fallstudie und mögliche Handlungssituationen

Es werden die vielfältigen Zusammenhänge und Dynamiken rund um Trinkwasserschutz und die Ausweisung der neuen Trinkwasserschutzzonen analysiert. Hierbei werden auch frühere Entwicklungen berücksichtigt, die Beziehungen zwischen dem Trinkwasserversorger SEBES, Gemeinden, Naturpark, Gewässervertrag, Landwirten (LAKU), Landwirtschaftsberatern und nationalen Verwaltungen prägen.

Ziel ist, Veränderungen und Herausforderungen an den Schnittstellen zwischen Wasserschutz, Naturschutz, Landwirtschaft und Regionalentwicklung aus der Perspektive beteiligter Akteure zu untersuchen. Im Vordergrund steht die Frage, wie die Wasserqualität im Stausee verbessert werden kann.

Untersucht wird, wie Abstimmungs- und Beteiligungsprozesse zwischen den Akteuren ablaufen und wie sich ihre Rollen, ihr Selbstverständnis und ihre Praktiken verändern: *welche Faktoren haben die Prozesse geprägt, was sind Möglichkeiten und Barrieren für mehr Abstimmung und Zusammenarbeit, für gemeinsames Lernen und die Veränderung von Praktiken?*

Übersicht über (mögliche) Handlungssituationen *(wir bitten um Feedback und Ergänzungen)*

Formale politische Prozesse	**Soziale Lernprozesse: informelle Aktivitäten und Organisation von Akteuren (sowie technisch-ökologische Faktoren)**
1955-69: Schaffung des rechtlichen, infrastrukturellen und organisationalen Rahmens für Trinkwasser- und Stromgewinnung am Stausee	1962-63: SEBES nimmt Arbeit auf

1952-1985: Ausarbeitung von Studien und Plänen seitens der Regierung zur Schaffung eines Schutzgebiets im Einzugsgebiet der Obersauer	
	1987-1993: Mobilisierung und Organisation von Gemeinden (SYCOPAN) und Landwirten (´Baureninitiativ´) gegen Regierungspläne, für Naturpark-Modell, sowie Zusammenarbeit (einschl. mit staatl. Vertretern) im Rahmen eines LEADER 1-Projekts
[technisch, 1991 : Entleerung des Obersauer-Stausees wegen Bauarbeiten an der Staumauer]	
1993-1999: Rechtliches Prozedere (´Loi relative aux parc naturels´) zur Gründung des Naturparks	1999-(bis heute): Naturpark Öewersauer nimmt Arbeit auf [technisch-ökologisch-pädagogisch u.a.: Tuchfabrik, Solarboot, Naturlehrpfade, Naturparkschule usw.)
1998-2000: Schaffung eines neuen EU-Rechtsrahmen : EU-Trinkwasserrichtlinie (1998), EU-Wasserrahmenrichtlinie (WRRL, 2000), Richtlinie über öffentlichen Zugang zu Umweltinformationen (2003) und WRRL-Dokument zu öffentlicher Beteiligung	
2002: RGD relatif à la qualité des eaux destinées à la consommation humaine	2006-2011: grenzüberschreitendes Interreg-Projekt und Gründung des „Gewässervertrags Obersauer“
2007: Beteiligung der Öffentlichkeit bei der Erstellung des WRRL-Bewirtschaftungsplans 2009-2015	
2000-2008: Ausarbeitung und Inkrafttreten des « Wassergesetzes » (´loi du 19 décembre 2008 relative à l'eau´)	2008-2011: Charta, Gründung und Aktionsplan des Gewässervertrags Obersauer
2009-2015: Umsetzung des 1. Lux. WRRL-Bewirtschaftungsplans	
2012-2018: Ausarbeitung eines Entwurfs des Reglements zu den neuen Trinkwasserschutzzonen im Einzugsgebiet der Obersauer	2012-2014: Organisation von Arbeitsgruppen zu den kommenden neuen Schutzzonen durch den Gewässervertrag Obersauer
	(März 2013: Erstes Kolloquium der Flusspartnerschaften in Noertrange)
2014: Inkrafttreten der geänderten Nitratrichtlinie	2014-(bis heute): Aktivitäten und Gründung (2015) der landwirtschaftlichen Kooperation LAKU
	[ökologisch: 17 September 2014: Pestizid-Unfall (Metazachlore) im Einzugsgebiet der Obersauer]
2015: Beteiligung der Öffentlichkeit bei der Erstellung des WRRL-Bewirtschaftungsplans 2015-2021 (Stellungnahmen der Flusspartnerschaften)	
2015: RGD zum Verbot des Metazachlore und Metolachlore in den Trinkwasserschutzgebieten	
2015-2021: 2. Lux. WRRL-Bewirtschaftungsplan	
(2016: Finanzierungsgesetz zum Ausbau der SEBES-Anlage in Eschdorf)	[technisch: 2016-2021 : Bau der neuen SEBES-Anlage]

2017: Änderungen des Wassergesetzes von 2008 (durch die Änderung ist die Landwirtschaft förderfähig in den Trinkwasserschutzgebieten)	März 2018: Weltwassertag-Kolloquium der Flusspartnerschaften zu Hürden bei der WRRL-Umsetzung
	[ökologisch-rechtlich: 2018: frühzeitige und vermehrte Algenblüte einhergehend mit Badeverboten]
Juni 2018-Juli 2019: Vorstellungen des RGD-Entwurfs zu den neuen Trinkwasserschutzzonen, öffentliche Konsultation, Einreichung und Einarbeitung von Stellungnahmen durch Akteure	
	Juli 2018 – November 2018: Schutzzonen-Arbeitsgruppen (Gewässervertrag), Ausarbeitung von Fragen und Anmerkungen sowie Treffen zwischen Gemeinden, Umweltministerium, Landwirtschaft
2019: Beteiligung der Öffentlichkeit bei der Erstellung des WRRL-Bewirtschaftungsplans 2021-2026 (Stellungnahmen der Flusspartnerschaften)	
	Feb. 2019: NEXUS-Workshop zu Herausforderungen Wasser, Natur, Landwirtschaft und Regionalentwicklung

b) Einzugsgebiet Syr: Mögliche Handlungssituationen *(wir bitten um Feedback und Ergänzungen)*

Es werden die vielfältigen Zusammenhänge, Dynamiken und Herausforderungen rund um Renaturierungen im Einzugsgebiet analysiert. Hierbei sollen bereits durchgeführte (Schlammwiss-Brill) wie auch geplante neue Projekte (Mensdorf-Betzdorf) untersucht werden.

Die Rollen der Flusspartnerschaft, von natur&ëmwelt, von Gemeinden, Landeigentümern und Landwirten und landwirtschaftlichen Beratern sowie Verwaltungen und Ministerien bei Renaturierungsprojekten beleuchtet werden.

Im Vordergrund steht der Zustand der Syr und die Biodiversität in den beiden oben genannten Gewässerabschnitten. Hierbei werden Herausforderungen an den Schnittstellen zwischen Wasser- und Hochwasserschutz, Naturschutz, Landwirtschaft, Siedlungsbau, Transport und Abwasser berücksichtigt.

Es soll aber auch um die Wasserqualität der Syr und um Biodiversität in derzeitigen oder geplanten renaturierten Gewässerabschnitten gehen. Aus diesem Grund wird ein Aspekt der Analysen das Abwasser aus der Kläranlage Uebersyren (aus wachsenden Siedlungen und vom internationalen Flughafen) betreffen. *Welche Faktoren fördern oder behindern die Durchführung von Renaturierungen und die Verbesserung der Wasserqualität?*

Formale politische Prozesse	**Soziale Lernprozesse: informelle Aktivitäten von Akteuren, deren Koordination und Organisation sowie technisch-ökologische Faktoren**
1974-1984: Schaffung des organisationalen und infrastrukturellen Rahmens bzgl. Abwasserklärung in Uebersyren und (Ausbau) des internationalen	

Flughafens Findel – *war Findel bereits damals an Uebersyren angeschlossen?*	
1974-1981: Schaffung des nationalen Rechtsrahmens zu Umweltschutz und Ausweisung von Naturschutzgebieten (einschl. „Schlammwiss“ in Uebersyren als prioritäres Feuchtgebiet), einschl. auf Grundlage der EU-Vogelschutzrichtlinie (1979)	
1992 : EU-Richtlinie zur Erhaltung der natürlichen Lebensräume sowie der wildlebenden Tiere und Pflanzen («Flora-Fauna-Habitat-Richtlinie(FFH)»)	1982-1994: Gründung der Fondation Hellef fir und Erwerb erster Flächen in „Schlammwiss“ (bis heute 20 ha) sowie Gründung der Vereinigung „n´Haus vun der Natur“ (1986), Bezug des Hauses vun der Natur (nach?) 1994
2000-2003: Inkrafttreten der EU-Wasserrahmenrichtlinie (WRRL), des Leitfadens zur öffentl. Beteiligung (2003) und der EU-Richtlinie über den Zugang der Öffentlichkeit zu Umweltinformationen	
2000-2008 : Ausarbeitung und Inkrafttreten des « Wassergesetzes » (´loi du 19 décembre 2008 relative à l'eau´)	
2002-2018: Planung des Ausbaus der Kläranlage Uebersyren (bis Finanzierungsgesetz 2018)	
2004: Inkrafttreten des nationalen Gesetzes zum Schutz der Umwelt und natürlicher Ressourcen (einschl. Natura 2000-Netz)	2003-2016: ´Schlammwiss - Mensder Brill´: Renaturierung und Ganzjahresbeweidung (bis 2016) – *in welcher Form waren Fondation beteiligt? Wann wurden Weiher bei Kläranlage angelegt?*
2007: Beteiligung der Öffentlichkeit bei der Erstellung des WRRL-Bewirtschaftungsplans 2009-2015	
2009-2015: Umsetzung des 1. Lux. WRRL-Bewirtschaftungsplans, einschl. der Ausarbeitung eines Hochwasserrisikomanagementplans (2014-2015) und Einrichtung von Hochwasserpartnerschaften – *seit wann ist Flusspartnerschaft Syr Hochwasserpartnerschaft?*	2011-2013: Flusspartnerschaft Syr: Gründung, Charta, 1.Sitzung des Flusskomitees, Arbeitsgruppen, Störfaktorenkartierung, Ausarbeitung des Aktionsplans
	2012: Zusammenschluss von Umweltorganisation zu Natur & Emwelt asbl
	2014-2019 (*laufend*): Umsetzung des Aktionsplans 2014-2017, einschl. Bemühungen bzgl. Renaturierungen und Abwasserklärung in Uebersyren (einschl. vom Flughafen)
2015-2017 ??: Partizipative Ausarbeitung des Natura 2000-Managementplans „Vallée de la Syre de Moutfort à Roodt/Syr“(2016-2026/2018-2027) – *in welcher Form und wann war Flusspartnerschaft Syr beteiligt (u.a. Übernahme der Störfaktoren) ?*	
2015: Beteiligung der Öffentlichkeit bei der Erstellung des WRRL-Bewirtschaftungsplans 2015-2021 – *Stellungnahme der Flusspartnerschaft Syr und von natur&emwelt (asbl oder Fondation)??*	
2015-2021: Umsetzung des 2. Lux. WRRL-Bewirtschaftungsplans	
2016-2027 : Umsetzung des Natura 2000-Managementplans „Vallée de la Syre de Moutfort à Roodt/Syr“	2016-2019 *(laufend):* Ausarbeitung einer Machbarkeitsstudie „Renaturierung der Syr

	zwischen Mensdorf und Betzdorf“ für die Gemeinde Betzdorf
2017-2021: Umsetzung des nationalen Naturschutzplans und Ausweisung des „Schlammwiss-Brill“ als Naturschutzgebiet von nationalem Interesse (2018)	März-Mai 2018: NEXUS-Veranstaltungen zu Herausforderungen und Handlungsfeldern im Einzugsgebiet der Syr (u.a. Thema Renaturierung)
	März 2018: Weltwassertag-Kolloquium der Flusspartnerschaften zu Hürden bei der WRRL-Umsetzung und Wanderung „Mensdorf Brill“ unter dem Motto „Naturbasierte Lösungen für das Wasser“ – *wie viele Teilnehmer?*
	2019 (*laufend):* Briefe und rechtliche Schritte des Präsidenten der Flusspartnerschaft Syr (als Privatperson) zum Zugang zu Umweltinformationen bzgl. der Abwassersituation an der Syr und des Flughafens
	März 2019: Weltwassertag-Kolloquium der Flusspartnerschaften zu „Dezentraler/ökologischer Überflutungsvorsorge“ bzgl. Starkregenereignissen
2019: Beteiligung der Öffentlichkeit bei der Erstellung des WRRL-Bewirtschaftungsplans 2021-2026 - *Stellungnahme der Flusspartnerschaft Syr und von natur&emwelt (asbl oder Fondation)?? Inwiefern war Flusspartnerschaft Syr an Living Rivers-Campagne Gewässerschutz (WRRL-Richtlinie) beteiligt?*	

Annex V: Besprechung erster Erkenntnisse aus den Fallstudien im Rahmen der NEXUS FUTURES-Referenzgruppe (13.11.2019)

Lernprozesse in Wasser-Governance- und Management in den Flussgebieten von Obersauer und Syr

(Gesprächsgrundlage für das Treffen der Referenzgruppe am 13.11.2019, im Nachgang leicht ergänzt)

Übergreifende Ausrichtung und Fragestellung der Fallstudie*:*

- *Welchen Herausforderungen begegnen Akteure an den Schnittstellen zwischen Wasser, Natur und Land, wie haben sich Governance- und Management-Ansätze verändert, um diese zu bewältigen?*
- *Welche Faktoren fördern und hindern soziale Lernprozesse und transformative Veränderungen in Governance und im Umgang mit Wasser und Land?*
- *Welche Rolle haben der Gewässervertrag Obersauer und die Flusspartnerschaft Syr in der Abstimmung und Zusammenarbeit zwischen unterschiedlichen Akteuren (Ministerien und Verwaltungen, Gemeinden und Syndikaten, Landwirten und Beratern und Umweltorganisationen)?*

Schwerpunkte:

- Flussgebiet Obersauer: Trinkwasserschutz an Schnittstellen zwischen Gewässer- und Naturschutz, Landwirtschaft und Regionalentwicklung
- Flussgebiet Syr: Wasserqualität und Renaturierungen an Schnittstellen zwischen Gewässer- und Naturschutz, Landwirtschaft, Abwasser und Transport

Konzepte und Methoden: Management and Transition Framework (MTF)

Die Fallstudie baut auf einen etablierten Rahmen auf, der Zusammenhänge zwischen sozialen und ökologischen Umständen untersucht und interdisziplinäre Forschung und Praxis zu Transformationsprozessen in Wassersystemen begleitet: dem Management and Transition Framework (MTF) von Prof. Dr. Claudia Pahl-Wostl (Universität Osnabrück).

Der Schwerpunkt des MTF-Ansatzes liegt darauf, Zusammenhänge und Wechselwirkungen zwischen ***formalen politischen Prozessen*** auf der einen, und ***informellen*** **Aktivitäten und Abstimmungsprozessen** zwischen beteiligten Akteuren auf der anderen Seite zu analysieren. Die Übergänge zwischen formalen und informellen Prozessen sind fließend, diese lassen sich selten scharf trennen. Im NEXUS FUTURES Projekt werden zudem die Rolle von ***materiell-ökologischen*** **Prozessen** in Ökosystemen, Infrastrukturen und Technologien, wie z.B. dem Metazachlor-Unfall an der Obersauer, betrachtet. Hinzu kommen Veränderungen in sozialen Strukturen (z.B. Gesetze und Institutionen) und Prozessen (z.B. zur Auswahl und Umsetzung von Maßnahmen).

Faktoren und Prozesse	**Formal-politisch**	**Informell-sozial**	**Materiell-ökologisch**

Beschreibung, Beispiele	Gesetze, Managementpläne und formale Organisationen: Gebunden an rechtlich vorgegebene Prozedere und Mandate, oft rechtlich bindende Ergebnisse	Zivilgesellschaftliche Akteure, Gruppen, Netzwerke: Teilnehmer, Ziele, Aufgaben, Regeln und Rollen werden weitgehend selbstorganisiert ausgehandelt, entwickeln sich dynamisch, sind unverbindlich und offen	Ökosysteme, Flächen, Infrastrukturen, Technologien, wirtschaftliche Stoffflüsse, Geld

Konzepte: Paradigmen in Wasser-Governance und -Management

Ein Augenmerk des Ansatzes richtet sich auf unterschiedliche Formen der **Wasser-Governance und des Wasser-Managements,** die auch als **Paradigmen** bezeichnet werden. Paradigmen wirken als Ordnungsprinzipien von Prioritäten, Ressourcen und Zeit, durch welche Schwerpunkte gesetzt und bestimmte Akteure und Werte in den Vordergrund gerückt werden.

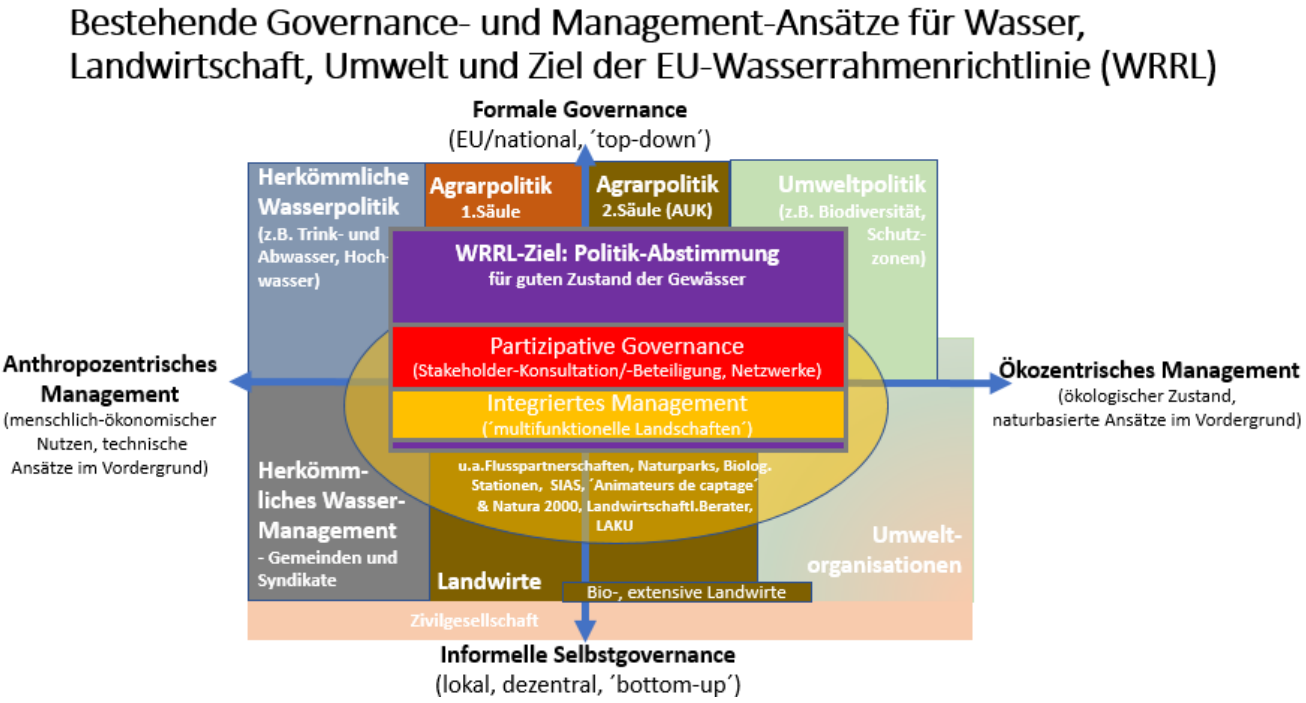
Governance regelt das Zusammenspiel von unterschiedlichen Ebenen und Akteuren und legt die übergreifenden Zielsetzungen fest, die im Management erreicht werden sollen. Governance kann vom **Staat** („Hierarchie"), **Wettbewerb** („Markt") oder der **Beteiligung von Akteuren** und Öffentlichkeit („Netzwerk") geprägt sein. Wasser-Governance in Luxemburg ist seit dem 20. Jahrhundert größtenteils hierarchisch aufgebaut. Die WRRL sieht mehr **Netzwerk-Governance** vor, in Form von öffentlichem Zugang zu Informationen und öffentlicher – u.a. zivilgesellschaftlicher – Beteiligung auf Ebene von Einzugsgebieten. Die Flusspartnerschaften und Naturparks in Luxemburg werden in Rahmen der Fallstudie als Schritt in Richtung von Netzwerk-Governance gewertet. Weitere ´**Brückenorganisationen**´, welche von der Struktur und/oder von ihrem Auftrag her darauf ausgelegt sind, zwischen nationalen und lokalen Ebenen und/oder zwischen verschiedenen Sektoren zu vermitteln und welche im Rahmen der Fallstudien behandelt oder erwähnt werden, sind u.a. der Naturpark Obersauer, die biologischen Stationen, das SIAS-Naturzenter, die (künftigen) Koordinatoren der Trinkwasserschutzzonen bzw. der Natura 2000-Gebiete, landwirtschaftliche Berater und LAKU.

Das **Management** betrifft z.B. Monitoring und die operationelle Umsetzung von Maßnahmen. Wasser-Management ist seit dem 19. Jahrhundert vor allem auf Gewässerregulierung, Hochwasserschutz, Trinkwasseraufbereitung und -versorgung und (wesentlich später) Abwasserklärung in der Siedlungswasserwirtschaft ausgerichtet (**technischer Wasserbau**), bei der die **menschlich-wirtschaftliche Nutzbarmachung** sowie die *Verringerung* von Verschmutzung und Risiken durch Technik im Vordergrund stehen.

Mit der Wasserrahmenrichtlinie hält ein neuer Ansatz Einzug: die Idee **vom integrierten Wasser-Management und naturnahen Wasserbau**, bei dem ökologische Ziele (Zustand der Gewässer) im Vordergrund stehen und mit menschlichen Nutzungsformen in Einklang gebracht werden sollen. Im naturnahen Wasserbau stehen dezentrale, naturbasierte ´Lösungen´ und ´grüne Infrastrukturen´ im Vordergrund, bei denen auf ´natürliche Dynamiken´ und die Selbstreinigungskraft von Gewässern sowie die *Vermeidung* von Verschmutzung gesetzt wird (u.a. in Schutzzonen).

Das Erreichen des guten Zustands der Gewässer erfordert integriertes Wasser-Management, basierend auf einer größeren Kohärenz zwischen u.a. Wasser-, Umwelt- und (Land-) Wirtschaftspolitik. Aus diesem Grund strebt die EU-Wasserrahmenrichtlinie eine sektorenübergreifende **politische Abstimmung an**, welches in untenstehender Graphik dargestellt wird.

Die Fallstudie zeigt auf, wie Wasser-Politik und -Management in Luxemburg (wie in anderen europäischen Ländern) bis zum Wassergesetz von 2008 von einem **hierarchisch-anthropozentrischen Ansatz** (Paradigma) geprägt sind, der durch zum einen auf die Hoheit des Staates bzgl. der Politik und, zum anderen, auf die Autonomie der Gemeinden im Bereich des urbanen Wasserkreislaufs beruht. Durch die **Neuausrichtung der Wasserpolitik** auf den ökologischen Zustand der Gewässer und die Beteiligung der Öffentlichkeit, u.a. über die Flusspartnerschaften, deutet sich ein **möglicher Paradigmenwechsel** in Richtung eines partizipativeren und integrierten Managements an. Entscheidend hierfür ist jedoch unter anderem auch die Einbeziehung und Mitarbeit landwirtschaftlicher Akteure.



Konzepte: Soziales Lernen

Ansätze und Paradigmen werden von Akteuren gestaltet und umgesetzt, die meist innerhalb bestimmter Organisationen, Gruppen und Gemeinschaften aktiv sind.

Der Ausgangspunkt des MTF-Ansatzes von Pahl-Wostl besteht in der Annahme, dass grundlegende Veränderungen in Wasser-Governance und -Management vor allem dann stattfinden, wenn staatliche und nicht-staatliche Akteure sich über Ebenen und Sektoren hinweg neu ausrichten, neue Arbeitsbeziehungen/Bekanntschaften eingehen, und sich in neuen Räumen und Formen austauschen. Hierdurch können Veränderungen auch in ihre Organisationen, Gruppen und Gemeinschaften getragen werden. Dies umfasst Veränderungen von Selbst- und Rollenverständnissen, neues Wissen und Know-how, neue Kontakte und Netzwerke sowie Praktiken (z.B. vom Massiv- zum naturnahen Wasserbau oder von intensiver zu extensiver Landwirtschaft).

Wenn diese zu neuen übergreifenden Zielsetzungen, Werten, Strukturen (z.B. Organisationen), Gesetzen und Praktiken in Akteursgruppen und Organisationen führen, spricht das MTF von **transformativen Veränderungen** oder einem **Paradigmenwechsel.** Das NEXUS FUTURES- Projekt trägt durch die Forschung sowohl zum Entstehen solcher neuen Räume bei, als auch zur Analyse der Veränderung von Beziehungskonstellationen, die zum Wandel beitragen können.

Das MTF ordnet Lernprozesse drei unterschiedlichen ´Stufen´ zu, die meist im Wechselspiel zwischen formalen, informellen und materiellen Faktoren stattfinden:

Soziales Lernen	**Formal-politisches Lernen** (formale Governance)	**Informell-soziales Lernen** (informelle Governance)	**Materiell-ökologische Prozesse** (am Beispiel Wasser-Management)
1.´Business as usual´ oder adaptives Lernen (*single-loop learning*) - Anpassung	**National:** Gesetze und Maßnahmen bleiben weitgehend im bestehenden sektoriellen und hierarchischem Rahmen, z.B. Fokus auf Infrastrukturen, Technik und „Expertenwissen“ **Organisationen**: Satzungen etc. bleiben weitgehend unverändert	Akteure bleiben weitgehend in bestehenden Gruppen, bei etablierten Zielen, Werten und Praktiken und Deutung von z.B. Gesetzen	Fokus auf menschlichen Nutzen und technische Verringerung von Verschmutzung statt Prävention (´graue Infrastrukturen´)
2.Infragestellung, Öffnung und Umdeutung (*double-loop learning*) - Neue Möglichkeiten, Spannungen und Widersprüche, Veränderungen in Beziehungen, Organisationen und Machtgefügen	**National:** Neue Gesetze, Maßnahmen und Förderprogramme basieren auf Neuausrichtung strategischer Ziele und sektorieller Abstimmung, z.B. mehr Fokus auf ökologische Ziele und Maßnahmen und Bürgerbeteiligung **Organisationen**: Satzungen werden geändert, Neugründungen angestrebt	Akteure stellen sich selbst infrage, interpretieren sich selbst, ihre Rolle(n), bestehende Werte, Gesetze und Satzungen neu (Selbstverständnis, Ziele), suchen neue Handlungs-spielräume, neue sektorenübergreifenden Kontakte, Arbeitsgruppen und Netzwerke, stellen bestehendes Wissen und Praktiken infrage und erwerben neues Wissen (z.B. im Rahmen der Flusspartnerschaften)	Mehr ´naturnahe Lösungen´, Experimente, Pilotprojekte mit neuen Praktiken und Techniken, die zu mehr Gewässer- und Umweltschutz beitragen sollen
3.Transformatives Lernen (*triple-loop learning*) - Etablierung neuer Strukturen, z.B. in Richtung Nachhaltigkeit	**National:** Neuausrichtung der gesamten Politik und Förderprogramme auf Nachhaltigkeit (politische Kohärenz), Abstimmung und Einbeziehung	Neue Denk- und Handlungsweisen etablieren und verstetigen sich, einschl. neuer Ziele, Werte, Selbstverständnisse, Rollen, Praktiken und Kooperationen	z.B. ´grüne Infrastrukturen´ und naturnahe, dezentrale Ansätze im Wasser-Management werden zur Norm, der Zustand von Ökosystemen verbessert sich

	Organisationen: Neue Kooperationen, Netzwerke werden verstetigt		

Methoden: Handlungssituationen (´action situations´)

Die qualitative Fallstudien zu den Einzugsgebieten Obersauer und Syr untersucht, welche Arten des Lernens zwischen Akteuren in und um Wasser-Governance und -Management in den Einzugsgebieten von Syr und Obersauer stattgefunden haben (und weiterhin stattfinden) und welche Faktoren diese Lernprozesse befördert oder behindert haben.

Handlungssituationen können z.B. bestimmte **Schlüsselereignisse**, **Meilensteine oder Wendepunkte** sein, die Handlungskontexte, Beziehungen und Ansätze nachhaltig verändern – entweder in Form **einzelner Ereignisse** oder als **Teilprozesse**. Eine Handlungssituation kann z.B. die Vorbereitung und das Inkrafttreten eines neuen Gesetzes sein (formale action situation) oder die Arbeit und Treffen einer Arbeitsgruppe (informelle action situation).

Bzgl. der Obersauer wurden diese im Hinblick auf Trinkwasserschutz und die Ausweisung der neuen Schutzzonen ausgewählt. Bzgl. der Syr standen Aktivitäten zu Renaturierungen (sowie andere hydromorphologische Maßnahmen) und der Verbesserung der Wasserqualität im Vordergrund (siehe weiter unten). Die Daten wurden aus knapp 60 qualitativen Interviews, Dokumentenrecherchen, Beobachtungsstudien und Workshops, die im Rahmen des Projekts NEXUS FUTURES organisiert wurden, erhoben.

Analysen und erste allgemeine Erkenntnisse aus den Fallstudien in Bezug auf Paradigmen und Lernprozesse (*RFG-Gesprächsgrundlage, die im Nachgang des Treffens leicht ergänzt wurde)*

Paradigmenwechsel zwischen hierarchisch-technischer und partizipativ-integrierter Wasser-Governance?

Die EU-Wasserrahmenrichtlinie hat die nationale Wasserpolitik grundlegend verändert. Dies äußert sich u.a.:

Formal:

- **Neues übergreifendes Ziel:** guter ökologischer Zustand der Gewässer
- **Abstimmung von u.a. WRRL-** und Natura 2000-Maßnahmen
- **Bündelung von Kompetenzen** innerhalb einer Verwaltung (AGE) und (ab 2013) innerhalb des Umweltministeriums
- **Wissen:** mehr wissenschaftlich-technisches Wissen und Daten über den Zustand von Gewässern
- **Neue Bewirtschaftungs-, Maßnahmenpläne** und Management-A**nsätze**, insbesondere auf Ebene von Flussgebietseinheiten: u.a. Trinkwasserschutzzonen und Renaturierungen
- (Möglichkeit der) **Gründung von Flusspartnerschaften** und ihrer Flusskommitees durch die Gemeinden in den Einzugsgebieten und dem zuständigen Ministerium, unter Teilnahme von Wasser, Natur- und Landwirtschaftsverwaltungen, Wassersyndikaten und anderen Akteuren

- **Formale öffentliche Beteiligungen**, u.a. zu den WRRL-Bewirtschaftungsplänen

Diese formalen Faktoren haben **informell-soziale Prozesse** in der Praxis verändert:

- Wesentlich mehr **Kontakte und Abstimmung** zwischen Akteuren auf unterschiedlichen Ebenen und über Ebenen hinweg, u.a. im Rahmen der Flusspartnerschaften, mit Verwaltungen, zwischen Gemeinden, LAKU-Gründung und -Experimente zwischen Landwirten und SEBES
- **Wissen**: neues Experten- und Praxiswissen, u.a. durch Best Practice-Beispielen aus dem Ausland und neue Erfahrungen mit naturnahmen Wasserbau und neuen Techniken in der Landwirtschaft
- **Allgemein**: Ein größeres Bewusstsein für die Bedeutung des Zustands der Gewässer und Wasserqualität, für Zusammenhänge, die diese beeinflussen, und für die Notwendigkeit der Zusammenarbeit

Materiell-ökologische Prozesse und Faktoren:

- Es sind bereits viele Maßnahmen umgesetzt worden, um die Ziele zu erreichen (besonders große Fortschritte im Bereich der Kläranlagen, hydromorphologische Verbesserungen sind schleppend)
- Einzelne Pilotprojekte und Experimente in den Bereichen Landwirtschaft und Gewässerschutz

Als **förderliche Faktoren** für Veränderungen und Lernprozesse erweisen sich in den Fallstudien Kompromissbereitschaft und Pragmatismus bei Akteuren, ein regelmäßiger Austausch zwischen lokalen und nationalen Akteuren (z.B. im Rahmen der Flusspartnerschaften), der Austausch mit Leuten mit relevanten Erfahrungen aus dem Ausland und anderer Projekte, sektorenübergreifende gemeinsame (Pilot-)Projekte und Aktivitäten (z.B. Ausflüge) zwischen unterschiedlichen Akteuren, auch als vertrauensbildende Maßnahmen.

Extremwetterereignisse und Unfälle (z.B. der Metazachlor-Unfall 2014) können ebenfalls zu Bewusstsein beitragen und den Handlungsdruck erhöhen.

Jedoch gibt es bislang nur punktuell Verbesserungen im Zustand der Gewässer. Das Ziel, bis 2015 den guten Zustand zu erreichen wurde (bis auf drei Gewässer) verfehlt und die Frist für fast alle Gewässer auf 2021 bzw. 2027 verschoben. Der am häufigsten angeführte Grund für die Verfehlung des Ziels ist die technische Durchführbarkeit, „es braucht mehr Zeit, das Problem zu lösen“ (2. WRRL-BWP 2015-2012, p.231).

Die vorläufigen Ergebnisse der Fallstudien zu Herausforderungen und Hürden deuten darauf hin, dass es sich keineswegs um rein ´technische Barrieren´ handelt. Sie zeigen Widersprüche innerhalb der Wasserrahmenrichtlinie selbst und bei ihrer Umsetzung auf.

Formale Widersprüche und Hürden innerhalb der WRRL und nationalen Gesetzgebung:

- **Integrierte Ansätze**: die Abstimmung mit u.a. der Landwirtschafts- und Wirtschaftspolitik ist nicht verpflichtend
- **Wissen:** die wissenschaftlich-technischen Anforderungen an Wasser-Management haben stark zugenommen und „Experten-Wissen“ kommt ein hoher Stellenwert zu, was das Ungleichgewicht zu*un*gunsten von „Praxiswissen“ weiter vergrößert

- **Verwaltung und Genehmigungen**: administrative Anforderungen für Genehmigungen, etc. steigen, z.T. unterschiedliche Anforderungen im Rahmen der EU-WRRL, Natura 2000 (Habitat-Direktive) und anderer Richtlinien
- **Gemeinden** sind (weiterhin alleine) für den urbanen Wasserkreislauf zuständig (innerhalb ihrer Gemeindegrenzen), d.h. es besteht keine Verpflichtung zu gemeindeübergreifenden Abstimmung und Management auf Ebene der Flussgebietseinheiten
- **Satzungen und offizielle Mandate von Wasserversorgern und Verwaltungen** (meist rein technisch, d.h. nicht auf Stakeholder-Einbeziehung ausgelegt) von z.B. Trinkwasserversorgern, Verwaltungen
- **Flusspartnerschafte**n: Status und Rolle(n) sind vage definiert, haben keine eigene Rechtspersönlichkeit und daher keinen einklagbaren Anspruch auf Zugang zu Umweltinformationen,
- Ausnahmen für die Erreichung des guten ökologischen Zustands sind aufgrund von ´**nationalem Interesse**´ bedingt möglich

Andere formale Hürden, u.a.: Ausbildung und Qualifikationen von Landwirten, Ingenieuren und Hydrologen, etc. und entsprechende Qualifikationsanforderungen und Stellenprofile

Informelle Hürden:

- **Ministerien**: fehlt es an politischem Willen und Mut, auch unangenehme ´große´ Themen und Widersprüche offen anzusprechen und anzugehen, die dem Erreichen des guten Zustands im Weg stehen? unzureichende Kapazitäten
- **Wasser-, Natur- und Landwirtschaftsverwaltungen**: teilweise fehlende Abstimmung und fehlendes Vertrauen? unzureichende Kapazitäten
- **Verwaltungsprozedere für Finanzierungen und Genehmigungen von Projekten**: Vorgaben und Prozedere werden oft streng ausgelegt, was zu langwierigen Verfahren, hohem Aufwand und geringer Flexibilität beiträgt
- **Flusspartnerschaften:** hoher Verwaltungsaufwand auch für kleine Projekte, teilweise viel Überzeugungsarbeit notwendig, um Gemeinden, Landwirte, Verwaltungen, usw. an Bord zu bekommen, unzureichende Kapazitäten
- **Gemeinden**: naturnahes Wasser-Management geringe Priorität, andere Themen und Projekte haben höheren Stellenwert – warten auf klare Impulse und Initiativen vonseiten der Verwaltungen, unzureichende Kapazitäten
- **Landwirtschaftsberater**: sind teilweise mit steigenden und widersprüchlichen Anforderungen konfrontiert, die sie an Landwirte vermitteln müssen, unzureichende Kapazitäten
- **Landwirte**: Umdenken und Änderung von Praktiken gehen langsam voran, benötigen mehr Planungs- und finanzielle Sicherheit, sind ebenfalls „am Limit“
- **Allgemein:** Wasser-Governance: Hierarchisch-technische Ansätze herrschen vor, die vor allem über rechtliche Restriktionen und Vorgaben sowie über finanzielle Anreize Umdenken bewirken wollen
- **Allgemein:** Weitverbreitete Präferenz für ´technische Ansätze´ im Wasser-Management (einschl. Planung, Finanzierung und Überprüfung), ob in Siedlungswirtschaft und Wasserbau (Gemeinden, Verwaltungen) oder in der Landwirtschaft?
- **Allgemein:** wenige Erfahrungen mit partizipativen Prozessen und strukturierter/systematischer Stakeholder-Einbeziehung (außerhalb der Flusspartnerschaften), die über formale Konsultationen und einzelne informelle Kontakte hinausgehen, geringe Bereitschaft bzw. geringer Glaube an deren „Wirksamkeit“?

- **Allgemein**: fehlendes Vertrauen zwischen insbesondere Akteuren im Umweltbereich und in der Landwirtschaft
- **Allgemein:** Bedarf an regelmäßiger „two-way communication“ zwischen Akteuren von unterschiedlichen Ebenen und Sektoren (bestehende Gremien und Kanäle werden nur teilweise für echten Austausch genutzt), Offenheit und Transparenz in Daten- und Informationsflüssen, vertrauensbildende Maßnahmen
- **Allgemein:** wenige positive gemeinsame Visionen und Projekte, die von Akteuren über Ebenen und Sektoren hinweg geteilt werden

Politisch-gesellschaftliche Ereignisse als Hürden: Austausch, Dialog und Vertrauen können auch im Zuge von Wahlkämpfen und Wahlen sowie durch Berichterstattung und Debatten in (sozialen) Medien negativ beeinflusst werden (Polarisierungen, Polemisierung).

Materielle Barrieren:

- Infrastrukturen und landwirtschaftliche Betriebe: hohe Investitionen in Bestehendes, Pfadabhängigkeiten (einschl. durch „sunk costs“)
- Flächenverfügbarkeit und -preise
- Wirtschaftliche und demographische Entwicklung (Trinkwasserbedarf, Abwassermengen, Flächenversiegelungen, Verkehr, etc. nehmen zu)

Vorläufiges allgemeines Fazit: Wasser-Governance und -Management in Luxemburg befinden sich in einer Umbruchsphase, die von Widersprüchen, Spannungen und Ungewissheiten geprägt ist. Was soziale Lernprozesse anbelangt, ist das Bewusstsein für die Bedeutung von Wasser an vielen Stellen größer geworden, viele Akteure stellen vieles (auch sich selbst) infrage und suchen nach neuem Wissen und neuen ´Antworten´. Viele Akteure wollen stärker an Governance-Prozessen beteiligt werden und setzen sich für naturnahes Wassermanagement (etwa Renaturierungen) ein. Gleichzeitig dominieren weiterhin hierarchisch-technische Ansätze und Denkweisen sowie wirtschaftlich-finanzielle Interessen und Prozesse. Es bedarf mehr Abstimmung, einer größeren Flexibilität und Kompromissbereitschaft (Nutzung von Interpretations- und Handlungsspielräumen) und des gegenseitigen Verständnisses und Austauschs zwischen allen Akteuren.

In Bezug auf Wasserschutz und den Zustand der Gewässer zeichnet sich bislang keine „Trendwende“ ab, da der Druck auf Wasser und Land weiter steigt. Es erscheint fraglich, ob ein Großteil der Gewässer den guten Zustand bis 2027 erreichen wird.

Zukunftsperspektiven und offene Fragen:

- Rollen der „Trinkwasser-Animateure“ und deren Beziehungen bspw. Vernetzung mit anderen Akteuren und Beratern, die im Naturschutz und der Landwirtschaft tätig sind?

- weiterer Landkauf durch öffentliche und private Akteure, wie werden Auflagen oder Wechsel vom Besitz der Flächen kompensiert?

-Öko-Punkte für Wasserschutz, nächster PDR 2021-2027, mögliche Vorzeigeprojekte?

c) Einzugsgebiet Obersauer: Ausrichtung der Fallstudie und Übersicht über die Handlungssituationen

Es wurden die vielfältigen Zusammenhänge und Dynamiken rund um Trinkwasserschutz und die Ausweisung der neuen Trinkwasserschutzzonen analysiert. Hierbei wurden auch historische

Entwicklungen berücksichtigt, die Beziehungen zwischen dem Trinkwasserversorger SEBES, Gemeinden, Naturpark, Gewässervertrag, Landwirten (LAKU), Landwirtschaftsberatern und nationalen Verwaltungen prägen.

Spezifische vorläufige Erkenntnisse aus der Fallstudie wurde bei dem RFG-Treffen vom 13.11.2019 vorgestellt und diskutiert und sind aus der RFG-Präsentation von Kristina Hondrila ersichtlich.

Formale politische Prozesse	**Soziale Lernprozesse: informelle Aktivitäten und Organisation von Akteuren (sowie technisch-ökologische Faktoren)**
2000-2003: Schaffung eines neuen EU-Rechtsrahmen : EU-Trinkwasserrichtlinie (1998), EU-Wasserrahmenrichtlinie (WRRL, 2000), WRRL-Leitfaden zu öffentlicher Beteiligung (2003)	
2000 : RGD du 24 novembre 2000 concernant l'utilisation de fertilisants azotés dans l'agriculture	
2002: RGD relatif à la qualité des eaux destinées à la consommation humaine	2006-2011: grenzüberschreitendes Interreg-Projekt und Gründung des „Gewässervertrags Obersauer“
2007: Beteiligung der Öffentlichkeit bei der Erstellung des WRRL-Bewirtschaftungsplans 2009-2015	
2000-2008: Ausarbeitung und Inkrafttreten des « Wassergesetzes » (´loi du 19 décembre 2008 relative à l'eau´)	2008-2011: Charta, Gründung und Aktionsplan des Gewässervertrags Obersauer
2009-2015: Umsetzung des 1. Lux. WRRL-Bewirtschaftungsplans	
2012-2018: Ausarbeitung eines Konzepts und Entwurfs des Reglements zu den neuen Trinkwasserschutzzonen im Einzugsgebiet der Obersauer	2012-2014: Organisation von Treffen und Arbeitsgruppen zu den kommenden neuen Schutzzonen durch den Gewässervertrag Obersauer
2014: Inkrafttreten des überarbeiteten RGD concernant l'utilisation de fertilisants azotés dans l'agriculture	2014-(bis heute): Aktivitäten und Gründung (2015) der landwirtschaftlichen Kooperation LAKU
	[ökologisch: 17 September 2014: Pestizid-Unfall (Metazachlore) im Einzugsgebiet der Obersauer]
2015: Beteiligung der Öffentlichkeit bei der Erstellung des WRRL-Bewirtschaftungsplans 2015-2021 (Stellungnahmen der Flusspartnerschaften)	
2015: RGD zum Verbot des Metazachlore und Metolachlore in den Trinkwasserschutzgebieten	
2015-2021: 2. Lux. WRRL-Bewirtschaftungsplan	
2017: Änderungen des Wassergesetzes von 2008 (durch die Änderung ist die Landwirtschaft förderfähig in den Trinkwasserschutzgebieten)	März 2018: Weltwassertag-Kolloquium der Flusspartnerschaften zu Hürden bei der WRRL-Umsetzung
	[ökologisch: 2018: frühzeitige und vermehrte Algenblüte einhergehend mit Badeverboten]
Juni 2018-Juli 2019: Vorstellungen des RGD-Entwurfs zu den neuen Trinkwasserschutzzonen, öffentliche Konsultation, Einreichung und Einarbeitung von Stellungnahmen durch Akteure	
	Juli 2018 – November 2018: Schutzzonen-Arbeitsgruppen (Gewässervertrag),

	Ausarbeitung von Fragen und Anmerkungen sowie Treffen zwischen Gemeinden, Umweltministerium, Landwirtschaft
2019: Beteiligung der Öffentlichkeit bei der Erstellung des WRRL-Bewirtschaftungsplans 2021-2026 (Stellungnahmen der Flusspartnerschaften)	

d) Einzugsgebiet Syr: Ausrichtung der Fallstudie und Übersicht über Handlungssituationen

Es wurden die vielfältigen Zusammenhänge, Dynamiken und Herausforderungen rund um den Zustand der Syr und Renaturierungen in ausgewählten Gewässerabschnitten analysiert. Hierbei wurde der geschichtliche Hintergrund, bereits durchgeführte (Schlammwiss-Brill) wie auch geplante neue Projekte (Mensdorf-Betzdorf) untersucht. *Spezifische vorläufige Erkenntnisse aus der Fallstudie wurde bei dem RFG-Treffen vom 13.11.2019 vorgestellt und diskutiert und sind aus der RFG-Präsentation von Kristina Hondrila ersichtlich.*

Formale politische Prozesse	**Soziale Lernprozesse: informelle Aktivitäten von Akteuren, deren Koordination und Organisation sowie technisch-ökologische Faktoren**
2000-2003: Inkrafttreten der EU-Wasserrahmenrichtlinie (WRRL), des Leitfadens zur öffentl. Beteiligung (2003) und der EU-Richtlinie über den Zugang der Öffentlichkeit zu Umweltinformationen	
2000-2008 : Ausarbeitung und Inkrafttreten des « Wassergesetzes » (´loi du 19 décembre 2008 relative à l'eau´)	
2002-2018: Planung des Ausbaus der Kläranlage Uebersyren (bis Finanzierungsgesetz 2018)	
2004: Inkrafttreten des nationalen Gesetzes zum Schutz der Umwelt und natürlicher Ressourcen (einschl. Natura 2000-Netz)	2003-2016: ´Schlammwiss - Mensder Brill´: Renaturierung und Ganzjahresbeweidung (bis 2016)
2007: Beteiligung der Öffentlichkeit bei der Erstellung des WRRL-Bewirtschaftungsplans 2009-2015	
2009-2015: Umsetzung des 1. Lux. WRRL-Bewirtschaftungsplans, einschl. der Ausarbeitung eines Hochwasserrisikomanagementplans (2014-2015) und Einrichtung von Hochwasserpartnerschaften	2011-2013: Flusspartnerschaft Syr: Gründung, Charta, 1.Sitzung des Flusskomitees, Arbeitsgruppen, Störfaktorenkartierung, Ausarbeitung des Aktionsplans
	2014-2019 (*laufend*): Umsetzung des Aktionsplans 2014-2017, einschl. Bemühungen bzgl. Renaturierungen und Abwasserklärung in Uebersyren (einschl. vom Flughafen)
2015-2016: Partizipative Ausarbeitung des Natura 2000-Managementplans „Vallée de la Syre de Moutfort à Roodt/Syr"(2016-2026/2018-2027)	
2015: Beteiligung der Öffentlichkeit bei der Erstellung des WRRL-Bewirtschaftungsplans 2015-2021	
2015-2021: Umsetzung des 2. Lux. WRRL-Bewirtschaftungsplans	

2016-2027 : Umsetzung des Natura 2000-Managementplans „Vallée de la Syre de Moutfort à Roodt/Syr“	2016-2019 *(laufend):* Ausarbeitung einer Machbarkeitsstudie „Renaturierung der Syr zwischen Mensdorf und Betzdorf“ für die Gemeinde Betzdorf
2017-2021: Umsetzung des nationalen Naturschutzplans und Ausweisung des „Schlammwiss-Brill“ als Naturschutzgebiet von nationalem Interesse (2018)	März-Mai 2018: NEXUS-Veranstaltungen zu Herausforderungen und Handlungsfeldern im Einzugsgebiet der Syr (u.a. Thema Renaturierung)
März 2018: Weltwassertag-Kolloquium der Flusspartnerschaften zu Hürden bei der WRRL-Umsetzung und Wanderung „Mensdorf Brill“ unter dem Motto „Naturbasierte Lösungen für das Wasser“	
2018: Finanzierungsgesetz vom 14. September 2018 zur Modernisierung und Ausbau der Kläranlage Uebersyren (auf 122000 EWG)	2019 (*laufend):* Briefe und rechtliche Schritte des Präsidenten der Flusspartnerschaft Syr (als Privatperson) zum Zugang zu Umweltinformationen bzgl. der Abwassersituation an der Syr und des Flughafens
März 2019: Weltwassertag-Kolloquium der Flusspartnerschaften zu „Dezentraler/ökologischer Überflutungsvorsorge“ bzgl. Starkregenereignissen	
2019: Beteiligung der Öffentlichkeit bei der Erstellung des 3. WRRL-Bewirtschaftungsplans 2021-2026	

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