2021

We count because you count!

Population census | Luxembourg

SPATIAL DISTRIBUTION OF THE POPULATION IN LUXEMBOURG:
from the sub-municipal level to the urban structure

Geoffrey Caruso, Kerry Schiel, Yann Ferro,
Isabelle Pigeron-Piroth (Université du Luxembourg),
Philippe Gerber (LISER)

At municipal level, despite very strong demographic growth (+25.7%), the major balances in the spatial distribution of the population have remained similar over the intercensal period. The largest centers attract a higher volume of population, and the capital even more so.

STATEC
Institut national de la statistique
et des études économiques

uni.lu
UNIVERSITÉ DU
LUXEMBOURG

LISER
LUXEMBOURG INSTITUTE OF
SOCIO-ECONOMIC RESEARCH

Zooming in on a regular 1km² grid, densities generally increase everywhere. There are, however, growth differentials, particularly within the urbanised area in the south of the country. According to the OECD's categorisation of 7 degrees of urbanisation applied per km², the conurbation of Luxembourg-City is expanding to the north and west, with urban centers emerging all around. On an even finer scale, the residential nuclei demonstrate the major importance (27% of the population) of the urban continuity formed from Luxembourg-City, and highlight high local densities (Esch-sur-Alzette nucleus or smaller nuclei in Kirchberg and Belval). Overall, the analysis reveals that growth is primarily a process of agglomeration and densification accompanied by centrifugal expansion close to existing centers. Despite the strong population growth, the analysis suggests that overly dispersed urban sprawl seems to be avoided.

Issues

In a context of strong population growth, it is particularly important to understand the way in which this population occupies the land. Many social and environmental issues are directly linked to the spatial distribution of the population. For example, greater concentration means that less agricultural and natural land is consumed, or that public services and transport are provided at lower cost. However, this concentration may not be uniform, and differences across the territory can then be a source of inequalities, for example in access to jobs, schools and services, but also to nature or cleaner air.

The way in which the population is distributed in space is of course - and fortunately - guided, in particular by spatial planning policies. Nonetheless, it reflects the trade-offs made by households when they move in or out. Traditionally, households are seen as making trade-offs between housing costs and transport costs. Thus, living further away from a city center reduces the cost of housing or rent, but means losing time and flexibility in accessing daily activities. This duality goes a long way towards explaining why population density decreases with distance from jobs, as does its corollary: the increase in the size of dwellings as you move further away from centers. This trade-off is compounded by local geographical effects and individual preferences, for example for lush green landscapes, which tend to be the preserve of outlying areas, small towns or even a remarkable valley, or, on the contrary, for greater proximity to typically urban activities (theatre, shopping, etc.), which go hand in hand with larger conurbations.

Analysing where the general population is located and understanding how the degree and structure of urbanisation is changing will help us to understand current trends and the extent to which residential development is in line with societal and climate issues. But that's not enough, because the choice to live closer or further away from a large or small center, or in the countryside, is the result not only of preferences, but also of budgetary constraints. So understanding who lives where within this urban structure is one way of understanding potential inequalities.

This publication focuses solely on the general distribution of the population and its evolution over the last decade. In so doing, we have produced two characterisations of urbanisation in Luxembourg (a typology of the degree of urbanisation and a definition of residential nuclei) as well as a discretisation of space into density classes. These structures can then be used as a grid for territorial analysis in subsequent publications, where the emphasis will be on the characteristics of the population. Knowing whether older people, foreigners or blue-collar workers, for example, tend to live in small towns, on the outskirts or in the heart of conurbations will give us a better understanding of residential decisions and enable us to act on any inequalities that may result.

Opportunity

Any territorial analysis comes up against the question of defining the spatial unit of reference. These units of analysis must make it possible to understand structures without, however, obliterating significant heterogeneity through excessively broad spatial aggregates, or drowning out the relevant information in too many small units. Although most statistical publications (in Luxembourg as elsewhere) focus on administrative divisions such as the commune, this is not a trivial choice for at least three reasons. Firstly, it assumes that phenomena are homogeneous within these administrative units. This is rarely the case, especially in a heterogeneous territory comprising 'town and country'. Secondly, it is precisely when we analyse urbanisation that we realise that continuities (and discontinuities) do not stop (or start) at the boundaries of administrative units. Where does the city of Luxembourg or Differdange begin/end, for example? This is not a trivial question, even from a simple morphological point of view, i.e. from the point of view of built (non-)form and intensity. Thirdly, administrative divisions themselves can change rapidly without any link to statistical information. This is the case in Luxembourg with municipal mergers (102 municipalities in 2021 compared with 116 in 2011), leading to a significant loss of information and making it difficult to compare over time.

The availability of the 2021 census, based on a grid of 2,795 cells of 1km², offers a fantastic opportunity to rethink the territorial structure and the distribution of the population precisely at the sub-municipal level[1] . We are taking advantage of this opportunity here, alternating maps at municipal and grid level in order to discuss the effects of aggregation and the value of more precise and probably less usual information.

As well as providing information that is spatially more detailed - on average 27 cells per municipality - and therefore closer to the people who live there, the grid also has the merit of providing a uniform surface area. While municipal areas vary enormously (15km² difference between the be 1st and 3rd quartile, or more than 100 km² difference between Remich, the smallest municipality, and Wincrange, the largest), using a common denominator (the km²) is much more appropriate for tackling issues of population density and urbanisation, central issues for Luxembourg given its strong demographic dynamics.

We will begin (section 1) in this publication by re-contextualising the spatial structure of Luxembourg and demographic trends over the last decade at municipal level. Then (section 2), we zoom in on the sub-municipal scale to analyse population densities and relative population change by 1 km cells[2]. Thirdly (section 3), we will apply the OECD's method for defining the degree of urbanisation[2] at the same cell level. This classification is based on criteria of population density within cells and population volume for contiguous areas. The result is a typology that objectively classifies each 1km² cell as urban, peri-urban or rural. This is one objectification among others, but it corresponds to criteria established on an international scale, with which it would be interesting to contrast with the perceptions of local residents. Living in the city or the country remains a subjective and cultural notion and, in the Grand Duchy, it is not uncommon to hear 'the city' spoken of solely in reference to the commune, or even the historic heart of Luxembourg City. Finally, we will conclude (section 4) by sketching out the contours of the settlement nuclei in even finer detail, using the population census at a more precise scale (a sub-division of the 1km² grid). This will involve defining so-called "morphological" conurbations based solely on settlement (dis-)continuities. Drawing continuous clusters of settlements is a particularly interesting exercise for identifying coherent areas that transcend administrative boundaries, and for developing sustainable land use, services, housing and transport.

---

1   See the publication "*La répartition de la population luxembourgeoise selon une grille d'un kilomètre carré : une nouvelle représentation de la situation démographique du Luxembourg*", RP2021.

2   See the publication: "*Applying the degree of urbanisation, Methodological manual for defining agglomerations, cities and rural areas for the purposes of international comparisons, Edition 2021*", Eurostat.

1.
Context and fundamentals of the urban structure: population distribution and trends at municipal level

Since the February 2011 census, Luxembourg's population has grown by 131,588 to reach 643,941 in November 2021. This represents considerable growth (+25.7%) and an average annual growth rate of 2.3%, one of the highest in Europe (behind Malta). Far from being uniform across the country, population growth is highly variable. However, as we shall see in this section, this growth does not upset the fundamentals of the country's urban structure. Despite the addition of a good quarter of the population, the balance between cities and between urban and peri-urban areas remains virtually unchanged. Of course, density is increasing everywhere, but the distribution is broadly in line with the previous structure: accumulation is proceeding at municipal level in the same concentrations as in the past, with the more densely populated municipalities attracting proportionately more population.

1.1
Nearly one in five people live in the capital

In 2021, with 128,097 inhabitants, Luxembourg City will be the most populous municipality in the country, well ahead of Esch-sur-Alzette (36,117). Three municipalities in the south of the country have more than 20,000 inhabitants: Differdange (28,532), Dudelange (21,568) and Pétange (20,385). In total, more than a third of the country's population (36.4%) lives in these five municipalities. They are followed by a number of municipalities with more than 10,000 inhabitants: Sanem (17,964) and Hesperange (15,835), Bettembourg (11,406), Schifflange (11,148), Käerjeng (10,761), Mamer (10,426), Strassen (10,261) and Mersch (10,167). These 13 most populous municipalities account for half (51.7%) of the country's total population (see Map 1). These municipalities, with the exception of Mersch, form two major urban areas: a conurbation around Luxembourg City and an urbanised area to the south. This immediately raises the question of the relevance of municipal boundaries for analysing the urban structure.
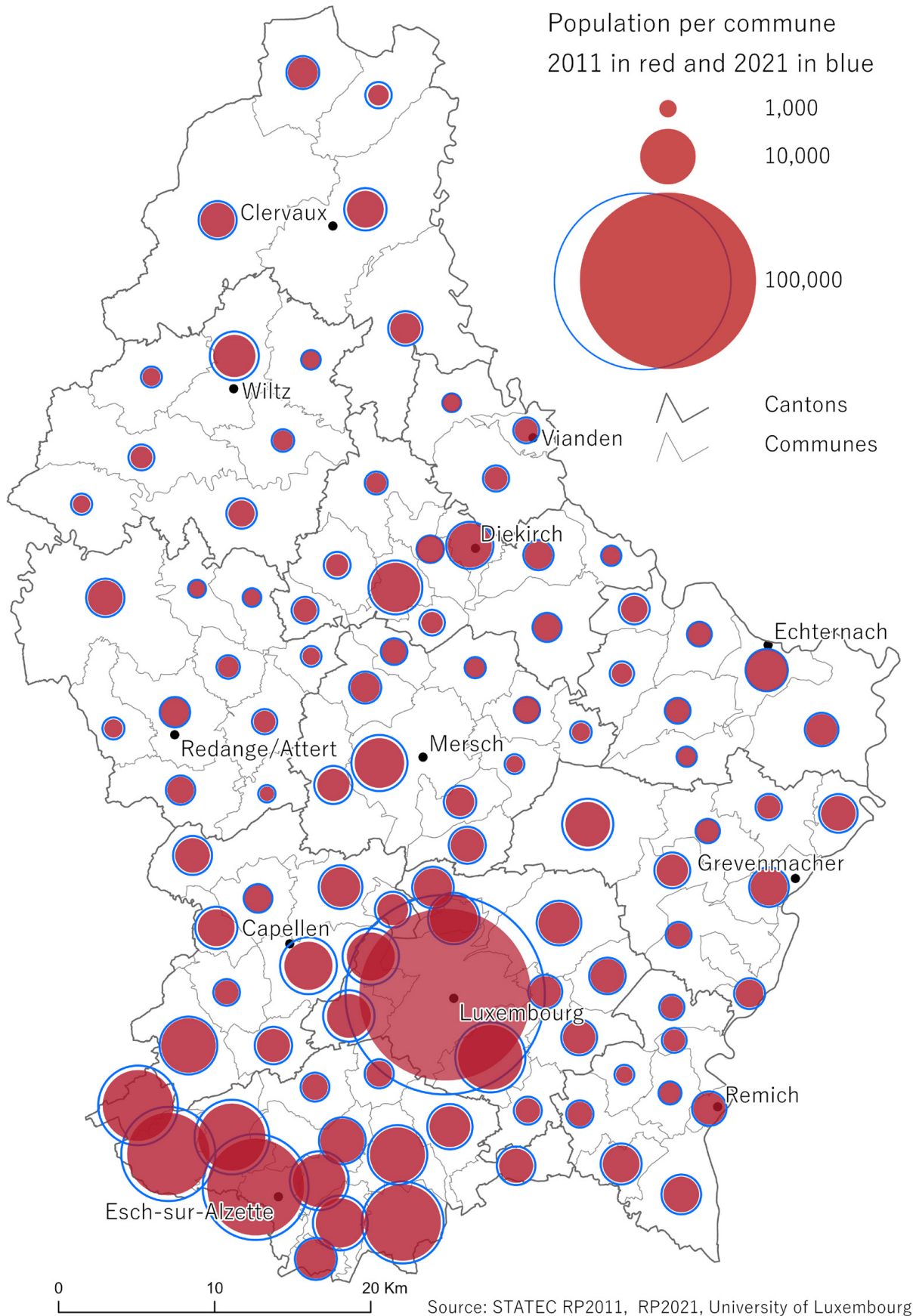
Some communes have a population of between 5,000 and 10,000: they are located in the southern strip, the north-eastern outskirts of Luxembourg City, the Nordstad or close to the German and French borders. They account for 20% of the total population.

The remainder of the population is spread across less populated municipalities located mainly in the north and east of the country, representing 28% of the total population living in 68.6% of the total number of municipalities[3].

Overall, a comparison of municipal populations by proportional symbols between 2011 and 2021 (see Map 1) does not show any radical change. Growth appears to be fairly balanced according to the previous population, with no new polarities emerging, despite the significant addition of population in volume terms (which appears to be greater for Luxembourg City).

---

3   See also *"The territorial distribution of the population"*, RP2021.

Map 1. Population by municipality in 2021 and 2011

Population per commune
2011 in red and 2021 in blue

● 1,000

● 10,000

● 100,000

Cantons

Communes

Clervaux

Wiltz

Vianden

Diekirch

Echternach

Redange/Attert

Mersch

Grevenmacher

Capellen

Luxembourg

Remich

Esch-sur-Alzette

0   10   20 Km

Source: STATEC RP2011, RP2021, University of Luxembourg

## 1.2 Population growth in all municipalities

However, relative growth is not uniform across the region. While all of the country's communes have gained population since the last census, the rates range from 6% for Erpeldange-sur-Sûre (from 2,295 to 2,435) to 63% for Weiswampach (from 1,362 to 2,225). The highest rates are found mainly in the least populated municipalities: for example, Saeul saw its population increase by 42.3% between the last two censuses (from 673 to 958 inhabitants). In view of this overall growth and these spatial disparities, it is interesting to compare the growth rates of the municipalities in relation to national demographic growth (as a reminder, +25.7%). The relative population growth rate analyses the difference between the population growth rate of each municipality and the national growth rate (see Map 2). It highlights which communes have experienced higher population growth than the country as a whole (in orange/red on the map) and which have experienced lower population growth (in green).

As expected, the map is broadly balanced, with 45% of municipalities growing faster than the country as a whole, and 55% slower. The municipalities with a higher growth rate are mainly located to the east of Mersch, to the north-west (forming a corridor as far as Clervaux) and on the western outskirts of Luxembourg City.

Conversely, the south (with the exception of Differdange), but also the east, the eastern outskirts of Luxembourg City and some municipalities in the Nordstad have lower growth rates than the country as a whole. It should be remembered that even if a municipality's growth rate is lower than that of the country as a whole, it is still positive and represents a population gain (e.g. 6% for Erpeldange-sur-Sûre and 7% for Echternach, the two municipalities with the lowest population growth between 2011 and 2021).

Map 2. Relative rate of population growth in municipalities between 2011 and 2021
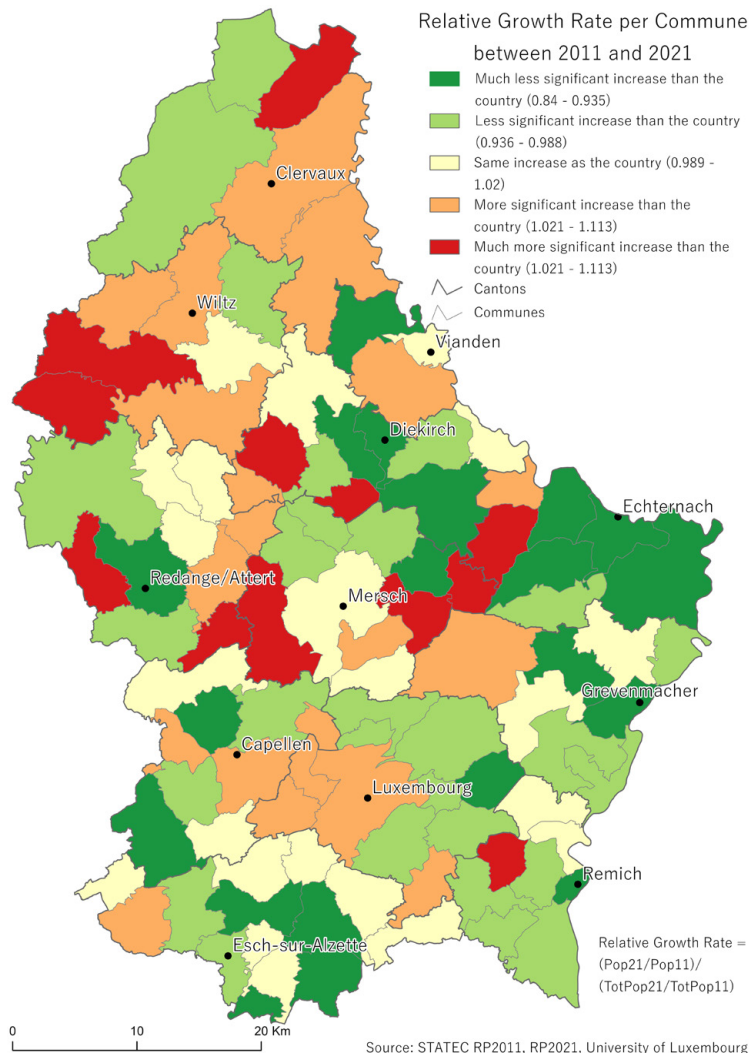
1.3
Nearly 100,000 additional residents in the most densely populated municipalities

This increase in population, observed in every municipality in the country, obviously has an effect on the concentration of population per square kilometre (density), which is more or less marked depending on the surface area of the municipality. Although it is difficult to group densities into single classes while taking into account the statistical distribution of values over two periods, we propose such a discretisation for maps 3A and B and table 1. The maps thus highlight an increase in density in the south of the country, but also and above all around the capital, along the German border and towards the Nordstad. With 2,509 inhabitants per square kilometre (inhab/km²), Esch-sur-Alzette is the most densely populated municipality in the country in 2021 (compared with 2,093 in 2011). The capital, meanwhile, has a population density of 2,476 inhabitants/km² in 2021, which is almost equivalent to that of Esch-sur-Alzette, compared with 1,837 inhabitants/km² in 2011.
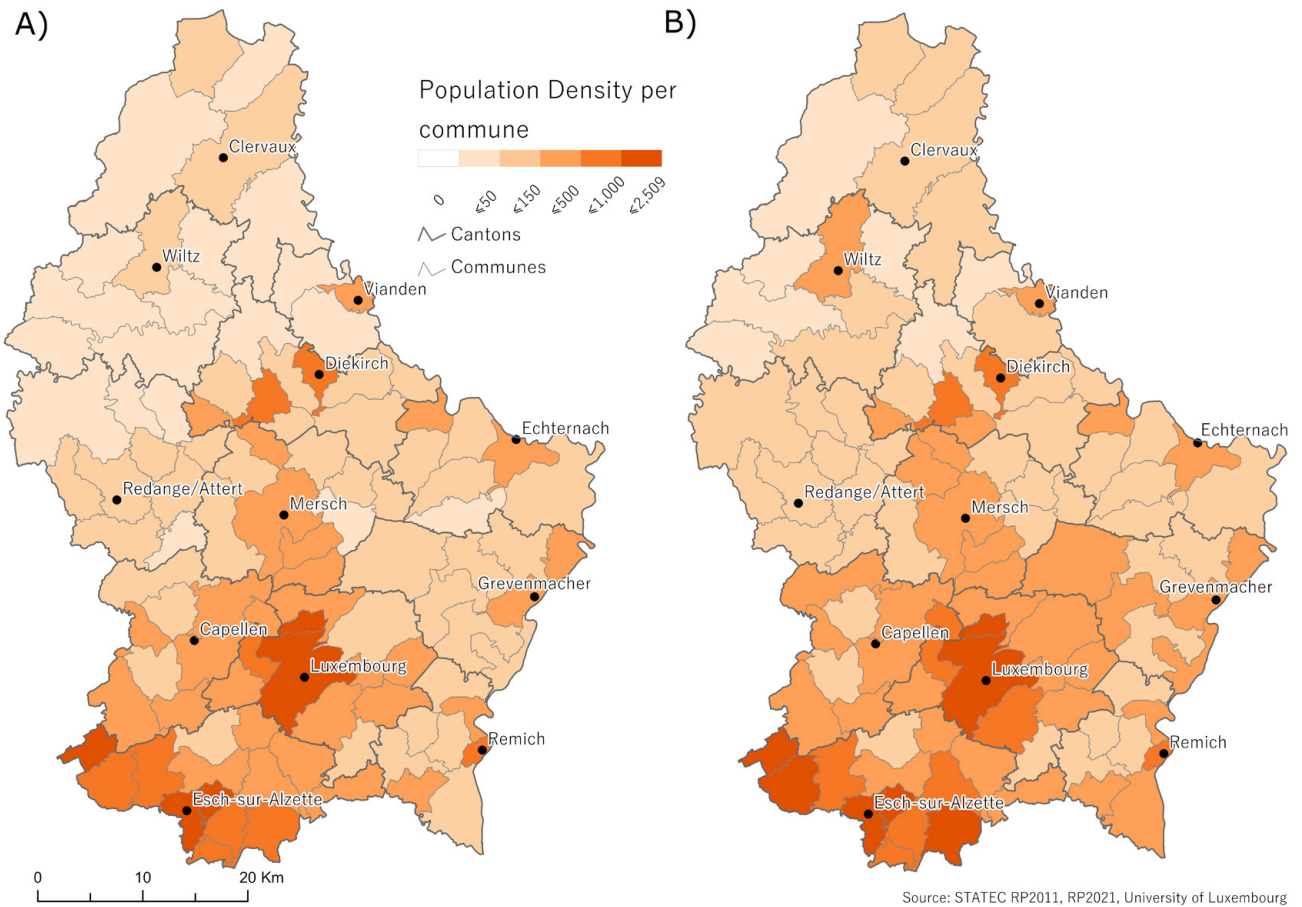
There are slightly more municipalities with a density of over 1,000 inhabitants/km² than in 2011, and these are mainly municipalities in the south or located around Luxembourg City. Above all, it is precisely these high-density municipalities that have received the vast majority of the population increase (almost 100,000) over ten years. Conversely, those with the lowest densities in 2021 are essentially located in the north and are significantly fewer in number than in 2011 (7 municipalities in 2021, compared with 20 in 2011). As a result, the proportion of the population living in municipalities with fewer than 50 inhabitants per km² fell sharply between the two censuses (see Table 1). These two combined effects clearly show a trend towards more agglomeration, even though almost a third of the new population has settled in municipalities with intermediate densities of 150 to 500 inhabitants/km2 (32.6%).

These analyses, carried out at municipal level on the basis of the 2021 boundaries, have the advantage of clarity, but the disadvantage of masking the variety within each municipality and of operating on different surface areas. By virtue of its homogeneity, the neutrality of its division and the comparability it allows over time and space (comparison possible despite mergers of municipalities, or with other countries), the 1km² cell analysis overcomes these disadvantages.

Table 1. Population and municipalities according to density thresholds in 2011 and 2021

Density (inhab/km²)	2011		2021		Change 2011 to 2021	
	Population	No. Communes	Population	No. Communes	in Population	in Population (%)
0 - 50	33937	20	12308	7	-21629	-63.7
50 - 150	91902	39	101344	43	9442	10.3
150 - 500	136213	29	180626	35	44413	32.6
500 - 1000	92871	9	95289	10	2418	2.6
1000 - 2509	157430	5	254374	7	96944	61.6
Total	512353	102	643941	102	131588	25.7

Map 3. Population density in the municipality in 2011 (A) and 2021 (B)

A)

B)

Population Density per commune

0   ≤50   ≤150 ≤500 ≤1,000 ≤2,509

⋀ Cantons

⋀ Communes

Clervaux

Wiltz

Vianden

Diekirch

Echternach

Redange/Attert

Mersch

Grevenmacher

Capellen

Luxembourg

Remich

Esch-sur-Alzette

0   10   20 Km

Source: STATEC RP2011, RP2021, University of Luxembourg

2.
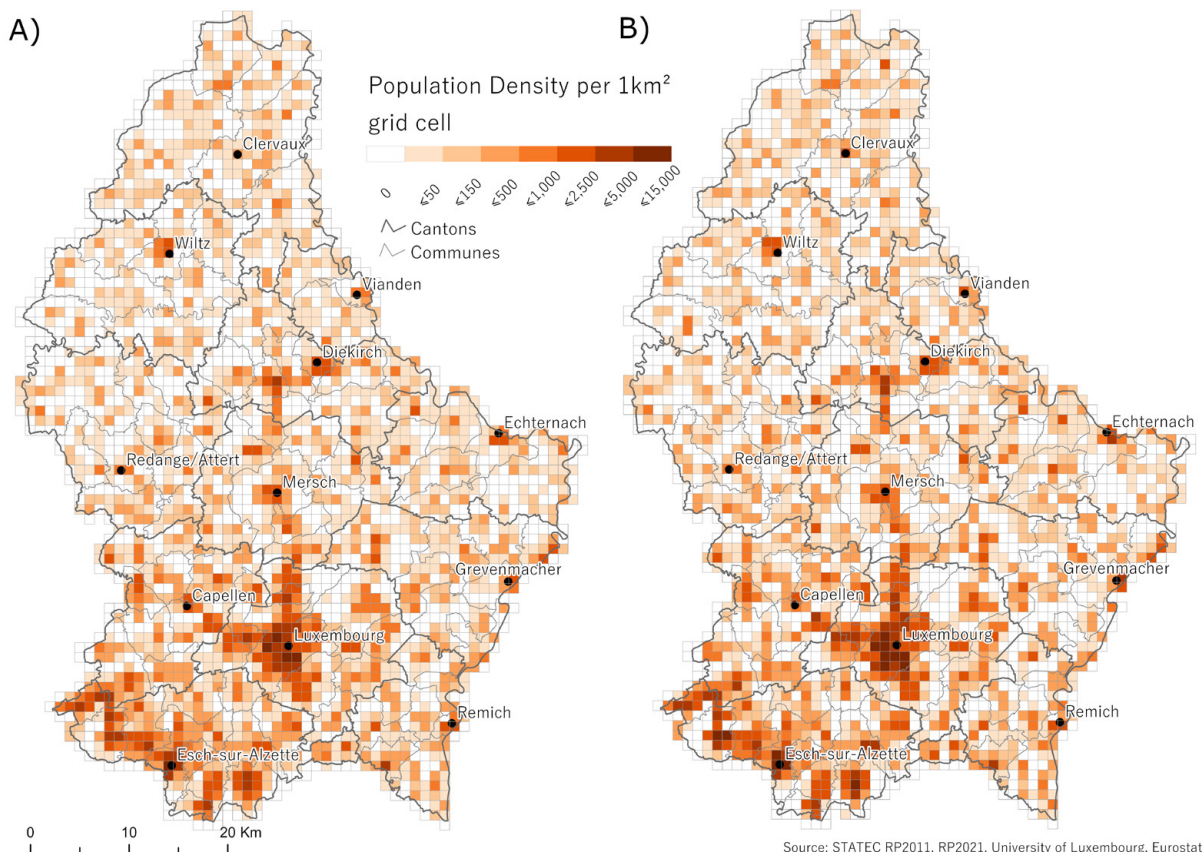# The "pixelated" population: distribution and evolution of the population per square kilometre

Maps 4A and B showing the country's population in 1 km² grids are difficult to read at first glance. They depart from the usual communal representations and seem "pixelated". However, they do provide an essential reminder: the fact that 41.5% of the 1km² cells are uninhabited. Whether forest or farmland, most of these empty cells are located in the north and east of the country. A few also separate the two major urban areas (around Luxembourg City and the southern conurbation). In the south, the few white dots that appear on the map are industrial wastelands (the former Dudelange rolling mill, Terres Rouges, etc.) which are the subject of redevelopment projects in the coming years (Neischmelz, Terres Rouges lentil, etc.) and will therefore very probably see population growth in the next censuses. As they are not evenly distributed, all these white cells effectively truncate the assessment of densities on a municipal scale (see Maps 3), particularly between the north and south, by underestimating the real concentration of housing in the north.

The 2021 map also reveals the variety of the spatial distribution of the population within urbanised areas: some cells have fewer than 150 inhabitants, while Luxembourg City contains a cell with 14,663 inhabitants (the cell stretching between the station, Bonnevoie-Nord and Bonnevoie-Sud districts) and Esch-sur-Alzette has a cell with 11,196 residents (the Uecht district, and part of Brill, Bruch and Al Esch). These high concentrations of population go well beyond the average density or even the communal maxima presented above. For example,
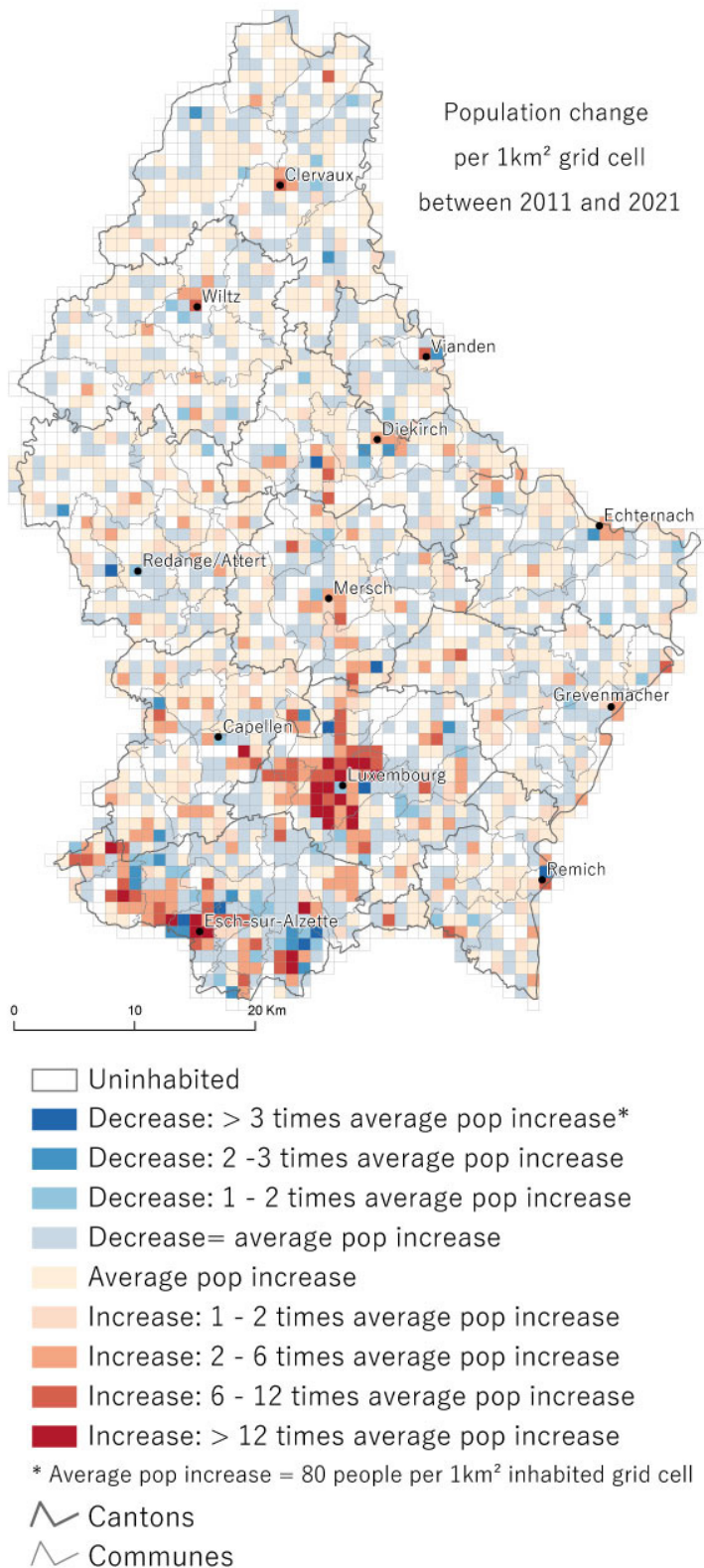
densities in excess of 2,500 inhabitants/km² have been identified in the "le bassin minier" (mining region) and the capital, as well as in Mersch and Nordstad.

A comparison of the population per grid in 2011 and 2021 also shows, on this scale, a high degree of stability in the structure. For example, no new densely populated cells have appeared in ten years. The density levels are higher, but the spatial distribution is very similar despite the addition of 131,588 inhabitants.

Map 4. Population mapping by 1 km² grid in 2011 (A) and 2021 (B)

Source: STATEC RP2011, RP2021, University of Luxembourg, Eurostat

Map 5. Map of population change at 1 km²

Population change
per 1km² grid cell
between 2011 and 2021

☐ Uninhabited
■ Decrease: > 3 times average pop increase*
■ Decrease: 2 -3 times average pop increase
■ Decrease: 1 - 2 times average pop increase
■ Decrease= average pop increase
■ Average pop increase
■ Increase: 1 - 2 times average pop increase
■ Increase: 2 - 6 times average pop increase
■ Increase: 6 - 12 times average pop increase
■ Increase: > 12 times average pop increase
* Average pop increase = 80 people per 1km² inhabited grid cell

⌁ Cantons
⌁ Communes

Source: STATEC RP2011, RP2021, University of Luxembourg, Eurostat

To better observe the changes, it is best to consider the differences in volume. If growth were spread evenly across the cells already inhabited in 2011, this would be equivalent to adding 80 people to each of these cells. Map 5 shows the differences in relation to this average.

Population trends per 1km² cell have varied considerably over the last ten years[4] . The map shows increases (of up to 5,000 inhabitants in one cell) and decreases (of up to 450 inhabitants, although more limited). Between 2011 and 2021, we can see a strengthening of concentration in " le bassin minier" (mining region) and the capital. However, unlike the municipal level, which only showed population increases between the last two censuses, an analysis by cell shows cells experiencing population decreases, including in "le bassin minier" (mining region) and around the capital.

Five of the six cells with the biggest increases are in Luxembourg City. The sixth is in the center of Differdange, where the sharp rise in population is explained by the town's development policy and major residential projects near a shopping center. In the "le bassin minier" (mining region), population increases tend to be concentrated in the central cells of towns, while decreases occur in the cells to the north of these municipalities (such as Dudelange, Esch-sur-Alzette and Differdange). The same is true for the central cells of Wiltz, Clervaux, but also Vianden, Diekirch and Mersch, which have also seen an increase of several thousand inhabitants in ten years, as have the cells along the A6 and A1 motorways, the main access routes to the capital.

As for population declines, they are most visible in the south, on the outskirts of the capital or in small towns. In this case, it is very likely to be a question of these cells leaving for other, more attractive areas[5] , with natural deficits (excess of deaths over births) or departures from the country to other countries being much more limited in number.

Nevertheless, it remains difficult to compare the general evolution of urbanisation with this grid and on the simple basis of the density of the cells and their individual changes. A typology of these cells, which takes into account both the densities and the context of the cells, therefore seems necessary.

4   The method used to calculate the cell population in 2011 is not exactly the same as that for 2021. It is in fact an extrapolation carried out by Eurostat on the basis of municipal populations and buildings. The small differences in volume may therefore be an artefact of the method. This is why we are presenting sufficiently broad categories of density (map 4) or change (map 5).

5   They will be the subject of a forthcoming publication on internal migration.

3.
An increasingly dense urban structure in Luxembourg

3.1
A new 7-class reading grid

It is possible to go further in the composition of the spatial structure of the population with cells of 1 km² by classifying these spatial units according to a degree of urbanisation. To do this, the OECD proposes a zoning system that combines two criteria: (i) four thresholds linked to population size based on groupings of contiguous cells (i.e. context), and (ii) four population density thresholds (see Figure 1). The result is seven different categories of cells, with varying degrees of density and belonging to a more or less densely populated area. This method, which is now applied internationally, makes it possible firstly to structure population data by aggregating it morphologically and spatially. It then enables statistics to be produced according to the 7 degrees of urbanisation in a way that is comparable across the case studies.

This classification goes beyond the traditional city-countryside dichotomy by defining high-density areas (cities, even rural ones), intermediate areas (suburban or peri-urban) and rural areas, which themselves have different densities (see Figure 1).

More precisely, this classification qualifies the urban-rural gradient mentioned in the introduction, which is at the heart of households' choices, and which is essential if we are to respond to current economic, environmental or social issues with targeted interventions (urbanisation projects, infrastructure, etc.).

Methodology insert

A UN resolution, adopted in September 2015 and entitled *Transforming our world: the 2030 Agenda for Sustainable Development* (UN, 2015) includes several indicators related to the Sustainable Development Goals (SDGs) that should be collected for cities or for urban and rural areas. To date, however, no global method or international standard has been proposed to define these areas. The wide range of different criteria applied in national definitions of urban and rural areas poses serious problems for cross-country comparisons (Eurostat, 2021).

The OECD[1], the European Union, the FAO[2], UN-Habitat and the World Bank have developed a method for classifying urban units using census data and the work of the GHS[3]. This method is based on studies defining the degree of urbanisation, the data used and the methods employed by the countries of the world. It is therefore based on the absence of a common method and is intended to be used on a national, European or international scale to provide an appropriate definition and improve international comparisons. This method, based on the aggregation of successive fine georeferenced data of 1 km², has seven classes divided according to density, different population thresholds and contiguity criteria (not shown in the table).

[1] OECD: Organisation for Economic Co-operation and Development
[2] FAO: Food and Agriculture Organisation of the United Nations
[3] GHS: Global Human Settlement

Figure 1: OECD definition of spatial population structure

		Population size thresholds of the cluster of cells			No population size criterion
		> 50 000	5 000 - 49 999	500-4999	
Population density of cells, inhabitants per km²	>1500	Urban Center	Dense Urban Cluster		
	>300		Semi-dense Urban Cluster (¹)	Rural Cluster	Suburban or Peri-Urban
	>50				Low Density Rural
	<50				Very Low Density Rural

3.2
Degrees of urbanisation in the area

We apply the degree of urbanisation methodology to inhabited cells surveyed in 2021 (i.e. excluding empty cells) and, for comparison, to 2011 data[6].

Map 6. OECD degree of urbanisation applied to Luxembourg in 2011 (A) and 2021(B)

Source: STATEC RP2011, RP2021, University of Luxembourg, Eurostat

---
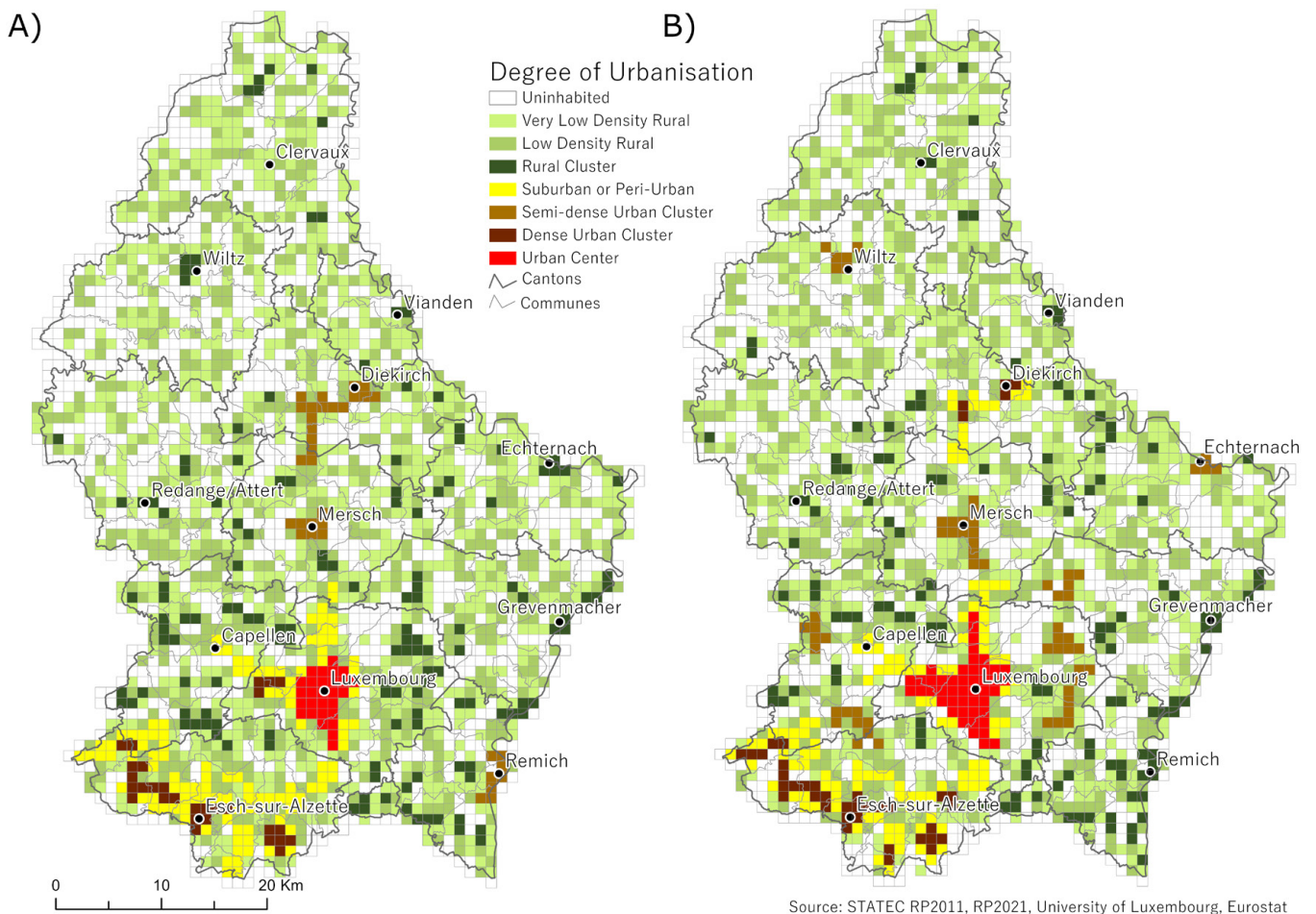
6   As a reminder, the cell populations have not been calculated in the same way in 2011 and 2021 (see note 4).

In 2021, the urban structure of the region is marked by an urban/rural contrast and between the north of the Nordstad and the rest of the country (see Map 6B). This structure is made up of three main centers: Luxembourg City, the southern urban cluster (Pétange, Esch-sur-Alzette, Differdange, Dudelange), and the Nordstad (Diekirch and Ettelbruck). The country's one and only urban center covers the city of Luxembourg and parts of Hesperange, Strassen, Bertrange and Walferdange, with a ring of suburbs to the north and north-west of the capital. In the former mining south, the whole is made up of several dense urban clusters and a peri-urban strip, forming what is usually referred to as a conurbation. The Nordstad is made up of two dense urban clusters, Diekirch and Ettelbruck, and a peri-urban ring stretching from Diekirch via Ettelbruck to Colmar-Berg. The rural clusters are mainly concentrated in the southern half of the country around Luxembourg City. Uninhabited areas and rural clusters with low and very low densities are mainly located in the north of the country.

Over the last ten years, peri-urban cluster cells close to the urban center have become so dense that they have been assimilated by the urban center. The process is similar in the south and Nordstad, with the emergence and growth of dense urban clusters. It should be noted that the densification of Diekirch and Ettelbruck has led to the transformation of a semi-dense urban cluster into two dense clusters and a peri-urban ring. This phenomenon can also be observed in rural clusters, leading to the emergence and growth of semi-dense clusters around Luxembourg City, Wiltz and Echternach. The same is true to the east of Luxembourg City, with Junglinster, Niederanven, Schuttrange and Contern moving from rural to semi-dense clusters, and to the west of the capital, with Dippach and Steinfort.

3.3
Population and localities by degree of urbanisation

It is interesting to compare the evolution of the population distribution of the clusters thus obtained with the localities, the historical reference for residential areas, prior to the creation of Luxembourg's communes in 1843. Thus, while the number of localities has changed over the centuries (there were officially 704 at independence in 1843, rising to 1,071 in 1900[7]), our analysis focuses on the current 564 localities. Table 2 shows these figures, comparing them with the population and cells classified according to degree of urbanisation.

In addition to the uninhabited cells, which will be very numerous in 2021, covering a very limited number of localities (85) and occupying 41.9% of the country's surface area, the rural cells (the three groups in green) represent almost 49% of the Grand Duchy's total surface area, i.e. 1,360 km² for 398 localities (almost three quarters of localities). Taken together, these uninhabited or sparsely inhabited areas account for 90.6% of the country's surface area, reflecting the importance of the morphologically rural areas scattered throughout the country. In 2021, they will comprise the vast majority of localities (86%), with less than a third of the country's total population (31.1%).

The density of the different degrees of urbanisation, meanwhile, is partly linked to the higher number of inhabitants and the number of cells. The densest clusters are those with the largest number of inhabitants and the smallest number of cells. It should be noted that proximity and contiguity between cells are also important in defining the degree of urbanisation, since even though the country's urban center is made up of 47 cells with a total of 157,407 inhabitants, they form a single cluster. Here, the number of localities is limited to 8, reflecting a higher density than in rural areas. The population density of the capital's urban center is 3,349 inhabitants/km², while rural areas have a density of 149 inhabitants/km². The 9 dense urban clusters, made up of 39 cells and 134,427 inhabitants, are scattered over 11 localities; their overall density is slightly higher than that of the Luxembourg conurbation, at 3,447 inhab/km², reflecting a deconcentrated yet compact urbanisation at the level of their localities.

To sum up, in 2021, according to the OECD definition, 53.5% of the total population will live in relatively dense cities, more precisely 24.5% in the urban center, 20.9% in dense urban clusters and 8.1% in semi-dense urban clusters. These three urban classes occupy just over 5.3% of Luxembourg territory and 7.4% of localities. The remaining 46.5% of the population live in suburban areas (15.5%) and rural areas (31.1%), covering most of Luxembourg's surface area (94.7%) and localities (92.6%). The majority of the population lives in the most densely populated areas, although a significant proportion lives in peri-urban areas, rural clusters and low-density rural cells.

Table 2. Change in population and number of affected localities (2011-2021) by definition of degree of urbanisation

	2011			2021			Change 2011 to 2021		
Degree of urbanisation	in km²	Popu-lation	Number of locations	in km²	Popu-lation	Number of locations	in km²	Population	Popu-lation (%)
	in Popu-lation	in Popula-tion (%)	33	1171	0	85	75	0	0
Uninhabited (0)	1096	0	33	1171	0	85	75	0	0
Very low density rural cell (11)	788	11305	136	660	9633	144	-128	-1672	-14.8
Low density rural cell (12)	562	85337	247	563	88604	193	1	3267	3.8
Rural cluster (13)	144	101578	87	137	101493	61	-7	-85	-0.1
Suburban or peri-urban cell (21)	114	105595	34	117	99439	39	3	-6156	-5.8
Semi-dense urban cluster (22)	34	30248	15	61	52241	23	27	21993	72.7
Dense urban cluster (23)	29	86691	9	39	134427	11	10	47736	55.1
Urban center (30)	28	92090	3	47	157407	8	19	65317	70.9
Total :	2795	512844	564	2795	643244	564			

---

7   see Gerber and Klein 2009

3.4
Changes in the degree of urbanisation between 2011 and 2021

In terms of changes, although the urban structure remains fairly similar overall between 2011 and 2021 (only 21% of cells have changed their degree of urbanisation, or 585 km²), significant changes are taking place. The most striking spatial change is the expansion of the only urban center (according to this definition), Luxembourg City. The conurbation has grown in size (from 28 to 47 cells or km²), particularly to the north and west, and now includes 8 towns compared with 3 previously. The second remarkable change, when comparing the 2011 and 2021 maps, is the 'transition' of five rural clusters located within a 10km radius of the main conurbation into urban clusters. They join Mersch and form a polycentric area with a major center and secondary centers distributed around it at regular intervals (almost the archetype of the central places theory). Thirdly and finally, the Nordstad seems to be redefining itself from a long semi-dense area into two dense urban centers and its own periphery (in yellow).

In terms of population volumes, we can see that over the last 10 years the population has become more concentrated in dense areas, and in particular in the urban center (+70.9%) and in dense and semi-dense towns (+55.1% and +72.7%). As we have seen, this has led to an increase in cells in the urban center and in dense cells, and a decrease in rural cells. There is a clear trend towards concentration or densification, even in more remote areas: the population is concentrated mainly in already urbanised areas and tends to cluster in areas that are already relatively dense without dispersing.

Suburbanisation, which is typical of a loose and fragmented habitat, therefore remains limited between the two censuses. Suburbanisation, which represented 4.1% of the territory in 2011, will remain at 4.2% in 2021. It is important to emphasise this: it is the type of urbanisation that is most criticised, as it carries significant social and environmental costs. This phenomenon is all the more notable given that the number of rural cells fell between 2011 and 2021. Taking together the three classes of rural cell (rural cluster, low-density rural cell and very low-density rural cell), their total will represent 1,360 km² in 2021, compared with 1,494 km² ten years earlier (a fall of around 10%). Their population has certainly increased, with the total rising from 198,220 in 2011 to 199,730 for the 2021 census, but this only represents a very small increase of 0.7%.

More specifically, by capturing the transitions between 2011 and 2021 in the state of urbanisation within a flow chart (see Figure 2 and Table 3), within the rural itself, the trend is clearly in favour of densification. For example, 104 rural cells (km²) with very low density in 2011 are becoming denser (low density cells). In terms of surface area, this is the biggest change in the typology. The opposite phenomenon exists, but in much smaller quantities (43 km²). The shift from rural to peri-urban, which could be a sign of diffuse urban sprawl, is very limited (21 km²).

Figure 2: Change in degrees of urbanisation in the OECD nomenclature between 2011 and 2021
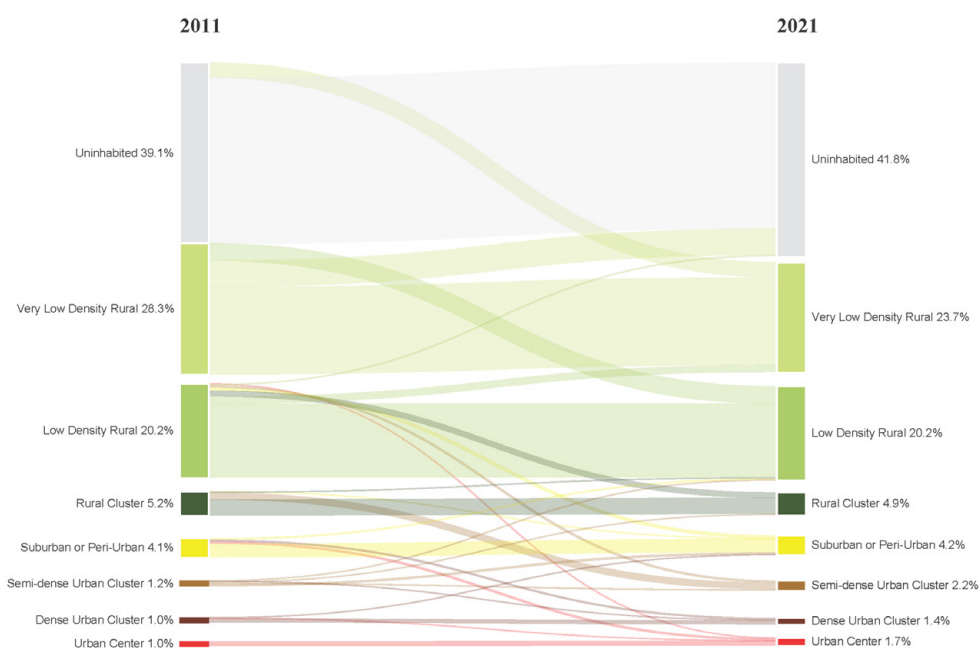

Table 3: Changes by degree of urbanisation of 1 km² cells

2021 \ 2011									Total 2021
Uninhabited	**1005**	**158**	**8**	0	0	0	0	0	**1171**
Very low density rural	**91**	**526**	**43**	0	0	0	0	0	**660**
Rural low density	0	**104**	**443**	**6**	**9**	**1**	0	0	**563**
Rural	0	0	**34**	**96**	0	**7**	0	0	**137**
Suburban	0	0	**19**	**2**	**81**	**13**	**2**	0	**117**
Semi-dense	0	0	**13**	**40**	0	**8**	0	0	**61**
Dense	0	0	0	0	**11**	**5**	**23**	0	**39**
City center	0	0	**2**	0	**13**	0	**4**	**28**	**47**
Total 2011	**1096**	**788**	**562**	**144**	**114**	**34**	**29**	**28**	**2795**

4.
308 settlements, one of which contains 27% of the population!

The use of 1 km² cells, rather than municipal divisions, has enabled us to highlight the fact that population growth is far from uniform within municipalities, and is in fact largely the result of a process of densification of already urbanised areas. This densification itself is not uniform, particularly in the largest urban areas.
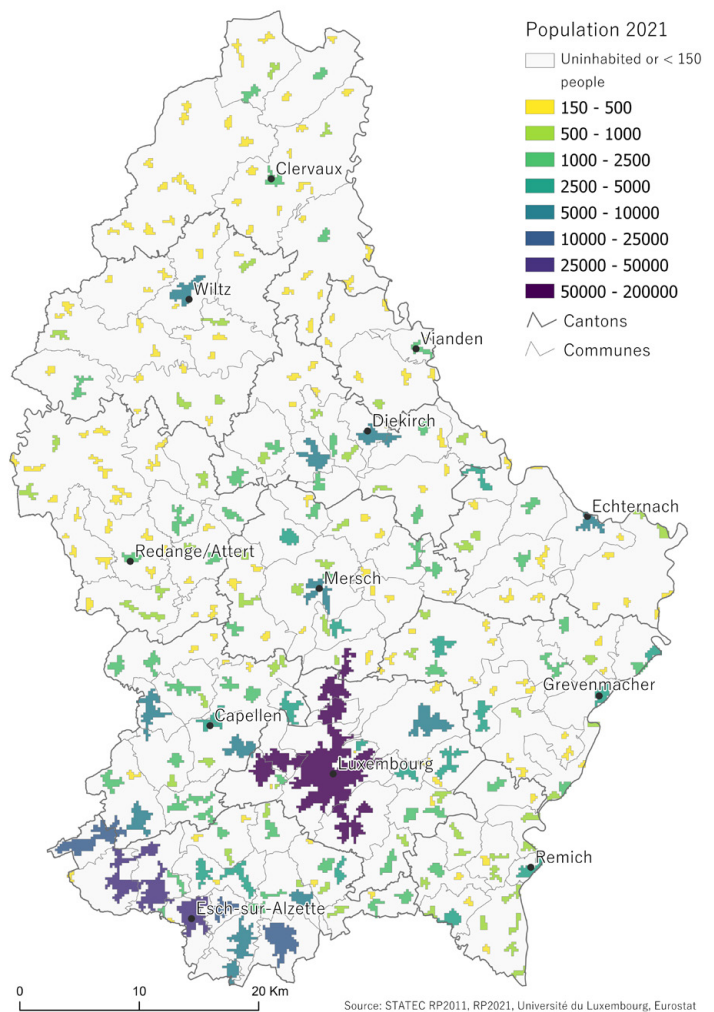
However, the boundaries of these urban areas, whether large or small (urban clusters, rural areas or urban centers), are not directly covered by the previous approach and, at best, can be visualised to within 1km. It is also important to look at any continuity of buildings. This continuity, or conversely discontinuity, is, for example, important for the provision of infrastructure (sewers, pavements, cycle lanes), or the possibility of creating roads to allow densification, or on the contrary the conservation of natural urban breathing spaces.

In this final section, we zoom in even further to identify settlement nuclei and the limits of their extension, sometimes also referred to as morphological agglomerations. Here we are working on the basis of 200m cells (a distance widely accepted in the literature for identifying urban breaks).

The calculation method is fairly simple. Using the population counted in 200m cells (nested within 1km cells), we consider all cells with at least 6 inhabitants, giving a density of 150 inhabitants/km² over 200m x 200m. These cells are then aggregated together when they have at least one side in common, forming clusters of contiguous cells[8] . We then retain the clusters containing a minimum of 150 inhabitants. Outside these clusters of at least 150 people, the population is said to be dispersed. The contours of the clusters thus defined are independent of any administrative boundary and of the 1km² grid.

Map 7 shows the nuclei on a national scale. There are 308 of them, which we characterise according to 8 population classes (less than 5,000 inhabitants in green/yellow, and more than 5,000 in blue/purple). Their number, surface areas and average densities are shown in Table 4. Mapping is all the more revealing and indicative of local discontinuities when it is possible to zoom in on particular clusters. For this, we refer you to the interactive Geoportal.

Map 7. Mapping of habitat nuclei in 2021

Source: STATEC RP2011, RP2021, Université du Luxembourg, Eurostat

Overall, the results are obviously similar to the degree of urbanisation. This time, however, there is a clearer focus on the boundaries of the aggregates/agglomerations. We can thus distinguish, for example, the constituent nuclei of the Nordstad, we can identify distinct elements within the southern urban area rather than a continuous urban form, and we can specify the sprawling extensions of the core of Luxembourg-City. The rest of the country is covered fairly evenly by nuclei with fewer than 5,000 inhabitants.

---

8 The method considers continuity in 4 directions (N, S, E and W), ignoring diagonals and roads. The robustness of the result was assessed by increasing the minimum by 6 inhabitants and by considering the diagonals. These variations do not make any significant qualitative changes to the result.

The most striking fact in terms of population is the importance of the core area center on Luxembourg City (in dark purple). This core alone accounts for 27% of the country's population, or 173,907 inhabitants. While 1 in 5 people live in the commune of Luxembourg, more than 1 in 4 live in the same built-up area stretching from Strassen and Bertrange in the west, to Walferdange, Steinsel and Lorentzweiler in the north, and Hesperange in the south-east.

The map also shows that the distribution of the population is far from being as homogenous as the urbanisation cells might suggest. In fact, there are population centers of varying sizes and areas, connected by continuous population corridors that are sometimes very fine, as is the case between Itzig and Hesperange or between Bofferdange and Heisdorf, for example. Junglinster is also an interesting example, since the semi-dense town as defined by the OECD is made up of two distinct population nuclei.

In the south, the Esch-sur-Alzette settlement is quite small (similar to Niederanven, for example, to the east of Luxembourg City), despite its large population. The discontinuity with Schifflange or Belval is marked here by industry, whereas it is often the forest or agriculture that marks the breaks. In the southern conurbation, it is in fact the nucleus of Differdange that represents the greatest continuity and is morphologically unified with Sanem, Niederkorn, Soleuvre or Belvaux through fine corridors. Further west, the core formed by Pétange and Rodange remains just separated from the Kaerjeng core.

Apart from the densely populated nuclei of Luxembourg City and the mining south, the importance of the nuclei of the canton capitals, such as Wiltz, Diekirch and Echternach, in relation to their direct vicinity (and therefore a local structural effect), can be seen here, but also the nuclei gravitating around Luxembourg City (Mersch to the north, Mamer and Steinfort to the west, Niederanven to the east, and Bettembourg to the south, but less clearly as an interface with the southern basin), all of which are themselves surrounded by smaller nuclei. Finally, these small and less populated nuclei are found sparsely but uniformly throughout the country. These are more isolated, i.e. without the benefit of a nucleus of 5,000 or more inhabitants, in the cantons of Clervaux to the north, Rédange to the west, Grevenmacher or Remich to the east.

Table 4. Information by population nucleus category (2021)

Category of population nuclei	Km²	Density	Number of locations	Number of cores	Population	Cumulative population	Cumulative population (% of total)
50000 - 200000	43.8	3970.5	15	1	173907	173907	27%
25000 - 50000	16.9	4655.9	7	2	78778	252685	39% (+12%)
10000 - 25000	14.7	3702.9	6	3	54506	307191	48% (+8%)
5000 - 10000	35.6	2399.9	22	12	85437	392628	61% (+13%)
2500 - 5000	28.6	2049.9	16	17	58709	451337	70% (+9%)
1000 - 2500	55.6	1456.9	53	53	81004	532341	83% (+13%)
500 - 1000	38.8	1125.1	45	64	43608	575949	89% (+7%)
150 - 500	57.1	810.6	101	156	46301	622250	97% (+7%)
Total cores	*291.2*	*2137.1*	*265*	*308*	*622250*		
Dispersed population	2294.8	9.3	299	0	21691	643941	100 (+3%)
Total	**2586**	**249**	**564**	**308**	**643941**		**100.00**

In addition to the map, the statistical aggregates (Table 4) are also revealing.

The first observation, highlighted earlier, is that Luxembourg City is a very large core. It has 4 times the population of the second core (Differdange with 44,589 inhabitants) and 5 times that of the third core (Esch with 34,189). Between them, they account for four out of every ten inhabitants. If we add the 3 other nuclei with more than 10,000 inhabitants, all located in the south (Pétange, Dudelange, Schifflange), 48% of the total population is found in just 6 nuclei. In addition to the trends towards local densification that we have identified using other sub-municipal methods, this is a highly agglomerated population structure.

At the other end of the scale, only 3.4% of the population (21,691 people) live dispersed, i.e. outside one of the 308 nuclei. That's not a lot, and it's very good news in terms of spatial planning and the fragmentation of natural areas. More anecdotally, but rather surprisingly, this dispersed settlement still covers almost half the list of localities.

Thirdly, the smallest nuclei, with between 150 and 500 inhabitants, spread out evenly as we have seen, are logically the most numerous but in the end account for only 7.2% of the population over 57 km². Of equal importance in terms of surface area are the nuclei of 1,000 to 2,500 inhabitants, covering 55 km², but housing almost twice the population. It will be particularly interesting to see how these very small nuclei evolve and by whom they are inhabited, compared with the denser nuclei, which probably offer additional services and opportunities. Despite the strong agglomeration at the top of the urban hierarchy, nuclei with fewer than 2,500 inhabitants still account for 26.5% of the total population.

Finally, we should note the extent to which the redefinition of the urban fabric, as close as possible to the contours of the habitat, through these cores, changes the usual notion of density that we know at the scale of the territory or the municipalities. Where maps 3A and B showed high densities (in excess of 1,000 inhabitants/km²), this threshold is well exceeded on average for all but the smallest nuclei. Here we are much closer to densities as perceived by the population and to net densities. Also, if this close density increases on average with the population of the cores, it is only up to a certain point. Among the large nuclei, for example, Esch-sur-Alzette is by far the densest, with 6,475 inhabitants/km², compared with 3,970 for Luxembourg City and 3,830 for Differdange. Regardless of surface area and population, the most densely populated nuclei include the small nucleus of Belval, with a density equivalent to 5,328 inhabitants/km², and the nucleus around the Kirchberg primary school, with 6,139 inhabitants/km².

Conclusions and outlook

Thus, the differences in density across and within municipalities, as well as the comparative application between 2011 and 2021 of the typology by degree of urbanisation, show that demographic growth reinforces the country's existing urban structure, consisting of a main urban center (the conurbation of Luxembourg City), a conurbation to the south and the Nordstad. In addition, over the intercensal period, the urban structure has not fundamentally changed, with shifts mainly towards higher degrees of urbanisation and from rural to urban areas, due in particular to the addition and concentration of population in urban clusters. The urban centers have become denser and, especially the capital, have extended into their immediate periphery. A large part of the territory remains sparsely populated, but even in these rural areas, the population remains concentrated in sparse nuclei, and growth tends to reinforce existing clusters. Classification according to degree of urbanisation, like the tracing of continuous settlement nuclei on a finer scale, highlights the demographic importance of the country's main core around the capital, which is expanding towards the north and west. This urbanised core is home to more than one in four of the country's inhabitants, but is not as densely populated as the cores of the southern conurbation.

These classification analyses of population distribution based on the latest censuses and its urban structure open up undeniable research opportunities. For example, it would be interesting to compare these structures with land resources and their consumption over recent decades in Luxembourg. In this respect, the work carried out by the Observatoire de l'Habitat (see https://logement.public.lu/fr/observatoire-habitat.html) would be extremely useful, particularly with regard to changes in the amount of land consumed. In the same vein, all these data could also be enriched through the General Development Plans (PAG), in order to identify the degree of urbanisation taking place (or not) within the perimeters of each municipality. It would also be possible to observe how population trends at sub-municipal level follow the particular structures of the built-up stock and/or the dynamics of filling in the PAGs.

Furthermore, by using the OECD classification, it is possible to capture the rural-urban continuum on an international scale and compare it with that of Luxembourg, but also homogeneously over time. Without going into detail, some OECD studies already point to differences in quality of life depending on the type of urban or rural zoning. To give just one example from 111 countries: almost 19% of urban dwellers are satisfied with their lives, compared with 16.5% of rural dwellers. Furthermore, satisfaction with life in towns and semi-dense areas (17%) is lower than in cities, but higher than in rural areas (see OECD 2020, p.41).

Finally, it is clear that these urban classifications and typologies will subsequently be used to work on the various issues of socio-demographic, economic or accessibility (to services, etc.) inequalities that may exist in the Grand Duchy. One of the Statec's forthcoming publications, for example, will look at the place of foreigners and migratory flows in the city according to location criteria. For example, by taking up the groupings of the composition of the migratory background (see Docquier et al. 2023), it will be possible to see whether Europeans born in Luxembourg to two foreign parents are more likely to be found in the urban center or in semi-dense areas.

Bibliography

Docquier F., Szymanska A. Chauvel L., Le Bihan E., Pigeron-Piroth I., Schiel K. (2023). RP 1er résultats 2021 N°06 « L'arrière-plan migratoire de la population du Grand-Duché de Luxembourg : structure et implications démographiques » [En ligne], 2023, mis en ligne le 12/10/2023, consulté le 09/11/2023. URL : https://statistiques.public.lu/fr/recensement.html

Eurostat (2021). *Appliquer le degré d'urbanisation, Manuel méthodologique destiné à définir les agglomérations, les villes et les zones rurales à des fins de comparaisons internationales*.

Gerber P. et Klein O. (2009). Des localités changeantes aux populations mouvantes. Dans Bousch P. et al. (dir.) *Der Luxemburg Atlas / Atlas du Luxembourg* (p. 26-27). Emons Verlag.

OECD / European Commission (2020). *Cities in the World. A new perspective on urbanisation*. OECD Urban Studies, OECD Publishing, Paris, https://doi.org/10.1787/d0efcbda-en

ONU (2015). *Transformer notre monde : le Programme de développement durable à l'horizon 2030*. Nations unies, Assemblée générale, A/RES/70/1, New York.

TO QUOTE THIS ARTICLE

Electronic reference

RP 1st results 2021 N°07 "Spatial distribution of the population in Luxembourg: from the sub-municipal scale to the urban structure" [Online], 2023, posted online on 11/23/2023, consulted on xx/xx /xx.

URL : https://statistiques.public.lu/fr/recensement.html

En savoir plus sur le recensement : statistiques.public.lu/fr/recensement