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FROM STANDARDS OF INTERNATIONAL LAW FOR
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Abstract

As space activities continue to develop and increase in number, so do environmental concerns in outer space. For decades now, humanity has continuously sent satellites into Earth orbits without caring for potential environmental consequences in outer space. Ultimately, these actions have proven to raise issues regarding the sustainability of the activity; issues which are now being addressed legally. Satellites were the first venture of humanity into space, and it is fair to admit we did not know better at the time. We do now. With the development of new types of space missions, such as space resources-related activities, it is safe to assume that new serious environmental problems will arise as well. Based on previous experience both on Earth and in outer space, it is logical, but also imperative, to question the environmental impact of these space resources activities and to consider legal solutions to promote and facilitate their sustainability. Accordingly, this research assesses the applicability of existing rules and mechanisms promoting environmental protection and sustainability in outer space to the case of the exploitation of space resources. To that end, an array of mechanisms is considered such as the framework of the UN Space Treaties, international environmental law, non-legally binding instruments, such as the space debris mitigation guidelines and COSPAR's planetary protection policy, as well as national space legislations. Ultimately, this work aims at drafting the roadmap for the environmentally sustainable exploitation of space resources from a legal standpoint. It recommends the adoption of a mix of interdisciplinary approaches which balances a national effective approach with international guiding rules.

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Contents

Abstract.....	i
Acknowledgments.....	ii
Contents.....	iii
Abbreviations.....	viii
Introduction.....	1
1. Research question.....	5
2. Methodology.....	8
3. Definitional Issues.....	10
4. Structure.....	12
5. The Way Forward.....	13
Chapter 1 Uncertain Definitions, Real issues.....	14
1. What Is the “Outer Space Environment”?.....	15
1.1. Key notions.....	17
1.1.1. “Outer Space”.....	17
1.1.2. “Environment”.....	22
1.2. Identification of key concepts.....	26
1.2.1. Environmental issues related to space resources activities.....	27
1.2.1.a. Space debris.....	28
1.2.1.b. Biological, chemical, and radiological contamination.....	31
1.2.1.c. Over-exploitation of space resources.....	34
1.2.2. Ethical approaches to (outer space) environmental protection.....	36
1.2.2.a. Anthropocentrism.....	37
1.2.2.b. Ecocentrism.....	40
2. What is “sustainability” in outer space?.....	44
2.1. Space sustainability.....	48
2.2. Sustainable development.....	52
2.3. Sustainability as a conceptual framework.....	66

3. Conclusion.....	73
Chapter 2 International Law	76
1. International space law.....	78
1.1. Overview of the sustainability factor	81
1.2. Environmental regime	84
1.2.1. Article IX of the Outer Space Treaty.....	84
1.2.2. Article 7 of the Moon Agreement	96
1.3. Conclusion	100
2. International environmental law.....	101
2.1. Precautionary Principle.....	104
2.1.1. Components	110
2.1.1.a. Potentially serious or irreversible harm to the environment.....	110
2.1.1.b. Uncertainty.....	112
2.1.1.c. Regulatory action.....	113
2.1.2. Burden of proof.....	115
2.1.3. Legal status.....	116
2.1.4. Conclusion	120
2.2. Due diligence.....	122
2.2.1. General obligation	124
2.2.2. ILC's Articles on Prevention of Transboundary Harm.....	129
2.2.3. Accessory obligations.....	136
2.2.4. Conclusion	138
2.3. Environmental impact assessment.....	140
2.3.1. Implementation.....	143
2.3.2. Conclusion	148
2.4. Conclusion	151
3. Conclusion.....	152
Chapter 3 Non-legally binding international instruments.....	155
1. COSPAR's Policy on Planetary Protection	159
1.1. History and Evolution of COSPAR's Policy	160
1.2. COSPAR's Planetary Protection Policy, as approved in 2021	164
1.3. Organizational Structure	166
1.4. Legal status of COSPAR's policy	170

1.5. Conclusion	173
2. The UN Nuclear Power Source Principles	175
3. Space Debris Mitigation Guidelines	179
3.1. The development of guidelines by the IADC	183
3.2. The adoption of guidelines by the UNCOPUOS	186
3.3. The creation of ISO standards	189
3.4. Conclusion	190
4. The Long-Term Sustainability Guidelines	192
4.1. History and Evolution	193
4.2. Content of the LTS Guidelines	196
4.2.1. Preamble	197
4.2.2. Section A on policy and regulatory framework for space activities	203
4.2.3. Section B on safety of space operations	206
4.2.4. Section C on international cooperation, capacity-building and awareness	207
4.2.5. Section D on scientific and technical research and development	208
4.3. Implementation of the LTS Guidelines	209
4.4. Conclusion	213
5. Conclusion	217
Chapter 4 National Laws	220
1. General national space legislations protecting the outer space environment	225
1.1. Belgium	226
1.1.1. Scope of the law	232
1.1.1.a. Material scope	232
1.1.1.b. Territorial scope	234
1.1.1.c. Personal scope	235
1.1.2. Authorization mechanism	236
1.1.3. Environmental component	239
1.1.4. Conclusion	245
1.2. Finland	247
1.2.1. Scope of the law	248
1.2.2. Authorization mechanism	251
1.2.3. Environmental component	254
1.2.4. Conclusion	257

2. Specific national legislations regulating space resources activities	258
2.1. United States of America	259
2.1.1. Scope of Title IV of the law	260
2.1.1.a. Definitional issues addressed in Title IV	261
2.1.1.b. Commercial purpose of Title IV.....	263
2.1.1.c. Relation of Title IV to Article II of the Outer Space Treaty	264
2.1.2. Authorization mechanism.....	266
2.1.2.a. Proposal of the White House Office of Science and Technology Policy.....	267
2.1.2.b. The American Space Commerce Free Enterprise Act of 2019.....	271
2.1.3. Environmental component.....	276
2.1.3.a. Space debris mitigation	276
2.1.3.b. The US planetary protection policy.....	278
2.1.4. Conclusion	282
2.2. Luxembourg	284
2.2.1. Scope of the law	287
2.2.2. Authorization mechanism.....	288
2.2.3. Environmental component.....	291
2.2.4. Conclusion	294
2.3. United Arab Emirates.....	295
2.3.1. Scope of the law.....	296
2.3.2. Authorization mechanism.....	299
2.3.3. Environmental component.....	301
2.3.3.a. Space debris.....	302
2.3.3.b. Planetary protection	304
2.3.4. Conclusion	305
2.4. Japan	306
3. Conclusion.....	311
Conclusion.....	315
1. Overview of the main findings	316
1.1. Design of a conceptual framework for the environmental sustainability of space resources activities	317
1.2. Contributions of space law and international environmental law to the environmental sustainability of space resources activities	318

2. From research question to research outcomes	325
2.1. Standards supporting the environmental sustainability of space resources activities	326
2.2. Implementation of the sustainability standards	327
3. Future perspectives	330
Appendix 1. Berlin II Guidelines	334
Bibliography	336
1. Treaties and International Agreements	337
2. International Law cases	339
3. United Nations Documents	340
4. National instruments and cases	346
5. Books.....	349
6. Book Chapters & Works in Collection	351
7. Journal Articles	358
8. Miscellaneous	368

« La protection de l'environnement n'est pas seulement indispensable pour notre avenir, elle représente la plus grande opportunité économique de notre époque. »

— Bertrand Piccard

Introduction

Over the past 60 years, space activities have grown and evolved drastically. In the beginning, space is the exclusive domain of States and a matter of national prestige.¹ The venture is government-driven, with few States having space capabilities;² and activities focus mainly on space research and development, with environmental concerns in outer space being limited to planetary protection issues.³

In the 1970s, the landscape shifts with private actors gradually entering the space market.⁴ Space activities become about commercial uses of space technology, such as telecommunication and remote sensing applications.⁵ The period is marked by the emergence of commercial telecom operators, like Intelsat and SES Astra.⁶ Space progressively leaves the exclusive domain of States, though they remain a driving force. The development of space activities and the democratization of knowledge cause another shift in the space economy, with private actors gradually becoming the leaders of the sector in the 21st century.⁷ In the past, these activities were driven by political or social forces where they are now bound by market forces and financed privately.⁸

This “NewSpace” era we live in is characterized by the privatization and evolution of space

¹ Walter Peeters, *Evolution of the Space Economy: Government Space to Commercial Space and New Space*, 19 *ASTROPOLITICS* 206, 208–210 (2021).

² In the 1960’s, only three States possess orbital launch capabilities: the Soviet Union, the United States of America and France, with the launch of *Asterix* in 1965. They are joined by Japan, China, and the United Kingdom in the 1970s. Some States, like Italy and Canada, proved capable to manufacture and operate a satellite in the 1960s but relied on the United States for the launch. As of mid-2022, only 16 space agencies, out of the 72 existing in the world, have the ability to carry out a space launch. Countries with Space Programs 2022, *WORLD POPULATION REVIEW* (2022), available [online](#); I-Shih Chang, *Overview of World Space Launches*, 16 *JOURNAL OF PROPULSION AND POWER* 853 (2000); GTS Editorial, *Space Agencies Around the World*, *GOING TO SPACE* (2022), available [online](#).

³ Report of the *Ad Hoc* Committee on the Peaceful Uses of Outer Space, UNGAOR, 14th Sess., at 76, UN Doc. A/4141 (1959); Peeters, *supra* note 1, 208–10.

⁴ Andrea Sommariva, *The Evolution of Space Economy: The Role of the Private Sector and the Challenges for Europe*, ISPI (2020), available [online](#).

⁵ Peeters, *supra* note 1, 210–11.

⁶ *Id.*

⁷ *Id.*, 211–13; Sommariva, *supra* note 4.

⁸ Ken Davidian, *Definition of NewSpace*, 8 *NEW SPACE* 53, 53–54 (2020). The year 2019 is representative of this shift. That year, commercial applications constituted two-thirds of the space economy turnover, with military and institutional orders only representing one-third of the total profit. Sommariva, *supra* note 4.

activities. Private entities now possess space capabilities on par with States', both financially and technologically. In the last two decades, they have demonstrated their ability to *inter alia* launch objects and humans into space, and to deploy mega-constellations.⁹ Private actors also act as a driving force, by pushing commercial activities beyond the limits of Earth orbits. One such example is the case of space resources activities.

Also known as “space mining”, space resources activities consist in extracting and exploiting *in situ* resources from celestial bodies for commercial purposes; it does not include scientific extraction and exploitation of these resources.¹⁰ The primary goal is to exploit these natural resources to develop further our long-term presence in outer space, both technologically and humanly. On a secondary level, space resources activities are seen as an opportunity to import to Earth resources we sorely lack—sometimes because of terrestrial overexploitation—and will need.¹¹ Outer space possesses abundant quantities of iron and platinum group metal resources that are scarce or non-existent on Earth.¹² Thus, space resources activities are thought out as a “second chance” for Earth, an opportunity to balance humanity’s careless abuse of the environment in its industrial rush.

Beyond terrestrial concerns, space resources activities are a necessity when considering longer missions in outer space, especially ones that include sending out humans. Human presence in space requires meeting human basic needs: food, water, and breathable air; all of which are naturally absent in space. It would be unrealistic to believe that Earth could generate the ecological resources required to sustain humanity both on Earth and in space. Already, humanity’s demands on Earth exceed what it can naturally regenerate.¹³ This is why the

⁹ Top 3 Biggest Private Space Companies, EARTH.COM (2022), available [online](#).

¹⁰ See Commercial Space Launch Competitiveness Act, 51 USC §51302 (US) [CSLCA]; Loi du 20 juillet 2017 sur l’exploration et l’utilisation des ressources de l’espace, art. 3, Mémorial A No 674, 28 juillet 2017 (LU) [SRL].

¹¹ Carol Dahl, Ben Gilbert & Ian Lange, *Mineral Scarcity on Earth: Are Asteroids the Answer*, 33 MINER ECON 29 (2020).

¹² Kevin MacWhorter, *Sustainable Mining: Incentivizing Asteroid Mining in the Name of Environmentalism*, 40 WM. & MARY ENVTL. L. & POL’Y REV. 645, 652 (2016).

¹³ In 2022, Earth overshoot day, *i.e.*, “the date when humanity’s demand for ecological resources and services in a given year exceeds what Earth can regenerate in that year” fell on July 28. “Earth Overshoot Day,” Overshoot Day, available [online](#).

discovery of water in outer space, in particular, has been a game changer.¹⁴ Whereas, on Earth, water covers about 70 percent of the planet's surface, in space, it is a rarefied but still undeniably essential resource for life support.¹⁵ It can be used to grow food and filtered to make drinkable water and breathable air.

In themselves, these resources have an incredibly high economic worth, as illustrated by the Japanese Aerospace Exploration Agency (JAXA)'s exploration of the asteroid Ryugu in 2018. The asteroid's economic worth was estimated at 82,7 billion dollars.¹⁶ Nonetheless, to assess the true economic value of space resources activities, the value of the resources themselves is not sufficient. It is only the first step. It is also necessary to consider if there is a demand for them and to assess the costs and feasibility of their process and transportation.¹⁷ Confining himself to the near-Earth asteroids (NEA) population, Lewis draws numbers to estimate how many people could be sustained in space, in the long-term, using these resources.¹⁸ He concludes that: "the NEA population could support approximately 400 billion people at a generous level of affluence from now until the Sun enters the red giant phase several billion years from now".¹⁹ Using NEA's resources, humanity could shield itself from radiation and hydroponically cultivate food and plants, and recreate nutrients and minerals necessary for our health.²⁰ Materially, we would be able to build habitat and make propellant using the Helium-3 naturally present in lunar regolith and other places.²¹ These are ample possibilities: the expression "space resources activities" theoretically encompasses a wide range of activities that future practice will have to backup.

¹⁴ NASA, *Is There Ice on Other Planets?*, NASA SPACE PLACE, available [online](#).

¹⁵ However, as emphasized by NASA on Twitter in May 2022, "71% of Earth's surface is water, but only 3.5 percent is drinkable freshwater!". @NASAEarth, *No Wonder It's Called the Blue Marble!*, TWITTER (2022), available [online](#).

¹⁶ *A la conquête de l'espace*, CHAMBER OF COMMERCE LUXEMBOURG (2019), available [online](#).

¹⁷ JOHN S. LEWIS, *ASTEROID MINING 101: WEALTH FOR THE NEW SPACE ECONOMY VIII* (David Gump ed., 2015).

¹⁸ *Id.*

¹⁹ LEWIS, *supra* note 17 at 101–102.

²⁰ *Id.* at 102–107.

²¹ *Id.* at 109.

1. RESEARCH QUESTION

The privatization and the resulting development of new space activities have not only changed how activities are conducted in outer space but also given rise to unanticipated environmental issues. The most striking example is the space debris problem—*i.e.*, the agglomeration of non-functional space objects—in, and the congestion of, low-Earth orbit (LEO). The rise of commercial activities in outer space has led to an intensification of satellite-based activities, most of which are focused in LEO. It means that the number of space objects launched into space, which has increased exponentially over the last 60 years, will continue to grow.²² From an economic and social perspective, these developments are positive as great benefits can be derived from space activities. The problem is that States have initially failed to consider the impact of increased activities in LEO from an environmental perspective. Such a view would have reminded operators that Earth orbits are a limited natural resource and, as such, need to be managed rationally. The increased pace of satellite activities, in addition to the increased generation of debris, is pushing the capacity of LEO to sustain operations in the area. In other words, as the international community has grown acutely aware of it over the last decade, the long-term sustainability of space activities is threatened.²³

From a legal standpoint, this awareness is reflected in the adoption of new non-legally binding international instruments under the umbrella of the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS). We note, for instance, the adoption of a set of guidelines specifically dealing with the necessity to mitigate space debris in orbit in 2007.²⁴ Similarly, three years later, the Committee establishes a “Working Group on the Long-term

²² According to a study published by Euroconsult in 2021, it is expected that an average of 1,700 satellites will be launched per year by 2030. This represents a fourfold increase over the last decade. Saly Sadek, *New Satellite Market Forecast Anticipates 1,700 Satellites to Be Launched on Average per Year By 2030 as New Entrants and Incumbents Increase Their Investment in Space*, EUROCONSULT (2021), available [online](#).

²³ Unedited transcript, UNCOPUOS, 536th Meeting, at 23-26, UN Doc. COPUOS/T.536 (2005); Unedited transcript, UNCOPUOS, 593rd meeting, at 12, UN Doc. COPUOS/T.593 (2008); Gérard Brachet, *Protecting our space interests*, 10 ROOM, 2016.

²⁴ Report of the Committee on the Peaceful Uses of Outer Space, UNGAOR, 62nd Sess., Supp. No. 20, at 117-118 and Annex, UN Doc. A/62/20 (2007) [“UNCOPUOS’ SDM Guidelines”].

Sustainability of Outer Space Activities” under the Scientific and Technical Subcommittee (UNCOPUOS STC) to consider the broader topic of space sustainability. The outcome is the adoption, by 2019, of a set of 21 non-binding guidelines.²⁵

In practice, it is apparent that the question of the long-term sustainability of space activities—and *a fortiori* of the outer space environmental protection—is linked narrowly to the space debris problem. It is the main focus in the large majority of the literature relating to the protection of the outer space environment. A supplementary topic, as regards to celestial bodies, is biological contamination.²⁶ Bringing live organisms to other planets has been a concern since the beginning of space activities, especially when it was still unknown whether there is life elsewhere in our solar system.

These different approaches have in common to focus on what we know of current problems. However, they might represent a too narrow perspective to ensure the sustainability of activities in general and of space resources activities in particular: a more open understanding of sustainability is required. Because our knowledge of outer space remains limited, even more so when involving new space activities like space mining, uncertainty is a tempting excuse to avoid regulating activities from an environmental perspective. Still, it is eventually counterproductive when aiming for sustainability—a concept that relies on a careful balance between socio-economic development and the protection of the environment. Drawing from our experience on Earth, it is indubitable that exploiting natural resources in outer space will have an impact on the surrounding environment with a host of potential issues which go beyond the question of debris and the one of contamination, such as the risk of over-exploitation.

If the reality of environmental concerns needs to be addressed from the beginning, it is because operating space resources missions without actively considering its environmental impact in outer space will only lead to outcomes similar to the one created by space debris.

²⁵ Report of the Committee on the Peaceful Uses of Outer Space, UNGAOR, 74th Sess., Supp. No. 20, at 163 and Annex II, UN Doc. A/74/20 (2019) [“LTS Guidelines”].

²⁶ See generally COSPAR’s policy on planetary protection *infra* in Chapter 3.

Admittedly, there seems to be a common understanding that space resources activities should be sustainable and that it involves considering their environmental impact on outer space.²⁷ While this is a welcome start, we need more than theoretical considerations. The problem of space debris began to be discussed in the late 1970s and early 1980s.²⁸ It, then, took the international community 15 years to acknowledge the issue as a priority matter in the UNCOPUOS, and almost as long to adopt formal mitigation guidelines.²⁹ Overall, about 30 years passed between the moment the international community realized there was a problem and the adoption of a formal solution. The question for new activities is whether we can shorten the lag period between the acknowledgment of problems and the implementation of solutions.

A logical path would be to anticipate the problem at the outset and act on it, rather than wait for it to occur, especially if it takes another 30 years to solve it. As to the how, to quote Williamson, “[u]nless the space community, including its commercial segment, suddenly experiences a collective epiphany, there will eventually have to be guidelines, policies, sanctions or laws to protect the space environment”.³⁰

The following research seeks to anticipate the inevitable framework that will need to be put in place and provides some insight as regards to its main orientations in the field of space resources activities. As such, it aims to answer the following question:

²⁷ See e.g. Mahulena Hofmann & Federico Bergamasco, *Space Resources Activities from the Perspective of Sustainability: Legal Aspects*, 3 GLOBAL SUSTAINABILITY (2020); 38 THE IAA COSMIC STUDY “PROTECTING THE ENVIRONMENT OF CELESTIAL BODIES,” (Petra Rettberg, Mahulena Hofmann, & Mark Williamson eds., 2010); HSRGWG, *Building Blocks*, in BUILDING BLOCKS FOR THE DEVELOPMENT OF AN INTERNATIONAL FRAMEWORK FOR THE GOVERNANCE OF SPACE RESOURCES ACTIVITIES: A COMMENTARY 7 (Olavo de O. Bittencourt Neto et al. eds., 1 ed. 2020). Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids for Peaceful Purposes, sec. 10 (2020).

²⁸ LOTTI VIHKARI, THE ENVIRONMENTAL ELEMENT IN SPACE LAW ASSESSING THE PRESENT AND CHARTING THE FUTURE 38 (2008).

²⁹ UNCOPUOS’ SDM Guidelines, *supra* note 24.

³⁰ Mark Williamson, *Scope and Methodology*, 38 in THE IAA COSMIC STUDY ON PROTECTING THE ENVIRONMENT OF CELESTIAL BODIES 7 (Mahulena Hofmann, Petra Rettberg, & Mark Williamson eds., 2010).

- **How does sustainable development of space resources activities compel us to create legal standards for uncertain environmental consequences?**

The main question is further broken down into three sub-questions:

- To what extent is space law efficient in addressing environmental threats in the use of space resources?
- To what extent can international environmental law contribute to the sustainable development of space resources activities?
- Which normative approach has the most value in ensuring the sustainability of space resources activities, based on the issues at stake?

2. METHODOLOGY

The creation of legal standards for the sustainability of space resources activities presupposes that there does not already exist rules fulfilling this goal or that they exist but are ineffective in regulating environmental contingencies of space resources activities. This research examines what kind of environmental problems may arise from space resources activities and which norms of international law might be applicable in addressing these threats within the framework of sustainability. It further considers domestic space legislations that directly address space resources activities or that are particularly relevant from an environmental perspective.

In order to determine the existence and content, in international law, of a rule protecting the outer space environment, the research primarily refers to formal sources of international law. These sources are listed in Article 38 paragraph 1 of Statute of the International Court of Justice (“ICJ Statute”),³¹ and include treaties, international custom, and general principles of international law; doctrine and jurisprudence being “subsidiary means for the determination of

³¹ Statute of the International Court of Justice, art. 38§1, [ICJ Statute].

rules of law”.³² In particular, the work reflects on the framework provided both by the *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*³³ (“Outer Space Treaty”) and by the *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies*³⁴ (“Moon Agreement”); both treaties have entered into force and regulate activities carried out in outer space. Moreover, since pursuant to Article III of the Outer Space Treaty, international law applies to space activities—meaning that international obligations contracted on Earth are still applicable and binding when States operate in outer space—the scope of the research further requires turning to other bodies of international law before creating unnecessary rules. In the present case, turning to international environmental law appears particularly opportune. Thus, the work further considers potentially relevant norms of international environment law as a means to fill the gaps of international space law.

However, to strictly limit our analysis of international law to its formal sources would amount to ignoring a large part of international space law. Indeed, some scholars consider that the development of international law has led to the expansion of its sources. In particular, when considering sources of international law applicable to space activities, Jakhu et al. do not restrict their study to sources outlined in the ICJ Statute.³⁵ They consider *inter alia* the value of soft law—*i.e.*, non-legally binding instruments—and of resolutions adopted by the United Nations (UN). These same sources have been used extensively since the adoption of the last UN space treaty in 1979 to govern space activities. Thus, the research also takes into consideration the practice of States by reference to soft law written instruments from international organizations acting in the space sector, such as UNCOPUOS resolutions and the work of the Committee on Space Research (COSPAR).

³² *Id.*, art. 38§1, d.

³³ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, *entered into force* on October 10, 1967, 18 U.S.T. 2410, 610 UNTS 205 [“Outer Space Treaty”].

³⁴ Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, *entered into force* July 11, 1984, 1363 UNTS 3 [“Moon Agreement”].

³⁵ Ram S. Jakhu, Steven Freeland & Kuan-Wei Chen, *The Sources of International Space Law: Revisited Space Law*, 67 ZLW 606, 607–608 (2018).

Accordingly, the work approaches the question of the sustainability of space resources activities from an environmental perspective on three levels: international, national, and, somewhat in between, international soft law instruments—*i.e.*, international non-legally binding instruments which States can voluntarily implement at the domestic level.

Use of treaty interpretation follows the customary rules of interpretation codified in Articles 31 to 33 of the Vienna Convention on the Law of Treaties (VCLT),³⁶ *i.e.*, textual, teleological, or systematic interpretations. When necessary, recourse is made to the jurisprudence of international jurisdictions to substantiate the interpretation of a formal source of international law.³⁷

3. DEFINITIONAL ISSUES

In order to avoid confusion, the usage of a number of terms should be clarified from the outset. “Sustainability” stands for, in the words of the International Court of Justice (ICJ), “[the] need to reconcile economic development with protection of the environment”.³⁸ Accordingly, “environmental sustainability” refers to the environmental dimension of the concept, *i.e.*, to the need to protect the environment. In the context of space resources activities, it is fundamental that space actors consider the impact of commercial exploitation of space resources on the outer space environment. Without carefully balancing the socio-economic benefits of commercial exploitation with the preservation of surrounding areas, they run the risks of compromising their and others’ ability to peacefully explore and use outer space in the future. “Space actor” and “space operator” designate the entity authorized by the State to carry out space resources missions, regardless of their public or private nature.

Additionally, using the concept of “sustainability” requires further clarifying environmental terminology. Unfortunately, in the absence of a consensus, defining the “outer space environment” is less evident than it seems. Chapter 1 attempts to find elements of definition

³⁶ Vienna Convention on the Law of Treaties, *entered into force* Jan. 27, 1980, 1155 UNTS 331 [“VCLT”].

³⁷ ICJ Statute, art. 38§1, d.

³⁸ Gabčíkovo-Nagymaros Project (Hungary v. Slovakia) (Judgement), 1997 ICJ 7 (Sept. 25).

and gives it a better-delimited meaning. Broadly understood, “outer space environment” designates, in an initial definition, natural areas potentially affected by space resources activities on celestial bodies. “Environmental degradation” denotes a negative phenomenon resulting from human activities in space, which compromises the natural environment of celestial bodies and their surroundings. “Celestial bodies” refer to any natural object within the solar system from which space actors intend to commercially extract and exploit natural resources. In the current state of business, the term includes Earth’s Moon, Mars and its moons Phobos and Deimos, as well as NEAs and asteroids from the Main Belt situated between Mars and Jupiter.³⁹ Unless specified otherwise, “Moon” refers to Earth’s sole natural satellite. “Space resources”⁴⁰ is used as an umbrella term for *in situ* abiotic resources originating from and located on celestial bodies. The term includes water but expressly excludes biological life. It applies indifferently to Lunar, Martian, and asteroid resources. “Renewable resources” designates natural resources that can be replenished to their original stock levels naturally on a human time scale. Conversely, “non-renewable resources” are exhaustible natural resources that cannot be replenished after exploitation. For this reason, “space resources” should not be considered renewable resources. Although there is scientific evidence that NEAs can be replenished to their original level, full replenishment takes about 30 million years,⁴¹ which is considerably beyond any human time scale.

In addition to the environmental terminology, there is a variety of legal terms used in this research, which stands to be clarified. “Treaty”⁴² refers to a binding international agreement concluded between States, in written form, and governed by international law. “Non-binding instruments”⁴³ designates agreements which contain political or moral commitments without

³⁹ SPACE RESOURCES.LU, OPPORTUNITIES FOR SPACE RESOURCES UTILIZATION FUTURE MARKETS & VALUE CHAINS (2018).

⁴⁰ Gabrielle Leterre, *Providing a legal framework for sustainable space mining activities*, 38, 46 (University of Luxembourg, 2017).

⁴¹ LEWIS, *supra* note 17 at 75, 91.

⁴² As it is commonly done, the definition is based on article 2§a of the VCLT, though it does not explicitly state that “treaties” are legally binding instruments; a precision that is necessary here.

⁴³ Philippe Gautier, *Non-Binding Agreements*, MAX PLANCK ENCYCLOPEDIAS OF INTERNATIONAL LAW 1 (Rüdiger Wolfrum ed., 2006).

creating legal rights or obligations. “Soft law” designates norms that range from political or moral commitments to strictly legal ones but are not enforceable as such. For the most, soft laws used in this work find their origin in the recommendations, guidelines, and resolutions adopted by international organizations, like the UNCOPUOS and COSPAR.

4. STRUCTURE

Four main chapters divide the development of this work. After the introductory remarks, Chapter 1 presents elements of definition for the “outer space environment”. It identifies potential environmental problems resulting from space resources activities and reflects on environmentalist ethical approaches to the discussion. Moreover, Chapter 1 contemplates the meaning of “space sustainability” and attempts to define a conceptual framework for sustainability that could be expanded to the exploitation of natural resources in outer space; thus, allowing to focus on the protection of the environment while keeping in mind the rationale for carrying out space resources activities.

Chapter 2 examines bodies of international law that have the potential to contribute to the sustainability of space resources activities, namely binding international space law and international environmental law. Additionally, Chapter 2 reflects on the juxtaposition of international space law to international environmental law and identifies potential gaps.

Chapter 3 concentrates on governance aspects. Since international treaties are not sufficient in themselves to deal with environmental issues, other instruments are investigated to substantiate existing international rules. It seeks solutions in other environmentally inclined international instruments developed specifically for space activities, namely so-called “soft law” space instruments.

Last, Chapter 4 considers national space legislations. In particular, it refers back to two environmentally advanced space legislations—Belgium’s and Finland’s—to create a baseline to which the four space resources national space legislations adopted so far, can be confronted. It aims to evaluate the potential of mechanisms developed at the national level in ensuring the sustainability of space resources activities. Chapter 4 is followed by concluding remarks

drawing up together the work contributions.

5. THE WAY FORWARD

Clearly, a thorough consideration of space resources activities from a legal standpoint would be a task too broad for one person and a single document. This research limits itself to the legal study of space resources activities from a legal, environmental, and sustainable perspective. It, therefore, leaves aside a variety of legal questions that arises from the activity itself—such as issues relating to liability for environmental damage, the permissibility of space resources appropriation, or dispute settlement solutions. It is further limited by the number of uncertainties that lingers over *inter alia* our small knowledge of the outer space environment, the methods of extraction that will be used on celestial bodies, and, more generally, how space mining will occur in practice. As we increase our knowledge, new legal issues will most likely arise and need to be addressed. Within these limitations, the work intends to lay the groundwork for the environmental sustainability of future space activities.

More broadly, it raises the issue of addressing legal issues regarding other NewSpace activities—*i.e.*, new activities emerging from the recent commercialization of outer space by private operators—like space tourism or future human settlements in space. Most reflective of the NewSpace area is the recent separate trips to space of billionaires Richard Branson and Jeff Bezos aboard private rockets they helped fund on July 11 and July 20, 2021. Although NewSpace activities are likely to contribute to the sustainable economic development of space activities, it remains that the discussion is predominantly focused on only one-half of this development, *i.e.*, its economic potential! Still, it will not be possible to shy for much longer from the fact that as varieties of activities develop in space, so will environmental issues.