

Space Law: History, Problems and Opportunities

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Abstract

In the 21st century, while humanity is slowly expanding into space, thanks to both national and private investments and initiatives, the inadequacies and gaps of current space law frameworks are becoming increasingly evident.

The second half of the 20th century and the early 21st century have been forever marked by groundbreaking innovations that have reshaped and changed the meaning and scope of space exploration. This evolution is shown in the preamble of the 1999 “*Space Millennium: Vienna Declaration on Space and Human Development*”, which acknowledges “that significant changes have occurred in the structure and content of world space activity, as reflected in the increasing number of participants in space activities at all levels and the growing contribution of the private sector to the promotion and implementation of space activities”¹

This paper examines the evolving challenges, mainly based upon outdated treaties, and opportunities of space law, emphasizing the need for a comprehensive, enforceable, and inclusive legal system that can balance sovereignty, ethical resource use, and the rights of future space inhabitants. Through a detailed analysis of historical treaties, technological advancements, and comparative jurisdictional approaches between the US and the EU, the paper proposes guiding principles for future space governance. It also advocates for a legal framework adaptable to rapid technological progress and capable of ensuring equitable access and sustainable use of outer space resources.

Keywords: term, term, term

¹ ‘Space Millennium: Vienna Declaration on Space and Human Development’: Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space, Vienna, 30 July 1999

I. Introduction

The 21st century has witnessed an unprecedented development in space exploration projects, not only by traditional national actors but also by different private corporations. The commercialization of space, mainly approached by companies like SpaceX, Blue Origin, and Virgin Galactic, has transformed space from a domain of governmental prestige to a frontier for economic opportunity. This shift underscores an urgent need to reassess and modernize the existing legal frameworks governing outer space, originally conceived in a period that could not possibly fathom the advancements that the following century would have brought.

In fact, the current state of space law is primarily rooted in treaties established during the Cold War era, such as the 1967 Outer Space Treaty and the 1979 Moon Agreement. While these treaties laid the foundational principles for peaceful exploration and the non-appropriation of celestial bodies, they lack specificity and enforceability in the context of modern technological capabilities and private sector involvement. Because technological advancements have changed state boundaries and their competencies, international agreement has become essential. The limitations of these treaties are increasingly apparent as nations and companies plan missions involving resource extraction and potential human settlements on the Moon and Mars, which brings us to this paper's question: How can international law evolve to provide enforceable, inclusive regulations that balance sovereignty and equitable access and use of outer space resources?

1.1 Background and Context

Space law is a specialized branch of international law that governs the activities of nations, private companies, and individuals in outer space. Rather than being a singular legal domain, like contract law, space law is multifaceted and, similar to environmental law, encompasses various legal frameworks based on the scope and nature of the issues it addresses. Since its conception, space law has significantly influenced both public and private stakeholders by setting out the principles that are applicable to all the activities that fall into space laws. In order to properly understand space law, we must observe its evolution, and, in particular, we must understand how

the various treaties have evolved the concept of space law itself².

1.2 History of Space Law

The concept of space law is deeply rooted in the evolution of aviation law, which emerged as aviation technology drastically improved during the 20th century. During this period, the advancements of aviation caused an increase in air traffic and, in order to solve this problem, jurists decided to make an analogy with the law of the sea, which was used to establish territorial zones which had freedom of flight. This change was further expanded with the affirmation of Article 1 of the Paris Convention of 1919, which introduced the “complete and exclusive sovereignty”³ of a state over its superjacent air-space⁴. The first proper separation between “air” and “space” law came in 1926, when a senior official of the Soviet Aviation Ministry, V.A. Zarzar, introduced a paper regarding the limitations of countries' sovereignty over space. In his paper he stated that there was an upper level of state sovereignty over air space, and, in order to deal with this “upper zone”, a separate legal regime would be required; in this area, international travel and interplanetary communication would be free from control by subjacent states⁵.

1.3 The Role of the United Nations

A pivotal point for space law is deeply intertwined with the advent of the space race in the mid-20th century, in particular with U.S. President Dwight D. Eisenhower, who introduced the topic at the United Nations in 1957. After the successful launch of the Soviet satellite Sputnik 1 in 1957 and the U.S. satellite Explorer 1 in 1958, both the United States and the U.S.S.R. took an active interest in the development of international space policy. This interest culminated in the UN General Assembly Resolution 1348

² Francis Lyall, Paul B. Larsen, *Space Law: A Treatise*, 3rd edition, 2024, <https://www.routledge.com/Space-Law-A-Treatise/Lyall-Larsen/p/book/9781032803395>

³ (Lyall & Larsen, 2024)

⁴ Convention on the Regulation of Aerial Navigation, Paris, 1919, https://applications.icao.int/postalhistory/1919_the_paris_convention.htm

⁵ (Lyall & Larsen, 2024)

(1958), which established the Ad hoc Committee on the Peaceful Uses of Outer Space (COPUOS).⁶

The committee was established as a permanent body in 1959, initially comprising 24 members⁷. Its primary purpose was to oversee and organize the peaceful utilization of outer space resources in order to facilitate international cooperation in this emerging field. Since its creation, COPUOS has served as a focal point for collaborative efforts in the peaceful exploration and use of outer space.

COPUOS increased to 83 in 2016, in order to equitably represent the interest of the developed and the developing countries. This number of participants, however, encumbered the decisions, slowing the rate of work.

COPUOS functions through its primary Committee and two sub-committees: the Scientific and Technical Sub-committee and the Legal Sub-committee. The latter is fundamental for the development of legal frameworks⁸.

Each sub-committee reports to the main Committee, which then annually reports to the UN General Assembly, which every year adopts a corresponding resolution, with a proceeding that normally works by consensus⁹.

Within COPUOS, proposed texts are meticulously negotiated and revised until all members are willing to accept them, allowing it to go forward. This method is used to facilitate compromise, which also means that the parties are more likely to ratify provisions they have helped shape.

⁶ Ad Hoc COPUOS had eighteen members: Argentina, Australia, Belgium, Brazil, Canada, Czechoslovakia, France, India, Iran, Italy, Japan, Mexico, Poland, Sweden, the United Arab Republic (Egypt and Syria 1958-61), the UK, the USA and the USSR. Czechoslovakia, Poland and the USSR declined to participate. These states did become members of the permanent COPUOS when it was established.

⁷ The twenty-four members were: Albania, Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Czechoslovakia, France, Hungary, India, Iran, Italy, Japan, Lebanon, Mexico, Poland, Romania, Sweden, the United Arab Republic, the UK, the USA and the USSR.

⁸ P.G. Dembling and D.M. Arons, 'Space Law and the United Nations: The Work of the Legal Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space' (1966), <https://scholar.smu.edu/jalc/vol32/iss3/2/>

⁹ (Lyall & Larsen, 2024)

While throughout its history, COPUOS has been fundamental in establishing the principles and treaties that have shaped space law, the rapid advancements in space technology, which have been exponentially increasing in the last decades, indicate that a shift may be needed.

Another fundamental moment in the development of space law was the adoption of the United Nations General Assembly Resolution 1721¹⁰, which emphasized, for the first time, that "the exploration and use of outer space should be only for the betterment of mankind and to the benefit of States irrespective of the stage of their economic or scientific development...". Among the 18 points that were outlined in the resolution, the two most important are the ones in which we can find these principles, which would later become cornerstones of space law, setting the stage for the treaties that would come in the following years. In particular it a) *Commends* to States for their guidance in the exploration and use of outer space the following principles: International law, including the Chapter of the United Nations, applies to outer space and celestial bodies; Outer space and celestial bodies are free for exploration and use by all States in conformity with international law and are not subject to national appropriation; And b) *Invites* the Committee on the Peaceful Uses of Outer Space to study and report on the legal problems which may arise from the exploration and use of outer space.

1.4 European Space Agency

Space law has also been significantly influenced by the contributions of various national space agencies, particularly in Europe, where these efforts are coordinated by the European Space Agency (ESA). The agency plays a fundamental role in the exploration of space, but most importantly it participates in the formation of space law through international agreements, with the most important one being the Space Station Agreements¹¹.

¹⁰United Nations General Assembly Resolution 1721 https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/resolutions/res_16_1721.html

¹¹ To see further information, see "International Space Station legal framework", https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/International_Space_Station/International_Space_Station_legal_framework

A legislative push came in the early 1960s when Europe realized that it was being left behind by the two main countries that were competing in the space race: the United States and the USSR. In response, the Council of Europe recommended the creation of a European agency, with the objective of promoting the peaceful use of outer space, while also developing a space vehicle¹². This objective was set with the creation of the European Preparatory Commission on Space Research (COPERS), which was set up in 1960.

In 1962, a Convention for the Establishing of a European Organization for the Development and Construction of Space Vehicle Launchers (ELDO) was adopted¹³, followed by a Convention for the Establishment of a European Space Research Organization (ESRO)¹⁴.

However, the existence of two separate space organizations was inefficient, so in 1975 ESRO and ELDO were fused to form the European Space Agency by the Convention for the Establishment of a European Space Agency (ESA)¹⁵, with the purpose of promoting European space research, technology and application (Art. II), which required the cooperation of national space programs.

According to Article X, ESA's structure consists of the Council and a Directorate under the direction of a Director-General. The Council is composed of all member states, meeting as needed at delegate or ministerial levels (Art. XI, 1-2) to adopt policies and approve activities and budgets. Today, ESA is seen as the main European intergovernmental organization engaged with space.

II. Sources of Space Law

¹² Council of Europe Recommendation 251, 24 September 1960

¹³ Convention for the Establishing of a European Organisation for the Development and Construction of Space Vehicle Launchers, 29 March 1962, in force 29 February 1964, 507 UNTS 177

¹⁴ Convention for the Establishment of a European Space Research Organisation, 14 June 1962, in force 20 March 1964, 528 UNTS 33

¹⁵ Convention for the Establishment of a European Space Agency, 1297 UNTS 161, 187;

2.1 Treaties

In the realm of international law, treaties are fundamental agreements that establish legally binding rules and principles among states, which create frameworks within which nations can coordinate their activities and work towards a common goal. In particular, space law is primarily shaped by a series of international treaties developed under the United Nations. These treaties address various aspects of space activities and are fundamental in creating a coherent legal basis. Starting with the first one, the Outer Space Treaty, which was created in 1967, the different treaties that have been created in the last century continue to play a critical role in guiding space activities even in the modern day. However, with the rapid evolution of space technology, along with the increasing participation of private companies, many gaps were highlighted, which prompted calls for updates or new treaties altogether. However, it's only by examining these treaties that we can understand how the current space law framework can be improved.

2.2 Antarctic Treaty

The Antarctic Treaty was established in 1959 and was a pivotal piece of international law since its implementation can be studied in order to properly understand how the space law framework was conceived. The treaty was created with the purpose of governing human activities in Antarctica, with the objective of promoting peace, scientific cooperation, and environmental protection, and has been doing so for over six decades. We can now focus on how this treaty has impacted the various law-making decisions that created the various treaties we know today.

The key principles were based on Peaceful use: According to the first article of the treaty, "Antarctica shall be used for peaceful ones only", showing a clear stance on opposing military activity¹⁶; Freedom of scientific investigation and Scientific cooperation: Article 2 and 3 show how the treaty promotes freedom of scientific investigation and encourages international collaboration in research efforts; last but not least, Non-Recognition of territorial claims: In article 4, section 1. a, a "status quo" of territorial claims is introduced, which prohibits the assertion of new claims or the extension of existing claims during its duration,

¹⁶ The Antarctic Treaty, <https://www.ats.aq/e/antarctictreaty.html>

freezing the position and claims that were made by states before the treaty.

By observing these principles we can see how many treaties, the majority of which we have previously seen, have enacted similar guidelines or objectives, which is a peculiar fact since we can imagine the space just like Antarctica was when this treaty was created; space is just a more dangerous and unexplored Antarctica, which, with time, will become a place not only easy to reach and navigate, but, hopefully, also to live in.

2.3 Outer Space Treaty

The Treaty on Principles Governing the Activities of States in the Exploration Use of Outer Space, including the Moon and Other Celestial Bodies, commonly known as the Outer Space Treaty, was adopted by the General Assembly of the United Nations on 19 December 1966 and entered into full force on 10 October 1967. This treaty established the key principles that aimed at ensuring peaceful exploration of space and shared benefits across the globe. It reached this objective by laying down a comprehensive framework that addressed several critical issues, with the most important one being sovereignty.

The OST's foundational principles are forged around the peaceful use of outer space, one of the most important aspects of the treaty, which shaped the following years of lawmaking decisions; The non-appropriation of celestial bodies, which caused the most controversy for some states, which in recent years started adopting an opposing mindset to this limitation; The protection of astronauts as "envoys of mankind", in order to address the importance of space exploration as a mission that involves the whole human race.

The most important principle can be found in Article II, which declares that outer space, including the Moon and other celestial bodies, cannot be claimed by any nation. This principle, referred to as the "non-appropriation principle", is essential for maintaining outer space as a global resource, accessible to all humanity.¹⁷ This prevents monopolization and exploitation of resources and echoes

the concept of "province of all mankind"¹⁸, suggesting that exploration should benefit humanity as a whole. This concept, however, fails to take into account the enormous costs of space expeditions, which, without an economic incentive, wouldn't be possible. Nowadays, especially with private companies, it's easy to see how the main focus of private entities is the economic aspect of space, so, although it shouldn't be the only thing to focus on, it should be taken into account in order to find a balance between humanity and private entities' interests.

Article IV further restricts the militarization of space by prohibiting the placement of nuclear weapons or any other weapons of mass destruction in orbit or on celestial bodies. It also specifies how the Moon and other celestial bodies can only be used for peaceful purposes, explicitly forbidding the establishment of military bases. This focus shows how the treaty doesn't only address specific threats and exploitation, but also sets the tone for international cooperation.

Because of its importance in establishing the fundamental rights and obligations for space activities, the OST is usually referred to as the "Magna Carta" of space law. Its creation laid the foundation for the following treaties, which expanded the principles and purpose of the original framework.

The focal point of the OST that creates uncertainty in the modern day is the non-appropriation principle. With the advent of space mining and the commercial use of extraterrestrial resources, questions about property rights and resource management are being asked every single day. A major shift happened with the United States and Luxemburg, which went against the Treaty and enacted national laws that allowed companies to claim ownership of resources extracted from asteroids. This wouldn't create many issues on its own, however, the main problem is a critical lack of clear international regulation, which creates conflicts over resource exploitation; developing a framework for space resource management that balances national interests with the common good is essential to prevent monopolization and ensure sustainable space activities.

So why is this problematic? The main problem is that without clear guidelines, private entities wouldn't want to

¹⁷ Kate Howells, The Planetary Society, *What is the Outer Space Treaty?*
<https://www.planetary.org/articles/what-is-the-outer-space-treaty>

¹⁸ Outer Space Treaty 1966

invest in this field, which could lead to a major loss considering the potential of space resources.

Another important aspect of today's technology is space traffic management and space debris. The number of satellites is increasing every single day, creating much more risk of collisions and debris generation, which could threaten space operations. In order to mitigate these possible risks, the OST encourages transparency and cooperation. In particular, the "Registration Convention" requires states to register space objects, which significantly reduces the likelihood of collision.¹⁹

Furthermore, the OST implicitly addresses environmental protection in space, by prohibiting harmful contamination of celestial bodies and requiring states to avoid adverse changes to the space environment (Art. IX). This principle could be tricky once we're able to colonize other planets, which could lead to irreversible damage to its ecosystem. The treaty's provision suggests that sustainable practices in space are essential for preserving these environments for future generations.

From this overview we can see how, although it provided a solid foundation for space governance, the OST fails to address modern challenges and, especially with today's technology, its limitations and gaps are clearer than ever before.

However, thanks to new and evolved treaties, such as the Artemis Accords, which we will be discussing later, we can see how a proper framework can be created, capable of facing modern issues and incentivizing private investments.

2.4 Rescue Agreement

The Rescue Agreement (ARRA), formally known as the *Agreement of the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched into Outer Space*, was adopted by the UN General Assembly in 1967 and entered into force on December 3, 1968. Its primary aim is to promote international cooperation in safeguarding human life and facilitating the return of astronauts and space objects on Earth.

The Rescue Agreement includes many key principles with the objective of fostering international cooperation and mutual assistance. First, under Article 2, states are required to take all possible and necessary steps in order to assist astronauts in distress and, if possible and necessary, rescue them from dangerous situations. This shared human interest is highlighted in the way astronauts are seen as "envoys of mankind", which emphasizes their status as international representatives in space exploration. Second, Article 4 establishes the duty of states, when possible, for the return of astronauts to the launching state. Following the same criteria, if an object lands on a foreign territory or international waters, the state is obliged to notify the launching state and return the object, as stated under Article 5. Lastly, the agreement emphasizes transparency and international cooperation by requiring states to immediately notify the launching state and the UN if they become aware of astronauts in distress or space objects that have returned to Earth.

The rescue agreement enhances the OST by enacting practical obligation, which binds states to enforce emergency responses in space, promoting a cooperative approach to the different challenges of human space exploration.

However, like the OST, the Rescue Agreement also faces challenges in the modern era, in particular, these problems arise when facing private companies. The framework, originally conceived during an era of state-led space exploration, is now tested, as private companies and new technologies have reshaped the landscape of space activities. The main criticalities of the Rescue Agreement can be found in many aspects of today's world, but it's important to mention one in particular:

Space tourism is a new area of business that poses significant challenges. Under the Rescue Agreement, astronauts are considered "envoys of mankind", which creates a special protection, and imposes a burden on other states to act in dangerous situations. However, space tourists, while traveling into space, do not have the same legal status as astronauts, since in its original context, an "astronaut" referred to individuals with extensive state-sponsored training and engaged in government-led missions. This creates several ambiguities in legal status,

¹⁹ Roger Quinland, *Galactic Governance: From the Outer Space Treaty to modern regulation*, <https://www.thespacereview.com/article/4843/1>

which creates two main complications²⁰. Firstly, regarding rescue and return obligation, under the OST and the Rescue Agreement, states are obliged to rescue astronauts in distress. However, with space tourism, it remains unclear whether these obligations extend to tourists. The traditional framework assumes state involvement, but in private spaceflight, the duty to rescue may fall on the launching company or the tourist's country of origin. Secondly, regarding financial responsibility for rescue operations, another significant challenge lies in cost allocation. Both the OST and the ARRA are silent on the cost associated with rescuing astronauts, which creates complications when facing private actors and space tourists. ARRA Article 5.5 obliges the launching state to cover the cost of recovering space objects, but no clear provision exists for the financial burden of rescuing space tourists. This raises critical questions about who pays for these potentially costly rescue operations in an era of commercial spaceflight.

In sum, while the Rescue Agreement provides fundamental frameworks for space exploration and astronauts' safety, it was not designed to accommodate private space travel and the idea of non-professional astronauts. As space tourism grows these problems become more relevant every day, and a revisited framework should be applied to ensure that it can reflect the realities of modern space travel and provide adequate protection for all participants while clarifying responsibilities in rescue operations and crisis management.

2.5 Liability Convention

The Liability Convention, formerly known as the Convention On International Liability For Damage Caused By Space Objects, was adopted in 1972, in order to address the various issues regarding liability and compensation for damages caused by activities conducted in space.

This convention defines the mechanism for compensation and responsibility in case of damages caused by space objects, both in space and on Earth; to do so, the

convention includes principles that show two different types of liability: Absolute liability, which is used for damages caused on Earth, and Fault-based liability which, instead, is used for damages in space.

Originally the convention was designed to address the state's responsibility for damages caused by space objects, however, with the rapid evolution of space technology, which also includes cyber threats and private space actors, many gaps have been exposed and it is fundamental to address them.

As shown in the paper "Closing the Liability Loophole: The Liability Convention and the Future of Conflict in Space", by Trevor Kehner²¹, the key challenges are many. Firstly, in regards to cybersecurity and space objects: Because of the evolution of technology, a major loophole in the Liability convention is the potential for space objects to be taken over or manipulated through cyberwarfare. In fact, if a satellite is hacked by a third party and causes damage to another country's space assets, the launching state of the hacked satellite could still be held liable under the current legal framework. As stated in the paper "*harm is an irrelevant consideration for the Liability Convention. The only relevant inquiry is the ownership of the satellite that caused harm on Earth*"; this situation causes a misattribution of responsibility, where the launching state is liable for damage it did not directly cause. Secondly, another problem lies in the outdated definition of control: As we have seen previously with other treaties, the convention was also framed during a period in which space activities were solely controlled by states. Today, however, with the growing involvement of private companies, the model based solely on state ownership no longer works. This problem is further enhanced and may become extremely problematic in situations in which commercial spacecraft are co-owned by multiple entities, which could lead to an unclear attribution of responsibility in case of damage. Last but not least, we must consider the lack of proximate cause consideration: The convention does not demand an inquiry into the underlying causes of an incident which, as we have seen before, even if a state is not at fault it could still be held liable, without considering proximate causation. Situations like these contradict established norms in other areas of international law, such

²⁰ F. Lyall, Who is an astronaut? The inadequacy of current international law, <https://www.sciencedirect.com/science/article/abs/pii/S0094576509005670>

²¹<https://cjil.uchicago.edu/print-archive/closing-liability-loop-hole-liability-convention-and-future-conflict-space>

as, for example, maritime law, where liability is often based on the direct cause of the incident.

The paper however offers some strong recommendation for a reform that could fix the majority of these problems: Firstly it states how we need a clarification of liability in case of third-party interference: the liability convention needs to be updated to account for modern threats, such as the previously mentioned cyber-attacks; furthermore, the reform should also take into consideration the proximate cause when considering liability, in order to ensure that the actual actor and not a state is responsible for the damage is held accountable. Secondly, it advocates for an adaption for commercial and private entities: as space becomes increasingly commercialized, the liability regime should be expanded to include clear guidelines for private space operators and multi-state missions, ensuring shared responsibility and a clearer allocation of liabilities. Thirdly, we would need a strengthening of cybersecurity control: the convention should also focus on integrating modern cybersecurity standards and protocols in order to safeguard space assets from malicious parties.

However, it would be possible to further improve the approach thanks to a double liability principle, which would differentiate between actors. A first, primary liability, should be allocated to the actor directly responsible for causing the damage, while a second liability should be imposed on the launching state when the primary actor cannot be held accountable or cannot compensate for the damages. This method takes into consideration the role of private parties in new missions, and it further improves and safeguards the interests of the parties involved in the accident.

Thanks to this overview we can see that, although the Liability Convention was ground-breaking in its time, and introduced many of the principles that are still used to this day in order to face liability problems, the modern realities of space activities demand significant reforms and changes. With the rise of new types of threats and private space actors, an updated approach to liability in space law is needed, especially to ensure equitable responsibility and international cooperation, which, with today's guidelines, still causes uncertainty.

2.6 Registration Convention

The Registration Convention, formally known as the Convention on Registration of Objects Launched into Outer Space, was adopted in 1976 as a critical instrument in space law. The convention introduced a fundamental principle, requiring states to register space objects launched from their territory with the United Nations; this introduction and requirement ensured transparency and traceability of space objects, a crucial mechanism for maintaining order in increasingly crowded orbits.

However, with the rise of space traffic management (STM), the sufficiency of the convention faces many challenges. As noted by recent discussions on the subject²², the registration process faces several shortcomings, in particular with data quality and scope. Modern space operations, especially involving large constellations of satellites (ex. SpaceX), generate vast amounts of traffic, and the data provided to the UN registry is often insufficient to support a robust STM regime, as it typically lacks detail on the ongoing status and operational parameters of space objects.

As outlined in the Secure World Foundation paper²³, modern space operations expose several problems of the convention, in particular, we have Data Incompleteness for Space Traffic Management, so in order to solve this problem the Registration Convention requires states to provide basic orbital data when registering space objects. However, in today's space environment, real-time tracking and more detailed operational data are needed for effective space traffic management; furthermore, the orbital parameters currently registered are not updated frequently enough to reflect the object's real-time status, which creates gaps in the ability to monitor and manage these assets effectively. Another important aspect is based on the

²² Secure World Foundation, Dr. Peter Martinez, Tanja Masson-Zwaan, Francesca Letizia, Catrina Melograna, Martin Reynders, Robert Rovetto, Mark A. Skinner, Marius Stanciu-Manolescu, Maruska Strah, Olga Volynskaya, Guoyu Wang, *The need to improve registration practices in the context of space traffic management*, August 2024

²³ Secure World Foundation, Dr. Peter Martinez, Tanja Masson-Zwaan, Francesca Letizia, Catrina Melograna, Martin Reynders, Robert Rovetto, Mark A. Skinner, Marius Stanciu-Manolescu, Maruska Strah, Olga Volynskaya, Guoyu Wang, *The need to improve registration practices in the context of space traffic management*, August 2024

challenges with private and commercial actors: As previously mentioned, the convention was designed when most space activities were conducted by nation-states. Compared to today's world, space activities are dominated by private companies, which are bound to face problems regarding outdated guidelines with the current guidelines private companies' objects need to be registered by the state in which the object was launched, however, enforcement of registration rules when dealing with private actors is inconsistent. This inconsistency creates a regulatory gap which, with the growing number of private companies that revolve around satellites, is only going to increase in the following years.

In order to resolve these problems, a much-needed reform is required and, according to the Secure World Foundation, three recommendations are suggested. Firstly, Improving data quality: States should be required to provide additional information on space objects; the gathered data should at least show their operational status and deorbit plans. This solution would not only enhance global space traffic management but would also align with the long-term sustainability guidelines recommended by UNCOPUOS²⁴. Secondly, Uniformity and standardization: A key recommendation is the implementation of the UNCOPUOS working group's 2023 guidelines, which calls for greater uniformity in registration practices, especially for large satellite constellations. It's clear that requiring more information without proper standardization would only lead to more confusion and dangerous situations. Thirdly, private sector accountability: The last suggestion is to incentivize compliance with registration requirements by making market access contingent on proper registration.

From what we have analyzed we can see that, although the Register Convention remains a foundational element of space governance, it must evolve in order to address the realities of modern space operations, especially when

²⁴ UNCOPUOS, "GUIDELINES FOR THE LONG-TERM SUSTAINABILITY OF OUTER SPACE ACTIVITIES OF THE COMMITTEE ON THE PEACEFUL USES OF OUTER SPACE", Guideline B.1, "Provide updated contact information and share information on space objects and orbital events" https://www.unoosa.org/documents/pdf/PromotingSpaceSustainability/Publication_Final_English_June2021.pdf

considering private companies. Improved registration practices and increased transparency are critical to ensure that space remains a sustainable and safe environment for future generations.

2.7 Moon Agreement

The Moon Agreement, formally the Agreement Governing the Activities of States on the Moon and other Celestial Bodies, was adopted by the United Nations General Assembly in 1979 in resolution 34/68, as the last of the five major treaties that comprise the foundation of international space law; however, it was only in June 1984, with the ratification of Austria, that the treaty was able to enter into full force. Its central aim was to prevent the Moon from becoming an area of national rivalry or exploitation between states and to ensure that any benefit derived from lunar activities would be shared.

Before the Moon Agreement, many gaps were filled with the introduction of the Outer Space Treaty, however many aspects were still without a legal framework, in particular regarding specific provisions for resource exploitation. In response to this need, the Moon Agreement introduced three main principles: the non-appropriation of celestial bodies, the equitable sharing of lunar resources, and the responsibility of states to ensure that the Moon was used for peaceful purposes only.

One of the most important aspects of the treaty is article 11, which introduced the concept of an international regime to govern the exploitation of lunar resources. This provision was introduced in order to prevent the commercial monopolization of the Moon's resources by technologically advanced states or private companies.

Despite the efforts, however, the principle stated in Article 11 creates legal uncertainties about how space resources should be utilized and regulated. It is only with today's technology that we can see the many gaps and challenges that the treaty faces. In order to explain the different problems, we can use Dr. Frans G. von der Dunk's paper²⁵, in which he shows the different aspects of today's

²⁵ Back in Business? The Moon Agreement, Private Actors and Possible Commercial Exploitation of the Moon and Its Natural Resources, Dr. Frans G. von der Dunk, https://www.mcgill.ca/iasl/files/iasl/Moon-Proceedings-Part_5_2006.pdf

problems. The first problem regards the limited adoption and non-ratification by major space powers: the treaty has been ratified only by 17 countries²⁶, leaving out key nations like the United States, Russia, and China, which have not signed or ratified it. In 2023 Saudi Arabia announced its withdrawal from the treaty, after signing the Artemis Accord, with effect recurring from 5 January 2024, which shows the treaty's waning influence. In fact, various nations are showing interest in treaties that offer more flexible and non-binding rules, such as the Artemis Accords.

Another important problem can be seen when looking at commercialization and resource exploitation: One of the main burdens that the treaty imposes on nations is the principle of the common heritage of mankind, which has been a major roadblock for nations and companies interested in lunar mining. The principle mentioned before requires lunar resources to be shared equitably, however, it does so without providing clear guidelines on how such a regime would operate. As private companies like SpaceX and Blue Origin prepare for lunar missions that may involve resource extraction, the Moon Agreement's restrictions become more exposed, especially when it conflicts with national legislation, such as the U.S. Space Resource Exploitation and Utilization Act and the Artemis Accords, which allow for private entities to extract and freely use space resources without being subject to an internal regime.

Of course, a major problem is the lack of an enforcement mechanism or governing body: A critical problem is the lack of a dedicated enforcement mechanism that can resolve disputes among parties; in fact, the treaty calls for the creation of an international regime, however no such body exists, which makes it difficult to implement its principles. We can observe how different treaties, such as the Law of the Sea Convention, created the International Seabed Authority, which regulates extraction from the ocean floor, which could offer a potential model for lunar governance. Lastly, we can see a state-centric framework: the treaty is fundamentally state-centric, focusing on national responsibility; however, in today's world, private

companies are the main actors when it comes to space mining. The lack of guidelines for these entities shows a clear and critical problem that caused many states to prefer the Artemis Accords, which embraces private sector involvement and offers a more pragmatic approach to space exploration, allowing private entities to operate under a national legal framework.

We can now observe how, in order to make it more relevant in today's world, the treaty must undergo significant changes, such as private sector regulation and revising the common heritage principle. However doing so would drastically change the treaty itself and will impact its very purpose, so it's unclear whether a revision is needed or a completely new treaty might be necessary; although a compromise between interests would definitely be beneficial, an incomplete clear stance could lead to more damages than it could actually resolve.

2.7 Artemis Accord²⁷

The Artemis Accord (from now on AA) represents a new approach to international space cooperation, which provides a framework for civil exploration of celestial bodies under the U.S.'s Artemis Program. The treaty was signed on October 13, 2020, initially by the US and seven other countries²⁸, followed by others; right now, on November 2024, we have a total of 47 partners²⁹. The main purpose of the framework is that, although non-binding, it provides a significant push in shaping international norms around space resource exploitation and exploration.

Now that we've explored all the different treaties, we can fully understand the AA's purpose; in fact, it emerged as a response to the increasingly complex nature of lunar and space exploration, which, as we have seen many times before, includes many private actors and international partners. We can clearly see this evolution in NASA's explanation of the Accord, which "reinforces the commitment by signatory nations to the Outer Space Treaty, the Registration Convention, the Rescue and Return Agreement, as well as best practices and norms of responsible behavior for civil space exploration and use".

²⁶ Armenia, Australia, Austria, Belgium, Chile, Kazakhstan, Kuwait, Lebanon, Mexico, Morocco, Netherlands, Pakistan, Peru, Philippines, Türkiye, Uruguay, Venezuela; https://treaties.un.org/Pages/ViewDetails.aspx?src=IND&mt dsg_no=XXIV-2&chapter=24&clang=_en

²⁷ <https://www.nasa.gov/artemis-accords/>

²⁸ The Artemis Accords were launched with : Australia, Canada, Italy, Japan, Luxembourg, the United Arab Emirates, the United Kingdoms and the United States

²⁹ We refer to countries as partners in the Accords

Now we can clearly see how the purpose of the AA is to extend the principles of the Outer Space Treaty while adapting them to new challenges, such as space resource extraction. A pivotal aspect of the Accords is that they function as bilateral agreements, between NASA and each partner, which has facilitated rapid adoption. The purpose of the AA, as stated in section 1, “is to establish a common vision via a practical set of principles, guidelines, and best practices to enhance the governance of the civil exploration and use of outer space with the intention of advancing the Artemis Program”, so we can clearly see the objective, especially if we observe the 10 core principles of Accords. First, we have an underlining of peaceful purposes: Reiterating the OST, the Accords mandate that all activities shall be conducted for peaceful purposes; Another important theme is transparency: The different partners shall show transparency in their activities, including the exchange of crucial information such as scientific data; Of course, the most important one is about space resources: The extraction and utilization of space resources has to be conducted under the auspices of the Outer Space Treaty, with particular emphasis on Articles II, VI and XI³⁰. The Accords endorse the use of in-situ resources to support sustained lunar operation; Registration of space objects is also mentioned: The accords reiterate the importance of registration, which was previously stated in the Registration Convention. A point that shows the scope of the accords is the usage of the term interoperability: Nations agree to utilize open international standards and strive for interoperability to ensure safe and robust space exploration. Another important aspect is emergency assistance: Signatories commit to rendering assistance to astronauts in distress, reaffirming commitments to the Rescue and Return Agreement.

Other noble goals are, for example: protecting Heritage: The Accords commit to the protection of sites and artifacts with historic values in space; Release of scientific data: Signatories agree to the timely sharing of scientific data, in order to benefit the global community; deconfliction of

³⁰ DLA Piper, Artemis Accords: New law for the moon and outer space?, <https://www.dlapiper.com/-/media/files/insights/publications/2020/07/new-law-for-the-moon.pdf?rev=-1&hash=3D5718424377CD51D23BF0742F592955>

activities: Signatories agree to provide public information regarding the location and nature of operation to prevent harmful interference, implementing Article IX of the Outer Space Treaty. Last but not least, orbital debris and spacecraft disposal: The Accords emphasize planning for the mitigation of orbital debris, including the safe and efficient disposal of spacecraft at the end of their missions. The main issues that arise from the Artemis Accords are³¹, however, still problematic. The main criticism is that the Accords were developed mainly by the US and a select group of allied nations, leading to a bypass of international forums, such as the United Nations, which could cause fragmentation in international space law³². Secondly, the so-called “safety zones” are still vague, and, without a clear definition, they could be interpreted in a way that would put them at the same level as semi-permanent territorial claims³³. Thirdly, we must also consider the commercial interest and the way it is acknowledged and protected in the treaty; in fact, this protection could lead to a prioritization of commercial interests over collective benefits³⁴, which could cause a significant gap in a field that is already hard to get into.

So we can see that while the Artemis Accords are a pivotal point in the field of space law and a step in the right direction, additional work might be needed in order to create a “perfect” legal framework.

III. Jurisdiction Comparison

3.1 European Union

The European Union is a key institution, which plays a fundamental and vital role in determining European space policy. A significant milestone happened in 2003, in which a Framework Agreement between the European Community and ESA was drafted, which entered into force in 2004 as the first step toward a formal EU stance as

³¹https://www.mcgill.ca/iasl/files/iasl/ram_jakhu-presentati on_at_iasl-iaass_webinar-10jul20-final.pdf

³²<https://www.lawfaremedia.org/article/artemis-accords-step-toward-international-cooperation-or-further-competition?>

³³ The Artemis Accords, <https://www.cambridge.org/core/journals/international-legal-materials/article/artemis-accords/5874DB518591888E52CF2B816E4593F0?>

³⁴ <https://hir.harvard.edu/the-artemis-accords/?>

to space and the creation of a “Space Council”³⁵. Simultaneously, in 2003, the EU also issued a White Paper on European Space Policy. Two other important steps were a Council resolution on space policy of 2007 aimed at enhancing the coordination of space activities between ESA, the EU, and their member states,³⁶ and the amendment of the EU basic document by the Lisbon Treaty of 2009 to include space competence as an EU function.

Key EU policies and programs underline the increasingly leading role of the EU in space innovation. The 2003 Framework Agreement with ESA³⁷ formalized the collaboration between the EU and ESA, establishing a “Space Council”, while also aligning space activities with EU principles of peace and technological advancement. The Lisbon Treaty³⁸ in 2009 gave the EU competence on space policy, allowing it to enact legislation on space and thus launching an intense legislative drive. The EU Space Program³⁹ 2021-2027 symbolizes the ambition of the EU to become a leading actor in space innovation, with major developments like GALILEO, a global satellite navigation system (GNSS), featuring positioning with unequaled precision, already mounted on over 2.5 billion smartphones; COPERNICUS, or the European Earth Observation (EO) system, gives data on crucial issues like environment and climate problems; EGNOS (European Geostationary Navigation Overlay Service), a system which improves GNSS signals, hence making it possible for 30 countries and over 426 airports to enable navigation. Another fundamental objective lies in the IRIS² Initiative⁴⁰ initiative, which will deploy a constellation of satellites to provide ultra-fast, secure communication by

³⁵ (Lyll & Larsen, 2024)

³⁶ N. Peter, ‘The EU’s Emergent Space Diplomacy’ (2007)

³⁷ Framework Agreement between the European Community and the European Space Agency
<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A22004A0806%2803%29>

³⁸ Treaty of Lisbon,
<https://www.europarl.europa.eu/factsheets/en/sheet/5/the-treaty-of-lisbon>

³⁹ Eu Space Programme,
https://defence-industry-space.ec.europa.eu/eu-space/eu-space-programme_en

⁴⁰ IRIS, the new EU Secure Satellite Constellation
https://defence-industry-space.ec.europa.eu/eu-space/iris2-secure-connectivity_en

2027. In parallel, the EU works on an urgent problem: space governance issues.

Furthermore, as orbits around Earth have become increasingly congested, Space Traffic Management (STM) has now become one of the top priorities in the agenda to enable safe and sustainable space activities. The 2023 EU Space Strategy for Security and Defense, on the other hand, spells out measures to guarantee security regarding the space infrastructure of the EU, showing a further reflection of the commitment by the union to address both opportunities and risks associated with the growing importance of space in modern society.

From this overview, it’s possible to see how the EU adopts a collaborative approach, rooted in sustainability and multilateralism, integrating space activities into its broader policy objectives.

3.2 The United States’s Approach

When it comes to main actors, the United States is the main one when it comes to global space policy, given how much it influences space law worldwide. In the U.S., space policy is primarily set by the President, which means that depending on the administration and the candidate, the development of space law and technology could suffer from substantial changes. One pivotal example is the space race during President Kennedy’s mandate; in that case, since the objective was so ambitious (reaching the moon for the first time), his policies caused a major impetus for technological advancement.

In the United States, federal responsibilities related to space activities are distributed across several departments. The Department of Defense and military authorities are heavily involved in space matters. Licensing space activities is mainly the responsibility of the Federal Aviation Administration (FAA), part of the Department of Transportation. Among the various agencies involved with space-related efforts, the most well-known is the National Aeronautics and Space Administration (NASA), which remains at the forefront of U.S. space exploration and scientific research.

A fundamental legislative act in the U.S. is the Commercial Space Launch Competitiveness Act (CSLCA) of 2015⁴¹,

⁴¹<https://www.congress.gov/bill/114th-congress/house-bill/2262/text>

which was introduced to support the growth of U.S. commercial space actors. The main objective of the act is to make it easier for private entities to explore and exploit space resources by clarifying the regulatory framework and promoting a competitive sector.

Although it was able to set a proper framework, it completely abandoned the previous guidelines set by the Outer Space Treaty, and in order to understand this, we need to properly explain the key provisions of the act: firstly we have private ownership of extracted resources, since the act grants US companies the rights to extract and sell the resources mined on celestial bodies; another important aspect is the extension of the liability protection: Under the Title IV of the CSLCA, the act limits liability for private companies under specific conditions, increasing and incentivizing private sector participation; Another important aspect would be the requirement of minimal government regulation: while this choice did in fact raise growth, it also raised concerns about insufficient oversight; last but not least, a pivotal aspect would regard the encouraging competitiveness: Thanks to the clarification of property rights over extracted resources, the act has positioned the U.S. as a leader in the commercial space race.

Regarding the problems that we have seen before, what we need to examine is Title IV of the Act, which regulates "Space Resource Exploration and Utilization". This section recognized commercial property rights in resources extracted from celestial bodies, which, on one hand, was met with enthusiasm from private actors, while on the other was met with harsh criticism from scholars that considered it a violation of international space law, especially when taking into consideration the Outer Space Treaty.

The U.S. has also implemented many policies and initiatives in order to further increase its competitiveness in the space field. One directive was the "Executive order on Encouraging International Support for Space Resource Use (2020)", which reaffirmed the U.S. commitment to the commercial use of space resources, while also encouraging international cooperation; Another important U.S. space policy was Executive Order 13821 (2018), aimed at improving space traffic management (STM), emphasizing the need for better coordination and oversight, especially in order to address the growing risks of orbital debris.

So, in conclusion, we can observe how, while U.S. space policy greatly promotes innovation and commercial growth, it does so in a way that could lead to conflicts with international law, while also minimizing government oversight too much. Balancing international obligations and cooperation with national ambitions is fundamental in order to shape the future of space governance.

IV. Precedents, Case Law, and other approaches

4.1 Cosmos 954 Incident (1978)

In the history of space law, few occurrences have been recorded of precedents, mainly because this field is both particular and new. One of the most important precedents in history is the Cosmos 954 incident of 1978, which marks one of the first practical applications of the 1972 Convention on International Liability for Damage Caused by Space Objects.

On January 24, 1978, a Soviet satellite, Cosmos 954, which was powered by a nuclear reactor, re-entered Earth's atmosphere, losing control, and leading to the dispersion of radioactive debris over Canada's territory. The main factor that led to the environmental contamination concerns was a malfunction that prevented the safe disposal of its nuclear materials.

From what we have previously seen⁴², the Liability Convention clearly states that the launching state must bear the absolute liability for damage caused by its space objects; based on this, Canada invoked this Convention, which led to a claim issued to the Soviet Union for a compensation amounting to approximately 6 million CAD, which was reduced to 3 million CAD after diplomatic negotiations⁴³. This compensation, which was used to cover the costs of various cleanup operations and related expenses, is the first and only instance of application of the Liability Convention to resolve a claim for damages caused by a space object.

4.2 Luxembourg Space Resource Law

⁴² Liability Convention, page 9

⁴³

https://www.jaxa.jp/library/space_law/chapter_3/3-2-2-1_e.html?

With an increasing interest in space resources in the last years, in 2017 Luxembourg decided to enact a new type of legislation to regulate the exploration and development of space resources. This law represents a freer market and is a significant step in the direction that we have yearned for previously since it offers clarity on the ownership and utilization of extraterrestrial resources⁴⁴.

In fact, the key provisions of the law are: ownership rights: A fundamental passage can be found in the very first article, which explicitly states that space resources are capable of being owned⁴⁵. This article, in its short enunciation provides legal certainty to private operators, which are now sure that their rights over-extracted resources are now protected; Authorization requirements: An authorization coming from the competent minister is required for entities that intend to explore or use space resources⁴⁶. This requirement ensures that activities are conducted according to international obligations; supervision and compliance: The requirement for authorization is only the first step since authorized operators are subject to continuous supervision to ensure adherence to the conditions of their authorization.

It's important to understand that this law doesn't contract with the Outer Space Treaty, since the latter prohibits national appropriation of celestial bodies, so we can see the ownership of extracted resources is not explicitly addressed. Since Luxembourg's law focuses on resource utilization rather than territorial claims (which, as stated before, are prohibited), it's capable of operating within the existing international legal framework.

Luxembourg, by enacting such a clear law and guidelines, has set an important precedent for many European countries, which may follow in the near future, by enacting their own framework or by applying to freer international frameworks, for example, the Artemis Accords.

V. The Future: Possible Frameworks

5.1 Homestead Act, a Possible Model for Space Resource Utilization

⁴⁴ Law of July 20th 2017 on the exploration and use of space resources, https://spaceagency.public.lu/en/agency/legalframework/law_space_resources_english_translation.html?

⁴⁵ Article 1, see supra

⁴⁶ Article 2, see supra

In order to properly understand how to conceive a framework for space resource utilization, we need to look back in history and reflect on the way governments used to regulate land ownership and on which condition.

The Homestead Act of 1862 played a pivotal role in the expansion of the United States, thanks to the grant of land ownership to settlers under specific conditions. As humanity ventures into space exploration and settlements planning, this Act offers an ideal precedent for developing new legal frameworks applicable to space.

This Act was a pivotal U.S. legislation, which consisted of giving 160 acres of public land to individuals willing to cultivate and reside on it for five years, which would promote settlement and development of the American West⁴⁷. Through this Act, the U.S. distributed approximately 270 million acres of land, forever impacting the country's demographic and economic landscape.

If we want to adapt the Homestead Act's ideas to space colonization and resource utilization, we need to take into consideration several aspects: First of all, it is fundamental to incentivize development, in order to avoid a monopoly that would give the majority of the resources to few corporations that are only interested about the economic aspect, a space-based homestead model should grant rights to individuals and entities that actively develop and utilize extraterrestrial resources, which would promote innovations and investments in space activities; Secondly, another important aspect would be equitable access since, for the same reasons stated above, all nations and entities should be able to engage in space exploration; Thirdly, non exclusivity: While people, under the homestead act, received land rights, in our case this would translate into resource rights; Last but not least, development: Just like people under the Homestead Act were required to develop the land within a specific timeframe, in space claimants should be required to implement sustainable extraction practices or establish the infrastructure necessary for the extraction process.

Although this is only a hypothetical comparison and adaptation, the "Space" Homestead Accord is capable of representing a transformative approach to space resource

⁴⁷ Homestead Act of 1862, <https://www.britannica.com/topic/Homestead-Act?>

governance, providing a robust combination between historical precedent and modern legal principles.

So, from what we have seen, we need to implement three fundamental policies in order to create a feasible framework. First, we need to implement a “Space Homestead Accord”, capable of defining the process for claiming and using resources, plus the duty to create infrastructures. Secondly, we need a central international institution, capable of administering claims and enforcing compliance, with severe punishment, such as total exclusion from extraction rights, to use as a deterrent. Thirdly, a mechanism capable of sharing benefits with new companies would incentivize a new era of space economy; this fund should be able to lend money to interesting companies capable of showing tangible plans for extraction missions. Of course, this wouldn’t fund the whole mission, however, it could be necessary in order to break the barriers that are still present in this field. In conclusion, the Homestead Act offers a valuable template for shaping a framework that could be used in the future; by adapting its principles to today’s requirements we can reach many of our objectives, such as fostering innovation, preventing monopolization, and ensuring that access to space remains inclusive.

VI. Conclusion

Humanity’s journey into the universe is filled with boundless potential and difficult challenges. This paper has tried to give a glimpse into the evolution that we need to accept in order to bring the framework of the pasts, which was shaped in an era of rudimentary technology, to a new level, capable of embracing the complexities of today’s space age, driven by private innovation and international collaboration.

Right now, we are standing on the edge of a new epoch, where the Moon is no longer a distant dream that we used to look at in the night sky; and Mars, the beautiful red planet so close yet so distant from us, could become our home one day. Yet, without a proper legal framework, all of these incredible and exciting opportunities, risk being overshadowed by different conflicts, which would only hinder our infinite journey to the unknown.

The future of space law demands a bold yet balanced approach, capable of recognizing sovereignty while also ensuring the universal benefits that come with space exploration. It must ensure sustainable technologies, capable of protecting the cosmic environment, and satisfy our ambitions.

Arthur C. Clarke stated in *2001: A Space Odyssey*, “*The only way of discovering the limits of the possible is to venture a little way past them into the impossible.*” This is exactly why space exploration, and the legal framework on which is based, must embrace the unknown and overcome traditional boundaries, which is the only way of knowing our species’ true potential.

This is not just a legal challenge; it is a moral imperative. Space has always represented the ultimate goal, capable of satisfying not only our thirst for knowledge but also our quest for exploration, always so embedded in our DNA. This is exactly why it is our responsibility to ensure that future generations will be able to have the right tools to *shoot for the stars* and to do so, we need to craft a legal framework capable of reflecting our highest aspirations as a species.

The cosmos awaits, it is our duty to fulfill its expectations.

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