A NEW GOLD MINING RUSH?

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ABSTRACT

Spacefaring nations and private companies are actively working to expand into outer space to gain access to its natural resources. From the beginning, space mining has been characterized by strong private sector involvement in the establishment of a space industry based on the exploitation of space resources. Given the rapid pace of technological developments and recent advances in solar system exploration, space resource exploitation and space mining will soon become a reality. But is space mining legal? The uncertainty presented by the current corpus of space law on this topic raises the question of whether the mining of space resources is permissible under existing international law and whether governments or private entities can claim property rights over such resources.

This article analyzes the current legal environment governing the exploitation of space resources and considers future prospects for the creation of an international regime for sustainable space mining activities. Part II presents the legal status of outer space and celestial bodies as well as extraterrestrial natural resources under international law. Part III discusses the ambiguity of international space law regarding the legality of space mining activities, with reference to the provisions of the Outer Space Treaty and the Moon Agreement, as well as recent developments in national legislation and the recent United Nations Committee on the Peaceful Uses of Outer Space initiative to establish a working group to address the issue of space resources. Last but not least, a new legal framework for sustainable extraterrestrial mining is proposed in Part IV.

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I. INTRODUCTION

Exploration, or more likely exploitation, of space has long been the aspiration of powerful nations. The 1960s marked humanity's journey into outer space and the beginning of the space race between the two superpowers at the time, the United States (US) and the then Soviet Union. However, today, for the first time since the dawn of the Space Age, spacefaring nations and private companies are actively seeking to expand into outer space to gain access to its natural resources. With the remarkable development of space technologies, the exploitation of space resources and space mining will soon become a reality. There is a growing interest in the possibility that the resource base of the solar system could be used in the future to supplement the economic resources of our own planet. In particular, the Moon and other celestial bodies, such as Mars and asteroids, are believed to contain an abundance of resources that are scarce or rare on Earth.[1] Some believe that using extraterrestrial resources as a source of energy will not only have a tremendous impact on the global economy, but will also be able to solve the energy crisis that currently exists on Earth.[2]

However, as the space mining industry develops, the need for a legal framework to regulate the use of space resources increases. To date, five international treaties and a set of principles on space-related activities have been concluded under the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUS). The 1967 Treaty Governing the Activities of States in the Exploration and Use of Outer Space[3] (Outer Space Treaty) provides the basic framework for international space law, but does not specifically address space resources. Moreover, although the Agreement

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[1] *See generally* Claire L. McLeod & Mark P.S. Krekeler, *Sources of Extraterrestrial Rare Earth Elements: To the Moon and Beyond*, 6 RESOURCES 3 (2017).

[2] Richard B. Bilder, *A Legal Regime for the Mining of Helium-3 on the Moon: U.S. Policy Options*, 33 FORDHAM INT'L L. J. 243, 246-47 (2009).

[3] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty].

Governing the Activities of States on the Moon and Other Celestial Bodies[4] (Moon Agreement), which came into force in 1984, contains particular provisions on the use of space resources, setting forth general principles and future commitments for the establishment of a legal regime as soon as exploitation becomes feasible, it has received no more than eighteen ratifications[5] and no major spacefaring nation subscribes to it. As a result, the question of whether the mining of space resources is permissible under existing international law remains open, and it is unclear whether governments or private entities can assert property rights over such resources.

Nevertheless, spacefaring nations seem to be reaching a common understanding that space resource extraction and utilization does not conflict with existing international space law. The ambiguity left by the Outer Space Treaty regarding the permissibility of such activities has already led a number of countries to adopt their own national legislation or other policy initiatives to create regulations for space mining and the extraction of materials from the Moon and other celestial bodies by private companies that explicitly permit the appropriation of natural resources. While the right of extraction and ownership of resources in space remains controversial, there is international consensus on one point: a legal framework must be agreed upon to govern the exploration and extraction of these resources.[6]

This article analyzes the current legal environment governing the exploitation of space resources and considers future prospects for the creation of an international regime for sustainable space mining activities. Part II presents the legal status of outer space and celestial bodies as well as extraterrestrial natural resources under international law. Part III discusses the ambiguity of international space law regarding the legality of space mining activities, with reference to the provisions of the Outer Space Treaty and the Moon Agreement, as well as recent developments in national

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[4] The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 5, 1979, 1363 U.N.T.S. 3 [hereinafter Moon Agreement].

[5] Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcommittee on its Sixty-Second Session, *Status of International Agreements Relating to Activities in Outer Space as at 1 January 2023*, U.N. Doc. A/AC.105/C.2/2023/CRP.3 (2023) [hereinafter Status of International Space Agreements].

[6] Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on its Sixty-Second Session, U.N. Doc. A/AC.105/1203 at 32 ¶ 242-267(2019).

legislation and the recent UN COPUOS initiative to establish a working group to address the issue of space resources. Last but not least, a new legal framework for sustainable extraterrestrial mining is proposed in Part IV.

II. THE LEGAL STATUS OF CELESTIAL BODIES AND EXTRATERRESTRIAL NATURAL RESOURCES

Under the rules of international space law, a distinction is made between the legal status of celestial bodies as a whole and that of their natural resources. The legal status of outer space and celestial bodies seems mostly clear and adequately elaborated, while the legal status of natural resources remains uncertain.

A. The Legal Status of Outer Space and Celestial Bodies

One of the most important issues that legal scholars grappled with in formulating space law in relation to the legal status of outer space initially was whether States could extend their sovereignty to outer space. The foundation upon which COPUOS built the space legal regime is the principle of *res communis omnium*, first declared in the United Nations (UN) General Assembly Resolutions 1721[7] and 1962[8] and then formally articulated in Article II of the Outer Space Treaty.[9] Presumably, the non-appropriative nature of outer space was the best guarantee for preserving the peaceful character of the space environment and for ensuring that all humanity could benefit from its exploration and use since by renouncing territorial claims States made clear that the classical means of acquiring property or sovereignty rights over things or lands did not apply to outer space and celestial bodies.[10] This commitment ensured that outer space would remain open to all States, free from the potential conflicts that often arise from territorial disputes on Earth. Articles I and II of the Outer Space Treaty accord outer space the status of *res communis omnium*, an area open to all States on a basis of equality and without any discrimination, but not appropriable by

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[7] G.A Res. 1721 (XVI) (Dec. 20, 1961).

[8] G.A. Res. 1962 (XVIII) (Dec. 13, 1963).

[9] Outer Space Treaty, *supra* note 3, art. II.

[10] FABIO TRONCHETTI, THE EXPLOITATION OF NATURAL RESOURCES OF THE MOON AND OTHER CELESTIAL BODIES 27 (2009).

any of them.[11] These principles represent rules of customary law.[12] The concept of *res communis* originates in Roman law and contrasts with the concept of *res nullius*, territory over which there is no sovereign open to acquisition by any State.[13] According to this concept, all States have the right to access, explore and use outer space without needing any form of permission, but cannot appropriate outer space and its celestial bodies. The term thus refers to the fact that State sovereignty cannot be exercised in outer space, as it is an area of common interest to all humankind. Early attempts to consider outer space as *res nullius*, i.e., an area not subject to the sovereignty of a State and which can be claimed and occupied by States, were discarded in favor of its status as *res communis*.[14]

1. The Province of [Hu]mankind

As regards the legal status of celestial bodies, Article I paragraph 1 of the Outer Space Treaty and Article 4 of the Moon Agreement provide that outer space and celestial bodies are "the province of [hu]mankind."[15] Consideration of what is meant by this phrase has formed the basis of substantial doctrinal discussion. Neither Treaty specifies what the term "[hu]mankind" encompasses. However, the Treaties do contain an obligation that space activities be carried out "for the benefit and in the interest of all countries, irrespective of their degree of economic or scientific development."[16] This underlines the interest of all States and all generations in the use and exploration of outer space and celestial bodies. In general terms, this provision suggests that the exploration and use of outer space, as a "province of all [hu]mankind," should serve the interests not only of those States that have the technological capabilities to explore and use outer space, but of all States, regardless of their level of economic and scientific development.[17] The "province of all

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[11] Outer Space Treaty, *supra* note 3, arts. I & II.

[12] Fabio Tronchetti, *The Non-appropriation Principle as a Structural Norm of International Law: A New Way of Interpreting Article II of the Outer Space Treaty*, 33 J. AIR & SPACE L. 277, 280-81 (2008).

[13] MALCOLM N. SHAW, INTERNATIONAL LAW 364 (8th ed. 2018).

[14] Michel Smirnoff, *Legal Status of Celestial Bodies*, 28 J. AIR L. & COMM. 385, 390 (1962).

[15] Outer Space Treaty, *supra* note 3, art. I. Moon Agreement, *supra* note 4, art. 4.

[16] *Id.*

[17] Outer Space Treaty, *supra* note 3, art. I.

[hu]mankind" articulates a concept of fairness in the use and conservation of the space environment and its natural resources.[18] The drafting of the Outer Space Treaty represented an opportunity to define a legal system governing State's activity in outer space within which every human somehow would have the opportunity to enjoy the benefits derived from space activities and in which the common interests of all humankind would be protected.[19]

2. The Common Heritage of [Hu]mankind

The Moon Agreement, on the one hand, reaffirms the provisions of the Outer Space Treaty and on the other hand, significantly expands them. In particular, related to the above-mentioned province of [hu]mankind clause is the principle of the common heritage of [hu]mankind (CHM), which expresses the idea that space is an area with a special status and should be open and preserved for all States and the whole of humankind.[20] The common heritage principle is part of customary international law and constitutes a distinct basic principle providing general but not specific legal obligations with respect to the utilization of areas beyond national jurisdiction.[21] The introduction of the term "[hu]mankind" combined with the word "heritage" indicates that the interests of future generations have to be respected in making use of the international commons.[22]

Article 11, paragraph 1 of the Moon Agreement, states that the Moon and its natural resources are the "common heritage of [hu]mankind."[23] The concept of common heritage of [hu]mankind is a principle of international law that is not limited to outer space

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[18] *See* Edith Brown Weiss, *Intergenerational Equity, in* MAX PLANCK ENCYCLOPEDIA OF PUBLIC INTERNATIONAL LAW (online), ¶15 (2021) https://opil.ouplaw.com/display/10.1093/law:epil/9780199231690/law-9780199231690-e1421?prd=MPIL.

[19] TRONCHETTI, *supra* note 10, at 21.

[20] *See* Ram S. Jakhu et al., *Article 11 (Common Heritage of Mankind/International Regime) Moon*, in II COLOGNE COMMENTARY ON SPACE LAW 388, 394-95, ¶ 194 (Stephan Hobe, Bernhard Schmidt-Tedd & Kai-Uwe Schrogl eds., 2013).

[21] I.A. Shearer, *Common Heritage of Mankind*, *in* ENCYCLOPEDIA OF PUBLIC INTERNATIONAL LAW 68 (Rudolph Bernhardt ed., 1989).

[22] *See generally* Ernst Fasan, *The Meaning of the Term Mankind in Space Legal Language*, 2 J. SPACE L. 125 (1974).

[23] Moon Agreement, *supra* note 4, art. 11(1).

law. It is also found in UN Convention on the Law of the Sea[24] and, to a lesser extent, in the Antarctic Treaty.[25] Although the purpose of the CHM principle is to ensure the special protection and integrity of areas which lie beyond the borders of any national territory and which are of great importance to present and future generations, this principle is one of the most controversial concepts in international law and there is no uniform interpretation of its meaning and legal consequences.[26]

From a legal point of view, the "common heritage of [hu]mankind" is a further development of the concept of *res communis*.[27] As described above, under the *res communis* concept, certain areas outside national jurisdiction may not be appropriated or occupied by any State because: they constitute a common concern for all humankind and confer on all States the right to freely explore, use and exploit the territory in question and its resources, without any obligation to share the benefits resulting from such activities.[28] However, the concept of the "common heritage of [hu]mankind" differs from this approach in that it assumes that certain areas beyond national jurisdiction should be used exclusively for peaceful purposes, and should be managed jointly by all States on behalf of humankind because of the scientific and commercial value of the resources they contain.[29] Thus the CHM principle is contrary to the *res communis* theory because States do not have the right to freely use and exploit a common area and its resources. Instead, all activities, especially those aimed at exploiting the resources of the area, can only be carried out in accordance with principles and rules established by an international regime or authority.[30] The concept also implies an obligation to share the benefits derived from exploitative activities and, in this respect, special attention must be paid

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[24] United Nations Convention on the Law of the Sea, art. 136, Dec. 10, 1982, 1833 U.N.T.S. 397, (entered into force Nov. 16, 1994) [hereinafter UNCLOS].

[25] The Antarctic Treaty, art. IV, Dec. 1, 1959, 12 U.S.T. 794, 402 U.N.T.S. 71, (entered into force June 23, 1961).

[26] Siavash Mirzaee, *Outer Space and Common Heritage of Mankind: Challenges and Solutions*, 21 RUDN J. L. 102, 105 (2022).

[27] Alexandre Kiss, *The Common Heritage of Mankind: Utopia or Reality*?, 40(3) INT'L J. 423, 425 (1985).

[28] *See, e.g.* UNCLOS, *supra* note, 24, art. 87.

[29] Fabio Tronchetti, *Legal Aspects of Space Resource Utilization*, *in* HANDBOOK OF SPACE LAW 769, 784 (Frans von der Dunk & Fabio Tronchetti eds., 2015).

[30] *See, e.g.* Moon Agreement, *supra* note 4, art. 11.

to developing States, regardless of the degree of participation in such activities.[31]

However, the principles underlying the exploration and exploitation of the Moon's natural resources are thought to be more flexible and, therefore, more likely to survive the rapid changes brought about by technological achievement than the principles embodied in any other context, for example the deep sea-bed area.[32] The 1996 Space Benefits Declaration clarified that in terms of international cooperation in the exploration and use of outer space the transfer of technology and sharing of benefits, which represented two key concepts of the common heritage of humankind principle is not mandatory.[33]

The Space Benefits Declaration may be interpreted as evidence of the fact that the developing States recognized the need of revising some aspects of the concept, in the same line as with the UN Convention on the Law of the Sea.[34] This new attitude of the developing States represents an important starting point for the progressive development of international space law.[35] By declaring also the commercial uses of outer space,[36] the Space Benefits Declaration makes clear that, despite the fact that the Moon and other celestial bodies are considered to be the "common heritage of [hu]mankind," exploitative activities in those areas are not precluded provided that such activities comply with the requirements of the concept.[37] The Space Benefits Declaration works as an

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[31] *See, e.g., id.* at art. 11(7)(d). *See also* UNCLOS, *supra* note 24, art. 140(1).

[32] Sylvia Maureen Williams, *The Law of Outer Space and Natural Resources*, 36 Int'l & Compar. L. Q. 142, 150 (1987).

[33] G.A. Res. 51/122 ¶ 2. (Dec. 13, 1996) ("States are free to determine all aspects of their participation in international cooperation in the exploration and use of outer space on an equitable and mutually acceptable basis.").

[34] *See* UNCLOS, *supra* note 24, art. 136. ("The Area and its resources are the common heritage of [hu]mankind"). Article 144(2) and Annex III, article 5 of UNCLOS also provide for the mandatory transfer of technology. The 1994 Agreement on Implementation of the Seabed Provisions of the Convention on the Law of the Sea, G.A. Res. 48/263, U.N. Doc. A/RES/48/263 (Aug. 17, 1994), revised the above statement in Section 5 ¶2 ("The provisions of Annex III, article 5, of the Convention shall not apply.").

[35] TRONCHETTI, *supra* note 10, at 81.

[36] G.A. Res. 51/122 ¶4 (Dec. 13, 1996). ("International cooperation should be conducted in the modes that are considered most effective and appropriate by the countries concerned, including, inter alia, governmental and non-governmental; commercial and non-commercial; global, multilateral, regional or bilateral; and international cooperation among countries in all levels of development.").

[37] TRONCHETTI, *supra* note 10, at 125.

incentive to enable developing countries to participate on fair terms in space initiatives.[38] According to Paragraph 5, international cooperation aims, among other things, at "facilitating the exchange of expertise and technology among States."[39] Thus sharing technologies and "know-how" is one way to conduct activities in outer space "for the benefit and in the interest of all countries," while "space benefits" are not necessarily financial in their form.[40] It must be noted that according to the 1969 Vienna Convention on the Law of Treaties,[41] subsequent agreements and subsequent practice being objective evidence of the understanding of the parties as to the meaning of the treaty, constitute authentic means of interpretation even though they may not necessarily be legally binding.[42]

It is clear is that under the Outer Space Treaty and the Moon Agreement, States cannot exercise sovereignty or claim exclusive rights in outer space or parts thereof, but are space resources subject to the same regime?

B. The Legal Status of Extraterrestrial Natural Resources

While the legal status of celestial bodies is clear under Article II of the Outer Space Treaty, in that they cannot be appropriated and are open to exploration, the status of natural resources in outer space remains uncertain, as there are no clear and internationally accepted rules in international space law governing their extraction and use. On the one hand, the Outer Space Treaty is practically silent on the issue of resources, and on the other hand, the Moon Agreement, which contains specific provisions on the use of celestial body resources, has not been accepted by the majority of spacefaring States.[43] This situation creates uncertainties and can be

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[38] G.A. Res 51/122, ¶ 2-3.

[39] *Id.* ¶ 5.

[40] Steven Freeland, *Common Heritage, Not Common Law: How International Law Will Regulate Proposals to Exploit Space Resources*, 35 QIL ZOOM-IN 19, 28 (2017).

[41] Vienna Convention on the Law of Treaties, art. 31, ¶ 3, May 23, 1969, 1155 U.N.T.S. 331 [hereinafter VCLT].

[42] International Law Commission, *Draft Conclusions on Subsequent Agreements and Subsequent Practice in Relation to the Interpretation of Treaties with Commentaries*, Conclusion 3 (2018).

[43] Status of International Space Agreements, *supra* note 5. It should be noted that Saudi Arabia has withdrawn from the Moon Agreement since Jan. 1, 2023.

considered as a factor hindering the potential start of extraterrestrial mining activities.

1. The Outer Space Treaty

In particular, the Outer Space Treaty Article II prohibits national appropriation of outer space including the Moon and other celestial bodies, but it does not refer to space resources, thus it is not certain whether these natural resources are subject to the prohibition of appropriation under Article II. This fact led to two diverging interpretations of the right to remove and appropriate natural resources contained in a celestial body. There is an argument that the prohibition laid down in Article II applies both to outer space and its natural resources because the Outer Space Treaty does not make a distinction between outer space and its natural resources and therefore, the term outer space must be understood in a comprehensive manner to include both outer space and its natural resources.[44]

Viewing the absence of an explicit prohibition on natural resource exploitation, however, the other interpretation of the non-appropriation principle considers only outer space as a whole and not its natural resources.[45] The analogy that comes closest to such an approach is fishing on the high seas.

The high seas are considered a "global commons," which means that appropriation of any part of the high seas as exclusively national territory is not permissible.[46] Nonetheless, one of the fundamental freedoms of the high seas is the freedom of fishing.[47] In particular, public and private subjects, provided they comply with international law, have the right to fish on the high seas without claiming appropriation of the area in which the fishing took place.[48] By analogy, the right to free exploration and use of outer space provided for in Article I of Outer Space Treaty could be interpreted to

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[44] Stephan Gorove, *Limitations on the Principles of Freedom of Exploration and Use in Outer Space: Benefits and Interests*, *in* PROC. 13TH COLLOQUIUM L. OUTER SPACE 74, 74 (1971).

[45] Sylvia Maureen Williams, *The Exploration and Use of Natural Resources in the Law of the Sea and the Law of Outer Space*, *in* PROC. 29TH COLLOQUIUM ON L. OUTER SPACE 198, 198 (1987).

[46] UNCLOS, *supra* note 24, art. 89.

[47] *Id.* at art. 87(1)(e).

[48] *Id.* at art. 116.

include the right to extract and use the natural resources therein. A similar principle applied to outer space would allow subjects to extract resources from celestial bodies and acquire property rights in the materials extracted, without any associated property claims to the surface and subsurface of the Moon and other celestial bodies. Moreover, the 1996 Space Benefits Declaration,[49] which provides an interpretation and elaborates on Article I paragraph 1 of Outer Space Treaty, makes no statement on the question of a possible prohibition of the appropriation of natural resources, so that Article II of Outer Space Treaty explicitly and implicitly prohibits only the acquisition of territorial property rights.[50] Thus, pursuant to this analysis, the extraction and appropriation of natural resources is permissible under the Outer Space Treaty. The only question in this respect remains the division of the benefits derived from those resources which is regulated by Article I paragraph 1 of the Outer Space Treaty and in this respect the Space Benefits Declaration authoritatively grants freedom to States to determine the specific aspects of international cooperation in order to pursue this aim.[51]

2. The Moon Agreement

The Moon Agreement includes particular provisions on the utilization of celestial bodies' resources. Although Article 11 paragraph 2 of the Agreement prohibits the appropriation of the Moon, paragraph 5 provides for the establishment in the future of an international regime regulating the exploitation of its natural resources.[52] Consequently, it can be inferred that the principle of non-appropriation does not preclude the exploitation of space resources. Furthermore, The Moon Agreement preserved this distinction between the celestial bodies and their resources by denying property or ownership rights to the natural resources of the Moon or celestial bodies only so long as such resources remain "in place."[53] The strong

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[49] G.A. Res. 51/122, (Dec. 13, 1996).

[50] Stephan Hobe*, Adequacy of the Current Legal and Regulatory Framework Relating to the Extraction and Appropriation of Natural Resources*, 32 ANNALS AIR & SPACE L. 115, 127 (2007).

[51] *Id.*

[52] Moon Agreement, *supra* note 4, art.11(5).

[53] Moon Agreement, *supra* note 4, art. 11(3); Carl Q. Christol, *The Common Heritage of Mankind Provision in the 1979 Agreement Governing the Activities of States on the Moon and Other Celestial Bodies,* 14 INT'L LAW. 429, 471 (1980).

statement in Article 11 paragraph 3 that resources "in place" cannot be appropriated by any entity whatsoever can also be interpreted as meaning that resources no more "in place" (i.e. extracted resources) could be owned.[54] The addition of "in place" that indicates that these resources, once extracted, could lawfully become the property of States or private operators was included exactly to allow for the existence of property rights over resources when removed from the Moon.[55]

Nevertheless, on account of the non-appropriation principle, while States would be entitled to the resources they extract, they are not allowed to have preemptive property rights over resources to be extracted.[56] The Moon Agreement specifically prohibits the acquisition of property rights in the surface or subsurface of the Moon and to natural resources in place but allows for exploitation of natural resources that have been reduced to possession by the act of removing them from their original "in place" location.

Pursuant to the common heritage of humankind principle, an orderly process for the sharing of the benefits derived from the exploitation and use of increasingly important resources will be established and such sharing, as the treaty explicitly provides, is to be based on equitable—not equal—considerations.[57] However, until an international regime is established, what is the applicable legal regime? There is an argument that, pending the establishment of an international regime and further acceptance and ratification of the Moon Agreement by States, the relevant provisions of the Outer Space Treaty govern the rights and obligations with respect to the removable objects that constitute the natural resources of the Moon.[58]

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[54] Frans von der Dunk, *Private Property Rights and the Public Interest in Exploration of Outer Space*, 13 BIOLOGICAL THEORY 142, 146 (2018).

[55] Daniel Goedhuis, *Some Recent Trends in the Interpretation and the Implementation of the Rules of International Space Law*, 19 COLUM. J. TRANSNAT'L L., 213, 224 (1981).

[56] Gabrielle Leterre, *Providing a Legal Framework for Sustainable Space Mining Activities,* 32 (2017) (Master's Thesis, University of Luxembourg).

[57] Moon Agreement, *supra* note 4, art. 11, ¶ 7(d).

[58] Carl Christol, *The Natural Resources of the Moon: The Management Issue*, *in* PROC. 41ST COLLOQUIUM L. OUTER SPACE 3, 7 (1998).

III. THE INTERNATIONAL LEGAL CONTEXT FOR SPACE MINING

A. The Resources of The Moon and Other Celestial Bodies

The Moon and other celestial bodies contain large quantities of natural resources.[59] It is believed that the use of extraterrestrial resources as a source of energy will not only have a tremendous impact, but could help solve the energy crisis that currently exists on Earth, which is about to get worse.[60] These natural resources can be mined in their natural locations and used "in situ" or even transported back to Earth.[61]

With respect to the Moon in particular, lunar resources can be used to facilitate further exploration of the Moon itself (in situ resource utilization), such as to build a scientific infrastructure on the lunar surface like the infrastructure in Antarctica and otherwise support human exploration in outer space.[62] Further, lunar water ice at the poles may be pivotal for habitation and propellant purposes on the Moon.[63] Additionally, lunar resources can be used to facilitate scientific and economic activity for both Earth and Moon, in the so-called cislunar space, including operations in Earth orbit.[64]

It has been recognized that lunar resources will be essential in the future economic development of near-Earth space since, while establishing resource extraction industries on the Moon will be a significant investment, the energy required to transport materials from the lunar surface to any location in Earth or lunar orbit will be much less than the cost of lifting those materials out of Earth's

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[59] US Geological Survey, Unified Geologic Map of the Moon (2020), https://astrogeology.usgs.gov/search/map/Moon/Geology/Unified_Geologic_Map_of_the_Moon_GIS_v2 [hereinafter Map of the Moon].

[60] Bilder, *supra* note 2, at 246-247.

[61] *See generally* Gerald B. Sanders et al., *Lunar In-situ Resource Utilization in the ISECG Human Lunar Exploration Reference Architecture*, Conference Paper presented at the 61st Int'l Astronautical Cong. (2010).

[62] Ian Crawford, *Lunar Resources,* 39 PROGRESS PHYSICAL GEOGRAPHY 137, 154-155 (2015).

[63] Ian Crawford & Katherine Joy, *Lunar Exploration: Opening a Window into the History and Evolution of the Inner Solar System*, 372 PHIL. TRANSACTIONS ROYAL SOC'Y 20130315, at 15 (2014).

[64] Crawford, *supra* note 62, at 157.

gravity.[65] One particular area where there could be a significant expansion of economic activity in cislunar space in the future would be the development of solar power satellites that would collect solar energy in space, convert it into electricity, and transmit it to Earth via microwave beams.[66] Last but not least, there is the possibility of importing lunar resources to the surface of the Earth, where they would contribute directly to the world economy. However, regarding the supply of resources for terrestrial applications, only resources with a high market value are interesting, due to the high transportation cost such as rare earth metals which have been the subject of asteroid mining studies.[67] The clear advantage of mining lunar resources is the Moon's proximity to the Earth since it is orbiting the Earth rather than the Sun or another planet in the Solar System, meaning that it is accessible at any time.[68]

The Moon presents vast amounts of mineral resources distributed across its surface and subsurface.[69] For example, the regolith (lunar soil), in an unprocessed form, is useful for radiation and thermal shielding for habitats; when processed, various elements and minerals can be extracted, including oxygen, silicon, iron, calcium, magnesium, aluminum, and others.[70] One of the most valuable resource on the Moon is Helium-3, as it can be used to generate electricity directly with little or no radioactive waste.[71] For this reason, it has become the subject of government and private interest, as it would have the potential to replace fossil fuels as the main source of energy on Earth.[72] Helium-3 is found in minimal quantities on Earth, however, it is abundant on the Moon where an estimated one million tons, carried from the sun by the solar wind are potentially

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[65] *See generally* Phillip T. Metzger et al., *Affordable, Rapid Bootstrapping of Space Industry and Solar System Civilization*, 26 J. AEROSPACE ENG'G 18 (2013).

[66] DON M. FLOURNOY, SOLAR POWER SATELLITES 1 (2012).

[67] Andreas Makoto Hein et al., *Exploring Potential Environmental Benefits of Asteroid Mining*, 69TH INT'L ASTRONAUTICAL CONG., at 1 (2018).

[68] RICKY J. LEE, LAW AND REGULATION OF COMMERCIAL MINING OF MINERALS IN OUTER SPACE 21 (2012).

[69] Map of the Moon, *supra* note 59.

[70] RAM S. JAKHU, GLOBAL SPACE GOVERNANCE: AN INTERNATIONAL STUDY, SPACE AND SOCIETY 385 (Ram S. Jakhu & Joseph Pelton et al., eds., 2017).

[71] Thomas Simko & Matthew Gray, *Lunar Helium-3 Fuel for Nuclear Fusion*, 6 WORLD FUTURE REV. 158, 159 (2014).

[72] Tronchetti, *supra* note 29, at 771.

recoverable from the lunar surface.[73] Although the technology has not yet been developed, the value of Helium-3 is that it can generate nuclear power and, as a consequence, energy in a clean way, namely through a process of nuclear fusion which does not produce toxic waste.[74] Due to these special properties, the extraction of Helium-3 is likely to have a huge impact on the way energy is generated and distributed on Earth. It is argued that 370 metric tons of helium-3 would be able to supply humankind with energy for an entire year,[75] thus the total lunar resource of one million tons of it could therefore meet current global electricity generation needs for about five thousand years. Additionally, the water ice deposits at the poles of the Moon make the Moon a potential location for a permanent lunar settlement as well as providing for in situ production of hydrogen and oxygen that are to be used as fuels for propulsion.[76]

As to celestial bodies other than the Moon, it is estimated that 1,400 Near-Earth Asteroids with a diameter larger than one kilometer cross the Earth's orbit around the Sun.[77] These are thought to contain vast amounts of platinum and minerals such as iron and nickel.[78] Some of these asteroids are dead comets with large amounts of water, others contain vast amounts of iron and the two Martian Moons, Phobos and Deimos, contain vast quantities of minerals.[79] Metal and stony asteroids, including stony-iron and ordinary chondrites, although regarded as interesting for their compositions, may be the most difficult source for extracting material.[80] For near-term space resource extraction, it seems that the best type of asteroid would be in the group of carbonaceous chondrites which

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[73] Bilder, *supra* note 2, at 250-51.

[74] Eur. Space Agency (ESA), *Helium-3 Mining on the Lunar Surface*, https://www.esa.int/Enabling_Support/Preparing_for_the_Future/Space_for_Earth/Energy/Helium-3_mining_on_the_lunar_surface (last visited Apr. 3, 2023).

[75] Niklas Reinke, *No Helium-3 from Moon – Commentary on the Current Moon Debate*, 25 DLR COUNTDOWN, 24 (2007).

[76] *See generally* Stanley K. Borowksi et al., *Commercial and Human Settlement of the Moon and Cislunar Space*, Presented on behalf of NASA at the AIAA Propulsion and Energy Forum (2019).

[77] TRONCHETTI, *supra* note 10, at 6; *see also* Daniel D. Durda, *Mining Near-Earth Asteroids*, 18 AD ASTRA 2 (2006) https://space.nss.org/mining-near-earth-asteroids-durda/.

[78] TRONCHETTI*, supra* note 10, at 6.

[79] *Id.*

[80] JAKHU, *supra* note 70, at 386.

represent the majority of Near-Earth Objects.[81] These asteroids have a significant fraction of metals, carbon, and other useful materials, and are the easiest to process since merely crushing and passing a magnet over the fragments the asteroid would reveal their metal components.[82]

B. The Provisions of the Outer Space Treaty

The Outer Space Treaty established a number of foundational principles for the activities of States in space. Some of these principles include the concept that space should be considered "the province of all [hu]mankind;"[83] that outer space is free for the exploration and use by all States;[84] that the Moon (and other celestial bodies) cannot be appropriated (by claim of sovereignty or otherwise) by nation-states;[85] and that international law, including the Unite Nations Charter, is applicable to outer space.[86] However, the treaty makes no explicit reference to the exploitation of space resources or other commercial space activities. As a consequence of its characterization as a treaty of principles, the Outer Space Treaty is capable of broad interpretation and is considered to form the basis upon which more specific agreements could be constructed.[87]

1. The Non-appropriation Principle

In 1980, Dennis Hope, an American citizen claimed ownership of the Moon and other planets and even the sun and he named himself "the omnipotent ruler of the lighted lunar surface" and the "big cheese."[88] Despite the obvious lack of legal basis, he gathered customers and actually made money by purportedly selling parts of the Moon.[89] Another more interesting claim followed a decision of the US District Court for the District of Nevada in 2003 when an

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[81] *Id.*

[82] *Id.*

[83] Outer Space Treaty, *supra* note 3, art. I.

[84] *Id.*

[85] *Id.* at art. II.

[86] *Id.* at art. III.

[87] *See generally* Hobe, *supra* note 50.

[88] *Dennis Hope's Purported "Claim" to Moon Ownership*, GEOCITIES.COM, https://www.geocities.ws/Moonsayles/own.htm (last visited May 31, 2023).

[89] Richard Stenger, *Prime Lunar Real Estate for Sale – but Hurry*, CNN (Nov. 20, 2000).

American citizen named Gregory Nemitz claimed the ownership of Eros, an asteroid.[90] When NASA landed a probe on the asteroid, he asked for rent.[91] Of course, NASA refused to pay and Nemitz went to federal court where is claim for rent was dismissed.[92]

Article II of the Outer Space Treaty establishes a cardinal concept of international space law: the non-appropriative nature of outer space. Article II reads as follows: "Outer space, including the Moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means." The text of Article II makes clear that the traditional means of acquiring property or sovereignty rights over things or lands do not apply to outer space and celestial bodies.[93] The phrase "any other means" makes the prohibition of sovereignty absolute, since neither use nor occupation can constitute legal titles or public or private law titles to justify the extension of sovereign rights by any States over outer space, the Moon and other celestial bodies.[94]

While Article I paragraph 1 of the Outer Space Treaty seeks a qualitative apportionment of the use of outer space that allows each State the potential use and benefit from such use by other States, Article II seeks to support that possibility by prohibiting any property rights from rendering a common use or a common benefit of the use virtually impossible.[95] The non-appropriative character of outer space was one of the first principles agreed upon by States when the fundamental rules governing space activities were laid down at the dawn of the space era and already appeared in both United Nations Resolution 1721[96] and United Nations Resolution 1962 and for this reason the non-appropriation principle is considered as a rule of customary international law.[97]

For the creators of the space law regime, the non-appropriative nature of outer space was the best guarantee for preserving the

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[90] *Nemitz v. United States*, No. CV-N030599-HDM, 2004 WL 3167042 (D. Nev. April 26, 2004).

[91] *Id.*

[92] *Id.*

[93] TRONCHETTI, *supra* note 10, at 27.

[94] MANFRED LACHS, THE LAW OF OUTER SPACE 43 (1972).

[95] Hobe, *supra* note 50, at 123.

[96] G.A. Res. 1721(XVI), Part A ¶ 1(b) (Dec. 20, 1961).

[97] G.A. Res. 1962(XVIII), ¶3 (Dec. 13, 1963).

peaceful nature of the space environment and to ensure that all humankind could benefit from its exploration and use.[98] Drafted in the 1960s, during the rapid decolonization following the postwar period, the drafters of the Outer Space Treaty did not want to open the door to a new era of colonialism in space, with space-capable States asserting territorial claims by planting flags on celestial bodies.[99] A systematic interpretation of Article II of the Outer Space Treaty by looking at the formulation of Article 11 of the Moon Agreement allows the assumption that exploitation of natural resources is not appropriation *per se* if such activities are governed by a regime established by the international community.[100] The non-appropriation principle is a fundamental rule not only with respect to exploitation of outer space resources, but also the allocation of slots in the geostationary orbit by the International Telecommunication Union (ITU)[101] as well as the exploitation of deep seabed resources under the United Nations Convention on the Law of the Sea (UNCLOS).[102] The principle must be understood in harmony with Article VI of the Outer Space Treaty, which establishes the international responsibility of States for national space activities, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions of the Outer Space Treaty.[103]

2. The Principle of the Exploration and Use of Outer Space for the Benefit and in the Interest of All Countries

Article I, paragraph 1 of the Outer Space Treaty declares that "the exploration and use of outer space shall be carried out for the benefit and in the interests of all countries. . . and shall be the

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[98] TRONCHETTI, *supra* note 10, at 27.

[99] Maureen Williams, *The Controversial Rules of International Law Governing Natural Resources of the Moon and Other Celestial Bodies*, *in* PROC. 58TH COLLOQUIUM L. OUTER SPACE 521, 525 (2016).

[100] Jakhu, *supra* note 20, at 395, ¶ 195.

[101] Constitution of the International Telecommunication Union, art. 12(1), Dec. 22, 1992, 97 T.I.A.S. 1026, 1825 U.N.T.S. 331.

[102] UNCLOS, *supra* note 24, art. 137(1).

[103] Vladimir Kopal, *Comments on the issue of "Adequacy of the Current Legal and Regulatory Framework Relating to the Extraction and Appropriation of Natural Resources of the Moon,"* PROC. POL'Y L. RELATING TO OUTER SPACE RES.: SESS 4, 227, 229 (2006).

province of all [hu]mankind."[104] The meaning and practical implications of this Article are uncertain. Some argue that it only has a moral value without imposing any legal obligation by pointing out that the article represents only a commitment of the international community without any practical and material consequence.[105] Other legal writers looking at the *travaux preparatoires* of the Treaty and United Nations Resolutions 1721 and 1962, which testify to the general desire to create a legal obligation to recognize the common interest of all humankind in the exploration and use of outer space, point out the binding value of its provisions.[106] Even if the province of all humankind concept was not designed to lay down specifics of the distribution or sharing of the benefits and products derived from activities carried out in outer space, nor to create an international entity charged with the power to effect such distribution, the concept still has an obligatory nature.[107]

In general terms, Article I can be understood to mean that the exploration and use of outer space, being the "province of all [hu]mankind," is not aimed at serving only the interests of States that have the technological capability to explore and utilize outer space, but the interests of all States, no matter what their degree of economic and scientific development. The most feasible way to enable the largest number of countries to benefit from space activities is through international cooperation.[108] In Resolution 72/77, the General Assembly reaffirmed the importance of international cooperation for the exploration and use of outer space for peaceful purposes and of the widest possible adherence to international treaties promoting the peaceful uses of outer space. [109]

The 1996 Space Benefits Declaration provides an interpretation of Article I of the Outer Space Treaty and clarifies that international cooperation represents the best way of realizing the

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[104] Outer Space Treaty, *supra* note 3, art. I.

[105] *See* Boris Maiorsky, *A Few Reflections on the Meaning and the Interrelation of 'Province of All Mankind' and 'Common Heritage of Mankind' Notions*, *in* PROC. 29TH COLLOQUIUM L. OUTER SPACE 58, 59 (1986).

[106] Nandasiri Jasentuliyana, *Article I of the Outer Space Treaty Revisited*, 17 J. SPACE L. 129, 140-41 (1989).

[107] TRONCHETTI, *supra* note 10, at 26.

[108] Stephan Hobe, *Article I Outer Space Treaty*, *in* I COLOGNE COMMENTARY ON SPACE LAW 25, 38-39 (Stephan Hobe, Berhard Schmidt-Tedd, Kai-Uwe Schrogl eds., 2009).

[109] G.A. Res. 51/122 (Dec. 13, 1996).

principle contained in that Article, namely that the exploration and use of outer space should be carried out in the interest of all States.[110] Paragraph 2 of the Resolution notes the freedom of States "to determine all aspects of their participation in international cooperation in the exploration and use of outer space on an equitable and mutually acceptable basis."[111] Paragraph 4 introduces effectiveness as a fundamental principle for international cooperation by stating that "international cooperation should be conducted in the modes that are considered most effective and appropriate by the States concerned, including *inter alia*, governmental and non-governmental; commercial and non-commercial; global, multilateral, regional or bilateral; and international cooperation among countries in all levels of development."[112] Paragraph 3 indicates that space powers must not forget to include developing States in space exploration and use.[113] Paragraph 5 enumerates the objectives of international cooperation, namely, to "promote the development of space science and technology and their applications," to "encourage the development of relevant and appropriate space capabilities in interested States," and to "facilitate the exchange of expertise and technology between States on a mutually acceptable basis."[114] Thus, international cooperation represents the means through which States could fulfill the principle that the exploration and use of outer space should be carried out for the benefit and in the interest of all humankind. It is clear that the provisions of Article I, paragraph 1 of the Outer Space Treaty have a profound impact on the legal regime governing the exploitation and use of outer space since they impose important, although general, limits and conditions on extraterrestrial mining.

3. The Principle of Freedom of Exploration and Use

Article I, paragraph 2 of the Outer Space Treaty establishes one of the most important principles: the freedom of exploration and use of outer space, which confirms the *res communis* character of outer space. The principle was incorporated in the first space law

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[110] *Id.;* Hobe, *supra* note 50, at 125-26.
[111] G.A. Res. 51/122, at ¶ 2 (Dec. 13, 1996).
[112] *Id.* ¶ 4.
[113] *Id.* ¶ 3.
[114] *Id.* ¶ 5.

legal documents elaborated in the United Nations and thus it is considered that the Outer Space Treaty incorporated an existing rule of customary international law.[115] The Article I sets out three basic rights: the right of free access; the right of free exploration; and the right of free use.[116] The Treaty does not, however, provide the meanings of these terms. It has been suggested that the term "freedom" means that all entities which are addressees of these provisions are entitled to use, explore or scientifically investigate in outer space without the need to ask for permission from other States or an international entity.[117] The term "exploration" as used in the Treaty appears to place emphasis on gaining knowledge about space that will enable humanity to develop its capabilities to go into space and develop activities there, including discovering resources that can eventually be used.[118] As regards the interpretation of the term "use," it might include many different types of human activities, which may or may not be aimed at gaining economic profit,[119] and may refer either to scientific or commercial purposes. The main question regarding the use of outer space for commercial purposes is whether or not the term "use" encompasses "exploitation."[120]

The Outer Space Treaty is an international agreement; thus, its interpretation if guided by the rules enshrined in the Vienna Convention on the Law of Treaties. According to Article 31 thereof, a treaty must first be interpreted in accordance with the "ordinary meaning to be given to the terms of the treaty in their context and in the light of its object and purpose" taking also into account "any subsequent agreement, any subsequent practice and relevant rules of international law applicable in the relations between the parties."[121] These principles of treaty interpretation focus on an objective and teleological interpretation of the treaty text and its object and purpose, rather than a subjective understanding that focuses

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[115] TRONCHETTI, *supra* note 10, at 22.

[116] Outer Space Treaty, *supra* note 3, art. I.

[117] Stephan Hobe, Kuan-Wei Chen, *Legal Status of Outer Space and Celestial Bodies*, *in* ROUTLEDGE HANDBOOK OF SPACE LAW 25, 31 (Ram S. Jakhu & Paul Dempsey eds., 2017).

[118] *Id.* at 32.

[119] *Id.* at 35.

[120] TRONCHETTI, *supra* note 10, at 22.

[121] VCLT, *supra* note 41, art. 31.

on the intent of the drafters or the historical circumstances at the time of drafting.[122] The interpretation of the word "use" must thus be consistent with the other provisions of the Outer Space Treaty.[123]

Article VI of the Outer Space Treaty allows, for instance, non-governmental entities such as companies to carry out activities in outer space as long as they are authorized and continuously supervised by their State. Therefore, by allowing private companies in space, the Outer Space Treaty opened the door to its commercial use. This interpretation of the term "use" in Article I is further confirmed by subsequent State practice, which "constitutes objective evidence of the understanding of the parties as to the meaning of the treaty".[124] Consequently, the commercial use of outer space is allowed under the "freedom of use" of the Outer Space Treaty.

The right of States parties to the Outer Space Treaty to freely use outer space to carry out activities includes an implicit authorization for commercial activities such as space mining. Space mining however opens the door to an entirely new type of industry which will require exploiting non-renewable resources and for this reason it can be interpreted as being included in the freedom of use of outer space as provided by Article I of the Outer Space Treaty so long as space mining does not violate other provisions of the Treaty. Thus, while States are free to use outer space under Article I(1), they are obliged to do so for the benefit of all countries, while paragraph 2 insists that each country is free to use and explore outer space "without discrimination of any kind, on the basis of equality."[125]

4. The Protection of the Outer Space Environment

Activities in respect of space resources utilization can be ultra-hazardous activities and prove harmful to both the outer space and the Earth environment. Such activities potentially will produce debris, hazardous waste, which might be chemically or physically

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[122] SHAW, *supra* note 13, at 707.

[123] International Institute of Space Law, Directorate of Studies, *Does International Space Law Either Permit or Prohibit the Taking of Resources in Outer Space and On Celestial Bodies, And How Is This Relevant for National Actors?*, 41 (2016) https://www.ila-americanbranch.org/wp-content/uploads/2022/10/IISL_Space_Mining_Study.pdf [hereinafter IISL Paper].

[124] ILC, *Draft Articles on the Law of Treaties with Commentaries*, 1966(II) Y.B. Int'l L. Comm'n 187, 221, (1996).

[125] Outer Space Treaty, *supra* note 3, art. 1.

dangerous and radioactive waste. There is also concern about biological material transferred from Earth in space probes or human missions contaminating another planetary body.[126] Due to the low gravity environment of asteroids, mining activities are prone to create clouds of dust materials that, after the excavation or mining activity, will drift into space at a different velocity than the asteroid.[127] The amount of unused excavated materials can exceed the combined mass of existing space debris by orders of magnitude and result in hampering the sustainable access to space.[128] Article IX of the Outer Space Treaty has laid the basis for environment protection of outer space since it requires that States pursue studies and conduct exploration of outer space so as to avoid harmful contamination and adverse changes in the environment of the Earth.[129] Therefore, States are obliged to take environmental aspects into account when authorizing and monitoring national activities in outer space and to take appropriate measures where necessary. The unregulated mining of the vast quantum of resources can be prevented by implementing the principle of sustainable use.[130] Even though the risk of overexploiting asteroid resources is not a main concern at the time, it must be highlighted that any mining activity is bound to contaminate outer space's pristine environment with pollutants and debris.[131]

5. Evaluation of the Provisions of the Outer Space Treaty

The Outer Space Treaty was written in general terms without defining the legal meaning of the terms used, leading to different

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[126] Fengna Xu, *The Approach to Sustainable Space Mining: Issues, Challenges, and Solutions,* 738 IOP Conf. Series: Materials Sci. Eng'g 012014, 5 (2020) https://iopscience.iop.org/article/10.1088/1757-899X/738/1/012014.

[127] Stefan Kaiser, *Legal Protection against Contamination from Space Resource Mining*, 66 ZLW 282, 287 (2017).

[128] *Id*.

[129] Outer Space Treaty, *supra* note 3, art. IX.

[130] *See generally* Sandeepa Bhat, *Application of Environmental Law Principles for the Protection of the Outer Space Environment: A Feasibility Study*, 39 ANNALS AIR & SPACE L. 323 (2014).

[131] Jinyuan Su, *Control Over Activities Harmful to the Environment*, *in* ROUTLEDGE HANDBOOK OF SPACE LAW 73, 74 (Ram S. Jakhu & Paul Dempsey eds., 2017); *See also* Francis Lyall, *Planetary Protection from a Legal Perspective - General Issues*, *in* IAA COSMIC STUDY 55, 55-56 (Mahulena Hoffmann, Petra Rettberg & Mark Williamson eds., 2010)

interpretations of its provisions. Simberg notes that while the technology is a challenge, one of the biggest business uncertainties that commercial space companies face is the legal status of any output from their off-world mining operations and the corresponding ability to raise the funds for extraterrestrial ventures.[132]

C. The Provisions of the Moon Agreement

With regard to the provisions of the Moon Agreement dealing with the exploration and use of the Moon and other celestial bodies, there is an analogy with those contained in the Outer Space Treaty. The Moon Agreement contains a number of potentially significant principles as a primary purpose of the Agreement was to formalize the terms of a legal regime that would ultimately apply to the exploitation of the natural resources of the Moon and other celestial bodies.[133]

1. The Principle of Non-appropriation

In particular, Article 11, paragraph 2 of the Moon Agreement reiterates the non-appropriative nature of the Moon and other celestial bodies with a wording that mirrors that of Article II of the Outer Space Treaty. The wording of Moon Agreement suggests that the exploitation of the natural resources of the Moon and other celestial bodies is not a means of appropriation. Although Article 11(2) of the Moon Agreement repeats the prohibitions of Article II of Outer Space Treaty, this must be seen in the context of the objectives of Moon Agreement with regard to the exploitation of natural resources in accordance with its specific provisions and the eventual establishment of an international regime.[134] Paragraph 3 of Article 11 moves one step forward towards addressing the issue of property rights in outer space by clarifying the position of natural and legal persons with respect to the non-appropriation of celestial bodies. Accordingly, neither the surface and subsurface of the Moon nor natural resources in place shall become the property of any

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[132] Rand Simberg, *Homesteading the Final Frontier*, COMPETITIVE ENTERPRISE INSTITUTE 8 (2012).

[133] *See* Stephan Hobe et al., *Historical Background and Context MOON*, in II COLOGNE COMMENTARY ON SPACE LAW 336, 341-42, ¶ 20 (Stephan Hobe, Berhard Schmidt-Tedd & Kai-Uwe Schrogl eds., 2013).

[134] IISL Paper, *supra* note 123, at 37.

State, international inter-governmental or non-governmental organization, national organization or non-governmental entity, or any natural persons.[135]

2. The Exploration and Use of the Moon

Article 4 of the Moon Agreement states, "[t]he exploration and use of the Moon shall be the province of all [hu]mankind and shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development."[136] Article 4, however, goes further than the text of Article I (1) of the Outer Space Treaty by establishing also that "due regard shall be paid to the interests of present and future generations as well as to the need to promote higher standards of living and conditions of economic and social progress and development."[137]

3. The Exploitation of the Natural Resources of the Moon and Celestial Bodies

Article 11, paragraph 1 declares the Moon and its natural resources to be the "common heritage of [hu]mankind." However, unlike United Nations Convention on the Law of the Sea, the Moon Agreement does not fully elaborate the CHM concept. Instead, its meaning and scope remain largely debatable.[138] Article 11 leaves it entirely open as to how the international regime for the exploitation of the resources of the Moon and other celestial bodies should be shaped and exploitative lunar activities organized. For example, nothing similar to the International Seabed Authority, formed under United Nations Convention on the Law of the Sea, is created under the Moon Agreement. When reading the Moon Agreement, it becomes evident that its drafters did not consider the exploitation of extraterrestrial natural resources as a matter of immediate urgency. Consequently, any specific decision on the rules governing such exploitation has not been reached. Indeed, Article 11, paragraph 5 calls upon States parties to establish an international

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[135] Moon Agreement, *supra* note 4, art. 11.

[136] *Id.* at art. 4.

[137] *Id.*

[138] Frans von der Dunk, *The Dark Side of the Moon – The Status of the Moon: Public Concepts and Private Enterprise*, *in* PROC. 40TH COLLOQUIUM L. OUTER SPACE 119, 121 (1998).

regime for the exploitation of the natural resources of the Moon and celestial bodies, but only when such exploitation is about to become feasible.[139]

Article 11, paragraph 7 frames the main purposes of this new international regime for the eventual exploitation of natural resources, by providing that: any exploitation of extraterrestrial resources should be undertaken in an orderly and safe manner; the natural resources should be rationally managed (which means that any resource-wasting activities should be avoided);[140] the use of extraterrestrial resources should enable the expansion of opportunities; and the benefits derived from the exploitation of extraterrestrial resources should be "equitably" shared among States.[141] The first three of these provisions reflect a tendency towards a best practice approach to the exploitation of such natural resources.[142] Article 11(7)(d) calls for an "equitable" rather than "equal" sharing that considers the needs of developing countries and the efforts of countries that have contributed directly or indirectly to lunar exploration, and seeks to balance the interests of investing and non-investing States.[143]

It should be noted however that Article 1(1) of the Moon Agreement, in principle, allows for a special regime in deviation from the Agreement, including, for instance, the application of the common heritage of humankind concept to be developed. Article 1 provides that "[t]he provisions of this Agreement relating to the Moon shall also apply to other celestial bodies within the solar system, other than the earth, except in so far as specific legal norms enter into force with respect to any of these celestial bodies."[144] Therefore, the development of an international regime specifically addressing asteroid mining, in a manner more conducive to the promotion of private enterprise than the original implementation of the concept of the common heritage of humankind under the law of the sea, is feasible under Article 1(1) of the Moon Agreement.[145]

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[139] Moon Agreement, *supra* note 4, art. 11(5).

[140] Tronchetti, *supra* note 29, at 787.

[141] Moon Agreement, *supra* note 4, art. 11(7).

[142] IISL Paper, *supra* note 123, at 36.

[143] *Id.* at 36.

[144] Moon Agreement, *supra* note 4, art. 1.

[145] *See generally* Frans von der Dunk, *Asteroid Mining: International and National Legal Aspects*, 26 MICH. STATE INT'L L. REV. 90 (2017).

4. The Protection of the Environment of the Moon and Other Celestial Bodies

Space mining as previously mentioned raises concerns about the environment of the Moon and other celestial bodies. Article 7 of the Moon Agreement clarifies the general obligations expressed in Article IX of the Outer Space Treaty by providing specific standards to be followed. For example, the Moon Agreement requires that States prevent upsetting the established balance of the environment of the Moon and other celestial bodies and established that they have a positive obligation to take steps to prevent such disturbance.[146] The Agreement also clarifies that such disturbance may occur through the introduction of adverse changes into that environment by harmful contamination or by other unspecified means, and does not limit the concept of harmful contamination to the introduction of extra-environmental matter, but encompasses harmful contamination as one form of environmental disturbance.[147]

5. Evaluation of the Provisions of the Moon Agreement

Although the Moon Agreement has received no more than eighteen ratifications and no major spacefaring nation subscribes to it, the Convention lays down general principles and future commitments by not prohibiting the taking of resources *per se* but leaving the distribution of benefits therefrom open for a future determined by a legal regime to be established as soon as this exploitation becomes feasible. The main conclusion is that the concept "common heritage of humankind," as elaborated in the Moon Agreement, which seemed to refer to the original version of the United Nations Convention on the Law of the Sea, could not form the basis of a new legal framework for the exploitation and commercialization of the resources of the Moon and other celestial bodies.[148] This is why, in the 1996 Space Benefit Declaration, developing countries recognized the need to soften some of the most rigid elements of the "common heritage of humankind" concept, such as the provisions

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[146] Moon Agreement, *supra* note 4, art. 7(I); Su, *supra* note 131, at 81.

[147] Moon Agreement, *supra* note 4, art. 7(I). *See* LOTTA VIIKARI, THE ENVIRONMENTAL ELEMENT IN SPACE LAW 62 (2008).

[148] TRONCHETTI, *supra* note 10, at 83-84.

on mandatory transfer of technology and benefits, thus providing a potential solution for the establishment of the above-mentioned legal framework.[149] Thus an envisaged regime could be further developed on the basis of the principles already set out in Moon Agreement and lead to new rules for the future exploitation of the natural resources of the Moon and other celestial bodies.

D. Latest Developments

1. National Legislation

A growing number of space faring nations have enacted national laws in an effort to create regulations for asteroid mining and the extraction of materials from the Moon and other celestial bodies by private companies, expressly allowing for the appropriation of the natural resources. In particular, former President Barack Obama signed the Commercial Space Launch Competitiveness Act in 2015, which has four titles, Title IV of which is titled "Space Resource Exploration and Utilization."[150]

The Act recognizes the property rights of U.S. citizens and companies over space resources once extracted on a first come, first served basis with Section 402 providing that

> [a] U.S. citizen engaged in commercial recovery of an asteroid resource or a space resource under [the Act] shall be entitled to any asteroid resource or space resource obtained, including to possess, own, transport, use, and sell the asteroid resource or space resource obtained in accordance with applicable law, including the international obligations of the United States."[151]

The Space Launch Competitiveness Act was presented at the United Nations Committee on the Peaceful Uses of Outer Space in 2016 where Russia and Belgium opposed it arguing that an international approach to developing a space mining law regime was needed rather than the *ad hoc* enactment of national legislation and took the view that space resources are prohibited from

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[149] *Id.*

[150] SPACE Act of 2015, Pub. L. No. 114-90, 129 Stat. 704, codified at 51 U.S.C. §51301 to §51303.

[151] 51 U.S.C §51303.

appropriation under the Outer Space Treaty.[152] It should be noted that, in the history of international space politics, such unilateral actions from the US are typically viewed as aggressive power grabs,[153] thus it is questionable whether these nations actually opposed the extraction and ownership of space resources or whether they merely opposed the unilateral decision made by the US.

Potential economic, scientific, and even security benefits are the reason for the emerging geopolitical competition for space mining. This is because, according to Mearsheimer, the structure of the international system gives States incentives to constantly pursue hegemony and further expansion, thus, the world is left with recurring great-power competition.[154] While such competition can be beneficial in promoting rapid technological advances in the space industry, the line separating space from becoming a healthy competitive environment or a cosmic battleground is thin.[155] Additionally, in April 2020 the Executive Order 13914, titled "Encouraging International Support for the Recovery and Use of Space Resources," was signed by the former President Donald Trump. The Order sets forth the US' intention to conduct commercial exploration and resource exploitation on the Moon and other celestial bodies upholding the American position that the use and exploitation of space resources is not prohibited by the Outer Space Treaty and that space does not constitute a "global commons."[156]

Following the US example in 2017, Luxembourg passed its own national space mining law, the Law of 20 July 2017 on the Exploration and Use of Space Resources.[157] It is the first legal and regulatory framework for space mining in Europe, outlining the authorization and supervision procedures for missions to explore and exploit natural resources in space.[158] Its objective is to provide a legal framework for commercial space mining by ensuring

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[152] Laura C. Byrd, *Soft Law in Space: A Legal Framework for Extraterrestrial Mining*, 71 EMORY L. J. 801, 819-820 (2022).

[153] *Id*.

[154] JOHN MEARSHEIMER, THE TRAGEDY OF GREAT POWER POLITICS 2 (2001).

[155] Byrd, *supra* note 152, at 823.

[156] Exec. Order No. 13,914, 85 Fed. Reg. 20381 (Apr. 6, 2020).

[157] Grand Duchy of Luxembourg, Law on the Exploration and Use of Space Resources (July 20, 2017).

[158] Jacques Graas et al., *Luxembourg Space Resources Act: Paving the Legal Road to Space*, JDSUPRA (Sep. 29, 2017) https://www.jdsupra.com/legalnews/luxembourg-space-resources-act-paving-66883/.

ownership of commercially mined space resources, notably on asteroids, and therefore providing a final incentive for mining companies to settle in the country.[159] The law focuses on the commercial exploration and utilization of space resources and Article 4 provides two conditions for its applicability: (1) the nature of the company and (2) the presence of the company on Luxembourg's territory. In implementing Article VI of the Outer Space Treaty, Luxembourg has avoided any suggestion that the government grants exclusive rights of exploitation, since, according to the law, it only licenses activities and it does not address the fundamental concerns about the efficacy of enacting a national law declaring space resources appropriable, although the international legal framework remains unclear in this regard.[160] Luxembourg thus operates a shift from the question of appropriation to the question of the authorization and supervision of the space mining mission.

More recently, the UAE enacted the Federal Law No. (12) of 2019 on the Regulation of the Space Sector.[161] The new law consists of nine chapters and 54 articles to regulate space activities in the UAE and it also provides for the facilitation of private space mining.[162]

Finally, in 2021, Japan enacted legislation allowing businesses to extract and utilize space resources.[163] After receiving permission from the Japanese government, the Act on the Promotion of Business Activities Related to Exploration and Development of Space Resources allows Japanese persons who explore and develop

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[159] Kiran Vazhapully, *Space Law at the Crossroads: Contextualizing the Artemis Accords and the Space Resources Executive Order*, OPINIOJURIS 2 (July 22, 2020) http://opiniojuris.org/2020/07/22/space-law-at-the-crossroads-contextualizing-the-artemis-accords-and-the-space-resources-executive-order/#:~:text=The%20Accord%20is%20consistent%20with,seen%20as%20part%20of%20the.

[160] Philip De Man, *Luxembourg Law on Space Resources Rests on Contentious Relationship with International Framework*, LEUVEN CTR. GLOB. GOVERNANCE STUD., 13 (2017).

[161] UAE Federal Law No. 12 of 2019 on the Regulation of the Space Sector (Dec. 19, 2019), https://www.moj.gov.ae/assets/2020/Federal%20Law%20No%2012%20of%202019%20on%20THE%20REGULATION%20OF%20THE%20SPACE%20SECTOR.pdf.aspx [hereinafter UAE Space Law]

[162] *Id.* at art. 18.

[163] Japan Act no. 83 of 2021 on Promotion of Business Activities Related to the Exploration and Development of Space Resources, https://kanpou.npb.go.jp/old/20210623/20210623g00141/20210623g001410004f.html [hereinafter Japan Space Resources Act].

space resources to acquire ownership of the resources that they have mined or extracted in accordance with their business activity plan.[164] Consequently, Japan is the fourth country after the US, Luxembourg and United Arab Emirates to pass national legislation allowing the private sector to exploit space resources showing that the international community is leaning toward the US position that the extraction and ownership of such resources comply with the Outer Space Treaty.

The enactment of national laws is considered an attempt to interpret international law since the enactment of national laws constitutes subsequent practice for the purpose of treaty interpretation under the Vienna Convention on the Law of Treaties.[165] Even though national laws are subject to international law in this case, the mere existence of the former has an impact on the latter because States codify a certain practice as well as *opinio juris* by enacting national laws.[166] State practice and *opinion juris* are the two constitutive elements of customary international law, which is internationally binding on States.[167] Such interpretations of Article II of the Outer Space Treaty, if adopted by other States, will be crucial to the future understanding and development of the non-appropriation principle, and can serve as a steppingstone for the development of international rules that will be evaluated through an international dialogue in order to coordinate the free exploration and use of outer space, including resource extraction, for the benefit and in the interests of all countries.[168] Nevertheless, the proliferation of national law approaches runs the risk of fragmenting the international legal order, possibly creating problematic inconsistencies between how States view their rights and obligations under international law, and possibly leading to "forum shopping" actions by

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[164] Hiroko Yotsumoto et al., *The Space Law Review: Japan*, THE LAW REVIEWS (Dec. 9, 2021) (*citing* art. 5 of the Japan Space Resources Act)

[165] International Law Commission, *Draft Conclusions on Subsequent Agreements and Subsequent Practice in Relation to the Interpretation of Treaties, with Commentaries,* 32, ¶ 18 (2018); *see also* VCLT, *supra* note 41, art. 31(3)(b).

[166] Tanja Masson-Zwaan & Neta Palkovitz, *Regulation of Space Resource Rights: Meeting the Needs of States and Private Parties*, 35 QIL ZOOM-IN 5, 5 (2017).

[167] *See* North Sea Continental Shelf, (Ger. v. Den.; Ger. v. Neth.), Judgement, 1969 I.C.J. 3, 44, ¶ 77 (Feb. 20).

[168] International Institute of Space Law, *Position Paper on Space Resource Mining*, 3 (2015).

commercial operators, thereby weakening the system as a whole.[169] In other words, a situation in which companies may continuously exploit natural resources in outer space based only on domestic laws would be generally unacceptable, because without regulations, space exploitation would generate significant disparity between States and upset global economic dynamics.[170] Off-Earth mining of space resources would be legal as long as it is for the benefit of all humankind, therefore it would not be in accordance with international space law if such mining is carried out only for exclusive interests, contrary to the terms of the Outer Space Treaty.[171]

However, given the reality that an overarching treaty-like regime is not feasible at this time, a scenario in which countries continue to adopt the US approach, enacting their own national laws on the issue while ensuring compliance with the Outer Space Treaty and other relevant provisions of international space law, would indicate that they are gradually coming to a common understanding of what should be considered legitimate or legally allowed.[172] There is precedent for such a scenario: When US President Harry Truman declared the continental shelf to be an extension of the American landmass in 1945, despite the fact that economic exploitation was against customary international law at the time, most States recognized the validity of the geological continuity argument and began to make similar claims with respect to their own continental shelves.[173] The concept of the territorial nature of the continental shelf was then transformed into treaty law by the 1958 Convention on the Continental Shelf.[174]

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[169] Ian Christensen & Christopher Johnson, *Putting the White House Executive Order on Space Resources in an International Context*, THE SPACE REVIEW (Apr. 27, 2020) https://www.thespacereview.com/article/3932/1.

[170] Senjuti Mallick & Rajeswari Rajagopalan, *If Space is 'The Province of Mankind', Who Owns its Resources*?, 182 ORF OCCASIONAL PAPERS, 13 (2019).

[171] Ram S. Jakhu, Steven Freeland, *The Relationship between the Outer Space Treaty and Customary International Law*, *in* PROC. 59TH COLLOQUIUM L. OUTER SPACE 183, 198-199 (2016).

[172] Frans von der Dunk, *supra* note 139, at 100-101.

[173] *Id.* at 101.

[174] United Nations Convention on the Continental Shelf, art. 2, April 29, 1958, 499 UNTS 311, (entered into force June 10, 1964).

2. The Artemis Accords

Over the years, international space law has progressed within the United Nations framework along with the negotiation and adoption of multilateral treaties and agreements. The introduction of the privately negotiated Artemis Accords,[175] led by the US, contradicts this precedent since, while the language itself acknowledges the merits of multilateralism, the Accords were not produced under the auspices of COPUOS.[176]

The Artemis Accords, introduced in October 2020, consist of 13 clauses that create a conceptual framework for long-term human exploration of the Moon and other celestial bodies, including the utilization of their natural resources, as part of the US National Aeronautics and Space Administration's (NASA) Artemis program. Through the Accords, NASA has established a set of rules to implement the Artemis program, which will be an important component of any later agreement with international partners. According to NASA the Artemis Accords represent a political commitment to a shared vision for principles, grounded in the Outer Space Treaty, to create a safe and transparent environment which facilitates exploration, science, and commercial activities.[177] The development of the Artemis Program and the Artemis Accords is part of the goal set forth in Executive Order 13914 to encourage international support for the public and private recovery and use of resources in outer space.[178] The Accords are an attempt to encourage the international community to reach a consensus on the legality of space resource extraction and also to persuade other nations to participate in the Artemis Program and future space resource activities.[179] The Artemis Accords' provisions are grouped into three categories: the first category simply transposes sections of the Outer Space Treaty into

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[175] The Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids for Peaceful Purposes (2020) [hereinafter Artemis Accords].

[176] Jack Nelson, *The Artemis Accords and the Future of International Space Law*, 24 AM. SOC'Y INT'L L. INSIGHTS, 1, 1 (2020).

[177] NASA, *Artemis Accords*, https://www.nasa.gov/specials/artemis-accords/index.html (last visited May 31, 2023).

[178] Exec.Order No. 13,914, *supra* note 157.

[179] Guoyu Wang, *NASA's Artemis Accords: The Path to a United Space Law or a Divided One?*, THE SPACE REVIEW (Aug. 24, 2020) https://www.thespacereview.com/article/4009/1.

the Artemis Accord's language; the second category implements provisions of the Outer Space Treaty by describing and clarifying the rights and duties included therein; and the third category introduces new concepts.[180]

The Accords affirm that the extraction of space resources does not inherently constitute national appropriation under Article II of the Outer Space Treaty and that contracts and other legal instruments relating to space resources should be consistent with that Treaty thereby creating a favorable international environment for space resources exploitation and utilization.[181] The Artemis Accords continue the interpretive trend set by Title IV of the U.S. Commercial Space Launch Competitiveness Act of 2015 and the April 6 Executive Order on Encouraging International Support for the Recovery and Use of Space Resources, which states that US companies have the right to possess, own, transport, use, and sell space resources without violating international law.[182]

The unilateral approach of the US in issuing the aforementioned national legislation is seen in light of the fact that the international community has yet to develop an agreement on the legal character of and attribution of the right to space resources.[183] Section 10(2) of the Artemis Accords declares that "the extraction of space resources does not inherently constitute national appropriation under Article II of the Outer Space Treaty."[184] This formulation reflects a novel interpretation of Article II of the Outer Space Treaty, in which the US attempts to codify its policy on extraterrestrial mining in customary international law, therefore resolving the interpretative uncertainty of the phrase "national appropriation."[185] The Artemis Accords are a political initiative, according to Frans von der Dunk, who states that "the intention of the United States is to gather consensus around its interpretation of the Outer

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[180] Rossana Deplano, *The Artemis Accords: Evolution or Revolution in International Space Law?*, 70 INT'L COMPAR. L. Q. 799, 801 (2021).

[181] Artemis Accords, *supra* note 177, §10.

[182] Exec.Order No. 13,914, *supra* note 157, Sec. 1; SPACE Act of 2015 *supra* note 151, §51303.

[183] Zhao Yun, *A Multilateral Regime for Space Resource Exploration and Utilization*, 17 INDONESIAN J. INT'L L. 327, 329 (2020).

[184] Artemis Accords, *supra* note 177, §10(2).

[185] Kunal Jhaveri*, Launching for Gold: The Artemis Accords and the Legality of Extraterrestrial Mining*, 42 MICH. J. INT'L L. (2020) https://www.mjilonline.org/launching-for-gold-the-artemis-accords-and-the-legality-of-extraterrestrial-mining/.

Space Treaty with regard to the exploitation of the resources of the Moon."[186] Hobe notes that "we already have internationally binding law, but there are a few countries that are not satisfied with the interpretation of this law. So, they create guidelines with the hope that eventually they will develop into customary law that will weaken the existing space law. That's a really clever maneuver."[187] The Artemis Accords so far have been signed by 23 countries: Australia, Bahrain, Brazil, Canada, Colombia, France, Israel, Italy, Japan, the Republic of Korea, Luxembourg, Mexico, New Zealand, Poland, Romania, Singapore, Ukraine, the United Arab Emirates, Saudi Arabia, Nigeria, Rwanda, the United Kingdom, and the US.[188]

The provisions, which seek to operationalize the relevant obligations of the Outer Space Treaty by clarifying the conduct required of States and other actors operating in outer space, raise the question, whether the conclusion of the Artemis Accords constitutes, subsequent practice within the meaning of Article 31(3)(b) of the Vienna Convention on the Law of Treaties, as an emerging subsequent practice, or under Article 32 of the Convention, as conduct by one or more parties in the application of the Outer Space Treaty that has the value of a supplementary means of interpretation.[189] Furthermore, sufficient acceptance of the US' understanding of this issue, as well as subsequent practice prompted by the implementation of the Artemis Accords, could contribute to the formation of *opinio juris*, which, in turn, could lead to the creation of customary international law, crystallizing an issue that has remained opaque and unclear to date.[190] Even acquiescence, which is tantamount to consent in customary international law, to the Artemis Accord's interpretation of Article II of the Outer Space Treaty would, unless objected to by other States, strengthen the US interpretation.[191]

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[186] Alexander Stirn, *Do NASA's Lunar Exploration Rules Violate Space Law?*, SCIENTIFIC AMERICAN (Nov. 12, 2020) (*quoting* statement made by Jim Bridenstine at IAC 2020).

[187] *Id.* (*quoting* statement made by Stephan Hobe).

[188] *See* NASA, *Artemis Accords*, *supra* note 177.

[189] VCLT, *supra* note 41, arts 31 & 32; Deplano, *supra* note 182, at 801.

[190] Almudena Azcárate Ortega, *Artemis Accords: A Step Toward International Cooperation or Further Competition?*, LAWFARE (Dec. 15, 2020) https://www.lawfaremedia.org/article/artemis-accords-step-toward-international-cooperation-or-further-competition.

[191] Jhaveri, *supra* note 187.

The Artemis Accords are a novel approach towards reaching international consensus on space operations, and will likely serve as a foundation for future agreements. Although the Accords are simply a political commitment, they might have a considerable influence on any prospective framework for the exploitation of space resources by defining practice and *opinio juris* in this field, despite the fact that they are not binding instruments of international law.

However, a number of the provisions of Artemis Accords are in stark contradiction to the *lex lata* on the exploration and use of outer space and raise some questions about their real intent.[192] The U.S. position on the legal status of outer space as not a "global commons," set forth in the Executive Order, is at odds with the long-held view in the international community that outer space is a "global commons" and that the exploration and use of its resources should be governed by an international agreement. It favors a unilateral approach to regulating the exploration and use of space resources rather than promoting negotiations for an international agreement with a broad support. In addition, it rejects the applicability of the 1979 Moon Agreement to any future lunar governance regime since, according to the Executive Order, the State Department should object to any attempt by any other State or international organization to treat the Moon Agreement as reflecting or otherwise expressing customary international law.[193]

3. The United Nations Committee on the Peaceful Uses of Outer Space

The United Nations COPUOS is the established international forum for the peaceful uses of outer space and the multilateral forum for the codification and development of norms regarding space activities.[194] However, no new internationally binding legal instruments have been developed at COPUOS since the Moon Agreement of 1979, after which, the development of space law took place mainly through soft law provisions. Soft law rules express common expectations of the conduct of international relations, and notwithstanding their non-committal quality, serve a variety of purposes

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[192] Vazhapully, *supra* note 160 at 3.

[193] *Id* at 3.

[194] Frans von der Dunk, *International Law, in* HANDBOOK OF SPACE LAW 29, 37 (Frans von der Dunk & Fabio Tronchetti eds., 2015).

such as: filling gaps of existing treaty law providing greater precision; crystallizing a trend towards a norm; forming part of State practice; consolidating political opinion around the need for action; and, possibly, leading to consensus on the matter.[195] Indeed, soft law instruments may provide the detailed rules and technical standards required for the interpretation and implementation of a treaty as well as be the first step in a process eventually leading to conclusion of a multilateral treaty.[196] Soft law is also extremely important for the identification and the progressive elaboration of relevant rules of customary law.[197] A special role in such a development of space law has been played by the United Nations General Assembly, not only since the early days of space law, but even more so today, as under the current global political climate, it appears to be the only avenue for the further development of international space law beyond the conventional framework.

In some cases, States opt for soft law instruments because they are often unable to settle their differences and agree on the wording and content of a treaty, while in other cases, States are not willing to be bound by mandatory rules in a particular area, and depending on the purpose States want to achieve, a soft law instrument may be the most convenient solution, as it is much more flexible than a treaty.[198] Soft law may even be more effective in reaching a particular goal with respect to regulating behavior than the slow and politically charged process of negotiating a new treaty.[199] The guidelines or standards of conduct in soft law instruments often influence States' actions, but as they do not have the legal 'force' of binding treaties in and of themselves, the subsequent incorporation of the relevant concepts into treaties or customary international law will give rise to binding international legal obligations.[200]

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[195] *See generally* Daniel Thürer, *Soft Law*, *in* MAX PLANCK ENCYCLOPEDIA OF PUBLIC INTERNATIONAL LAW (2009).

[196] Alan Boyle, *Some Reflections on the Relationship of Treaties and Soft Law*, 48 Int'l Compar. L. Q. 901, 904-905 (1999).

[197] Fabio Tronchetti, *Soft Law*, *in* 8 OUTER SPACE IN SOCIETY, POLITICS AND LAW 619, 624-625 (Christian Brunner & Alexander Soucek eds., 2011).

[198] *Id.* at 625-626.

[199] Cassandra Steer, *Sources and Law Making Processes Relating to Space Activities*, *in* ROUTLEDGE HANDBOOK OF SPACE LAW 3, 19 (Paul S. Dempsey & Ram Jakhu eds., 2017).

[200] Steven Freeland*, The Use of Soft Law within the International Legal Regulation of Outer Space,* 36 ANNALS AIR & SPACE L. 434 (2011).

On the issue of space resources, given the emerging nature of commercial space resource access and utilization, a binding treaty prior to the commencement of actual activities is probably inappropriate and may not be appropriate thereafter, while unilateral adoption of national laws on the subject by individual countries is also not an appropriate solution.[201] For this reason, the alternative of developing soft law provisions on this issue is the most appropriate solution. A model for this type of soft law instrument is the 2019 Guidelines for the Long-Term Sustainability of Outer Space (LTS Guidelines), which encourage the conduct of space operations in a way that promotes their safety and long-term sustainability.[202] For the development of the Guidelines, COPUOS first established a Working Group on the Long-Term Sustainability of Outer Space Activities in 2010, then agreed on a number of Guidelines which were officially adopted in 2019.[203]

In the context of space resources, a number of working papers, conference room papers, and statements served as the foundation for informal consultations of the COPUOS Legal Subcommittee in 2021. Statements made during the 60th session of the Legal Subcommittee referred to the equitable access to space resources and collaboration on the issue of space resources so that developing countries are not left behind by spacefaring countries.[204] The preservation of the space environment and the sustainable management of space resources were also discussed, with a focus on the development of norms for the sustainable utilization of the resources, the avoidance of contamination, and the prevention of causing irreversible changes to the environment of celestial bodies.[205] At its 61st session, following eight rounds of informal consultations, the Legal Subcommittee resolved to develop, under a detailed five-year work-plan from 2022 to 2027, a working group

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[201] Christensen & Johnson, *supra* note 171.

[202] Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on Its Fifty-Seventh Session, U.N. Doc. A/AC.105/1177, at 20, ¶ 237 (2018).
Comm. on the Peaceful Uses of Outer Space, Rep. of the Comm. on Its Sixty-Second Session, Annex II, U.N. Doc A/74/20 (2019) [hereinafter LTS Guidelines].

[203] UNOOSA, *Long-term Sustainability of Outer Space Activities*, https://www.unoosa.org/oosa/en/ourwork/topics/long-term-sustainability-of-outer-space-activities.html (last visited May 31, 2023).

[204] Rep. of the Legal Subcomm. on its 60th Sess. U.N. doc. A/AC.105/1243, at 31, ¶ 242 (June 24, 2021).

[205] *Id*. at 32, ¶ 247-49.

focused on potential legal models for activities in exploration, exploitation, and use of space resources.[206] The Working Group welcomed the strong interest and active participation by Member States of the Committee in its work and encouraged Member States, in particular developing countries, to continue sharing their views on issues related to space resource activities in order to ensure that the work of the Working Group remained open, inclusive and transparent.[207]

IV. A NEW LEGAL REGIME FOR SPACE MINING

While the right of extraction and ownership of resources in space remains a matter of controversy, one point of international consensus has prevailed: a legal framework to govern the exploration and extraction of these resources must be agreed upon in order to ensure the peaceful use of space and prevent a second space race.[208] The author proposes a legal regime for sustainable space mining activities and the management of space resources that is an adaptation of the carbon credit system applied for the reduction of global emissions of CO2 as envisioned in the Kyoto Protocol to the United Nations Framework Convention on Climate Change.[209] According to this approach each country would be allocated a certain amount of mining credits, which would allow the holder of the credits to engage in mining certain tonnage of natural resources on the Moon for a given period.[210] Emissions trading, as set forth in Article 17 of the Kyoto Protocol, allows countries that have spare emissions units to sell that excess capacity to countries that exceed their targets.[211] Under the Protocol, while Parties are allowed to emit a certain amount of emissions per period, they are allowed to either transfer or receive emission allowances from any other Party as long as the combined emission levels of the transferring and receiving Parties do not exceed the sum of their individual allowed

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[206] Rep. of the Legal Subcomm. on its 61st Sess. U.N. doc. A/AC.105/1260, at 38-40 (Apr. 8, 2022).

[207] *Id.* at 38.

[208] TRONCHETTI, *supra* note 10, at 235-236.

[209] Kyoto Protocol to the United Nations Framework Convention on Climate Change, Dec. 11 1997, 2303 U.N.T.S. 162 [hereinafter Kyoto Protocol].

[210] Edwin W. Paxson, *Sharing the Benefits of Outer Space Exploration: Space Law and Economic Development,* 14 MICH. J. INT'L L. 487, 514 (1992).

[211] Kyoto Protocol, *supra* note 212, art. 17.

emission levels.[212] In this sense, the Protocol permits effective procedures to control who can emit how much while guaranteeing a stable level of emissions.

The first significant carbon market in the world, and still the largest, is the EU Emission Trading System.[213] By permitting private permit trading, the EU ETS can enhance the country-to-country trade outlined in the Kyoto Protocol because national or international bodies can allot permits to certain enterprises under such programs, which can then be coordinated with the national emissions objectives specified under the framework of the Kyoto Protocol.[214] A similar system is envisioned by the International Civil Aviation Organization.

ICAO has implemented a global marked-based measure scheme, in order to compensate for the CO2 emissions in the form of a Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), which was the first agreement to tackle CO2 emissions in a globalized sector of the economy.[215] The system adopted by ICAO is based on offsetting, whereby the global aviation sector will offset its emissions through the reduction of emissions elsewhere, and the purchase of credits from a supply and demand driven "carbon market" generated by projects that reduce carbon emissions around the world.[216]

The carbon credit system for the reduction of global emissions of CO2 adapted and applied to outer space and particularly the Moon, offers a viable way to govern the exploitation of space resources**.**

A new system that grants transferable credits and permits space mining for limited periods of time provides a sustainable solution for using space for the benefit of all people. The credit system would also be beneficial to the space environment and the management of its resources, as it would ensure, from an environmental

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[212] *Id. See* UN Framework Convention on Climate Change (UNFCCC) website, *Kyoto Protocol: Emissions Trading*, https://unfccc.int/process/the-kyoto-protocol/mechanisms/emissions-trading (last visited Apr. 2, 2023).

[213] EU Emissions Trading System, https://ec.europa.eu/clima/eu-action/eu-emissions-trading-system-eu-ets_en.

[214] *See* Kyoto Protocol, *supra* not 212, Annex B.

[215] ICAO, *Environmental Protection: Volume IV: Carbon Offsetting and Reduction Scheme for International Aviation*, Annex 16 of the Chicago Convention (2018).

[216] RON BARTSCH, INTERNATIONAL AVIATION LAW 344 (2d ed. 2018).

perspective, that space resources are not over-consumed without imposing burdensome constraints on space actors. According to the credit system, spacefaring States might, if necessary, purchase more credits from non-spacefaring nations to meet their material needs without overexploiting outer space. Besides, a free market in mining credits allows for the efficient exchange of credits and the corresponding supply and demand principles of the market would govern the value and pricing of the credits maintaining lunar mining commercially viable.

The credit system aims at the fair and equitable distribution of credits by adopting specific criteria for allocating credits to a country set, for example, in proportion to its population, perhaps with a margin for higher allocations to countries most in need. The regime also promotes the goal of equitable sharing by all States in the benefits derived from lunar resources since countries technologically capable of mining may do so to an extent equal to their credit quota, but in case they wish to mine more than they were allotted, they could buy credits from countries that would not or could not mine, or they could include those countries in their mining activities. In this way, the system allows developing countries to benefit financially from space exploration without needing access to space, since it mitigates their technological deficit by enabling them to use their credits to purchase access to space technology by participating in space ventures in which they would contribute rights for additional mining. In any case, they could still reap financial rewards from space exploration by selling their credits. Consequently, the regime would provide an effective means for sharing the benefits of space exploration with developing countries while leaving spacefaring States free to engage in mining in a legally certain environment.

V. CONCLUSION

From its inception, space mining has been characterized by strong private sector involvement in the development of a space industry based on the exploitation of space resources. Existing legal models and practice demonstrate that the utilization of natural resources is not inconsistent with the outer space regime, nor is their exploitation by private entities. The safe, orderly, and peaceful development of the exploitation of the natural resources of the Moon and other celestial bodies can only be ensured by a stable and

predictable legal regime governing space resource utilization that provides an adequate guarantee that such efforts and investments will be rewarded and can proceed without controversy or disruption. While technology is still a challenge, one of the greatest business uncertainties for commercial space companies is the legal status of any proceeds from their off-Earth mining activities and the associated ability to raise the funds necessary for their success.

The need to create a new legal regime stems from the fact that existing space law does not contain specific rules for the exploitation of space resources. While the legal status of celestial bodies is clear, as they cannot be appropriated under international space law and are open to exploration, the status of natural resources in space, on the other hand, remains uncertain, as there are no clear and internationally recognized rules for their extraction and use in international space law. The Outer Space Treaty makes no reference to the possibility of exploiting extraterrestrial resources, while the Moon Agreement, whose main purpose is to establish rules for the exploitation of the natural resources of the Moon and other celestial bodies, and which envisages the establishment in the future of an international regime, has not been ratified by the majority of States. In the absence of an agreed international legal framework, unilateral attempts by States or private entities to exploit space resources could lead to controversy and conflict.

To this end, this paper proposes the establishment of a legal regime for the extraction and exploitation of the natural resources of the Moon and other celestial bodies. The most appropriate legal regime for sustainable space mining and management of space resources is considered to be an adaptation of the carbon credit system applied for the reduction of global CO2 emissions under the Kyoto Protocol to the United Nations Framework Convention on Climate Change. The system grants transferable credits and allows the extraction of space resources for limited periods of time, providing a sustainable solution for the use of space for the benefit of all people.

It should be noted that the consideration of the future legal framework for space resources exploitation is not a mere theoretical exercise, but corresponds to crucial interests of humankind. Given the rapid pace of technological development and recent advances in solar system exploration, it is believed that the resources of outer

space will soon be within our reach. The resources available in space are abundant and valuable, and commercial space mining could form the basis of the space economy. Space resources have also become the subject of government and private interest as they are seen as a substitute for Earth-derived resources at a time when these resources are becoming increasingly scarce and could have the potential to replace fossil fuels as the primary source of energy on Earth. The need for affordable, secure, and environmentally friendly energy for the world's growing population is becoming increasingly obvious and urgent, and such a development, while still uncertain, offers humanity a credible prospect of meeting this need in the centuries to come.