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VOLUME 46 | 2022 | NUMBER 2

CONTENTS

FROM THE EDITOR

It is fitting that we start this issue of the *Journal* with an article building on the legacy of the incomparable space law pioneer, Manfred Lachs, the author of the – dissenting – opinion in which the freedom of movement in outer space was put to paper. Historians will look back on the 2020s and 2030s as the "bridge" years during which humanity redefined its relationship with the cosmos and built a flexible legal lens through which to frame our relationship with each other as we wander further from our planet Earth. The *Journal* is proud to be a platform for discourse and analysis of the law as it exists today and as it should evolve to build a solid foundation for a peaceful future. Articles in this issue are as wide-ranging as the legal challenges that face humanity as we test the laws created through terrestrial custom and tradition. They address the potential of space weaponization, encourage the use of arbitration to settle disputes relating to harmful interference with radio frequencies, discuss the use of data gathered by Earth observation satellites as evidence in court rooms in the United States and suggest the development of labor law to protect space-based workers. We close with new views on space resource extraction and use, a topic with burning imminence.

This issue is also the last that we will distribute widely in paper form. There are two primary reasons that drove our decision to embrace digitization. First, as we promote the sustainability of space activities, we must also acknowledge the need to reduce our footprint here on Earth. We have accomplished this by removing both print production and delivery activities. Second, we recognize the need to disseminate the important research with which we are entrusted as widely as possible. Going digital assures that everyone, everywhere, will have access to our *Journal* for free. We offer this last print version with pride as well as humble gratitude and deep appreciation for our authors.

Michelle L.D. Hanlon
Editor-in-Chief
Oxford, Mississippi

WHAT PLACE FOR *JUS COGENS*? HOW MANFRED LACHS FORESAW NEW THINKING IN INTERNATIONAL SPACE LAW

Laura Jamschon Mac Garry and Steven Freeland***

I. INTRODUCTION

Manfred Lachs was a golden personality at the intersection of international and space law. He was a renowned Polish diplomat and academic born in 1914. As a member of the International Law Commission (ILC) between 1962 and 1966, he contributed significantly to the initial stages of the study on peremptory norms of international law when he participated in the work on the law of treaties. In 1966, he was appointed as a judge of the International Court of Justice (ICJ) and was elected as the President in 1973. Significant decisions rendered during those years include the *Barcelona Traction Case*[1] (1970) and the *Namibia Advisory Opinion*[2] (1971); both landmarks in the jurisprudence and development of *erga omnes* obligations.

In the space field, he was the first Chair of the Legal Subcommittee (LSC) of the Committee on the Peaceful Uses of Outer Space (COPUOS) from 1962 until 1966. In that capacity, he imprinted his expertise in the adoption of the Declaration of Legal Principles Governing the Activities in Outer Space,[3] and the Treaty on Principles

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The views expressed in the present paper are those of the authors and do not necessarily reflect the views or positions of any institutions or entities they represent.

[1] Barcelona Traction, Light and Power Co., Ltd. (Belg. v. Spain) 1970 I.C.J. 3 (Feb. 5).

[2] Legal Consequences for States of the Continued Presence of South Africa in Namibia, Advisory Opinion 1971 I.C.J. 16 (June 21).

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

Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies.[4] Undoubtedly, he deserves to be considered a pioneer of space law.[5]

At the crossover of his brilliant international and space acumen, he dissented for the first time in the *North Continental Shelf Cases* (1969).[6] In his dissenting opinion—although this was not an issue addressed by any other Judge nor the reason for his dissent—he argued that "the freedom of movement into outer space" had become international law created within a short period of time, reinforcing the idea that the time factor might not necessarily be a bar to the formation of a new rule of customary law, depending on the specific circumstances.[7]

Hand in hand with the legacy of Manfred Lachs, this article seeks to examine the possibility that unique doctrines of international law relating to the highest "rank" of international legal norms may have developed around certain provisions of the Outer Space Treaty. On the basis of the work carried out by the ILC, these principles will be put to the test in order to confirm or reject the hypothesis that at least Articles I and II of that instrument might be considered *jus cogens* norms. In such an endeavor, two conditions will be established against which the Outer Space Treaty needs to be scrutinized: do those provisions represent principles of general international law? and, if so, have they been accepted and recognized by the international community of States as peremptory?

This article concludes with a recommendation to include for further study by the ILC the extent to which (if at all) the fundamental principles of space law demonstrate a potential *jus cogens* character.

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[4] 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].

[5] For a more detailed look at Manfred Lach's scholarship, *see* Francis Lyall, *Manfred Lachs (21.4.1914 – 4.1.1993)*, *in* PIONEERS OF SPACE LAW 193, (Stephan Hobe ed., 2013).

[6] North Sea Continental Shelf (Ger. v. Neth., Ger. v. Den.) 1969 I.C.J. 3 (Feb. 28). The other dissenting opinion of Judge Lachs was in Application for Review of Judgment No. 273 of the United Nations Administrative Tribunal Advisory Opinion 1982 I.C.J. 325 (July 20). *See generally Dissenting Opinion of Judge Lachs,* INTERNATIONAL COURT OF JUSTICE, https://www.icj-cij.org/sites/default/files/case-related/66/066-19820720-ADV-01-05-EN.pdf (last visited Mar. 23, 2023).

[7] Ger. v. Neth., Ger. v. Den., 1969 I.C.J. 219 at 230.

II. THE CONCEPT OF *JUS COGENS* IN INTERNATIONAL LAW

As a general introductory remark, it is useful to refer to Robert Kolb, who identified five different criteria on which to define *jus cogens* norms: (a) as an expression of natural law; (b) as a hierarchic superior norm; (c) as a constitutional rule; (d) as a non-derogable norm; and (e) as a rule for conflict in successive treaties.[8] These criteria synthesize how the literature has interpreted the concept of *jus cogens* throughout past and more recent history.

It is possible to refer back to the Romans and see an early forerunner of peremptory norms in their concept of *jus strictum*.[9] The Greek notion of natural law also provided a source of explanation for the idea of peremptory norms.[10] In the sixteenth century, the School of Salamanca developed even further the possibility that certain rules govern the international community (*totus obiter*) without any possibility of derogation.[11] The nineteenth and twentieth centuries brought legal positivism into the scene, and the idea of public order from domestic law was transposed into international law. In effect, *jus cogens* norms are linked with the notion of public order because they are said to protect the public interest of the international community.[12]

Within that school, Alfred Verdross distinguished *jus cogens* from *jus dispositivum*; the former being absolute because it does not satisfy individual State's interests but rather those of the international community.[13] Moreover, in his 1937 precursory article on the matter, he explained that "treaties *contra bonos mores*" are void be-

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[8] ROBERT KOLB, PEREMPTORY INTERNATIONAL LAW – JUS COGENS: A GENERAL INVENTORY 30-42 (2015).

[9] Ian Ayres, *Valuing Modern Contract Scholarship*, 112 YALE L.J. 881, 885 (2003).

[10] James A. Green, *Questioning the Peremptory Status of the Prohibition of the Use of Force*, 32 MICH. J. INT'L L. 215, 225 (2011).

[11] Luis Francisco Martinez Montes, *The School of Salamanca and the Emergence of Modern International Law*, GLOBAL SQUARE MAG., https://www.globalsquaremagazine.com/2017/12/10/the-school-of-salamanca-and-the-emergence-of-modern-international-law/ (last visited Mar. 28, 2023).

[12] Carl Q. Christol, *Judge Manfred Lachs and the Principle of Jus Cogens,* 22 J. SPACE L. 33, 35 (1994).

[13] Alfred Verdross, *Jus Dispositivum and Jus Cogens in International Law*, 60 AM. J. INT'L L. 55, 58 (1966).

cause they run against an ethical minimum accepted by the international community.[14] This moral element is articulated by the ICJ in its 1951 *Advisory Opinion on the Reservations to the Genocide Convention*, where the Court described genocide as "contrary to moral law."[15] Furthermore, this natural law aspect was reinforced by expressing that the object of that treaty is "to endorse the most elementary principles of morality."[16]

Having such an axiological role, *jus cogens* norms enjoy the highest rank in the international hierarchy.[17] They are regarded as superior because of their content, scope or effects.[18] More than "rules," *jus cogens* are "norms" since they have a higher status than the former;[19] and thus they deserve a "quality label."[20] As explained by the ILC in the commentaries to the Draft Articles on State Responsibility, peremptory obligations refer to "substantive rules of conduct that prohibit what has come to be seen as intolerable because of the threat it presents to the survival of States and their peoples and the most basic human values."[21]

Despite the fact that these precedents support the idea of *jus cogens* being a well-rooted concept, a modern approach finds the origin of peremptory norms in the aftermath of the Second World War, with the United Nations Charter and the earliest universal instruments on human rights.[22] The Convention on the Prevention

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[14] Alfred von Verdross, *Forbidden Treaties in International Law: Comments on Professor Garner's Report on "The Law of Treaties,"* 31 AM. J. INT'L L. 571, 573 & 574 (1937).

[15] Reservations to the Convention on the Prevention and Punishment of the Crime of Genocide, Advisory Opinion, 1951 I.C.J. Rep. 15, ¶ 23 (May 28). [hereinafter Reservations to the Genocide Convention].

[16] *Id*.

[17] Int'l Law Comm'n, Rep. on the Work of Its Seventy-First Session, U.N. Doc. A/74/10, at 154 (2019) [hereinafter U.N. Doc. A/74/10]; Int'l Law Comm'n, Rep. on the Work of Its Fifty-Eighth Session, U.N. Doc. A/61/10, at 419 (2006) [hereinafter U.N. Doc. A/61/10].

[18] Int'l Law Comm'n, Rep. on the Work of Its Fifty-Seventh Session, U.N. Doc. A/60/10, at 223 (2005) [hereinafter U.N. Doc. A/60/10].

[19] Christol, *supra* note12, at 34.

[20] Sue S. Guan, *Jus Cogens: To Revise a Narrative* 26 MINN. J. INT'L L. 461, 466 (2017).

[21] Int'l Law Comm'n, Rep. on the Work of Its Fifty-Third Session, U.N. Doc. A/56/10, at 283 (2001) [hereinafter U.N. Doc. A/56/10].

[22] Stefan Kadelbach, *Jus Cogens, Obligations Erga Omnes and other Rules –The Identification of Fundamental Norms*, *in* THE FUNDAMENTAL RULES OF THE INTERNATIONAL LEGAL ORDER 21, 22 (Christian Tomuschat & Jean-Marc Thouvenin

and Punishment of the Crime of Genocide (Genocide Convention)[23] was the first instrument to codify such a grave violation of human rights as an international crime; however, it was only in 1951 that the prohibition on genocide was described by the ICJ as what later essentially became known as *jus cogens*.[24] Given the opportunity, the Court defined two consequences of the special character of the prohibition against genocide: the first being that the principles underlying the Genocide Convention are recognized by civilized nations as binding on States, even without any conventional obligation, and the second being the universal character of both the condemnation of genocide and the obligation to cooperate against it.[25]

In 1953, the second ILC Special Rapporteur on the law of treaties, Hersch Lauterpacht, made reference to "an absolute obligation towards a transcending and imperative international interest" as "a sense of moral obligation and international solidarity."[26] In 1963, the second report by Humprey Waldrock provided a definition of *jus cogens* in the following terms: "a peremptory norm of general international law from which no derogation is permitted except upon a ground specifically sanctioned by general international law, and which may be modified or annulled only by a subsequent norm of general international law."[27]

Following several years drafting by the ILC, the text of the Vienna Convention on the Law of Treaties[28] (VCLT) was adopted in 1969. It provides that a peremptory norm of general international law (*jus cogens*) "is a norm accepted and recognized by the international community of States as a whole as a norm from which no

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eds., 2006); Stefan Kadelbach, *Genesis, Function and Identification of Jus Cogens Norms*, 46 NETH. Y.B. INT'L. L. 147, 149 (2015).

[23] Convention on the Prevention and Punishment of Crimes of Genocide, Dec. 9, 1948, 102 Stat. 3045, 78 U.N.T.S. 277 [hereinafter Genocide Convention].

[24] International Court of Justice, Armed Activities on the Territory of the Congo (New Application: 2002) (Dem. Rep. Congo v. Rwanda), Jurisdiction and Admissibility, Judgment, Sess. 2006 I.C.J. 6, ¶ 64.

[25] *Id*.

[26] H. Lauterpacht (Special Rapporteur), *Report on the Law of Treaties,* U.N. Doc. A/CN.4/63, at 127 (Mar. 24, 1953).

[27] Humphrey Waldock (Special Rapporteur), *Second Report on the Law of Treaties*, U.N. Doc. A/CN.4/156 and Add.1-3, at 39 (Mar. 20, Apr. 10, Apr. 30, & June 5, 1963).

[28] Vienna Convention on the Law of Treaties, May 23, 1969, 1155 U.N.T.S. 331 [hereinafter VCLT].

derogation is permitted and which can be modified only by a subsequent norm of general international law having the same character."[29] Article 64 of the VCLT foresees that any norm conflicting with a *jus cogens* norm is void.[30] This approach, based on consequences, is what Ulf Linderfalk has termed the "legal-consequences-as-criterion theory."[31]

A final point that deserves some attention is the issue of identification of norms of *jus cogens*. It should be recalled that, in the context of the study of the then draft Article 37 of the VCLT, the ILC decided in 1963 not to include any examples of *jus cogens* norms for two reasons: first, the experts were cautious not to create confusion regarding the cases not mentioned, and secondly, they were aware that such a task would be time-consuming.[32]

In 2005, the Study Group on Fragmentation of International Law followed suit and did not elaborate any catalogue of *jus cogens* norms.[33] However, the following year, the ILC cited several examples in the context of its work on fragmentation of international law, namely the prohibition of aggression, slavery and the slave trade, genocide, racial discrimination, apartheid and torture, the right of self-determination, and basic rules of humanitarian law.[34]

The topic of this particular category of norms has been on the agenda of the ILC again since 2015.[35] The Special Rapporteur, Mr. Dire Tladi (South Africa), has produced five reports dedicated to the study of their nature, the requirements for their identification, their consequences and effects. The fourth report (2019) produced a non-exhaustive list of peremptory norms that the ILC had considered as such in its previous work[36] (that work includes the commen-

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[29] *Id.* at art. 53.

[30] *Id.* at art. 64.

[31] Ulf Linderfalk, *What Is So Special About Jus Cogens? – On the Difference between the Ordinary and the Peremptory International Law,* 14 INT'L COMM. L. REV. 3, 4 (2012).

[32] Int'l Law Comm'n, Rep. on the Work of Its Fifteenth Session, U.N. Doc. A/CN.4/163, at 199 (1963).

[33] U.N. Doc. A/60/10, *supra* note 18, at 224.

[34] U.N. Doc. A/61/10, *supra* note 17, at 419.

[35] Int'l Law Comm'n, Rep. on the Work of Its Sixty-Seventh Session, U.N. Doc. A/70/10, at 138 (2015).

[36] Dire Tladi (Special Rapporteur), *Fourth Report on Peremptory Norms of General International Law (jus cogens)*, U.N. Doc. A/CN.4/727, ¶ ¶ 60 & 137, (Jan. 31, 2019).

tary to draft Article 50 of the VCLT on treaties conflicting with peremptory norms, the report on fragmentation of international law, and the Draft Articles on State Responsibility).[37]

Neither that illustrative list nor the record of other possible *jus cogens* norms includes any principle of international space law.[38] Accordingly, in this article we seek to examine whether peremptory norms can be regarded as also including certain elements of existing international space law.

III. THE DISTINCTION BETWEEN *JUS COGENS* NORMS AND *ERGA OMNES* OBLIGATIONS

One of the consequences of *jus cogens* norms is that they "create" *erga omnes* obligations, which are the concern of all States, due to the importance of the rights involved.[39] This assessment makes clear that, although interrelated, *jus cogens* and *erga omnes* are *not* synonyms. At first glance, there is a difference that sometimes is blurred: the former refers to norms, whereas the latter deals with ensuing obligations—i.e., the former give rise to the latter.[40]

As a starting point, *jus cogens* belongs to primary law and *erga omnes* to secondary rules on State responsibility.[41] In the same vein, some publicists described *jus cogens* as substantive law and *erga omnes* as procedural law.[42] In Weatherall's view, *jus cogens* norms are directed towards the individual—although this is not always the case (for example with respect to the *jus cogens* norm relating to the right of a "peoples" to self-determination)—whereas

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(Reference is made to the prohibition of aggression, genocide, slavery, apartheid and racial discrimination, crimes against humanity, torture, the right to self-determination and basic rules of humanitarian law).

[37] *Id.* ¶ 56.

[38] *Id.* ¶ ¶ 122-123 (the right to life, the principle of non-refoulement, the prohibition of human trafficking, the right to due process (the right to a fair trial), the prohibition of discrimination, environmental rights, and the prohibition of terrorism).

[39] Belg. v. Spain, Judgment, 1970 I.C.J. Rep. at ¶ 33.

[40] MAURIZIO RAGAZZI, THE CONCEPT OF INTERNATIONAL OBLIGATIONS ERGA OMNES 190 (2000).

[41] For further reference, *see* Articles 42 and 48 of the Draft Articles on State Responsibility. Int'l Law Comm'n, Titles and Texts of the Draft Articles on Responsibility of States for Internationally Wrongful Acts Adopted by the Drafting Committee on Second Reading, U.N. Doc. A/CN.4/L.602/Rev.1 (July 26, 2001). *See also* Guan, supra note 20, at 26.

[42] MALCOLM N. SHAW, INTERNATIONAL LAW 124 (6th ed. 2008); Kadelbach, *supra* note 22, at 163.

erga omnes obligations emerge as a consequence of the need to enforce *jus cogens* norms by States.[43]

Jus cogens focuses on the fundamental character of certain obligations, while *erga omnes* obligations focus on the legal interest, and responsibility, of (all) States in compliance.[44] A further distinction is that the *jus cogens* character determines the hierarchy of a norm, while the *erga omnes* character establishes the scope of application of the ensuing obligations.[45] Finally, in the ICJ *Wall Advisory Opinion,* Judge Rosalyn Higgins, in her separate opinion, explained that *erga omnes* obligations are linked to "a very specific issue of jurisdictional *locus standi*" and do not create substantive obligations on third States.[46]

Once again, the role of Judge Manfred Lachs comes to the forefront in this part if we recall that it was he who used the expression *erga omnes* in 1964 during the discussions on the then Article 62 of the VCLT relating to rules in a treaty becoming binding on third States through international custom (current Article 38 of the VCLT).[47] At that time, some of the ILC members reflected on treaties that would fall under that provision and mentioned as examples: "treaties for the neutralization or demilitarization of particular territories or areas," specifically referring to the 1959 Antarctic Treaty.[48]

In 1970, the ICJ for the first time introduced the notion of *erga omnes* obligations in the famous *obiter dictum* in the *Barcelona Traction Case*.[49] Judge Lachs was a member of the bench at the time and it is possible to perceive his personal stamp here.[50] The

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[43] THOMAS WEATHERALL, JUS COGENS: INTERNATIONAL LAW AND SOCIAL CONTRACT 351 (2015).

[44] U.N. Doc. A/56/10, *supra* note 21, at 112.

[45] ANTONIO REMIRO BROTÓNS ET AL., DERECHO INTERNACIONAL: CURSO GENERAL [INTERNATIONAL LAW. GENERAL COURSE] 230 (Trant Lo Blanch ed., 2010).

[46] Legal Consequences of the Construction of a Wall in the Occupied Palestinian Territories, Advisory Opinion, 2004 I.C.J. 136 (July 9), separate opinion of Higgins [hereinafter The Wall Opinion].

[47] Int'l Law Comm'n, Rep. on the Work of Its Sixteenth Session, U.N. Doc. A/CN.4/173, at 184 (1964).

[48] *Id.* at 184-185; Antarctic Treaty, Dec. 1, 1959, 12 U.S.T. 794, 402 U.N.T.S. 71.

[49] Belg. v. Spain, 1970 I.C.J. at ¶¶ 33-34.

[50] RAGAZZI, *supra* note 40, at 8.

Court identified two features in these type of obligations: universality (they are binding upon all States), and solidarity (every State has a legal interest in their observance).[51]

Regardless of the fact that the Court did not specify if the origin of such obligations was a *jus cogens* norm, it did mention a few peremptory norms that, in effect, give rise to *erga omnes* obligations, such as the prohibition of aggression and genocide, and the rules protecting basic human rights.[52] Furthermore, the Court explained that: "others are conferred by international instruments of a universal or quasi universal character."[53] The Court also examined the concept of *erga omnes* obligations in some other cases, both contentious and advisory.[54]

It is important to note that this category of obligations does not in and of itself establish a basis for the jurisdiction of the ICJ, which is instead grounded on the rule of consent, as acknowledged by the Court in the *East Timor Case* (1995)[55]—the mere existence of an obligation *erga omnes* does not automatically confer jurisdiction.[56]

Turning back to the relationship between *jus cogens* and *erga omnes*, it should be kept in mind that the ILC Study Group on Fragmentation of International Law considered this point thoroughly.[57] It acknowledged that the former holds a superior position, whereas

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[51] *Id*. at 17.

[52] Belg. v. Spain, 1970 I.C.J. at ¶ 34.

[53] *Id.*

[54] Application of the Convention on the Prevention and Punishment of the Crime of Genocide (Bosn. & Herz. v. Serb. & Montenegro), Judgment, 2007 I.C.J. 43, ¶ 147 (Feb. 26); Legal Consequences for States of the Continued Presence of South Africa in Namibia, Advisory Opinion 1971 I.C.J. 16 ¶ 126 (June 21), East Timor (Port. v. Austl.), Judgment, 1995 I.C.J. 90, ¶ 29 (June 30); Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion, 1996 I.C.J. 226, ¶ 83 (July 8); The Wall Opinion *supra* note 46, at ¶¶ 155-156.

[55] Port. v. Austl., 1995 I.C.J at¶ 29; *See* Dem. Rep. Congo v. Rwanda, 2006 I.C.J. at ¶ 64; Bosn. & Herz. v. Serb. & Montenegro, 2007 I.C.J at ¶ 147; Application of the Convention on the Prevention and Punishment of the Crime of Genocide (Croatia v. Serb.), Judgment, 2015 I.C.J. Rep. 3 ¶ 88.

[56] Dem. Rep. Congo v. Rwanda, 2006 I.C.J, at ¶ 64.

[57] U.N. Doc. A/61/10, *supra* note 17, at 419.

erga omnes does not imply any hierarchy, but only a special status.[58] It went on to conclude that all *jus cogens* norms have an *erga omnes* character, but that the reverse is not necessarily true.[59]

The following year, the ILC added that not all *erga omnes* obligations are established by peremptory norms and gave certain obligations relating to the global commons, enshrined in Article 1 of the Outer Space Treaty as an example.[60] This takes on particular relevance when dealing with outer space, which is generally—although not universally[61]—considered as a global commons.[62]

In his seminal work on the concept of *erga omnes* obligations, Maurizio Ragazzi drew upon three common elements of such obligations. By comparing the prohibition of aggression, the protection from slavery, the protection from racial discrimination and the prohibition of genocide, he came to the conclusion that they all refer to well-defined obligations in the form of negative duties or prohibitions; that they derive from rules of general international law having a *jus cogens* nature; and finally, that they all are instrumental to the realization of basic values such as the preservation of peace and the protection of human rights.[63]

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[58] U.N. Doc. A/60/10, *supra* note 18, at 223, ¶ 488.

[59] *Id.* at 224.

[60] U.N. Doc. A/61/10, *supra* note 17, at 421; U.N. Doc. A/74/10, *supra* note 17, at 192.; BROTÓNS ET AL., *supra* note 45, at 231.

[61] Consider the United States statement that "[o]uter space is a legally and physically unique domain of human activity, and the United States does not view space as a global commons." Exec. Order No. 13914, 85 Fed. Reg. 20,161 (Apr. 10, 2020).

[62] Paul Meyer, *Outer Space and Cyberspace: a Tale of Two Security Realms,* (2016) https://core.ac.uk/reader/56380350); NATO Allied Command Transformation, *Assured Access to the Global Commons* (2011), at 4, https://www.act.nato.int/ (last visited Mar. 21, 2023); Thérèse Delpech, *Nuclear Deterrence in the 21st Century: Lessons from the Cold War for a New Era of Strategic Piracy* (2012), https://www.rand.org/pubs/monographs/MG1103.html/ (last visited Mar. 21, 2023); Vladimir Kopal, *International Legal Regime on Outer Space: Outer Space Treaty, Rescue Agreement and the Moon Agreement, in* PROCEEDINGS OF THE UNITED NATIONS/NIGERIA WORKSHOP ON SPACE LAW 8, 9 (2006); Eligar Sadeh, *Evolution of Policy and Law for International Space Governance*, *in* 50 YEARS OF THE OUTER SPACE TREATY: TRACING THE JOURNEY 153, 154 (Ajey Lele ed., 2017); U.N. Secretary-General, *Our Common Agenda* (2021), https://www.un.org/en/content/common-agenda-report/assets/pdf/Common_Agenda_Report_English.pdf (last visited Mar. 21, 2023); Frans G. von der Dunk, *A Tale of Two Oceans: Governance of Terrestrial and Outer Space "Global Commons"*, (2012), https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1085&context=spacelaw (last visited Mar. 21, 2023).

[63] RAGAZZI, *supra* note 40, at 132-133.

More importantly for the purposes of this article, Ragazzi examined possible candidates of *erga omnes* obligations in addition to those included in the *Barcelona Traction dictum*. He examined the right to development as one giving rise not only to negative obligations (to refrain from doing something), but also to positive obligations (to actively engage in promoting equal access, share benefits, etc.).[64] Likewise, he assessed the protection of the environment as another possible candidate that, like the right to development, would expand the criteria taken from the ICJ jurisprudence.[65] Both examples have significant relevance when it comes to space law and the protection of global commons.

IV. IDENTIFICATION OF *JUS COGENS* NORMS IN INTERNATIONAL LAW

The draft conclusions adopted in 2022 by the ILC serve as a useful guidance for the determination and identification of *jus cogens* norms on the basis of Article 53 of the VCLT. According to draft conclusion number four, two criteria are necessary.[66]

A. It Is a Norm of General International Law

The ILC Study Group on Fragmentation acknowledged that there is no accepted definition of norms of general international law.[67] The *North Sea Continental Shelf Cases* reveal that the ICJ seems to have used general law and customary law as synonyms in the sense of "having equal force for all the members of the international community."[68] Similarly, in the specialized literature, some authors equate general international law with customary law, yet having a special form of *opinion juris*.[69]

This is a core condition because, as a consequence of its general character, *jus cogens* norms are universally applicable—i.e., they are binding on all subjects of international law.[70]

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[64] *Id*. at 151.

[65] *Id*. at 154.

[66] Int'l Law Comm'n, Rep. on the Work of Its Seventy-Third Session, U.N. Doc. A/77/10 at 29 (2022).

[67] U.N. Doc. A/61/10, *supra* note 17, at 410, n. 1017.

[68] Ger. v. Neth., Ger. v. Den. 1969 I.C.J. 3.

[69] RAGAZZI, *supra* note 40, at 53.

[70] U.N. Doc. A/74/10, *supra* note 17, at 155.

B. It Is Accepted and Recognized as Jus Cogens by the International Community of States as a Whole.

This consensual element constitutes what some authors have termed the *opinio juris cogentis*.[71] In Article 53 of the VCLT, the community of States as a whole becomes a new international actor capable of creating norms of a higher hierarchy.[72] This requirement means that the international community of States recognizes and accepts the norm as one from which no derogation is permitted and which can only be modified by a norm having the same character.[73] A large majority of States is required in this exercise of recognition and acceptance;[74] however, there is no need of acceptance by each and every State.[75] States are the main actors in the recognition and acceptance; however, there might be other actors giving context and contributing to its assessment.[76]

Even though universal acquiescence is not necessary, this requirement implies a prohibition of either unilateral derogation under domestic law or by an international agreement. Non-derogability means that States may not opt out from such provisions.[77]

In the *Advisory Opinion on the Reservations to the Genocide Convention*, the ICJ built the *jus cogens* nature of the prohibition of genocide upon the intent behind that instrument being universal in scope and its text having been unanimously adopted by the United Nations General Assembly.[78] Moreover, the Court considered that a common interest is protected by the convention, whose achievement is its *raison d'etre*.[79] In effect, the criterion for the existence of *jus cogens* norms is the fact that they do not satisfy the individual interest of a State but that of the international community.[80]

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[71] BROTÓNS ET AL., *supra* note 45, at 233.

[72] VCLT, *supra* note 28, art. 53; Kirsten Schmalenbach, *Article 53, in* VIENNA CONVENTION ON THE LAW OF TREATIES: A COMMENTARY 897, 899 & 910 (Oliver Dörr & Kirsten Schmalenbach ed. 2012).

[73] U.N. Doc. A/74/10, *supra* note 17, at 157 & 164.

[74] *Id*. at 167.

[75] Christol, *supra* note 12, at 37.

[76] U.N. Doc. A/74/10, *supra* note 17, at 167.

[77] Alexander Orakhelashvili, *Audience and Authority—The Merit of the Doctrine of Jus Cogens, in* NETHERLANDS YEARBOOK OF INTERNATIONAL LAW 118 (Maarten den Heijer & Harmen van der Wilt eds., 2015).

[78] Reservations to the Genocide Convention, *supra* note 15, ¶ 23.

[79] *Id*.

[80] Alfred Verdross, *Jus Dispositivum, supra* note 13, at 58.

V. IDENTIFICATION OF *JUS COGENS* IN SPACE LAW

Pursuant to Article III of the Outer Space Treaty, space activities shall be carried out in accordance with international law.[81] This provision confirms the premise that space law is part of the broader system of international law. In the words of Judge Vereshchetin: "[c]learly, this is but another affirmation of the well-established tenet of international law that human activities anywhere beyond national jurisdiction are governed by international law."[82] Article 31(3)(c) of the VCLT is the legal foundation for this systemic integration,[83] according to which "treaties are a creation of the international legal system."[84]

From this starting point, it is possible to examine the principles enshrined in the Outer Space Treaty under the lens of the international law relating to *jus cogens*, in line with what was described in the previous sections of this article. That said, this task has some potential complexities: on the one hand, the identification of peremptory norms is generally difficult due to the lack of State practice, which has been acknowledged by the ILC itself.[85] On the other hand, in the six decades since the start of the development of international space law, most State practice has been *not* to do something (e.g., engage in war in space) rather than positive action.

Within these possible constraints, we seek below to examine how the two conditions for *jus cogens* might be met in space law.

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[81] Outer Space Treaty, *supra* note 4, art. III. The full text of Article III is as follows:

> States Parties to the Treaty shall carry on activities in the exploration and use of outer space, including the Moon and other celestial bodies, in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international cooperation and understanding.

[82] V.S. Vereschetin, The Law of Outer Space in the General Legal Field (Commonality and Particularities), Adaptation from *Lecture Series of the United Nations Audiovisual Library of International Law*. Original: English (46 minutes), 2009, p. 4, http://legal.un.org/avl/ls/Vereshchetin_LOS_1.html (last visited Mar. 21, 2023).

[83] Oliver Dörr, *Article 31, in* VIENNA CONVENTION ON THE LAW OF TREATIES. A COMMENTARY 521, 560 & 561 (Oliver Dörr & Kirsten Schmalenbach eds., 2012).

[84] U.N. Doc. A/61/10, *supra* note 17, at 413.

[85] Dire Tladi, Special Rapporteur, *Fifth Report on Peremptory Norms of General International Law (Jus Cogens)*, ¶ 15, U.N. Doc. A/CN.4/747 (2022).

A. Norms of General International Law

The Outer Space Treaty contains several provisions that are currently considered custom (either pre-existing treaty law,[86] or subsequently crystallizing as such).[87] One of them is the freedom principle relating to the exploration and use of outer space enshrined in Article I.[88] Article II, embodying the principle of non-appropriation, is also categorized as general international law by scholars.[89] Likewise, Article III is a provision whose content is described as customary.[90]

There are barely any traces in the literature qualifying the prescriptions against military uses enshrined in Article IV[91] as customary. It is possible to cite the view of the representative of Sri

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[86] Vladlen S. Vereshchetin & Gennady M. Danilenko, *Custom as a Source of International Law of Outer Space,* 13 J. SPACE L. 22, 25 (1985).

[87] *See* Cassandra Steer, *Sources and Law-Making Processes Relating to Space Activities*, *in* ROUTLEDGE HANDBOOK OF SPACE LAW 3, 8 (Ram S. Jakhu & Paul Stephen Dempsey eds., 2017); Ram S. Jakhu & Steven Freeland, *The Relationship between the Outer Space Treaty and Customary International Law*, *in* 67TH INTERNATIONAL ASTRONAUTICAL CONGRESS (2016), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3397145 (last visited Mar. 21, 2023).

[88] *See* Stephan Hobe, *Article I - Outer Space Treaty*, *in* COLOGNE COMMENTARY ON SPACE LAW: VOLUME 1 25, 29 (Stephan Hobe, et al., eds., 2009); Henry H. Hertzfeld et al., *How Simple Terms Mislead Us: The Pitfalls of Thinking about Outer Space as a Commons,* at 3-4 (2015), https://swfound.org/media/205285/how-simple-terms-mislead-us-hertzfeld-johnson-weeden-iac-2015.pdf. (last visited Mar. 21, 2023).

[89] Bin Cheng, *The United Nations and the Development of International Law Relating to Outer Space, in* STUDIES IN INTERNATIONAL SPACE LAW 151, 189 (Bin Cheng ed. 1997) (online version, 2012); Steven Freeland & Ram Jakhu, *Article II - Outer Space Treaty, in* COLOGNE COMMENTARY ON SPACE LAW: VOLUME 1 44, 45-46 (Stephan Hobe, et al. eds., 2009); P.J. Blount, *Renovating Space: The Future of International Space Law*, 40 DENV. J. INT'L L. & POL'Y 515, 517 (2011); MARTHA MEJÍA-KAISER, THE GEOSTATIONARY RING. PRACTICE AND LAW 109 (2020); Le Bao Ngoc Pham, *Does the Outer Space Treaty Permit the Protection and Preservation of Cultural Heritage Sites on the Moon?, in* PROTECTION OF CULTURAL HERITAGE SITES ON THE MOON: VOLUME 24 27, 38 (Annette Froehlich ed., 2020); Ricky J. Lee, *Article II of the Outer Space Treaty: Prohibition of State Sovereignty, Private Property Rights, or Both,* 11 AUSTL. INT'L L.J. 128, 135 (2004).

[90] FRANCIS LYALL & PAUL B. LARSEN, SPACE LAW: A TREATISE 64 (2nd ed. 2018).

[91] Outer Space Treaty, *supra* note 4, art. IV. The Article states in full:

> States Parties to the Treaty undertake not to place in orbit around the earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner.
>
> The moon and other celestial bodies shall be used by all States Parties to the Treaty exclusively for peaceful purposes. The establishment of military bases,

Lanka to the United Nations General Assembly First Committee, who contended that the annual resolution on the Proposed Prevention of an Arms Race in Space (PAROS)[92] and its almost universal endorsement had turned this provision into customary law.[93]

For their part, the content of Article VI (responsibility for national activities), Article VII (liability for damage caused by a space object), and Article VIII (registration of space objects) are considered by several authors as constituting general international law.[94] With regard to Article IX, Sergio Marchisio suggested in 2009 that the obligations contained therein are in the process of becoming customary law,[95] whereas Nicolas Matte had already supported such a suggestion in the late 1980s.[96]

Generally, evidence of the customary character of such provisions can be drawn mainly from the following arguments: first, gen-

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installations and fortifications, the testing of any type of weapons and the conduct of military manoeuvres on celestial bodies shall be forbidden. The use of military personnel for scientific research or for any other peaceful purposes shall not be prohibited. The use of any equipment or facility necessary for peaceful exploration of the moon and other celestial bodies shall also not be prohibited

[92] Proposed Prevention of an Arms Race in Space (PAROS) Treaty, U.N. Doc. A/Res./36/97 (1981). PAROS was finally put on the agenda of the Conference on Disarmament in 1981, after the General Assembly recognized the need for appropriate action to avoid an arms race in outer space in the final document of its Tenth Special Session in 1978.

[93] Ram Jakhu, *United Nations Principles on Outer Space, in* PROCEEDINGS OF THE UNITED NATIONS/NIGERIA WORKSHOP ON SPACE LAW 28, 37 (2006) (*quoting* Sergio Marchisio) https://www.unoosa.org/documents/pdf/psa/activities/2005/nigeria/splawproc05.pdf (last visited Mar. 21, 2023).

[94] Alexander Soucek, *International Law*, *in* OUTER SPACE IN SOCIETY, POLITICS AND LAW: VOLUME 8, 294, 340 (Christian Brünner & Alexander Soucek eds., 2011); Bin Cheng, *The United Nations, supra* note 89, at 176; *See also* Armel Kerrest & Lesley Jane Smith, *Article VII - Outer Space Treaty, in* COLOGNE COMMENTARY ON SPACE LAW: VOLUME 1, 126, 129 (Stephan Hobe, et al., eds., 2009).

[95] Sergio Marchisio, *Article IX - Outer Space Treaty, in* COLOGNE COMMENTARY ON SPACE LAW: VOLUME 1, 169, 181 (Stephan Hobe, et al., eds., 2009).

[96] Nicolas M. Matte, *Environmental Implications and Responsibilities in the Use of Outer Space*, 14 ANNALS AIR & SPACE L. 419, 439 (1989).

eral State practice is reflected by the fact that United Nations General Assembly Resolution 1962 (XVIII)[97]—in some sense the "predecessor" of the Outer Space Treaty—was adopted by consensus.[98] Secondly, Resolution 2222 (XXI), embodying the text of the Outer Space Treaty, was also adopted by consensus.[99] Moreover, such an assertion can be reinforced by the quasi-universal nature of this instrument (112 ratifications and 23 signatures as of January 2023).[100]

As a source of evidence, it is helpful to draw upon Member State responses between 2015 and 2021 to the questionnaire proposed by the Chair of the COPUOS Working Group on the Status and Application of the Five UN Treaties.[101] For instance, Indonesia answered the question regarding the existence of customary law stating that "provisions in the five United Nations Treaties on Outer Space that could be considered as forming part of international customary law are the article I (the freedom of exploration and use of outer space) and article II (the principle of non-appropriation) of the Outer Space Treaty 1967."[102]

For its part, the Czech Republic asserted that "[...] the general principles of the Outer Space Treaty can be considered as forming part of international customary law due to the wide adherence to it

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[97] G.A. Res. 1962 (XVIII) (Dec. 13, 1963). This resolution laid down important principles, including the freedom of exploration (¶ 2), non-appropriation (¶ 3), applicability of international law (¶ 4), international responsibility (¶ 5); due regard (¶ 6), jurisdiction and control (¶ 7) and liability for damage (¶ 8).

[98] Michael J. Listner, *Evaluating Customary International Law in Space*, 11 MICH. J. INT'L L. 1 (2020), https://www.mjilonline.org/evaluating-customary-international-law-in-space/,(last visited Mar. 29, 2023).

[99] G.A. Res. 2222 (XXI), (Dec. 19, 1966).

[100] Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcommittee on its Sixty-First Sess., *Status of International Agreements Relating to Activities in Outer Space as at 1 January 2022*, U.N. Doc. A/AC.105/C.2/2022/CRP.10 (2022). The updated status of the space treaties can be found at: https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/status/index.html.

[101] A question regarding the relationship between the Outer Space Treaty and customary law was added to the questionnaire in 2014, *see* Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on Its Fifty-Third Session, U.N. Doc. A/AC.105/1067, at 34 (2014).

[102] Comm. on the Peaceful Uses of Outer Space Legal Subcomm. for its Fifty-Seventh Sess., Responses to the Set of Questions Provided by the Chair of the Working Group on the Status and Application of the Five United Nations Treaties on Outer Space, U.N. Doc. A/AC.105/C.2/2018/CRP.16, at 5 (2018).

by the international community in the conduct of space activities."[103]

For the Philippines, the answer was only limited to "[t]he exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all [hu]mankind."[104]

Both Austria and Germany considered additional provisions to fall within the same category. In effect, "[i]n the view of the Austrian delegation, the general principles contained in the Outer Space Treaty can be regarded as customary international law."[105] Austria made express reference to Articles I, II, III, IV, VI, VI, VIII, IX and XI.[106] For its part, "[t]he German delegation is of the opinion that the general principles of the Outer Space Treaty (OST) have become international customary law since almost all States conducting activities in outer space have ratified the OST and act according to its provisions,"[107] referring to Articles I, II, III, VI, VII and VIII.[108]

The only country that has so far expressly denied the customary character of the Outer Space Treaty provisions has been Chile.[109]

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[103] Comm. on the Peaceful Uses of Outer Space Legal Subcomm. for its Fifty-Seventh Sess., Responses to the Set of Questions Provided by the Chair of the Working Group on the Status and Application of the Five United Nations Treaties on Outer Space, U.N. Doc. A/AC.105/C.2/2018/CRP.12, at 5 (2018).

[104] Comm. on the Peaceful Uses of Outer Space Legal Subcomm. for its Sixtieth Sess., Set of Questions Provided by the Chair of the Working Group on the Status and Application of the Five United Nations Treaties on Outer Space, Taking into Account the UNISPACE+50 Process, U.N. Doc. A/AC.105/C.2/2021/CRP.23, at 20 (2021) [hereinafter U.N. Doc. A/AC.105/C.2/2021/CRP.23].

[105] Comm. on the Peaceful Uses of Outer Space Legal Subcomm. for its Fifty-Sixth Sess., Responses to the Set of Questions Provided by the Chair of the Working Group on the Status and Application of the Five United Nations Treaties on Outer Space, U.N. Doc. A/AC.105/C.2/2017/CRP.6, at 5 (2017).

[106] *Id.*

[107] Comm. on the Peaceful Uses of Outer Space Legal Subcomm. for its Fifty-Fourth Sess., Responses to the Set of Questions Provided by the Chair of the Working Group on the Status and Application of the Five United Nations Treaties on Outer Space, U.N. Doc. A/AC.105/C.2/2015/CRP.11, at 3 (2015).

[108] *Id.*

[109] U.N. Doc. A/AC.105/C.2/2021/CRP.23, *supra* note 104, at 6.

In sum, it is possible to assert that there are several provisions in the Outer Space Treaty that would fulfill the first condition regarding the determination of a possible *jus cogens* norm.

B. It Is Accepted and Recognized by The International Community of States as a Whole as a Jus Cogens Norm.

We concur with Sue Guan, who assessed that Article 53 of the VCLT is a "curious combination" of naturalism and positivism,[110] since the consent ingredient is also present. The grounds for this are to be found in the legacy of the very system of Westphalian international relations and the legal doctrine emanating from the *Lotus* ruling.[111]

According to a relatively recent (2019) report of the ILC, evidence of the acceptance and recognition of *jus cogens* norms is to be found in public statements made on behalf of States; official publications; government legal opinions; diplomatic correspondence; legislative and administrative acts; decisions of national courts; treaty provisions; and resolutions adopted by an international organization or at an intergovernmental conference.[112] Subsidiary mechanisms for the determination of the *jus cogens* nature of a norm when it is not possible to discern its character by the means previously set out include—similar to Article 38(1)(d) of the ICJ Statute[113]—international jurisprudence and the teachings of the most highly qualified publicists.[114] We examine each of these in turn.

1. State Manifestations

Delving into the *travaux préparatoires* of the Outer Space Treaty, it is possible to set out a few—at least implicit—traces of the State practice that might support the acceptance and recognition of specific principles of the Outer Space Treaty as having a *jus*

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[110] Guan, *supra* note 20, at 469-470.

[111] SS Lotus (Fr. v. Turk.), 1927, P.C.I.J. (Ser. A) No. 10 (Sept. 7), at 18.

[112] U.N. Doc. A/74/10, *supra* note 17, at 168.

[113] Statute of the International Court of Justice, Art. 38, June 26 1945, 6 L.N.T.S. 391-413. According to Article 38, public international law consists of three primary sources: (1) international conventions, (2) international custom, as evidence of general practice accepted as law and (3) the general principles of law recognized by civilized nations. In addition, judicial decisions and the "teachings of the most highly qualified publicists of the various nations" may serve as subsidiary sources.

[114] U.N. Doc. A/74/10, *supra* note 17, at 190.

cogens nature, taking into account the definition of *jus cogens* in part II:

> **United States:** "The United States had taken the position those principles [1962 resolution] constituted **international law** as it was **accepted** by the members of the United Nations."[115]
>
> **The Soviet Union**: "What happened in space was of profound concern to the whole [hu]mankind, as was **universally recognized** by States and by the public opinion all over the world."[116] "The Soviet draft treaty was not, however, a mere statement of rights [...] it also contained provisions designed to protect the interests, not only of individual States, **but of all countries and of the international community as a whole**, would be protected."[117]
>
> **Canada**: "Space law would govern not only relations between States in outer space, but also relations between Earth **as a whole** and outer space."[118]
>
> **Italy**: "…three **fundamental** principles: firstly, that outer space should be a *res communis* accessible to all; secondly, that outer space and celestial bodies should not be subject to national appropriation; thirdly, that the exploration and use of outer space should be carried out in accordance with international law…"[119]
>
> **Japan**: "The second principle reflected a **general recognition** among United Nations Members that outer space was a *res communis omnium*. No space activity by any State should be regarded as ground for a claim to territorial sovereignty in

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[115] Comm. On the Peaceful Uses of Outer Space, Summary Record of the Legal Subcomm.'s Fifty-Seventh Meeting at its Fifth Sess., U.N. Doc. A/AC.105/C.2/SR.57, at 5 (1966) (emphasis added) [hereinafter U.N. Doc. A/AC.105/C.2/SR.57].

[116] Comm. On the Peaceful Uses of Outer Space, Summary Record of the Legal Subcomm.'s 29th-37th Meeting at its Third Sess., U.N. Doc. A/AC.105/C.2/SR.29-37, at 11 (1964) (emphasis added) [hereinafter U.N. Doc. A/AC.105/C.2/SR.29-37].

[117] U.N. Doc. A/AC.105/C.2/SR.57, *supra* note 115, at 12 (emphasis added).

[118] Comm. On the Peaceful Uses of Outer Space, Summary Record of the Legal Subcomm.'s Second Meeting at its First Sess., U.N. Doc. A/AC.105/C.2/SR.2, at 6-7 (1962) (emphasis added) [hereinafter U.N. Doc. A/AC.105/C.2/SR.2].

[119] U.N. Doc. A/AC.105/C.2/SR.29-37, *supra* note 116, at 44 (emphasis added).

> outer space or a celestial body."[120] **Poland**: "His delegation reaffirmed its support for the two **essential** legal principles stated in the resolution [1721]."[121]
>
> **Australia**: "The principle of the non-appropriation [...] was of the **greatest importance to [hu]mankind.**"[122]
>
> **India**: "...those principles should be defined in a **Magna Carta** of outer space".[123] "[...] the rule of *res communes* must prevail in cosmic space."[124]
>
> **Czechoslovakia**: "The rule that outer space was a *res communis omnium* implied that each State maintained its own freedom but none might infringe the freedom **of others."**[125]
>
> **France**: "Traditional international law was based on the concepts of **sovereignty** and continental **appropriation**. **No State** had yet attempted to apply those concepts in space."[126]
>
> **Romania**: "The principles should be acceptable to all States and the obligations arising from them acceptable to, **and accepted by, all States."**[127]

When the United States planted the American flag on the Moon, the authorities clarified that this was intended "as a symbolic gesture of national pride in achievement and is not to be construed as a declaration of national appropriation by claim of sovereignty."[128]

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[120] Comm. On the Peaceful Uses of Outer Space, Summary Record of the Legal Subcomm.'s Fifth Meeting at its First Sess., U.N. Doc. A/AC.105/C.2/SR.5, at 5 (1962) (emphasis added).

[121] Comm. On the Peaceful Uses of Outer Space, Summary Record of the Legal Subcomm.'s Sixth Meeting at its First Sess., U.N. Doc. A/AC.105/C.2/SR.6, at 7 (1962) (emphasis added).

[122] Comm. On the Peaceful Uses of Outer Space, Summary Record of the Legal Subcomm.'s Seventy-First Meeting at its Fifth Sess., U.N. Doc. A/AC.105/C.2/SR.71, at 15 (1966) (*emphasis added*).

[123] U.N. Doc. A/AC.105/C.2/SR.2, *supra* note 118, at 6.

[124] U.N. Doc. A/AC.105/C.2/SR.57, *supra* note 115, at 19 (emphasis added).

[125] U.N. Doc. A/AC.105/C.2/SR. 8 (Aug. 21, 1968), at 5 (emphasis added).

[126] U.N. Doc. A/AC.105/C.2/SR.57, *supra* note 115, at 16 (emphasis added).

[127] U.N. Doc. A/AC.105/C.2/SR.29-37, *supra* note 116, at 20 (emphasis added).

[128] Anne M. Platoff, *Where No Flag Has Gone Before: Political and Technical Aspects of Placing a Flag on the Moon* (1993) https://escholarship.org/uc/item/93t5x9dq (last visited Mar. 21, 2023).

2. Legislative Acts

Apollo Lunar Landing Legacy Act

The proliferation of space actors with the technological capacity to land on the Moon, and the renewed interest in this celestial body and its resources, laid the ground for this legislative initiative.[129] In 2013, a bill entitled Apollo Lunar Landing Legacy Act was introduced in the House. The aim was to preserve and protect the Apollo lunar landing sites for the benefit of present and future generations.[130] Those sites were defined in Section 4 as: "all areas of the Moon where astronauts and instruments connected to the Apollo program between 1969 and 1972 touched the lunar surface."[131]

In addition, Section 8 provided that the Apollo 11 lunar landing site was to be submitted to the United Nations Educational, Scientific, and Cultural Organization (UNESCO) for designation as a World Heritage Site.[132] However, the limitation imposed by the non-appropriation principle under space law is the very obstacle for its inclusion in that list, since one of the conditions under the World Heritage Convention is that the site must be within the territory of the State submitting the proposal.[133]

This is a core incompatibility between the UNESCO Convention and the Outer Space Treaty.[134] Although that shortcoming is recognized by the literature, publicists like Michelle Hanlon and Andrea Harrington agree that the protection of the scientific and historic value of these[135] and other sites that the international community are deemed to be of universal value, should be preserved for

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[129] Brian Fung, *Space: The Final Legal Frontier*, WASH. POST (Aug. 31, 2019), https://www.washingtonpost.com/technology/2019/08/31/space-final-legal-frontier/.

[130] H.R. 2617, 113th Cong. (2013), available at https://www.congress.gov/bill/113th-congress/house-bill/2617. This bill did not advance to a vote.

[131] *Id.*

[132] *Id.* § 8.

[133] UNESCO World Heritage Convention, Nov. 16, 1972, 27 U.S.T. 37, 1037 U.N.T.S. 151, art. 4.

[134] Diane Zajackowski, *Could the Moon's Cultural Heritage Be Inscribed on UNESCO's World Heritage List?*, *in* PROTECTION OF CULTURAL HERITAGE SITES ON THE MOON: VOLUME 24 13, 19 (Annette Froehlich ed. 2020) .

[135] In line with that, Article 7(3) of the Moon Agreement reads: "States Parties shall report to other States Parties and to the Secretary-General concerning areas of the Moon having special scientific interest in order that, without prejudice to the rights of other

future generations.[136] Such concerns have fueled a discussion regarding possible venues to protect space sites and whether a new international instrument is the solution.[137]

Senate Bill 1694 - The One Small Step to protect Human Heritage in Space Act:

The limitations already pointed out were followed by advocacy by concerned members of civil society, which ultimately paved the way for this law to be passed in 2019, which aimed to develop and extend best practices to preserve the lunar landing sites. A relevant part of this legislation reads: "[t]he lunar landing sites of the Apollo 11 spacecraft, the robotic spacecraft that preceded the Apollo 11 mission, and the crewed and robotic spacecraft that followed, are of *outstanding universal value to humanity*."[138] There are at least 100

States Parties, consideration may be given to the designation of such areas as international scientific preserves for which special protective arrangements are to be agreed upon in consultation with the competent bodies of the United Nations." *See generally* The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 5, 1979, 1363 U.N.T.S. 3, art. 3 [hereinafter Moon Agreement].

[136] Michelle L.D. Hanlon and Bailey Cunningham, *The Legal Imperative to Mitigate the Plume Effect: An "Aggravation and Frustration" that Imperils Our History and Our Future,* 43 J. OF SPACE L. 309 (2019); Andrea A. Harrington, *Preserving Humanity's Heritage in Space: Fifty Years after Apollo 11 and Beyond*, 84 J. AIR L. & COM. 299, 376 (2019). It is appropriate to make reference to Article 4(1) of the Moon Agreement, which reads as follows: "The 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. 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 in accordance with the Charter of the United Nations." *See* Moon Agreement, *supra* note 135, art. 4.

[137] Zajackowski, *supra* note 134, at 7, 18-19. Hanlon offers a model by which such a new instrument can be developed. Michelle Hanlon, *"Due Regard" for Commercial Space Must Start with Historic Preservation,* 9 GLOBAL BUS. L. REV. 130, 151. *See also* Lixinski et; al., *Envisioning a Legal Framework for Outer Space Cultural Heritage,* 45 J. Space L. 1 (2021).

[138] S. 1694, 116th Cong. § 1 (2019), https://www.congress.gov/bill/116th-congress/senate-bill/1694/text#:~:text=3358%5D%5D%20Public%20Law%20116,site%20artifacts%2C%20and%20for%20other/ (last visited Mar. 21, 2023) (emphasis added).

objects that were left at the Tranquility Base and have been catalogued.[139] In fact, there are more than 100 sites on the Moon that host objects and evidence of human activity.[140]

The scope of application of the One Small Step Act applies to lunar activities that require licensing under American federal regulations, but it has no applicability to activities controlled or undertaken by third States. This is in fact a necessary constraint to keep it in harmony with Article II of the Outer Space Treaty. However, some authors have criticized the "spillover effect" on to third States (or a kind of extraterritorial application of American law), due to the conditions that the United States may seek to impose on third countries based on this bill in future co-operational undertakings for lunar exploration.[141]

The Case of Colombia

Based on Article 44 of the International Telecommunication Union (ITU) Constitution, Colombia claimed that a segment of the geostationary orbit was a sovereign natural resource suprajacent to its territory.[142] That provision reads in the relevant part as follows:

> " … that radio frequencies and any associated orbits, including the geostationary-satellite orbit, are **limited natural resources** and that they must be used rationally, efficiently and economically, in conformity with the provisions of the Radio Regulations, so that countries or groups of countries may have *equitable access to those orbits and frequencies, taking into account the special needs of the developing countries and the geographical situation of particular countries.*"[143]

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[139] Archaeological Inventory at Tranquility Base, LUNAR LEGACY PROJECT https://spacegrant.nmsu.edu/lunarlegacies/artifactlist.html (last visited Mar. 21, 2023).

[140] FOR ALL MOONKIND MOON REGISTRY, https://moonregistry.forallmoonkind.org/ (last visited Mar. 20, 2023).

[141] Giulia Persoz, *One Small Step to Protect Human Heritage in Space Act as One Small Step Towards U.S. Space Dominance? The Case for a Multilateral Treaty Protection Regime*, *in* PROTECTION OF CULTURAL HERITAGE SITES ON THE MOON: VOLUME 24 41, 50 (Annette Froehlich ed. 2020).

[142] MEJÍA-KAISER, *supra* note 89, at 86.

[143] Constitution and Convention of the International Telecommunication Union, Dec. 22, 1992, 1833 U.N.T.S. 331 (emphasis added).

In support of such a claim, in 1976, Colombia and other Equatorial States issued the Bogota Declaration, which explicitly proclaimed that the geostationary orbit "must not be considered part of the outer space."[144] These countries contended that Article II of the Outer Space Treaty was not applicable to this orbit.[145] In 1977, Colombia rejected being bound by that provision, and explicitly denied its peremptory nature in the terms of Article 53 of the VCLT, since "the international community did not endow it with such a nature."[146]

The position of Equatorial States has modified as they progressively abandoned sovereign claims over the geostationary orbit in international fora.[147] Colombia itself ceased to claim sovereignty internationally and switched to the language of "equitable access."[148] However, in 1999, the Colombian Constitution crystallized its sovereign claims domestically in Article 101, which reads in part as follows: "... Also part of Colombia is [...] the segment of the geostationary orbit, the electromagnetic spectrum and the space where it applies, in accordance with international law or the laws of Colombia in the absence of international regulations..."[149]

The following year (2000), the Legal Subcommittee of COPUOS—of which Colombia has been a member since 1977[150]—took note in its 39th session of a paper entitled "Some aspects concerning the use of the geostationary orbit," stating that: "access to that orbit must take place, *inter alia*, in an equitable manner and

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[144] *Declaration of the First Meeting of Equatorial Countries*, JAPAN AEROSPACE EXPLORATION AGENCY https://www.jaxa.jp/library/space_law/chapter_2/2-2-1-2_e.html (last visited Mar. 21, 2023) [hereinafter *Declaration of Equatorial Countries*]. *See also* Verbatim Record of the 173rd Mtg. of the Comm. on the Peaceful Uses of Outer Space, U.N. Doc. A/AC.105/PV.173, at 56 (1977) [hereinafter U.N. Doc. A/AC.105/PV.173].

[145] *Declaration of Equatorial Countries, supra* note 144.

[146] U.N. Doc. A/AC.105/PV.173, *supra* note 144, at 56-57.

[147] MEJÍA-KAISER, *supra* note 89, at 105. *See also* different arguments in favor and against in Juan Carlos Velazquez Elizarrás, *The Outer Space Law in Critical Time: Statehood, Monopolization or Universality?*, 13 ANUARIO MEXICANO DE DERECHO INTERNACIONAL 583 (2013).

[148] MARTHA MEJÍA-KAISER, *supra* note 89, at 90 & 93.

[149] A translated version of the Constitution of Colombia is available at *Constitución Política de Colombia*, CONFERENCIA IBEROAMERICANA DE JUSTICA CONSTITUCIONAL https://www.cijc.org/es/NuestrasConstituciones/COLOMBIA-Constitucion.pdf (last visited Mar. 23, 2023).

[150] G.A. Res. 32/196B, U.N. Doc. A/RES/32/196B (Dec. 20, 1977).

according to the ITU Radio Regulations."[151]Such an agreement was noted with satisfaction in the 4th paragraph of UNGA Resolution 55/122.[152] One year later, in 2001, COPUOS agreed by consensus that the geostationary orbit is part of the outer space.[153]

So far, Colombia has only signed but has not ratified the Outer Space Treaty (apart from the Congo, Colombia is the only country from the signatories of the Bogota Declaration that has not ratified it).[154] This is not particularly understandable in light of the developments in COPUOS just mentioned. Furthermore, it is doubtful if it was even before then, because the 4th paragraph of the Bogota Declaration can be said to have worked for a long time as a disclaimer: "[t]he lack of definition of outer space in the Treaty of 1967 . . . implies that Article II should not apply to the geostationary orbit and therefore does not affect the right of the equatorial states that have already ratified the Treaty."[155]

To date, Colombia has neither requested any authorization for placing satellites in its presumably claimed portion of the geostationary orbit, nor protested at the operation of those satellites,[156] although it had originally declared that such a requirement was necessary.[157] Furthermore, the Colombian Ambassador, Héctor Charry Samper, recognized in 1984 at COPUOS that Equatorial States were not claiming an absolute and exclusive sovereignty over the geostationary orbit in the classical sense, but rather only priority.[158]

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[151] Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on Its Thirty-Ninth Session, U.N. Doc A/AC.105/738, at 22 (2020).

[152] G.A. Res. 55/122, U.N. Doc. A/RES/55/122 (Dec. 8, 2000).

[153] Comm. on the Peaceful Uses of Outer Space, Rep. on Its Forty-Fourth Session, U.N. Doc. A/56/20, at ¶126 (2001); Comm. on the Peaceful Uses of Outer Space, Rep. of the Technical and Scientific Subcomm. on Its Thirty-Ninth Session, U.N. Doc. A/AC.105/786, at ¶ 132 (2002).

[154] Outer Space Treaty, *supra* note 4.

[155] *Declaration of Equatorial Countries*, *supra* note144.

[156] MEJÍA-KAISER, *supra* note 89, at 95 & 108.

[157] U.N. Doc. A/AC.105/PV.173, *supra* note 144, at 56.

[158] ALVARO A. SEQUERA DUARTE, EL DERECHO ESPACIAL DE COLOMBIA [SPACE LAW OF COLOMBIA] 36, (2020); Ernesto Rodríguez Medina, *Nuestro Derecho al Espacio: La Órbita Geoestacionaria: Una Frustrada Regulación* [Our Right to Space: The Geostationary Orbit: A Failed Regulation], REVISTA DE TEMAS CONSTITUCIONALES 51, 67 (2006), https://revistas-colaboracion.juridicas.unam.mx/index.php/elementos-de-juicio/article/view/10248/ (last visited Jan. 14, 2023).

3. Non-Binding Arrangements including Bilateral Agreements

The Artemis accords (2020)

The Artemis Accords advance the NASA-led Artemis program to build up co-operation with partners.[159] These arrangements were described by the United States as a set of principles or political commitments, thus giving rise to some uncertainty as to the real nature of these instruments: are they legally or only politically binding? On the one hand, these agreements restate binding principles enshrined in the Outer Space Treaty, such as non-appropriation.[160] On the other hand, they establish "a *political* commitment to the principle described [t]herein," which also encompasses ideas such as the preservation of outer space heritage, including "historically significant human or robotic landing sites, artifacts, spacecraft, and other evidence of activity on celestial bodies."[161]

4. Domestic Case Law

The twentieth century has witnessed a few private claims of ownership over the Moon and asteroids. The literature recounts the famous case of Dennis Hope, who established the Lunar Embassy in 1980, a company selling "extraterrestrial real estate," or rather "unreal estate."[162] Admittedly, he was not the first to claim "property rights" over celestial bodies. Reference can be made to the case of James Thomas Mangan, the inventor of Celestia as a "micro nation," which even attempted to apply for membership at the United Nations in 1948.[163] In addition, lawyer Jenaro Gajardo Vera in 1954 registered the Moon as his own property under Chilean law, allegedly inherited continuously since 1857.[164]

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[159] Artemis Plan, Nasa's Lunar Exploration Program Overview (Sep. 2000), *https://www.nasa.gov/sites/default/files/atoms/files/artemis_plan-20200921.pdf*

[160] The Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids, NASA, https://www.nasa.gov/specials/artemis-accords/img/Artemis-Accords-signed-13Oct2020.pdf

[161] *Id*. at art. 9 (emphasis added).

[162] VIRGILIU POP, WHO OWNS THE MOON? EXTRATERRESTRIAL ASPECTS OF LAND AND MINERAL RESOURCES OWNERSHIP 2 (2009).

[163] Virgiliu Pop, *The Nation of Celestial Space*, 22 SPACE POL'Y 205, 206, (2006).

[164] *La historia del chileno dueño de la luna,* CHILE CULTURA https://eligecultura.gob.cl/cultural-sections/31/ (last visited Mar. 23, 2023).

Another lunar-related example is the Declaration of Lunar Ownership issued in 1966 by a group of citizens of Geneva, Ohio.[165] Finally, in 1996 a German citizen claimed to have inherited the Moon from his Prussian ancestors who owned it since 1756.[166]

Although some of these claims pre-existed the Outer Space Treaty, none of them have been widely recognized or "granted," which supports the proposition that there was either a customary rule or a principle that protected outer space and celestial bodies from appropriation, or at least a factual hindrance (the lack of *corpus possidendi*). In 2004, the Board of Directors of the International Institute of Space Law (IISL) issued a statement on the basis of Articles II and VI of the Outer Space Treaty, underlying that "[t]he sellers of such deeds are unable to acquire legal title to their claims."[167]

Another legal precedent is that involving Gregory Nemitz, an American citizen who claimed to be the owner of asteroid Eros 433 and invoiced NASA for rent.[168] The Court did not inquire into the interpretation of the Outer Space Treaty and dismissed the case on the basis that the plaintiff had not proven his alleged property rights over the asteroid.[169]

There is a twin case in China. The Lunar Embassy of China was a company established by Mr. Li Jie, which issued customers a "certificate" that purportedly ensured property ownership.[170] The

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[165] See POP, *supra* note162, at 19.

[166] Frans G. von der Dunk, *The Dark Side of the Moon The Status of the Moon: Public Concepts and Private Enterprise, in* PROCEEDINGS OF THE FORTIETH COLLOQUIUM ON THE LAW OF OUTER SPACE 119, 120 (1997).

[167] *Statement by the Board of Directors of the International Institute of Space Law (IISL) on Claims to Property Rights Regarding the Moon and Other Celestial Bodies*, BLACK HOLES https://black-holes.eu/resources/IISL_Outer_Space_Treaty_Statement.pdf (last visited Mar. 23, 2023).

[168] Armel Kerrest, *Outer Space as International Space: Lessons from Antarctica*, ANTARCTIC TREATY SUMMIT: 50 YEARS OF ACHIEVEMENTS AND CHALLENGES (2011), www.atsummit50.org/media/book-I8pdf (last visited Mar. 22, 2023); John G. Wrench, *Non-Appropriation, No Problem: The Outer Space Treaty Is Ready for Asteroid Mining*, 51 CASE W. RES. J. INT'L L. 437, 446 (2019).

[169] Nemitz v. NASA, 126 Fed. Appx. 343; *U.S. District Court Judge McKibben's Order to Dismiss*, THE EROS PROJECT FOR SPACE PROPERTY LAW http://www.erosproject.com/order02.html (last visited Mar. 22, 2023); POP, *supra* note165, at 41-43.

[170] *The Man Who Sells the Moon*, N.Y. TIMES (Mar. 10, 2013), https://www.nytimes.com/2013/03/11/opinion/the-man-who-sells-the-moon.html

Haidian District People's Court ruled against the company in 2005, and two years later the appeals court upheld the decision.[171]

5. International Jurisprudence

The only ICJ jurisprudence making reference to space law – in Judge Lachs' dissenting opinion – is in the *North Sea Continental Shelf Cases* (1969). That was the first of only two international cases in which Judge Lachs dissented.[172] In the *North Sea Continental Shelf Cases*, he highlighted the freedom of movement in outer space as an example of custom with a limited temporal factor,[173] or what Bin Cheng called "instant custom."[174]

6. Doctrine

Although primary sources of evidence are rather modest and not conclusive, it is still possible to resort to the subsidiary means proposed by the ILC, namely doctrine.

Commentators like Carl Christol pointed at early manifestations from scholars like Judge Hersch Lauterpacht, arguing as early as 1949 in favor of a *jus cogens* hierarchy for the freedom in outer space.[175] For his part, in 1956, C.W. Jenks considered that the prohibition of appropriation of outer space rests on grounds of international public policy.[176] Denying claims of sovereignty over outer space would serve the interests of the international community.[177]

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[171] *Selling Moon Plots Is Legal Lunacy*, L.A. TIMES (Mar. 18, 2007), https://www.latimes.com/archives/la-xpm-2007-mar-18-fg-location18-story.html.

[172] Press Release, Int'l Ct. Just., The International Court of Justice Pays Tribute to Judge Manfred Lachs (Poland), Former President of the Court, U.N. Press Release No. 2014/17 (Apr. 4, 2014); Oscar Schachter, *The UN Years: Lachs the Diplomat*, 87 THE AM. J. OF INT'L L. 414, 415 (1993).

[173] Ger. v. Den., Ger. v. Neth., 1969 I.C.J. 219 at 230.

[174] Bin Cheng, *United Nations Resolutions on Outer Space: "Instant" International Customary Law?* 5 INDIAN J. OF INT'L L. 125 (1965).

[175] Christol, *supra* note 12, at 42.

[176] C. Wilfred Jenks, *International Law and Activities in Space*, 5 INT'L & COMP. L. Q. 99, 113 (1956).

[177] D. Goedhuis, *Some Recent Trends in the Interpretation and the Implementation of the Rules of International Space Law*, 19 COLUM. J. TRANSNAT'L L. 213, 214 (1981).

Another early assertion in this direction was made by Imre Csabafi pointing to the language of UNGA Resolution 1962 and Article I of the Outer Space Treaty. Csabafi concluded that the wording is similar to that used in the definition of *jus cogens*.[178] Moreover, he came to the conclusion that, in particular, the principle of non-appropriation has become *jus cogens*.[179] Han-Taek Kim considered the non-appropriation principle a customary rule "even developing into *jus cogens*".[180]

Ram Jakhu, Steven Freeland and Kuan-Wei Chen agreed that the freedom of use and exploration and the non-appropriation are peremptory norms.[181] For his part, Zachos Palourias characterized the principle of non-appropriation as the *Grundnorm* of *corpus juris spatialis*.[182] P.J. Blount referred to UNGA Resolution 1721 (XVI) and contended that the principles enshrined in the first UNGA resolution on space matters (including the non-appropriation principle) "maintain a place of primacy in space law."[183] In addition, he emphasized that its adoption without a vote is a clear indication of the international will.[184]

Yevgeniya Oralova argued that *jus cogens* rules in space law are reflected by concepts such as "common benefit" and "province of [hu]mankind" enshrined in the Outer Space Treaty, which reveal that space law protects common interests and values of the international community.[185] Other publicists have pointed at the very

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[178] IMRE ANTHONY CSABAFI, THE CONCEPT OF STATE JURISDICTION IN INTERNATIONAL SPACE LAW: A STUDY IN THE PROGRESSIVE DEVELOPMENT OF SPACE LAW IN THE UNITED NATIONS 46 (1971).

[179] *Id.* at 47.

[180] Han-Taek Kim, *The Non-Appropriation Principle and Corpus Juris Spatialis,* 35 REVISTA DE LA SOCIEDAD DE DERECHO Y POLÍTICA AEROESPACIAL 188 (2020).

[181] Ram S. Jakhu et al., *The Sources of International Space Law. Revisited*, 67 ZLW 606, 647-648 (2018).

[182] Zachos A. Paliouras, *The Non-Appropriation Principle: The Grundnorm of International Space Law*, 27 LJIL 37, 38 (2014).

[183] P.J. Blount, *Outer Space and International Geography: Article II and the Shape of Global Order*, 52 NEW ENG. L. REV. 95, 97 (2018).

[184] *Id.*

[185] Yevgeniya Oralova, *Jus Cogens Norms in International Space Law*, 6 MEDITERRANEAN J. SOC. SCI. 421, 422-423 (2015).

purpose of Article II, which is to avoid war and violence in outer space.[186]

Perhaps the most authoritative scholar is once again Manfred Lachs, who made an important contribution in this field as well: he argued that the peremptory nature of non-appropriation of outer space rests essentially on grounds of international public policy.[187] Regarding the wording "province of all [hu]mankind" in Article I, he was convinced that it had not only a moral but also a legal character.[188]

Our analysis above indicates a degree of support within the specialized literature to the freedom of exploration being regarded as a *jus cogens* norm. Even more solid consensus is found with respect to the principle of non-appropriation enshrined in Article II of the Outer Space Treaty[189] – a rule of progressive development as highlighted by Maureen Williams.[190] The reason behind this assessment is that, at the time of the Outer Space Treaty negotiations, it was already well-established and accepted that claims of sovereignty over outer space or parts thereof were incompatible with its *res communis omnium* nature.[191] The two space powers agreed to prevent "any land grab" because they were aware of the egregious consequences and human suffering that colonization on Earth had caused by the end of the previous century.[192] The ultimate goal was to avoid armed conflict in outer space.[193]

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[186] Robert Kelly, *Nemitz v. United States, a Case of First Impression: Appropriation, Private Property Rights and Space Law before the Federal Courts of the United States*, 30 J. SPACE L. 297, 306 (2004).

[187] Marjorie M. Whiteman, *Jus Cogens in International Law, with a Projected List*, 7 GA. J. INT'L & COMP. L. 609, 615 (1977) (*quoting* Manfred Lachs).

[188] Yvonne Schmidt, *International Space Law and Developing Countries*, *in* OUTER SPACE IN SOCIETY, POLITICS AND LAW: VOLUME 8 690, 695 (Christian Brünner & Alexander Soucek ed. 2011).

[189] Freeland & Jakhu, *supra* note 89, at 55 & 57; Cestmir Cepelka & Jamie H.C. Gilmour, *The Application of General International Law in Outer Space*, 36 J. AIR L. & COM. 30, 46 (1970); Ram S. Jakhu et al., *supra* note 181, at 647; Whiteman, *supra* note 187, at 626.

[190] Sylvia Maureen Williams, *The Law of Outer Space and Natural Resources*, 36 INT'L & COMP. L.Q. 142, 147 (1987).

[191] Freeland & Jakhu, *supra* note 89, at 49; OGUNSOLA O. OGUNBANWO, O., INTERNATIONAL LAW AND OUTER SPACE ACTIVITIES 78 (1975).

[192] Frans von der Dunk, *Some Remarks Further to Outer Space and International Geography: Article II and the Shape of Global Order by P.J. Blount,* 52 NEW ENG. L. REV. 125, 127 & 128 (2018).

[193] *Id*. at 133.

Other authors have pointed to practical reasons that would support the idea that sovereignty in outer space is not even feasible.[194] Within that group, Zachos Paliouras contended that areas unsusceptible to *corpus occupandi* or effective control "have *ipso facto* the status of *res communes omnium*."[195] Thus, he considered that, even without Article II, sovereignty over outer space would be impossible due to the absence of one of the two essential elements for possession.[196] Fabio Tronchetti supported the special character of this rule by identifying it as the cardinal principle of outer space and contending that "any amendment or modification thereof should only be carried out by all States acting collectively."[197] Despite acknowledging such a special nature, Tronchetti falls short of considering the non-appropiation principle a norm of *jus cogens*, instead calling it a "structural norm." [198]

A small group of authors has even gone as far as to argue that the prohibition of installation or placement of nuclear weapons and weapons of mass destruction in outer space is also *jus cogens*.[199] Cestimir Cepelka and Jamie Gilmour included under the *jus cogens* category, in addition to the non-appropriation principle, the limitation on the use of outer space resources, the prohibition on the threat or use of force, and humanitarian rules concerning astronauts.[200] Ricky Lee contended that there is some support for considering Articles III and IV under this category.[201]

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[194] Samuel Kucherov, *Legal Problems of Outer Space. USA and Soviet Viewpoints, in* PROCEEDINGS OF THE SECOND COLLOQUIUM ON THE LAW OF OUTER SPACE 64, 66 (Andrew G. Haley & Welf Heinrich Prince of Hanover ed. 1960); Stephen Gorove, *On the Threshold of Space: Toward a Cosmic Law. Problems of the Upward Extent of Sovereignty, in* PROCEEDINGS OF THE FIRST COLLOQUIUM ON THE LAW OF OUTER SPACE 69, 72 (Andrew G. Haley & Welf Heinrich Prince of Hanover ed. 1959).

[195] Zachos A. Paliouras, *supra* note 182, at 41.

[196] *Id*. at 42-43.

[197] Fabio Tronchetti, *The Non-Appropriation Principle Under Attack: Using Article II of the Outer Space Treaty in its Defense, in* PROCEEDINGS OF THE FIFTIETH COLLOQUIUM ON THE LAW OF OUTER SPACE (2007).

[198] *Id*.

[199] Ekta Rathore & Biswanath Gupta, *Emergence of Jus Cogens Principles in Outer Space Law*, 18 ASTROPOLITICS 1, 17 (2020).

[200] Cepelka & Gilmour, *supra* note 189, at 46-48.

[201] Ricky J. Lee, *The Jus ad Bellum in Outer Space: The Interrelation between Article 103 of the Charter of the United Nations and Article IV of the Outer Space Treaty, in* PROCEEDINGS OF THE 45TH COLLOQUIUM ON THE LAW OF OUTER SPACE 139, 141 (2002).

G.S. Sachdeva promoted what he named the "*jus cogens* Panchsheel" (five principles, in Sanskrit language) of space law: outer space as a province of humankind; freedom of access to outer space; international responsibility for national space activities; the prohibition of placement of nuclear weapons and weapons of mass destruction in orbit around the Earth; and the rescue and return of astronauts and space objects.[202]

VI. CONCLUDING COMMENTS

This article has examined the concept of *jus cogens*, distinguished it from the separate notion of *erga omnes*, and analyzed the main provisions of international space law in light of the two criteria that the ILC has recently identified in the draft conclusions on the identification and legal consequences of peremptory norms of general international law, in order to assess whether they indeed do have a peremptory nature.

According to our analysis, it is possible to conclude that there are at least two important rules in international space law that might be considered as *jus cogens* norms: the common interest/freedom principle and the non-appropriation rule. This assertion is grounded on the recognition that both are customary rules and that they are generally accepted as peremptory. The latter was confirmed through State practice in the context of COPUOS, national legislation, bilateral agreements, domestic case-law, international jurisprudence and doctrine.

The conclusion that there are at least two *jus cogens* rules in international space law opens the door to the interrogation as to whether they create emerging obligations of an *erga omnes* character. It is safe to conclude that there are at least two provisions that clearly create *erga omnes* obligations: the first being the partial disarmament clause in Article IV of the Outer Space Treaty – as do most demilitarization clauses. In this regard, it is timely to recall that United Nations Secretary-General Guterres has recognized in

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[202] G. S. Sachdeva, *Select Tenets of Space Law as Jus Cogens, in* RECENT DEVELOPMENTS IN SPACE LAW. OPPORTUNITIES & CHALLENGES 7, 17-26 (R. Vencata Rao, V. Gopalkrishan & Kumar Abhijeet eds., 2017).

the Agenda for Disarmament, that disarmament has "ensured respect for the principles of humanity".[203]

The other provision in the same treaty that enshrines obligations imposed on the international community of States as a whole is Article IX, which relates to the avoidance of harmful contamination, and potentially harmful interference, as well as the importance of conducting activities in outer space with "due regard to the corresponding interests of all other States Parties".

Both sets of *erga omnes* obligations emerge as a consequence of the principles enshrined in Articles I (common interest clause) and II (non-appropriation clause) of the Outer Space Treaty. Consequently, we do not agree with the assertion that some specific rules governing global commons create *erga omnes* obligations but do not have a *jus cogens* nature.

Although there is relatively little evidence of further norms of such a nature, the door remains open to consider the principles relating to the treatment of astronauts as *jus cogens* due to its underlying humanitarian concerns. However, this is an issue that will require further analysis in the face of future activities in outer space involving human personnel who are not necessarily fully trained professional 'astronauts', as the concept was originally envisaged. The need for humanitarian treatment being rendered to *any* person in outer space will prove to be the most fit-for-purpose solution, in line with the "sentiments of humanity" as expressed in the preamble of the Agreement on the Rescue of Astronauts, the Return of Astronauts and Return of Objects Launched into Outer Space.[204]

Notwithstanding our conclusions, there will likely be some scholars who remain skeptical about characterizing certain international space law rules as *jus cogens*, most importantly due to the intrinsic relation between those norms and the protection of most fundamental human rights. That said, the link between a peaceful, secure, safe and sustainable use of outer space and the resulting socio-economic benefit for people is uncontested. Furthermore, the causal nexus between socio-economic development, incorporating

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[203] *Securing our Common Future: An Agenda for Disarmament*, U.N. OFFICE FOR DISARMAMENT AFFAIRS, (2018) https://www.un.org/disarmament/sg-agenda/en/.

[204] Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, Apr. 22, 1968, 672 U.N.T.S. 119, preamble ¶ 4.

the exploration and use of outer space, and the basic realization of human rights is also increasingly evident.[205]

The international community does not need to sit idle and wait until certain action precipitates a disaster in outer space to consider the prohibition against that action as a *jus cogens* norm. In that regard, in this article we have sought to put forward a proactive rather than a reactive approach towards identifying possible new peremptory norms. The ILC might wish to consider whether these arguments are convincing enough to include "*jus cogens* in space law" as a specific issue for consideration in its future work, and we look forward to the ongoing discussions in this regard.

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[205] Steven Freeland, *The Regulation of Space Activities: A Human Rights Perspective, in* LIBER AMICORUM SERGIO MARCHISIO: IL DIRITTO DELLA COMUNITÀ INTERNAZIONALE TRA CARATTERISTICHE STRUTTURALI E TENDENZE INNOVATIVE: VOLUME 1 1057 (2022).

THE NEXT ARMS RACE AND THE UNKNOWN FRONTIER OF OUTER SPACE: THE CONCEPTUAL CHALLENGES FOR INTERNATIONAL LAW AND SPACE WEAPONIZATION

Dr. Rebecca Connolly[*] *and Aine Bennett*[**]

ABSTRACT

Space activity is growing at an exponential rate, with world powers heightening their military capabilities and non-State actors using military-able space technology. The rapid development in space military technology has created the real possibility that the next arms race will occur in outer space. Further, the war in Ukraine has showcased the impacts of unilateral military acts of aggression, emphasising the urgent need to address the global issue of space weaponization. This article will consider the gaps in the current international space law agreements relating to space weaponization. Then, the article will explore the conceptual challenges for bridging these normative gaps, with the potential for a soft law approach as a way forward. This article places a spotlight on the urgency for the international community to negotiate and develop appropriate regulations for space weaponization before outer space becomes a warfighting domain.

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I. INTRODUCTION

As we venture into the 2020s, space activity will continue to grow at an exponential rate. The precariousness of international stability, the capacity and willingness of world powers to exercise their military capabilities in space, and the prominence of non-State actors utilizing military-able space technology, create an explosive mix potentially laying the foundation for an arms race in space. The rapid advancements in space technology, coupled with new commercial and State actors, raises concerns that space law has not developed at the same pace, leaving potential gaps in the international regulatory framework. This article will consider the pressing question of whether current international space law is effective in addressing the emerging issues involving the weaponization of space.

Part II of this article will consider the current global situation with a specific focus on space weaponization and why this is a pressing international political and legal issue. Part III will briefly cover the existing international legal framework for international space activities as it relates to weaponization. Part IV then analyzes the conceptual challenges that exist under international law concerning space weaponization. Finally, Part V will consider the potential for a soft law approach as a way forward to bridge the normative gaps in the existing international law relating to the weaponization of space.

II. AN OUTER SPACE ARMS RACE—ON THE EDGE OF A PRECIPICE?

The reality of States developing and exercising their military capabilities has repercussions for the balance of power, diplomatic processes, national economies, and global inequality.[1] It is predicted that this will be amplified with the additional domain of space, particularly for States without spacefaring capabilities.[2] With the unfolding war in Ukraine and Russia's unilateral exercise of military aggression, the weaponization of outer space has

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[1] Kathryn Robinson Hasani, *The Next Frontier of The Global Commons, in* COMMERCIAL AND MILITARY USES OF OUTER SPACE 25, 25 (Melissa de Zwart & Stacey Henderson eds., 2021).

[2] *Id.*

emerged as a pressing global issue. The security assurances made in the Budapest Memorandum by Russia (along with the United Kingdom and the United States (US)) to "respect the independence and sovereignty and the existing borders of Ukraine" and to "refrain from the threat or use of military force," have been completely disregarded.[3] One cannot help but feel that the world order is at a tipping point. Space technology, specifically satellite technology, has played a role in the war in Ukraine.[4] Examples include the small gesture of the US providing Ukrainian President Volodymyr Zelensky with a satellite phone for communication,[5] to Google turning off real-time traffic updates for the geographical area of Ukraine[6]—presumably in an attempt to avoid the misuse of this data by Russia to formulate military strategic targets based on troop movements. There have been reports of Western high-quality, real-time satellite imagery of Russian troop movements being made available to both the Ukraine military and to Ukraine private companies (non-State actors).[7] Notably, SpaceX owner Elon Musk turned on the Starlink satellite services over Ukraine at the request of the Ukrainian Minister of Digital Transformation.[8] Starlink has provided the Ukraine military (and civilians) with unparalleled continuous communications and internet coverage (due to the placement of the Starlink satellites in the Low Earth Orbit). While this is not the first time

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[3] Memorandum on Security Assurances in Connection with Ukraine's Accession to the Treaty on the Non-Proliferation of Nuclear Weapons, § 1, Dec. 5, 1994, 3007 U.N.T.S. 52241.

[4] Morgan Meaker, *High Above Ukraine, Satellites Get Embroiled in the* War, WIRED (Mar. 4, 2022), https://www.wired.com/story/ukraine-russia-satellites/.

[5] Kylie Atwood & Zachary Cohen, *US in contact with Zelensky through secure satellite phone given to him by the US*, CNN 9 (Mar. 1, 2022), https://edition.cnn.com/europe/live-news/ukraine-russia-putin-news-03-01-22/h_5a65303ee7ffa3cb8765d5aafd8c2202.

[6] Gavin Butler, *Google Turns off Maps Features in Ukraine that Inadvertently Showed Russian's Invasion,* VICE NEWS (Feb. 27, 2022), https://www.vice.com/en/article/5dgjka/google-maps-ukraine-live-traffic-russia-invasion.

[7] Mark Krutov & Sergei Dobrynin, *In Russia's War On Ukraine, Effective Satellites Are Few And Far Between*, RADIO FREE EUROPE RADIO LIBERTY (Apr. 11, 2022), https://www.rferl.org/a/ukrain-satellites-ukraine-war-gps/31797618.html; Mark Hilborne, *Ukraine war: how it could play out in space – with potentially dangerous consequences*, THE CONVERSATION (Mar. 10, 2022), https://theconversation.com/296kraine-war-how-it-could-play-out-in-space-with-potentially-dangerous-consequences-178557.

[8] *How Elon Musk's satellites have saved Ukraine and changed warfare*, THE ECONOMIST (Jan. 5, 2023), https://www.economist.com/briefing/2023/01/05/how-elon-musks-satellites-have-saved-ukraine-and-changed-warfare.

that satellite technology has played a role in an international conflict, it demonstrates the real-time need for international law to keep pace in this area as both State and non-State actors have readily engaged with space technology to achieve military objectives.

There have also been several successful attempts to destroy satellites in space. In January 2007, China fired a missile to shoot down an old satellite. This action was condemned by many States including the US, particularly because the destruction created significant space debris.[9] Interestingly, despite condemning China's action, the US continued to pursue several space and missile defense projects, and a year later shot down a failed spy satellite.[10] It is noted that it was announced by US Vice President Kamala Harris, in April 2022, that the US was committed to refraining from conducting destructive, direct-ascent anti-satellite (DA-ASAT) missile testing.[11] The US is the first State to adopt a voluntary moratorium on destructive testing of DA-ASAT missile systems.[12] In the announcement, other nations were also called upon to make similar commitments, in the hope of establishing it as a "new international norm for responsible behavior in space."[13] The UN General Assembly approved a resolution in December 2022 encouraging countries to refrain from conducting DA-ASAT tests. A total of 155 nations voted in favor of the non-binding resolution. So far, 13 States have made the commitment to not conduct DA-ASAT tests. Panda and Silverstein remain doubtful on whether this push by the US for a moratorium on DA-ASAT tests will slow space militarization overall – but nevertheless acknowledge that it has ignited the development of norms for space sustainability. [14]

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[9] PAROS Treaty, THE NUCLEAR THREAT INITIATIVE https://www.nti.org/education-center/treaties-and-regimes/proposed-prevention-arms-race-space-paros-treaty/ (last visited Aug. 27, 2022) [hereinafter PAROS Treaty].

[10] *Id.*

[11] THE WHITE HOUSE, Fact Sheet: Vice President Harris Advances National Security Norms in Space (April 18, 2022), https://www.whitehouse.gov/briefing-room/statements-releases/2022/04/18/fact-sheet-vice-president-harris-advances-national-security-norms-in-space/ [hereinafter White House Fact Sheet].

[12] Ankit Panda & Benjamin Silverstein, *The U.S. Moratorium on Anti-Satellite Missile Tests Is a Welcome Shift in Space Policy* ¶ 1 (Apr. 20, 2022) https://carnegieendowment.org/2022/04/20/u.s.-moratorium-on-anti-satellite-missile-tests-is-welcome-shift-in-space-policy-pub-86943.

[13] White Hour Fact Sheet, *supra* note 11, ¶ 1.

[14] Panda & Silverstein, *supra* note 12, ¶ 5.

In February 2023, the international media reported four unidentified flying objects shot down by the US over South Carolina, Alaska, the Yukon Territory (in Canadian airspace with the authorization of the Canadian Government), and Michigan.[15] The first object, a Chinese "spy" balloon, was tracked by the US over a number of days and flew at an altitude of approximately 20 kilometers (km) (which is above the flight path of commercial and military aircraft).[16] The Chinese have maintained that the balloon was a civilian device for meteorological purposes, despite its size and intelligence-gathering capabilities (parts of its antennae, sensors, and electronics were recovered by the US).[17] As demonstrated by the Chinese spy balloon, it is now possible for military technology (such as balloons and drones) to operate in the zone that sits above the altitude flown by aircraft but below the orbit of satellites—a grey area for international law. These incidents have launched discussions on the potential for this "Near Space Zone" as a "new front for militarization."[18] As will be discussed later in this paper, the extension of sovereignty beyond air space (namely, the demarcation of the boundary with outer space) has emerged as a pressing international legal issue, particularly in relation to weaponization, surveillance and national security.

Scholars have raised several concerns about the inadequacy of current space law to manage the weaponization of space.[19] Tronchetti surmised that space law is not a "comprehensive and

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[15] Julian E. Barnes, Adam Goldman & Chris Cameron, *What Were Those Flying Objects? Not Aliens, the White House Says*, N.Y. TIMES (Feb. 14, 2023), https://www.nytimes.com/article/ufo-spy-balloons-china.html; *4 Flying Objects Have Been Shot Down Over North America: Timeline of Key Moments,* ABC7 NEWS, (Feb.14, 2003), https://abc7news.com/chinese-spy-balloon-flying-object-shot-down-over-lake-huron-unidentified-objects/12809246/

[16] Paul Stephen Dempsey & Maria Manoli, *Suborbital Flights and the Delimitation of Airspace Vis-à-Vis Outer Space: Functionalism, Spatialism and State Sovereignty*, 42 ANN AIR SPACE L. 209, 248 (2017).

[17] Max Matza, *Chinese Balloon Sensors Recovered from Ocean, Says US*, BBC NEWS (Feb. 15, 2023), https://www.bbc.com/news/world-us-canada-64633705.

[18] Simone McCarthy, Nectar Gan & Wayne Chang, *China's Balloons Are Part of a Strategy to Beat the US on a New Battlefield: 'Near Space'*, N.Y. TIMES (Feb. 10, 2023), https://edition.cnn.com/2023/02/09/china/china-balloon-near-space-development-intl-hnk/index.html.

[19] Yan Ling, *Prevention of Outer Space Weaponization under International Law: A Chinese Lawyer's Perspective*, 4(2) J. EAST ASIA INT. LAW 271, 272 (Autumn 2011) (discussing international legal community concerns).

integral legal system" despite having "a vast number of applicable rules," it is limited in that it does not address all the issues needed for "completeness."[20] Moreover, with the increasing number of States developing the capability to access space, the challenge of forming effective law is exacerbating.[21] According to Hoffstadt, space law is "one of the most unstable areas of international law" due to its ambiguous phrasing, and this has only been intensified exacerbated by changes in technology.[22] As will be discussed in the next part of this paper, the current space agreements embrace underlying principles of maintaining international peace and security and promoting international cooperation for the benefit of all. These principles potentially clash with the rising commercialization of space activities, the potential fiscal benefits from the appropriation of space natural resources and driving national security objectives. On this basis, some scholars have predicted that the current international space agreements will eventually be rejected.[23] Maogoto and Freeman further this reasoning, indicating that the current international space laws leave room for uncertainty and exploitation for military and strategic purposes.[24] In the absence of clear provisions in the space agreements relating to weaponization, the "vacant" international regulatory hole will, at best, be filled by other existing international law (such as international humanitarian law),[25] or at worst, go completely unregulated with States independently following their own laws that suit their military and national security objectives.[26] This article will now turn its

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[20] FABIO TRONCHETTI, FUNDAMENTALS OF SPACE LAW AND POLICY 3 (2013).

[21] *Id.* at 4.

[22] Brian M. Hoffstadt, *Moving the Heavens: Lunar Mining and the Common Heritage of Mankind in the Moon Treaty,* 42, UCLA L. REV. 575, 581 (1994).

[23] Adam G. Quinn, *The New Age of Space Law: The Outer Space Treaty and the Weaponization of Space*, 17, MINN. J. INT'L L. 475, 489 (2008); Ivan Vlasic, *Space Law and the Military Applications of Space Technology, in* PERSPECTIVES ON INTERNATIONAL LAW 385, 406 (Manfred Lachs & Nandasiri Jasentuliyana eds., 1995).

[24] Jackson Nyamuya Maogoto & Steven Freeland, *Space Weaponization and the United Nations Charter Regime on Force: A Thick Legal Fog or a Receding Mis*t? 41 INT'L LAW 1091, 1118 (2007).

[25] Michel Bourbonnière & Ricky J. Lee, *Legality of the Deployment of Conventional Weapons in Earth Orbit: Balancing Space Law and the Law of Armed Conflict*, 18 EUR. J. INT'L L. 873, 901 (2007).

[26] Note—this article will not specifically consider the application (and suitability) of international humanitarian law to the weaponization of space, as this analysis merits a separate scholarly paper in its own right.

consideration to the existing space agreements and then the conceptual challenges for normative reform.

III. OVERVIEW OF CURRENT INTERNATIONAL SPACE LAW

There are five key international agreements that form the regulatory framework governing outer space—they are known colloquially as the Outer Space Treaty[27] (OST), the Rescue Agreement,[28] the Liability Convention,[29] the Registration Convention,[30] and the Moon Agreement[31] (MA). These agreements were negotiated within the framework of the United Nations (UN), under the umbrella of the UN Committee on the Peaceful Uses of Outer Space (COPUOS).[32] Customary international law and international law principles, such as the UN Charter, also apply to space law.[33] It is also important to note the influence domestic law and national agendas have on international law.[34] For the purpose of this article, only the space law agreements relevant to weaponization will be discussed.

A. The Space Agreements

1. The Outer Space Treaty

Sometimes referred to as the Magna Carta of space, the OST established a guiding framework to regulate States' activities in space.[35] Presently, the OST has been ratified by 112 States, with

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

[28] Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, Apr. 22, 1968, 19 U.S.T. 7570, 672 U.N.T.S. 119 [hereinafter Rescue Agreement].

[29] Convention on the International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S 187 [hereinafter Liability Convention].

[30] Convention on Registration of Objects Launched into Outer Space, Jan. 14, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15 [hereinafter Registration Convention].

[31] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 18, 1979, 1362 U.N.T.S. 3 [hereinafter Moon Agreement].

[32] TRONCHETTI, *supra* note 20, at 3.

[33] Brian Wessel, *The Rule of Law in Outer Space: The Effects of Treaties and Non-binding Agreements on International Space Law*, 35 HASTINGS INT'L & COMP. L. REV. 289, 298 (2012).

[34] *Id.* at 308.

[35] TRONCHETTI, *supra* note 20, at 8.

signatures by a further 23 States.[36] Article I of the OST establishes that the "exploration and use of outer space, including the Moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries … and shall be the province of all [hu]mankind."[37] Further, Article II of the OST provides that outer space "is not subject to national appropriation by claim of sovereignty, by means of use or occupation or by any other means."[38] Of particular relevance, in Article III of the OST, States are obliged to carry out activities in space "in the interest of maintaining international peace and security and promoting international co-operation and understanding."[39] However, it is unclear what is encapsulated in the term "peace" and whether weaponization and militarization (terms that will be distinguished further on in this article) are incompatible with maintaining peace and security. The OST touches on weapons in Article IV, stating that States undertake "not to place in orbit around the earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner."[40] Establishing "military bases, installations, and fortifications" is specifically "forbidden" under the OST, as is "the testing of any type of weapons and the conduct of military maneuverers on celestial bodies."[41] However, the OST allows the use of equipment or facilities that are necessary, even the use of military personnel, if it is for scientific or peaceful exploration.[42] The OST places responsibility on States to ensure all activities are conducted in accordance with the OST, even those carried out by non-governmental agencies. [43]

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[36] 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].

[37] Outer Space Treaty, *supra* note 27, art. I.

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

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

[40] *Id.* at art. IV.

[41] *Id.*

[42] *Id.*

[43] *Id.* at art. VI.

2. The Liability Convention

The Liability Convention establishes State responsibility for compensation in the event their space object causes damage to the surface of the earth or an aircraft in flight.[44] In this Convention, accountability is placed not only on the State who launched or procured the space object, but also on the State whose territory or facility the space object was launched from.[45] If these are two different States, then they will have joint liability.[46] Article XXII specifies that the reference to States throughout the Convention, encompasses intergovernmental organizations, with the exception of Articles XXIV and XXVII which details State ratification and review.[47] Although this treaty was drawn up to provide further clarification on the international responsibility for space activities, it is emblematic of its time in that it is State-centric and does not necessarily contemplate (nor account for) the rise of non-State actors, commercialization and the changing face of the current space industry.[48]

3. The Moon Agreement

The Moon Agreement (MA) applies to the Moon and other celestial bodies in the solar system (except for Earth).[49] Drawing similarities with the OST, Article III of the MA states that the Moon shall strictly be used for peaceful purposes, prohibiting the threat of and use of force, as well as any hostile acts.[50] It also prohibits the placing of nuclear weapons or other weapons of mass destruction in or on the Moon and its orbit.[51] Moreover, testing any type of weapon and establishing military bases or conducting military maneuvers on the Moon are forbidden.[52] The MA specifies that "the moon and all its resources are the *common heritage of [hu]mankind*"[53]—a

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[44] Liability Convention, *supra* note 29, art I.

[45] *Id*. at arts. I & II.

[46] *Id*. at art. IV.

[47] *Id*. at arts. XXII, XXIV & XXVII.

[48] Petr Boháček, *Peaceful Use of Lasers in Space? Potential, Risks, and Norms for Using Lasers in Space*, 61 SPACE POL'Y 1, 6 (2022).

[49] Moon Agreement, *supra* note 31, art. 1.

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

[51] *Id.*

[52] *Id.*

[53] *Id.* at art. 11(1) (emphasis added).

phrase that invokes slightly different connotations in international law compared to the characterization of the exploration and use of space as the "province of all [hu]mankind" as indicate in the OST.[54] The MA elaborates that "neither the surface nor subsurface of the moon, nor any part thereof or natural resources in place, shall become the property of any State, international intergovernmental organization or non-governmental organization, national organization, non-governmental entity or of any natural person."[55] Article 11(6) of the MA also requires States to inform the UN Secretary General, the international scientific community and the public of any natural resources they find on the Moon, to the "greatest extent feasible and practical."[56] Article 11(7)(d) of the MA advocates for an international regime to be established to ensure that the Moon's resources are shared equitably, taking into consideration the needs of developing States and States who have contributed, both directly and indirectly, to the exploration of the Moon.[57] The specificity (and potentially restrictive nature) of these provisions on natural resources led to the MA receiving only 18 ratifications (with four additional signatories)[58] and is considered by some to be a "failed" international law.[59]

B. United Nations Resolutions and Legal Instruments

On October 17, 1963, the UN General Assembly adopted UN Resolution 1884 with the stated purpose of preventing the "spread of the arms race to outer space."[60] Specifically, UN Resolution 1884 called on States to "refrain from placing in orbit around the earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, installing such weapons on celestial bodies, or stationing such weapons in outer space in any other manner."[61]

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[54] Outer Space Treaty, *supra* note 27, art. I.

[55] Moon Agreement, *supra* note 31, at art. 11(3).

[56] *Id.* at art. 11(6).

[57] *Id.* at art. 11(7).

[58] Status of the International Space Agreements, *supra* note 36. In January 2023, Saudi Arabia announced its intention to withdraw from the Moon Agreement with effect from January 5, 2024.

[59] *See* Michael Listner, *The Moon Treaty: failed international law or waiting in the shadows?*, THE SPACE REV. (Oct. 24, 2011), https://www.thespacereview.com/article/1954/1.

[60] G.A. Res. 1884 (XVIII), ¶ 2 (Oct. 17, 1963).

[61] *Id.* at ¶ 2(a).

Later that year, on December 13, 1963, the General Assembly passed UN Resolution 1962, which set out broad principles for space activities, including that such activities should be carried out in the "interest of maintaining international peace and security and promoting international cooperation and understanding."[62] Both of these UN Resolutions formed the basis for the negotiations of the text for the OST.

Following the formulation of the five UN treaties on outer space, the UN General Assembly (GA) adopted a number of additional resolutions relating to outer space activities including the Principles Relevant to the Use Nuclear Power Sources in Space[63] and the Space Benefits Declaration.[64] However, the international community has been unable to finalize further binding international agreements since the five treaties were established.[65]

Manuals are another legal instrument used to interpret and elucidate international agreements.[66] Recently, two manuals have been launched to elucidate the applicable international law to military operations in space. The Woomera Manual on the International Law of Military Space Activities and Operations (Woomera Manual) aims to articulate and clarify "existing international law applicable to military space operations."[67] The McGill Manual on International Law Applicable to Military Uses of Outer Space (MILAMOS) seeks to clarify "the fundamental rules applicable to the military use of outer space in time of peace, including challenges to peace."[68] They aspire to follow in the footsteps of other successful manuals, such as the San Remo Manual on International Law Applicable to Armed Conflict at Sea[69] and the Tallin Manual on

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[62] G.A. Res. 1962 (XVII), at 4 (Dec. 13, 1963).

[63] G.A. Res. 47/68 (Feb. 23, 1993).

[64] G.A. Res. 51/122 (Feb. 4, 1997).

[65] Yun Zhao, *Space Commercialization and the Development of Space Law*, OXFORD RSCH. ENCYC. OF PLANETARY SCI. 1, 3 (2018).

[66] WILLIAM H. BOOTHBY, CONFLICT LAW 65, 66 (2014).

[67] *The Woomera Manual on the International Law of Military Space Activities and Operations*, THE UNIVERSITY OF ADELAIDE, § Mission, https://law.adelaide.edu.au/woomera/ (last visited March 2023).

[68] *Manual on International Law Applicable to Military Uses of Outer Space*, MCGILL UNIVERSITY, § What is the MILAMOS Project**?,** https://www.mcgill.ca/milamos/, (last visited March. 2023).

[69] SAN REMO MANUAL ON INTERNATIONAL LAW APPLICABLE TO ARMED CONFLICTS AT SEA (Louise Doswald-Becks, ed. 1995).

International Law Applicable to Cyber Warfare.[70] The adoption of this "soft law" approach to the regulation of outer space activities will be discussed in more detail later in this article.

IV. CONCEPTIONAL CHALLENGES UNDER EXISTING LAW

This article turns now to the consideration of some of the conceptual challenges for bridging the normative gaps in the international legal framework for the regulation of space weaponization. The interception of politics, commercialization, military power and technological development has led to a discourse on many of these existing and emerging issues.

A. What Is Outer Space?

In analyzing the international law that applies to the weaponization of outer space, one must first consider the definitional terms of what legally constitutes "outer space." In particular, whether there is a legal (if not physical) boundary between where the air space of Earth ends and outer space begins.[71] The importance of this "boundary" is relevant in the context of conflicting provisions between the two legal frameworks governing air space and outer space activities. Article 1 of the Chicago Convention recognizes that each State has "complete and exclusive sovereignty over the air space above its territory."[72] This contrasts with the OST, which affirms that space is "not subject to national appropriation by claim of sovereignty."[73] A further potential conflict between the two regimes relates to liability.[74] The Montreal Convention places liability on the air carrier,[75] whereas the Liability Convention attributes liability for space activities to the launching State.[76] Any debate over the need to address conflicts between the two regimes of air

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[70] TALLINN MANUAL 2.0 ON THE INTERNATIONAL LAW APPLICABLE TO CYBER OPERATIONS (Michael N. Schmitt & Liis Vihul, eds., 2017).

[71] Alexandra Harris & Ray Harris, *The Need for Air Space and Outer Space Demarcation*, 22 SPACE POL'Y 3, 4 (2006).

[72] Convention on International Civil Aviation, Dec. 7, 1944, T.I.A.S. 13-613.1, 15 U.N.T.S. 295, art. 1.

[73] Outer Space Treaty, *supra* note 27, art II.

[74] Dempsey & Manoli, *supra,* note 16, at 217.

[75] Convention for the Unification of Certain Rules for International Carriage by Air, art. 17, 51 Stat. 233, 2242 U.N.T.S. 309.

[76] Liability Convention, *supra* note 29, art. 2.

law and space law is somewhat moot in the absence of a consensus for delimitating a boundary between air space and outer space.[77] Defining "outer space" is crucial to the issue of space weaponization—the demarcation line affects which legal regime applies (air law or space law) and has huge ramifications for national sovereignty claims and the legitimacy of military activities.[78] Harris and Harris suggest that the lack of a space boundary is rooted in political objectives, with a blurry definition of a boundary being advantageous to States with interests in space exploration and mining.[79] However, there have been numerous proposed boundary demarcation methods, which will now be discussed.

1. The Kárman Line

The Kárman line is 100 km above mean sea level, based on Theodore von Kárman's discovery of the certain altitude where the atmosphere becomes thin and requires the object traveling through it to be at a certain speed (faster or close to the orbital speed) in order to move forward, or in other words to be able to commence aeronautical flight.[80] Although the change in atmosphere was found to be at 83.8 km, von Kárman and the World Sport Federation adapted this to 100 km for ease of use and remembrance.[81] However, this method has been criticized for neglecting scientific evidence that demonstrates this altitude is much lower.[82] As McDowell points out, lower values around 30 to 35km have been proposed as space, or near space, such as by Alan Stern, a prominent astrophysicist currently involved in a near-space tourism venture.[83]

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[77] Dempsey & Manoli, *supra* note 16, at 218.

[78] *Id.* at 98.

[79] Harris & Harris, *supra* note 71, at 5.

[80] Alex S. Li, *Ruling Outer Space: Defining the Boundary and Determining Jurisdictional Authority*, 73 OKLA. L. REV. 711, 725 (2021); O. DE OLIVEIRA BITTENCOURT NETO, DEFINING THE LIMITS OF OUTER SPACE FOR REGULATORY PURPOSES 46 (2015).

[81] Li, *supra* note 80, at 725.

[82] *Id.* at 725-726.

[83] Jonathan C. McDowell, *The Edge of Space: Revisiting the Karman Line*, 151 ACTA ASTRONAUTICA 668, 669 (2018).

2. The Astronaut Badge Line

The Astronaut Badge line advocates for an 80 km altitude boundary (which would equate to 50km above mean sea level).[84] It comes from the award given to US military personnel to those flying at least 80 km above the Earth.[85] Although this method has not been officially endorsed by the US, their criteria for the award suggests an indirect acceptance, as the US has made it clear that they do not support the demarcation of space.[86] It is interesting that this criteria for an accolade has gained traction as a potential method for demarcation, rather than being based on scientific evidence. This award, referred to as the Wing program, ended in 2021 with the impending commencement of space tourism. However, the US Federal Aviation Industry continues to recognize those who have flown this distance on their website.[87]

3. The Mission Intent Line

The Mission Intent Line aligns with the functionalist group of thought, proposing that the destination of an airborne object should determine whether it is classified as a spacecraft or aircraft.[88] From this perspective, objects and activities are based on intention rather than geographical boundaries.[89] Critics see this approach as too subjective, warning that people will abuse the system by choosing a legal system that would be more favorable.[90] For example, stating the intent of the object was to reach space even though it was never planned to, in order to have the less restrictive law applied.[91] This would become even more complicated when considering dual-use technologies.[92]

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[84] Li, *supra* note 80, at 726.

[85] *Id.*; Chelsea Gohd, *New FAA Rules Change Who Qualifies for Commercial Astronaut Wings*, SPACE.COM, ¶ 1, (Jul. 27, 2021), https://www.space.com/faa-commercial-astronaut-wings-rule-change.

[86] Li, *supra* note 80, at 726-727.

[87] FEDERAL AVIATION ADMINISTRATION, *FAA Ends Commercial Space Astronaut Wings Program, Will Recognize Individuals Reaching Space on Website*, (Dec. 10, 2021), https://www.faa.gov/newsroom/faa-ends-commercial-space-astronaut-wings-program-will-recognize-individuals-reaching.

[88] Li, *supra* note 80, at 728.

[89] *Id.*

[90] *Id.*

[91] *Id.*

[92] *Id.*

4. Near-Space or Transitionary Outer Space Zone

A more recent demarcation approach is the creation of a transitionary zone, most popularly called the Near Space Zone. Dempsey and Manoli posit that the emergence of New Space activities occurring at altitudes between 20 km to 160 km has given rise to the need for the establishment of a Near Space Zone.[93] This zone sits above the flightpaths of most commercial and military jets but falls below the orbit for satellites—making it a unique space for low-cost spaceflight and also weaponization.[94] As previously mentioned in this article, both the US and China have focused on developing military space capabilities in the Near Space Zone. Li advocates that the zone between 80 and 100 km should become a Transitionary Outer Space Zone (TOS Zone).[95] The TOS Zone would be modeled on the Exclusive Economic Zone stipulated in the Law of Sea Convention,[96] where all States can operate in the area provided that their activities do not impede on national security.[97] Li reasons this as an amalgamation of the three predominant approaches to boundary demarcation; the Kárman line, the Astronaut Badge Line, and the Mission Intent Line. Creating a "transitionary" Near Space Zone would permit the regulation of activities that occur within the zone limits, without States sacrificing the freedoms resulting from a strict boundary delimitation between national air space and outer space.[98]

5. Functionalist versus Spatialist

There are currently two broad schools of thought regarding how space should be demarcated.[99] The spatialist approach advocates for a fixed demarcation line to be based on scientific or technological criteria, which include some of the aforementioned methods. In contrast, the functional approach considers the 'function'—being the objective and purpose—of the space activities as the

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[93] Dempsey & Manoli, *supra* note 16, at 248.
[94] McCarthy, Gan & Chang, *supra* note 18.
[95] Li, *supra* note 80, at 728.
[96] U.N. Convention on the Law of the Sea, arts. 55-56, Dec. 10 1982, 1833 U.N.T.S. 397.
[97] Li, *supra* note 80, at 728.
[98] *Id.* at 730.
[99] BITTENCOURT NETO, *supra* note 80, at 3.

trigger for regulation under international space law.[100] In the context of space weaponization, a functionalist approach would turn on whether the "activity" (weapons) in question is designed and intended (their *function*) to operate in outer space. While superficially straightforward, we are left with the task of considering the definitional parameters of the "functional" criteria that would trigger the normative provisions.[101] This turns on the subjective assessment of the "objective" and "purpose" of the space activity. As will be discussed below, the distinction between a weapon that is intended to be a "space" weapon and a "conventional" weapon is blurry. It is also unclear whether the triggering space "activity" is the launching of the space weapons, the weapons themselves, or both?

It could be said that the existing legal regime for outer space already takes a somewhat functionalist approach, as it focuses primarily (in terms of liability, responsibility, and access) on the objects (and act of) entering space rather than the activities conducted once in outer space.[102] The latter activities are referred to in broad brush terms with objectives of "peace," "cooperation," and "sharing." Although Harris and Harris advise that a border needs to be decided on before it becomes a "major source of friction on the international stage;" this has arguably already occurred through practice.[103] Notwithstanding such practice, formality and certainty on the definition of "outer space" is desirable—specifically, the inclusion of a definition of "outer space" vis-à-vis "air space" in an international agreement. Alternatively, the creation of a Near-Space Zone that permits regulation of space activities in that zone. However, in the absence of such agreement (and given the obstacles in realistically achieving a consensus amongst States), it is the authors' opinion that the functional approach, however flawed, is currently the best suited approach for the definition and demarcation of outer space from national air space law. With world powers maintaining their opposition to boundary delimitation and the international legal community emphasizing its necessity to minimize the risk of space weaponization, we are faced with the challenge of

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[100] *Id.*
[101] *Id.* at 40.
[102] *See* Harris & Harris, *supra* note 71.
[103] *Id.* at 6.

paving a way forward. This is particularly the case given the potential for weapons-building capabilities in the Near Space Zone.

B. Defining "Weaponization"

The definition of what constitutes a space "weapon" is a significant challenge for achieving any sort of international consensus for the development of normative provisions on this issue. This article will consider— (1) the distinction between weaponization and militarization and (2) the definitional distinction of a space weapon compared to conventional weapons and the challenges posed by dual-use space technology on definitional parameters of the term.

1. "Weaponization" as distinct from "Militarization"

It is important to note the difference between weaponization and militarization. Vlasic defines militarization as the "use of outer space by a significant number of military spacecraft."[104] Whereas weaponization refers to "placing in outer space for any length of time any device designed to attack [hu]man-made targets in outer space and/or in the terrestrial environment."[105] Mosteshar further clarifies, "space weaponization is always a form of militarization, but space militarization . . . does not necessarily involve space weaponization."[106] Weaponization is a significant issue for space law, and increasingly so, with the use and value of space growing rapidly.[107] Weaponization also entails extensive risk. It risks further global insecurity as it has the potential to destabilize current international and State relations.[108] This would jeopardize not only national security but also human security.[109] This article is limiting its consideration to the "weaponization" and not the broader concept of militarization of space.

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[104] Vlasic, *supra* note 23, at 386.

[105] *Id.*

[106] Sa'id Mosteshar, *Space Law and Weapons in Space*, OXFORD RSCH. ENCYC. OF PLANETARY SCI. 1, 10 (2019).

[107] *Id.* at 16.

[108] Blair Stephenson Kuplic, *The Weaponization of Outer Space: Preventing an Extraterrestrial Arms Race* 39 N.C. J. INT'L L. & COM. REG. 1123, 1142 (2014).

[109] *Id.* at 1142.

2. Space "Weapons"–Categorization of "Lawful"

In the context of the somewhat terrifying possibility of warfare in outer space, it is necessary to consider whether international law provides adequate guidance on the parameters of the definition between "lawful" or "unlawful" space weapons.

The only specific reference in the OST relating to the "unlawful" use of weapons in outer space is found in the prohibition in Article IV of the OST on space objects that carry "nuclear weapons or any other weapons of mass destruction."[110] Alongside treaties between States, customary international law is also a recognized source of international law.[111] Further, Article III of the OST provides that States shall carry on activities in the exploration and use of outer space "in accordance with international law, including the Charter of the United Nations."[112] Accordingly, the customary law principles relating to "lawful" conventional weapons (now also reflected in the UN Convention on Certain Conventional Weapons[113]) may also apply to outer space weapons. These principles provide that for a weapon to be considered "lawful" it must not cause superfluous injury/unnecessary suffering and must not be indiscriminate in nature.[114] This provides a starting point for developing normative provisions.

We then turn to what types, or categories of "lawful" space weapons should be regulated at the international level? There are three types of space weapons, according to Lyall and Larson:

> (1) weapons in orbit which may be used to strike the surface of the Earth or targets in air-space,

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[110] Outer Space Treaty, *supra* note 27, art. IV.

[111] Statute of the International Court of Justice, Art. 38, June 26 1945, 6 L.N.T.S. 391-413.

[112] Outer Space Treaty, *supra* note 27, art. III.

[113] Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons which may be Deemed to be Excessively Injurious or to have Indiscriminate Effects, Oct. 10, 1980, U.N.T.S. 137 (registered ex officio Dec. 2, 1983;
Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects, as amended on 21 December 2001, https://geneva-s3.unoda.org/static-unoda-site/pages/templates/the-convention-on-certain-conventional-weapons/CCW%2Btext.pdf [hereinafter Convention on Conventional Weapons].

[114] Bill Boothby, *Space Weapons and the Law*, 93 INT'L L. STUD. 180, 185 (2017).

> (2) weapons in orbit that may be used to strike other space objects and,
>
> (3) weapons located in outer space used to target ballistic missiles being boosted from the surface of the Earth (ASATs).[115]

These weapons may have the capability to paralyze radio frequencies and energy sources, or they may be in the form of kinetic energy used to strike targets.[116] Anti-satellite technology (ASAT) is a technological weapon used in space that has been tested successfully to destroy satellites.[117]

Kuplic breaks up space "weapons" further into the following five different categories based on the weapon type and functionality:[118] (1) kinetic energy weapons which are designed to destroy hostile satellites by utilizing high speed and kinetic energy on impact, and are the most common type of weapon in space;[119] (2) co-orbital ASAT's which utilize a missile armed with explosives to detonate when the target is in close proximity;[120] (3) directed energy technologies which destroy targets by "shooting" energy at, or almost at, the speed of light, such as a laser or high-powered radio frequency;[121] (4) soft kill weapons that aim to disable rather than destroy their target, such as disrupting power supply or nudging a satellite out of orbit (these are considered a covert method of attack because they can easily be perceived as a routine failure);[122] and (5) electromagnetic and radiation weapons which create an electromagnetic pulse that can disable electronics within a 700 mile radius and have the potential to cause blackouts on Earth.[123]

Also impeding the consensus on a neat definition of a space weapon is the reality that space technology is often dual-use in nature.[124] An example of this technology is lasers, which can be used

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[115] FRANCIS LYALL & PAUL B. LARSEN, SPACE LAW: A TREATISE 448 (2nd ed. 2018).
[116] *Id.*
[117] Kuplic, *supra* note 108, at 1138.
[118] *Id.*
[119] *Id.*
[120] *Id.*
[121] *Id.* at 1139.
[122] *Id.*
[123] Kuplic, *supra* note 108, at 1140.
[124] Joan Johnson-Freese & David Burbach, *The Outer Space Treaty and the Weaponization of Space*, 74(4) BULL. ATOMIC SCIENTISTS 137, 137 (2019).

to track satellites and temporarily or permanently blind them.[125] The use of technology for both civil and military purposes renders it potentially difficult to identify the true purpose of the use of technology and thereby poses a challenge for regulation.[126] Mosteshar stresses that this paradigm is complicated even further when the technology is used by multiple States.[127] What happens when a technology is used as a weapon by one State? Should this lead to the entire technology or system being classified as a weapon (despite also having non-military uses)?[128]

The dual-use nature of space technology presents issues not only for identifying space weapons but also for the enforcement of international laws. It is difficult to hypothesize how soft-kill weapons can be regulated from a practical perspective. For example, what happens when a State destroys its own satellite in order to generate space debris to damage or destroy another State's space object indirectly? How will it be determined whether such damage was an unintentional consequence of an innocent (legitimate) space activity or a military attack? How will the humanitarian laws of "aggression" apply to international space activities? Clearly, this is a conceptual challenge for international law that is crucial to maintaining peace and security.

It is evident that there are varying interpretations of what constitutes a space weapon and how they are categorized. Further clarification and consensus about space weapons could enable us to ascertain and monitor the number of weapons in space.[129] This, in turn, could facilitate the development of legal regimes in addressing space weaponization as there would be a better understanding of what the space weapon landscape looks like, and the risks and threats that need to be addressed. In the absence of a clear definition, there is scope for debate and ambiguity over which (if any) law applies to the situation. For example, the Convention on Certain Conventional Weapons may apply depending on the specific location of the weapon and one's application of the demarcation between air space and outer spaces.[130] Further, will space "weapons"

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[125] *Id.* at 138.
[126] *Id.* at 137.
[127] Mosteshar, *supra* note 106, at 11.
[128] *Id.*
[129] LYALL & LARSEN, *supra* note 115, at 467.
[130] Convention on Conventional Weapons, *supra* note 113.

be regulated on the potential use or "actual" use, and what level of destruction (or protentional destruction) will act as a trigger to invoke the normative laws? In this regard, Boothby raises the pertinent question of whether the amount of *damage* the space weapon technology inflicts upon another mechanism or system in space will distinguish the action as a "weapon" or a "method of warfare"—the latter being defined as when the action does not damage or injure but merely "adversely affects enemy military operations or capacity."[131] If the "use" of a space weapon is deemed a "method of warfare," then International Humanitarian Law may be applied.[132] As the questions surrounding the definitional parameters of the phrase "space weapon" pile up, it is clear that there is a pressing need for clarity going forward.

C. "Peaceful Use" of Outer Space

A contributing factor impacting the effectiveness of the regulation of space weaponization is the growing concern over the absence of a clear definition of "peaceful purpose" in Article IV of the OST. Article IV relevantly provides:

> …. The moon and other celestial bodies shall be used by all States Parties to the Treaty exclusively for peaceful purposes. The establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military maneuvers on celestial bodies shall be forbidden. ….[133]

In fact, the "peaceful" use of outer space is a cornerstone element of the OST—appearing eight times throughout the preamble and the Articles of the agreement. Post World War II, the phrase "peaceful use" in the context of outer space activities was generally agreed (if only tacitly) to mean "non-military" activities.[134] The launch of Sputnik in 1957 was a catalyst for debate over the

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[131] Boothby, *supra* note 114, at 183.

[132] Roxanne Pope, *Space Weapons and the Increasing Militarisation of Outer Space: Whether the Legal Framework Is Fit-for-Purpose*, 27 AUCKLAND U. L. REV. 263, 267-278 (2021).

[133] Outer Space Treaty, *supra* note 27, art. IV.

[134] KIRAN KRISHNAN Nair, SMALL SATELLITES AND SUSTAINABLE DEVELOPMENT - SOLUTIONS IN INTERNATIONAL SPACE LAW 11 (2019).

interpretation of the term "peaceful use," sparking concern over the demonstration of Soviet military space technology and capabilities. In the same year, the four western powers of the US, France, the United Kingdom, and Canada requested an inspection system to ensure that space objects were used only for peaceful and scientific purposes from the UN Disarmament Commission.[135] As famously retorted by John F. Kennedy in 1960, "if the Soviets control space they can control the earth, as in past centuries the nation that controlled the seas dominated the continents."[136] The launch of Sputnik was followed by an escalation of military activity in space, with the launching of numerous military satellites and nuclear tests conducted by both the US and the Soviet Union.[137]

Given the ambiguity of the scope of the phrase "exclusively for peaceful purposes" in the OST, assistance may be garnered from looking at the broader context and any subsequent relevant normative principles.[138] In 1959, the UN established COPUOS as a permanent body in recognition of "the common interest of [hu]mankind as a whole in furthering the peaceful use of outer space."[139] Relevantly, it was recognized by the General Assembly at the time that there was a desire "to avoid the extension of present national rivalries into this new field [of space]" and "the great importance of international co-operation in the exploration of and exploitation of outer space for peaceful purposes."[140] It is noted, with some irony, that COPUOS was not specifically tasked with defining the meaning of "peaceful use" of outer space, but rather was mandated to (a) "review, as appropriate, the area of international co-operation and to study practical and feasible means for giving effect to programmes in the peaceful uses of outer space, and (b) to study the nature of legal problems which may arise from the exploration of outer space."[141] Perhaps, in the context of the Cold War tensions of

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[135] U.N. DCOR, 153rd mtg., at 18, U.N. Doc. DC/SC.1/PV.153 (Aug. 29, 1957).

[136] Edward Clinton Ezell & Linda Neuman Ezell, *Competition Versus Cooperation: 1959-1962*, NASA HISTORY, https://history.nasa.gov/SP-4225/documentation/competition/competition.htm, (Last Visited Aug. 27, 2022).

[137] NAIR, *supra* note 134, at 12-15.

[138] Vienna Convention on the Law of Treaties, art. 31, May 23, 1969, 1155 U.N.T.S. 331.

[139] G.A. Res. 1472 (XIV) (Dec. 12, 1959).

[140] *Id.*

[141] *Id.* at ¶ A1.

the time, the meaning of "peaceful use" activities was less contentious?

Guidance might also be taken from Article 2 of the UN Charter, which provides that "all Members shall settle their international disputes by *peaceful means* in such a manner that international peace and security, and justice, are not endangered."[142] The UN Security Council also has the power to determine "any threat to the peace, breach of the peace, or act of aggression."[143] This provides the Security Council with the power to determine and potentially define, what is peace, or at least what is not peaceful. Consequently, in the context of contemplations of the Security Council, the determination of what is, or what is not, "peaceful" activity is not clarified until the situation has already eventuated and is on a case-by-case basis. This provides little assistance in determining categories of peaceful (or specifically *non-peaceful*) space activities before the fact.

More recently, a dichotomy of thinking has materialized on the interpretation of space activities for "peaceful purposes" in the context of Article IV of the OST. Kuplic suggests a narrower view that the phrase in Article IV only prohibits "aggressive" actions.[144] The definition of "aggression" according to the UN is "the use of armed force by a State against the sovereignty, territorial integrity or political independence of another State."[145] In this sense, if space law only prohibited *aggressiv*e acts, then non-aggressive military activities would be permitted within the scope of Article IV.[146] However, this appears to be in direct contrast to the expressed terms in Article IV that prohibits the establishment of military bases, weapons testing, and military maneuvers on celestial bodies.

Nevertheless, the absence of a precise definition of "peaceful" has left Article IV open to subjective interpretation permitting States and international organizations to pursue their own interests whilst maintaining that such activities are aligned with "peaceful" purposes. The US Department of Defense, along with leading US military strategists, now consider space to be a

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[142] U.N. Charter art. 2 (emphasis added).
[143] *Id.* at art. 39.
[144] Kuplic, *supra* note 108, at 1146.
[145] G.A. Res. 3314 (XXIX), art. 1 (Dec. 14, 1974).
[146] Kuplic, *supra* note 108, at 1146.

warfighting domain.[147] In its 2021 *US Space Priorities Framework*, the US states that it "will defend its national security interests from the growing scope and scale of space and counterspace threats."[148] Further, "the United States also will take steps to protect its military forces from space-enabled threats."[149] In 2019, NATO declared space as an operational domain, integrating space into their defense and deterrence approach.[150] They are also establishing dedicated divisions, including a Space Centre in Germany and a Space Centre of Excellence in France. [151] In NATO's overarching space policy, they declare that they have a reliance on space for their activities and specify that they utilize their space capabilities in order to meet their political and military objectives.[152] NATO has also affirmed their position on space exploration, stating "the free access, exploration, and use of outer space for peaceful purposes is in the common interest of all nations."[153] Although NATO does not clarify what they mean when they refer to "peaceful purposes", by their reference to military objectives/activities, it would be inferred that they view it from the same lens as the US, as perhaps meaning "non-aggressive." Thus, we have started to see a potential carve out of Article IV for military activities where the objective may be considered passive (or defensive) versus aggressive.

As Nair notes, there are instances where military activities could be considered "peaceful" (e.g., UN military peacekeeping and humanitarian efforts).[154] Conversely, some non-military activities may be considered non-peaceful.[155] Would military payloads on commercial space flights be considered a peaceful use of outer

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[147] Stephen M. Mccall, CONG. RSCH. SERV., *Space As A Warfighting Domain: Issues For Congress* (2021). https://crsreports.congress.gov/product/pdf/IF/IF11895

[148] *United States Space Priorities Framework*, December 2021. https://www.whitehouse.gov/wp-content/uploads/2021/12/united-states-space-priorities-framework-_-december-1-2021.pdf

[149] *Id.*

[150] *NATO's overarching Space Policy*, NORTH ATLANTIC TREATY ORGANISATION, §9 (Jan. 17, 2017), https://www.nato.int/cps/en/natohq/official_texts_190862.htm?utm_source=linkedin&utm_medium=nato&utm_campaign=20220117_space#:~:text=In%20November%202019%2C%20NATO%20declared,Air%20Command%20in%20Ramstein%2C%20Germany.

[151] *Id.*

[152] *Id.* § 10 & 16.

[153] *Id.* § 5.

[154] *See* NAIR, *supra* note 134, at 20.

[155] *Id.*

space? Commercial agreements with military forces involving space are already a reality—for example, on September 21, 2011, the launch by Science Applications International Corporation included a US Air Force Commercially Hosted Infrared Payload (CHIRP)—the CHIRP had been integrated onto a commercial telecommunications satellite.[156] With the increase in commercial activities in space, and the potential for growth in military-commercial partnerships, these joint space missions challenge the black-and-white interpretation of "non-peaceful" activities. This leads us to the question of the true purpose behind the phrase "peaceful purposes" in Article IV of the OST. Specifically, whether the narrow characterization of it being analogous with military activities still holds accurate? Which leads to the following question—how do we re-draft (or at least clarify) Article IV in order to give meaningful effect to the phrase "peaceful" so as to maintain global security and avoid space warfare?

D. Space in the 2020s and Beyond—Is it a Global Commons?

An issue currently being raised in the international legal (and diplomatic) community is whether outer space, like the high seas, is truly a shared global resource.[157] Article I of the OST provides that space exploration shall be carried out for the "benefit and in the interests of all countries" and shall be the "province of all [hu]mankind."[158] To further support this overarching principle of "sharing," Article II of the OST provides that space, including the Moon and other celestial bodies are "not subject to national appropriation by claim of sovereignty."[159] Interestingly, according to Cheng, in 1958 the US National Aeronautics and Space Act included a declaration by Congress affirming that the US's policy and

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[156] Major Peter A. Cunningham, *Military Payloads Hosted on Commercial Satellites: How Can the Space and Missile Systems Center Increase the Number of Commercially Hosted Military Payload Contract Awards*?, 53 WRIGHT FLYER PAPER 1 (2015). *See also*, *SAIC Helps Launch Commercially-Hosted Infrared Payload Sensor for U.S. Air Force Space and Missile Systems Center*, LEIDOS (Sep. 23, 2011), https://investors.leidos.com/news-and-events/news-releases/press-release-details/2011/SAIC-Helps-Launch-Commercially-Hosted-Infrared-Payload-Sensor-for-US-Air-Force-Space-and-Missile-Systems-Center/default.aspx.

[157] U.N. Convention on the Law of the Sea, *supra* note 96, art. 136. (The high seas "and its resources are the common heritage of [hu]mankind.")

[158] Outer Space Treaty, *supra* note 27, art. 1.

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

"activities in space should be devoted to peaceful purposes for the benefit of [hu]mankind."[160] Cheng notes that the Soviet Union made similar assertions.[161]

While there may be general agreement between States that celestial bodies should not be subject to claims of territorial "sovereignty," other proprietary claims and rights over space minerals and resources remain more contentious.[162] As is well known, the inclusion of limitations on the exploitation of space resources and references to space as a "common heritage of [hu]mankind" (a phrase that has particular connotations from the international Law of Sea legal regime) was a contributing reason for the lack of support afforded to the Moon Agreement.[163] From this starting point in the 1950s, we have seen a policy shift by some States toward the rejection of space as a shared global resource.

In 2015, President Obama signed the Commercial Space Launch Competitiveness Act affording US citizens engaged in the commercial recovery of an asteroid resource or a space resource the right to possess, own, transport, use, and sell that same asteroid or space resource.[164] Then, in 2020, President Trump issued an Executive Order declaring that the US did not view space as a global common.[165] It is noted that this is a movement away from the position taken by the US in its 2010 National Security Strategy in which "safeguarding the global commons. . . to optimize the use of shared sea, air and space domains" was a key policy strategy.[166] The Biden Administration is yet to confirm their position but did affirm their commitment to a "rules-based international order for space" in their recent statement about DA-ASAT testing.[167]

Commercial interests and the promise of an abundance of resources in space is a likely driving factor in the policy shift away from recognizing outer space as a "common heritage." It is predicted

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[160] BIN CHENG, STUDIES IN INTERNATIONAL SPACE LAW 514 (1997).

[161] *Id.*

[162] *See* Zhao, *supra* note 65.

[163] *Id.*

[164] U.S. Commercial Space Launch Competitiveness Act, Pub L No 114–190, 129 Stat 704 § 51303.

[165] Exec. Order No. 13914, 85 Fed. Reg. 70, § 1 (Apr. 6, 2020). This Executive Order reiterated the Congressional act in 2018; H.R. 2809 115th Cong. § 80308 (2018).

[166] National Security Strategy, 47, (2010), https://obamawhitehouse.archives.gov/sites/default/files/rss_viewer/national_security_strategy.pdf.

[167] White House Fact Sheet, *supra* note 11, ¶ 6.

that there will be a new phase of globalization, which Fox calls "asterization," where globalization expands beyond Earth's orbit, such that the "sky is no longer the limit" for commercialization and profit.[168] The resources in space can be used to manufacture everyday products such as televisions and cars but can also be used for weapons, making them "faster, stronger, lighter and more efficient."[169] The potential for rapid growth in research, development and manufacture of space weapons, suggests we could see the creation of a new "industry" which would be intrinsically linked to commercialization, profit, and power. The movement away from recognizing space as a global commons may make it just that little bit harder to regulate space weapons.

V. A SOFT LAW APPROACH—A WAY FORWARD?

The effectiveness of international law is contingent upon State support, ratification, and compliance.[170] This is a key challenge to the efficacy and development of space law. In recent years, both Russia and China have pushed for new regulations for space activities. In 2008, these two States jointly proposed two treaties relating to space weapons, the Prevention of an Arms Race in Space (PAROS) and the Prevention of the Placement of Weapons in Outer Space Treaty (PPWT).[171] The central obligation of the PPWT is set out in Article II of the draft treaty as follows:

> The States Parties undertake not to place in orbit around the Earth any objects carrying any kinds of weapons, not to install

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[168] Sarah Jane Fox, *Space: The Race for Mineral Rights 'The Sky is No Longer the Limit' Lessons from Earth*!, 49 RESOURCES POL'Y 165, 166-175 (2016).

[169] Julie Butters, *Elements of Conflict*, THE BRINK - BOSTON UNIVERSITY ¶ 1 (2016) https://www.bu.edu/articles/2016/rare-earths/.

[170] Anthea Roberts & Sandesh Sivakumarani, *The Theory and Reality of the Sources of International Law, in* INTERNATIONAL LAW 89, 107-108. (Malcom D. Evans ed., 5th ed. 2018).

[171] PAROS Treaty, *supra* note 9; Draft Treaty on Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force against Outer Space Objects, *in* letter dated Feb. 12, 2008 from the Permanent Representative of the Russian Federation and the Permanent Representative of China to the Conference on Disarmament addressed to the Secretary-General of the Conference transmitting the Russian and Chinese texts of the draft 'Treaty on Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force against Outer Space Objects (PPWT)" introduced by the Russian Federation and China, U.N. Doc. CD/1839 (Feb. 29, 2008) [hereinafter Prevention of the Placement of Weapons].

> such weapons on celestial bodies and not to place such weapons in outer space in any other manner; not to resort to the threat or use of force against outer space objects; and not to assist or induce other States, groups of States or international organizations to participate in activities prohibited by this Treaty.[172]

Not surprisingly, these two draft treaties of China and Russia were met with suspicion from the US, with the latter suggesting it was "a diplomatic ploy by the two nations to gain a military advantage."[173] In considering the draft treaty provisions proposed by the PPWT, the US took particular issue with the inclusion of the phrase "threat of force."[174] Highlighting that the text of the draft treaty leaves the definition only loosely defined within the context of "use of force" being "any hostile actions against outer space objects . . . ."[175] The US then raised the question of whether activities—such as developing an ASAT capability, destroying one's own satellite, or a close fly-by of either one's own, or another State's, satellite—would be considered a "threat" of force within the meaning of the PPWT.[176] In addition, the US raised concerns over the ambiguities on how a new self-defense exception (contained in Article V of the PPWT) would operate in relation to the obligations in Article II.[177]

The US reaffirmed its policy position (which it declared it had held for three decades) that it would:

> oppose arms control concepts, proposals, and legal regimes that (i) seek prohibitions on military or intelligence uses of space; or (ii) fail to preserve the rights of the United States to conduct

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[172] Prevention of the Placement of Weapons, *supra* note 171, at art II.

[173] PAROS Treaty, *supra* note 9, at § 2008-2007.

[174] Analysis of a Draft "Treaty on Prevention of the Placement of Weapons in Outer Space, or the Treaty or Use of Force against Outer Space Objects", Letter dated 19 August 2008 from the Permanent Representative of the United States of America addressed to the Secretary-General of the Conference Transmitting Comments on the Draft "Treaty on Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force Against Outer Space Objects (PPWT)" as Contained in Document CD/1839 of 29 February 2008, U.N. Doc. CD/1847, (Aug. 26, 2008).

[175] *Id.* ¶ 6.

[176] *Id.*

[177] *Id.*

> research, development, testing, and operations in space for military, intelligence, civil, or commercial purposes.[178]

Potentially even more concerning was the declaration by the US that it had "consistently posited that it is not possible to develop an effectively verifiable agreement for the banning of either space-based weapons or terrestrial-based anti-satellite systems."[179]

Given the difficulties in negotiating a formal international agreement for space weaponization, a "soft law" approach may be the way forward to address immediate concerns. "Soft law" agreements are non-binding instruments that have been particularly important in the space law area, considering the international community has failed to adopt any binding documents following the Moon Agreement.[180] Initially, UN General Assembly Resolutions were adopted to cover gaps in the space agreements—such as the 1963 Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space.[181] More recently, the international community has developed guidelines through COPUOS to address emerging issues—such as the Space Debris Mitigation Guidelines[182] and the Guidelines for the Long-term Sustainability of Outer Space Activities.[183]

As noted by Freeman and Zhao, some scholars take issue with the term "soft law," given these non-binding instruments do not enjoy the status of being "law" at all.[184] While accepting that this point may warrant deeper consideration, it is outside the scope of this article to delve down this philosophical tunnel. It is sufficient to say that the non-binding nature of soft law agreements is often the sole reason *why* States "agree" to abide by the legal instrument. Further, it is noted that some States perceive a status difference

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[178] *Id.* ¶ 21.

[179] *Id.* ¶ 24.

[180] *See* Zhao, *supra* note 65.

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

[182] U.N. Office for Outer Space Affairs, Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space, U.N. Sales No. E.99.I.17 (2010), *available at* http://www.unoosa.org/pdf/publications/st_space_49E.pdf.

[183] 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].

[184] Steven Freeland & Yun Zhao, *Rules of the "Space Road:" How Soft Law Principles Interact with Customary International Law for the Regulation of Space Activities*, 44 J. SPACE L. 405, 414 (2020).

between soft law resolutions adopted by a unanimous vote and those simply adopted by a majority.[185] For instance, the United Kingdom indicated that they view unanimous resolutions as more authoritative.[186] However, the eminent late Professor Cheng points out that "legally and constitutionally, no special virtue attaches to a unanimous vote, even though it may be of political significance."[187] Irrespective of the legal status as "formal" law, such soft law instruments provide an avenue to achieve some consensus and consistency on principles, actions, and responsibilities. Further, following Cheng's theory of the role of customary international law as an integral part of space law—these "soft law" instruments, over time, may become customary international law, if universally accepted and implemented.[188]

Turning specifically to soft law instruments and space weapons, in December 2020, the General Assembly adopted the resolution on Reducing Space Threats through Norms, Rules and Principles of Responsible Behaviours.[189] Specifically, the Resolution calls upon Member States to:

> . . . reach a common understanding of how best to act to *reduce threats* to space systems in order to maintain outer space as a peaceful, safe, stable and sustainable environment, *free from an arms race and conflict*, for the benefit of all, and consider establishing channels of direct communication for the management of perceptions of threat.[190]

In their response to the Resolution, the US declared that, in line with their National Space Policy, they would:

> lead the enhancement of safety, stability, security, and long-term sustainability in space by promoting a framework for responsible behavior in outer space, including the pursuit and

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[185] *Id*. at 133-134.

[186] *Id*.

[187] CHENG, *supra* note 160, at 135-136.

[188] See Bin Cheng, *United Nations Resolutions on Outer Space: 'Instant' International Customary Law?*, 5 INDIAN J. INT. L. 23 (1965), *reprinted in* BIN CHENG, STUDIES IN INTERNATIONAL SPACE LAW (1997). *See also* Freeland & Zhao, *supra* note 184.

[189] G.A. Res. 75/36, (Dec. 7, 2020).

[190] Id. § 3 (emphasis added).

> effective implementation of best practices, standards, and norms of behavior.[191]

It was determined, by the Resolution adopted by the UN General Assembly on December 24, 2021, to create an open-ended working group on Reducing Space Threats.[192] The Open-Ended Working Group is tasked with (a) taking stock of the existing international legal and other normative frameworks concerning space threats; (b) considering current and future threats by States to space systems, and actions, activities, and omissions that could be considered irresponsible; (c) making recommendations on possible norms, rules, and principles of responsible behaviors relating to threats by States to space systems, including, as appropriate, how they would contribute to the negotiation of legally binding instruments, including on the prevention of an arms race in outer space; and (d) the submission of a report to the General Assembly at its seventy-eighth session in September 2023.[193] The Working Group on Space Threats, which met twice in 2022 and twice 2023, has opened a new pathway for the creation of space law principles to address space threats. However, it is noted that due to a lack of consensus (notably the objection by Russia), no formal report could be submitted to the UN General Assembly following the latest meeting of the working group in August 2023.

In March 2021, President Biden released the Interim National Security Strategic Guidance, which affirmed the US will take a leading role in "promoting shared norms and forging new agreements on outer space."[194] Most recently, the US has spearheaded a new direction in space law through the creation of the Artemis Accords (as part of its NASA Artemis Program). The Artemis Accords is an agreement to "establish a common vision via a practical set of principles, guidelines, and best practices to enhance the governance of the civil exploration and use of outer space."[195] The Accords

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[191] U.N. Secretary-General, Reducing Space Threats Through Norms, Rules and Principles of Responsible Behaviours, at 95, U.N. Doc. A/76/77 (Jul. 13, 2021).

[192] G.A. Res. 76/231 (Dec. 24, 2021).

[193] *Id.* ¶ 5.

[194] Interim National Security Strategic Guidance (Mar. 2021), https://www.whitehouse.gov/wp-content/uploads/2021/03/NSC-1v2..pdf

[195] The Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids, NASA, https://www.nasa.gov/specials/artemis-accords/img/Artemis-Accords-signed-13Oct2020.pdf [hereinafter Artemis Accords].

contain 13 principles governing the human exploration of the Moon and the other celestial bodies and the exploitation of their natural resources. As of this writing, the Artemis Accords have 21 signatories, including Australia, Canada, Italy, Japan, Luxembourg, United Arab Emirates, United Kingdom, and the United States of America.[196] From a legal standpoint, the Artemis Accords are non-binding and sit more in the category of "guidelines." However, the reality is that in order to engage in partnerships with the US, accession to the Artemis Accords is being proffered as a pre-requisite.[197] While the Accords do not deal directly with space weapons, it is important to highlight the concern over the direction taken by the US to create a framework for regulating space activities that have been negotiated outside of the UN and operate outside of the formal international space agreements. While the Artemis Accords shows a willingness of States to address emerging issues in space law, there is concern that this might signal an end to the negotiations of multilateral law (or even soft law) within the framework of the UN for outer space.[198]

VI. CONCLUSION

Unilateral acts of aggression, competing interests over resources and territory, and militarization are well-known risks that have the potential to disrupt international stability. The unilateral use of military aggression in the Ukraine War and the downing of four flying objects have put a spotlight on the urgency to address the gaps in international law arising from the threat of the weaponization of space.

It is evident that the landscape of space activities and exploration has changed since the formation of the five original space treaties. Rapid technological development has been the catalyst for space weaponization becoming a reality in such a short amount of

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[196] NASA, *The Artemis Accords,* https://www.nasa.gov/specials/artemis-accords/index.html (Last Visited Aug. 15 2022); Press Release, NASA, International Partners Advance Cooperation with First Signings of Artemis Accords (Oct. 14, 2020), https://www.nasa.gov/press-release/nasa-international-partners-advance-cooperation-with-first-signings-of-artemis-accords.

[197] Rossana Deplano, *The Artemis Accords: Evolution or Revolution In International Space Law?*, 70(3) INT'L & COMP. L.Q. 799, 799 (2021).

[198] Jack Wright Nelson, *The Artemis Accords and the Future of International Space Law*, 24(31) AM. SOC'Y OF INT. L. 1, 4 (2020).

time. There are several components of space law that need to be clarified to regulate space weaponization effectively. This paper has sought to identify and discuss a number of these conceptual challenges. However, as alluded to, determining the 'gaps' in the law is one thing; achieving consensus for new international normative provisions is quite another. In the absence of any successful negotiations on formal space agreements since the Moon Agreement, it is suggested that a soft law approach might be the best and only way forward at this point in time. The recommendations by the UN *Working Group on Space Threats* in its upcoming report to the General Assembly (due at the end of 2023) will hopefully provide some guidance on the way forward to address the gaps in the international normative framework concerning threats from State behavior in outer space. With world military powers already present in space, and grave concerns about the global ramifications of space warfare, it is imperative that action is taken now to develop a framework for regulating space weaponization before it is too late.

SPACE ARBITRATION AND HARMFUL INTERFERENCE DISPUTES

*Laura Yvonne Zielinski**

ABSTRACT

The current and further predicted increase of objects launched into outer space brings with it endless opportunities but also growing risks. Among those risks is an increase in harmful interference with radio frequencies. Harmful interference can interrupt the functioning of satellite systems thereby causing significant financial losses to satellite operators and potentially causing more acute danger if the interrupted satellite transmissions have safety or security implications. International space law and especially the International Telecommunications Union provide substantive rules intended to prevent and resolve harmful interference. However, as with international space law in general, these rules, while substantive in nature, lack an efficient and binding dispute settlement mechanism available to private parties. To the extent that the prevention of harmful interference is often agreed in contractual instruments negotiated by different satellite operators, this article argues that the parties to these so-called coordination agreements should consider agreeing to refer any future disputes relating to their agreements to international arbitration thus ensuring the availability of an efficient dispute settlement mechanism for any harmful interference disputes they might face in relation to these agreements.

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I. DEFINING HARMFUL INTERFERENCE

The term "harmful interference" refers to interference with radio communication waves. The International Telecommunication Union (ITU) defines the term in Article 1(169) of its 2020 Radio Regulations and in the Annex to its Constitution as "interference which endangers the functioning of a radio navigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radio communication service operating in accordance with Radio Regulations."[1]

Harmful interference can have a substantial financial impact on satellite operators. Any degradation of the quality of the signal to or from a satellite at best diminishes its efficiency and at worst renders it useless.[2] As a consequence, harmful interference causes the degradation of available satellite capacity and prevents the satellite operator from being able to commercialize its full capacity. In turn, a satellite operator might no longer be able to serve as many customers as planned or might be in violation of existing contracts by not being able to guarantee the contractually agreed satellite capacity.[3] In the worst case, harmful interference can render satellite services entirely useless.[4]

There are acknowledged to be two types of harmful interference: unintentional and intentional. Intentional harmful interference refers to the deliberate jamming of radio communications, for example to prevent certain information from reaching the public.[5] Unintentional harmful interference can be caused by inadvertent errors in the operation of communication equipment, for example of

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[1] Int'l Telecomm. Union Radio Regulations Articles (2020), https://www.itu.int/hub/publication/r-reg-rr-2020/ [hereinafter Radio Regulations].

[2] FRANCIS LYALL & PAUL B. LARSEN, SPACE LAW – A TREATISE 189 (2nd ed. 2018).

[3] Johan G. Kroon, *Harmful Interference from the Netherlands Radiocommunication Agency Perspective, in* HARMFUL FREQUENCY INTERFERENCE IN REGULATORY PERSPECTIVE – LEGAL RULES FOR INTERFERENCE-FREE RADIO COMMUNICATION – 3RD LUXEMBOURG WORKSHOP ON SPACE AND SATELLITE COMMUNICATION LAW 163, 164 (Mahulena Hofmann ed., 2015).

[4] Francis Lyall, *The Role of Consensus in the ITU, in* DISPUTE SETTLEMENT IN THE AREA OF SPACE COMMUNICATION – 2ND LUXEMBOURG WORKSHOP ON SPACE AND SATELLITE COMMUNICATION LAW 33 (Mahulena Hofmann ed., 2015).

[5] Lesley Jane Smith, *Contractual Responses to Loss of Satellite Based Services, in* HARMFUL INTERFERENCE IN REGULATORY PERSPECTIVE – LEGAL RULES FOR INTERFERENCE-FREE RADIO COMMUNICATION – 3RD LUXEMBOURG WORKSHOP ON SPACE AND SATELLITE COMMUNICATION LAW 65, 72-73 (Mahulena Hofmann ed., 2015).

Earth station antennas that are not correctly aligned.[6] It can also be caused by poor quality equipment, for example when old equipment no longer complies with current satellite communication standards.[7]

In addition to physical collisions, the recent increase in satellites being launched into outer space, and the corresponding congestion of the lower orbits, also increases the risk of unintentional harmful interference.[8] All active satellites use the radio communication frequency spectrum to transmit and receive operation signals.[9] As a consequence, together with the increase of active satellites, the demand for radio spectrum is growing and harmful interference issues are increasingly becoming a problem.[10] In the words of Jennifer Manner:

> In near space, we are seeing a significant increase in low-Earth orbit and above satellite systems and space vehicles. For example, Elon Musk's SpaceX System will have upwards of 28,000 satellites. [...] With tens of thousands of satellites deployed in a single network talking to and from Earth and with other [non-geostationary orbit] and [geostationary orbit] satellites through vast networks of intersatellite links, the interference environment on the ground and in space is going to change. The possibility for aggregate interference in space and on the ground will increase. Compounding this is the real likelihood of increased use of the spectrum for communications for space tourism and sensing in low-Earth orbit, and for mining, living, and exploration beyond. [In deep space, we must consider planetary communications.] As more countries race for the moon,

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[6] Mitsuhiro Sakamoto, *ITU and Harmful Interference Prevention, in* HARMFUL INTERFERENCE IN REGULATORY PERSPECTIVE – LEGAL RULES FOR INTERFERENCE-FREE RADIO COMMUNICATION – 3RD LUXEMBOURG WORKSHOP ON SPACE AND SATELLITE COMMUNICATION LAW 31, 32-33 (Mahulena Hofmann ed., 2015).

[7] Kroon, *supra* note 3, at 164-165.

[8] *See* Laura Yvonne Zielinski, *The Rise of Satellite Arbitrations, in* THE GUIDE TO TELECOMS ARBITRATIONS 98, 103-104 (Wesley Pydiamah ed., 2022).

[9] LYALL & LARSEN, *supra* note 2, at 189.

[10] Tanja Masson-Zwaan, *Orbits and Frequencies: The Legal Context,* DISPUTE SETTLEMENT IN THE AREA OF SPACE COMMUNICATION – 2ND LUXEMBOURG WORKSHOP ON SPACE AND SATELLITE COMMUNICATION LAW 59 (Mahulena Hofmann, ed., 2015); Kroon, *supra* note 3, at 165.

> Mars and beyond, that means increased spectrum use, with increased potential for harmful interference.[11]

Confirming these bleak scenarios, after receiving 329 reports of harmful interference or infringements of the Radio Regulations in 2021, the ITU issued, in August 2022, a warning to its Member States regarding interference with radio waves-based satellite navigation services.[12] At the World Radio Conference in 2023, the ITU Radiocommunications Bureau "will inform the delegates of the severity of the situation and report on progress to date in addressing and mitigating harmful interference."[13]

II. THE APPLICABLE LEGAL FRAMEWORK

A. The International Telecommunications Union

As mentioned above, almost all satellites launched into space use the radio communication frequency spectrum to transmit and receive operation signals. The radio communication frequency spectrum is, however, a scarce natural resource.[14] In order to ensure its efficient use, it needs to be managed.

The global organization responsible for this management of the radio frequency spectrum and the associated satellite orbits is the ITU.[15] The organization was founded in 1865 and has 193 Member States as of today.[16] The ITU's activities are defined and governed by the ITU Constitution,[17] the ITU Convention,[18] the Radio

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[11] JENNIFER A. MANNER, SPECTRUM WARS: THE RISE OF 5G AND BEYOND 137 (2022).

[12] *ITU Issues Warning on Interference with Radio Navigation Satellite Service,* ITU NEWS (Aug. 23, 2022), https://www.itu.int/hub/2022/08/warning-harmful-interference-rnss/. *See also Managing Radio Frequency Spectrum Amid a New Space Race,* ITU NEWS (Nov. 12, 2021), https://www.itu.int/hub/2021/11/managing-radio-frequency-spectrum-amid-a-new-space-race/.

[13] *Id.*

[14] RAM S. JAKHU & PAUL STEPHEN DEMPSEY, EDS., ROUTLEDGE HANDBOOK OF SPACE LAW 111 (2017).

[15] *Id.*

[16] A list of current members can be found here: https://www.itu.int/en/ITU-R/terrestrial/fmd/Pages/administrations_members.aspx (last visited May 15, 2023).

[17] Constitution of the Int'l Telecomm. Union [ITU], *available at* https://www.itu.int/dms_pub/itu-s/opb/conf/S-CONF-PLEN-2022-PDF-E.pdf [hereinafter ITU Constitution].

[18] Convention of the Int'l Telecomm. Union [ITU], *available at*

Regulations[19] and the International Telecommunications Regulations (together the Administrative Regulations).[20] The legal framework also includes an Optional Protocol for dispute resolution concerning the interpretation or application of the Constitution, the Convention, the Radio Regulations and the International Telecommunications Regulations.[21]

According to Article 1 of the ITU Constitution, the purposes of the ITU are *inter alia* to maintain and extend international cooperation for the improvement and rational use of telecommunications, to promote and offer technical assistance to developing countries, and to improve the efficiency of telecommunication services.[22] To this end, the ITU: allocates bands of the radio frequency spectrum; allots radio frequencies; and registers radio-frequency assignments and, for space services, any associated orbital position in the geostationary satellite orbit or any relevant characteristics of satellites in other orbits, all in order to avoid harmful interference.[23] According to Article 1(b) of the ITU Constitution, the ITU shall "coordinate efforts to eliminate harmful interference between radio stations of different countries."[24]

The allocation of frequency bands is recorded in an international table called the International Table of Frequency Allocations.[25] It can only be amended during the World Radiocommunication Conferences (WRCs) during which the ITU Radiocommunication Sector, the ITU's organ responsible for the management of the radio spectrum, meets in plenary and adopts the Radio

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https://www.itu.int/dms_pub/itu-s/opb/conf/S-CONF-PLEN-2022-PDF-E.pdf [hereinafter ITU Convention].

[19] Radio Regulations, *supra* note 1.

[20] International Telecommunications Regulations [ITRs], *available at* https://www.itu.int/en/wcit-12/Pages/itrs.aspx. *See* TANJA MASSON ZWAAN AND MAHULENA HOFMANN, INTRODUCTION TO SPACE LAW ¶ 10.04. (4th ed. 2019).

[21] Srinivasan Venkatasubramanian, *ITU and its Dispute Settlement Mechanism. in* DISPUTE SETTLEMENT IN THE AREA OF SPACE COMMUNICATION – 2ND LUXEMBOURG WORKSHOP ON SPACE AND SATELLITE COMMUNICATION LAW 23, 29 (Mahulena Hofmann ed., 2015); the Optional Additional Protocol to the International Telecommunication Convention, *available at* https://search.itu.int/history/HistoryDigitalCollectionDocLibrary/4.10.43.en.101.pdf.

[22] ITU Constitution, *supra* note 18, art. 1.

[23] *Id.* at art. 1(2).

[24] *Id.*

[25] Radio Regulations, *supra* note 1, art. 5.

Regulations.[26] The WRCs take place every three to four years.[27] Between the WRCs, study groups meet to work on technical studies to prepare for the next WRC.[28]

Only ITU Member States can vote during the WRCs but the study groups present an opportunity for private parties to participate in the development of recommendations and conduct studies based on which countries submit proposals to the WRCs to amend the International Table of Frequency Allocations.[29] Private parties also participate in these conferences as part of national delegations.[30]

The allocation of the radio spectrum into different frequency bands is done in a way that ensures the most efficient use of the radio spectrum in line with the purposes of the ITU stated in Article 1 of its Constitution. This principle of efficiency also applies to the ITU Member States who must transpose the International Table of Frequency Allocations into national law.[31] In this context, Article 44 of the ITU Constitution provides that "Member States shall endeavour to limit the number of frequencies and the spectrum used to the minimum essential to provide in a satisfactory manner the necessary services. To that end, they shall endeavour to apply the latest technical advances as soon as possible."[32]

This is important to avoid harmful interference as addressed in Article 45 of the ITU Constitution. According to Article 45:

> All stations, whatever their purpose, must be established and operated in such a manner as not to cause harmful interference to the radio services or communications of other Member States or of recognized operating agencies, or of other duly authorized operating agencies which carry on a radio service, and which operate in accordance with the provisions of the Radio Regulations.
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> Further, the Member States recognize the necessity of taking all practicable steps to prevent the operation of electrical

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[26] ITU Constitution, *supra* note 18, art. 13(1).
[27] *Id.* at art. 13(2).
[28] MANNER, *supra* note 11, at 42-44.
[29] Venkatasubramanian, *supra* note 21, at 25.
[30] *Id.*
[31] *Id.* at 31.
[32] ITU Constitution, *supra* note 18, art. 44.

> apparatus and installations of all kinds from causing harmful interference . . . .[33]

In addition to the International Table of Frequency Allocations, the WRCs also present an opportunity to revise the Radio Regulations themselves. According to Article 4 of the ITU Constitution, the Radio Regulations complement the ITU Convention and the ITU Constitution and are binding on all Member States.[34] In particular, the Radio Regulations help to achieve the objective of operating radio communications without harmful interference. In this regard, they provide both for the prevention and the resolution of harmful interference.[35]

To avoid harmful interference, Article 4(2) of the 2020 Radio Regulations provides that "Member States undertake that in assigning frequencies to stations which are capable of causing harmful interference to the services rendered by the stations of another country, such assignments are to be made in accordance with the Table of Frequency Allocations and other provisions of these Regulations."[36] Article 4(3) adds that "[a]ny new assignment or any change of frequency or other basic characteristic of an existing assignment shall be made in such a way as to avoid causing harmful interference to services rendered by stations using frequencies assigned in accordance with the Table of Frequency Allocations," and Article 4(4) states that:

> Administrations of the Member States shall not assign to a station any frequency in derogation of either the Table of Frequency Allocations in this Chapter to the other provisions of these Regulations, except on the express condition that such a station, when using such a frequency assignment, shall not cause harmful interference to, and shall not claim protection from harmful interference caused by, a station operating in accordance with the provisions of the Constitution, the Convention and these Regulations.[37]

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[33] *Id.* at art. 45.
[34] *Id.* at art. 4.
[35] Sakamoto, *supra* note 6, at 34-35.
[36] Radio Regulations, *supra* note 1, art 4.2.
[37] *Id.* at art. 4.4.

Mirroring Article 44 of the ITU Constitution, Article 15.1 of the 2020 Radio Regulation stipulates that "all stations are forbidden to carry out unnecessary transmissions, or the transmission of superfluous signals, or the transmission of false or misleading signals, or the transmission of signals without identification."[38] Further, Chapter III of the 2020 Radio Regulations, comprising Articles 7 to 14, addresses the coordination, notification and recording of frequency assignments and plan modifications.[39] In particular, Articles, 7, 8, 9 and 11 provide for the registration and coordination of radio frequency assignments. New or replacement satellites have to be registered with the ITU and frequency assignments have to be recorded in an international frequency register, the Master International Frequency Register.[40] According to Article 8(1), "[t]he international rights and obligations of administrations in respect of their own and other administrations' frequency assignments shall be derived from the recording of those assignments in the Master International Frequency Register . . . ."[41] And according to Article 8.3 of the Radio Regulations, "[a]ny frequency assignment recorded in the Master Registry with a favorable finding under No. 11.31 shall have the right to international recognition."[42] International recognition means that "other administrations shall take it into account when making their own assignments in order to avoid harmful interference."[43] In other words, a frequency assignment has the right to be protected from harmful interference if it is recorded in the Master International Frequency Register and used in accordance with the Radio Regulations.

A favorable finding under Article 11.31 refers to an assignment being in conformity with the International Table of Frequency Allocations and the other provisions of the Radio Regulations except those relating to conformity with the procedures for obtaining coordination or the probability of harmful interference . . . .[44] In turn, Article 11.32 refers to an assignment being in conformity with the procedures relating to coordination with other administrations

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[38] *Id.* at art. 15.1.
[39] *Id.* at arts. 7-14.
[40] *Id.* at art. 8.1.
[41] *Id.*
[42] *Id.* at art. 8.3.
[43] *Id.*
[44] Radio Regulations, *supra* note 1, art. 11.31.

applicable to the radio communication service and the frequency band in question.[45] This means that an assignment needs to be coordinated with existing satellite systems to avoid harmful interference. Coordination can require adjustments to the technical characteristics of a satellite, such as power, coverage pattern or other matters that are then reflected in the filing with the ITU.[46]

With regard to the order of priority of different assignments, in practice, it is a "first-come, first-served" system where those that come later have to coordinate so as not to interfere with those satellites that were registered before.[47] Article 7.5A explicitly states that "[i]f a frequency assignment is brought into use before commencement of the coordination procedure under Article 9 when coordination is required, or before notification when coordination is not required, the operation in advance of the application of the procedure shall, in no way, afford any priority."[48]

In accordance with Article 9 of the 2020 Radio Regulations, coordination under the Radio Regulations requires an administration which wants to bring into use an assignment to publish Advanced Publication Information, followed by a Coordination Request in the International Frequency Information Circular of the ITU Radiocommunication Bureau, which is published every two weeks.[49] The list of administrations and satellite networks with which coordination has to be completed before bringing a satellite into use or notify for recording in the Master International Frequency Register are contained in the Coordination Request publication.[50]

Each year, the ITU publishes special sections for more than 250 coordination requests received from 50 different administrations.[51] In each of the 250 special sections, the ITU indicates the affected administrations and affected satellite networks. At the

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[45] *Id.* at art. 11.32.

[46] Gerry Oberst, *Dispute Resolution before the ITU: The Operator's Experience, in* DISPUTE SETTLEMENT IN THE AREA OF SPACE COMMUNICATION – 2ND LUXEMBOURG WORKSHOP ON SPACE AND SATELLITE COMMUNICATION LAW 43, 45 (Mahulena Hofmann ed., 2015).

[47] *Id.* at 44-50.

[48] Radio Regulations, *supra* note 1, art. 7.5A.

[49] *Id.* at art. 9.

[50] Ventakatasubramanian, *supra* note 21, at 27.

[51] *Id.* at 28.

very least, 20 administrations and 200 satellite networks are identified for a satellite network filing with which coordination needs to be effected by a satellite operator before bringing into use a satellite network. Depending on the frequency bands used and nature of service, the number of administrations and satellite networks identified can be far greater than those numbers.[52]

An administration is the State or State entity that discharges the ITU obligations on behalf of a public or private satellite operator.[53] A State can fulfill this role for several satellite operators. In practice, it means that the State in question is responsible for obtaining and protecting international rights for the use of orbital positions and frequency bands for satellites, for the benefit of the satellite operator.[54] In fact, compliance with the rules of the ITU in general mainly lies in the hands of the Member States, as the ITU has no direct means of enforcement.[55] In accordance with Article 45.1 of the ITU Constitution, it is the Member States of the ITU that are bound by its rules and that have to ensure compliance with the ITU regulations by private operators.[56]

To notify an assignment on the Master International Frequency Register, an assignment must be in accordance with the International Table of Frequency Allocations and with the Radio Regulations, and it needs to be coordinated with the relevant satellite assignments.[57] However, while according to Article 8.3 the first two conditions are mandatory, the third is not: if coordination efforts fail, an operator may still insist on its network being entered into the Master International Frequency Register with an accompanying note indicating the administrations with whom coordination was impossible.[58] According to Article 11.41 of the 2020 Radio Regulations:

> After a notice is returned under No. 11.38, should the notifying administration resubmit the notice and insist upon its reconsideration, the Bureau shall enter the assignment in the

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[52] *Id.*
[53] Radio Regulations, *supra* note 1, art. 1.2.
[54] Kroon, *supra* note 3, at 163.
[55] Smith, *supra* note 5, at 72.
[56] ITU Constitution, supra note 18, art. 45.1.
[57] Radio Regulations, *supra* note 1, art. 8.
[58] *Id.* at art. 8.3.

> Master Register with an indication of those administrations whose assignments were the basis of the unfavorable finding. . . .[59]

Article 8.5 adds that:

> If harmful interference to the reception of any station whose assignment is in accordance with No. 11.31 is actually caused by the use of a frequency assignment which is not in conformity with No. 11.31, the station using the latter frequency assignment must, upon receipt of advice thereof, immediately eliminate this harmful interference.[60]

In conclusion, any new or replacement satellites need to be coordinated with all stations who have "priority" on the Master International Frequency Register. Registration is possible without having completed the entire coordination process. However, in case such a non-coordinated station creates harmful interference, this interference must be eliminated immediately. Only fully coordinated radio stations benefit from the full protection of the ITU regulations.

B. International Space Law

As regards the radio spectrum used by satellites, it is not just the ITU framework that is applicable but also international space law more generally. According to Professor Masson-Zwaan, "[t]he use and management of the orbit/spectrum must be seen in the wider context of the legal principles governing the use of outer space as contained in the UN outer space treaties, especially the 1967 Outer Space Treaty."[61]

According to Article I of the Outer Space Treaty,[62] the exploration and use of outer space "shall be carried out for the benefit and in the interest of all countries [...] and shall be the province of all [hu]mankind."[63] Article II of the Outer Space Treaty clarifies that

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[59] *Id.* at art. 11.41 (footnote omitted).

[60] *Id.* at art. 8.5.

[61] Masson-Zwaan, *supra* note 10, at 62.

[62] 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].

[63] *Id.* at art. I

"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."[64] Article III further states that the exploration of outer space shall be carried out "in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international cooperation and understanding."[65]

Finally, Article VI of the Outer Space Treaty provides that State Parties to the Outer Space Treaty "shall bear international responsibility for national activities in outer space . . . whether such activities are carried on by governmental agencies or by non-governmental entities, for assuring that national activities are carried out in conformity with the provisions [of the Outer Space Treaty]," and that the activities of non-governmental entities in outer space "shall require authorization and continuing supervision by the appropriate State Party to the Treaty."[66] And, as further elaborated in the Liability Convention,[67] Article VII states that

> [e]ach State Party to the Treaty that launches or procures the launching of an object into outer space . . . and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth [or in space].[68]

The principle of space being for all humankind, the prohibition of national appropriation, and the encouragement of international cooperation can be applied to the use of the radio-spectrum, confirming the need to use the spectrum efficiently in coordination with other public and private users. They also indicate that the use of frequency bands does not confer an ownership right.

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

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

[66] *Id.* at art. VI.

[67] Convention on the International Liability for Damage Caused by Space objects, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S 187 [hereinafter the Liability Convention]. The Liability Convention provides that a launching State shall be absolutely liable to pay compensation for damage caused by its space objects on the surface of the Earth or to aircraft, and liable for damage in space if at fault. The Convention also provides for procedures for the settlement of claims for damages.

[68] Outer Space Treaty, *supra* note 62, art. VII.

As concerns State responsibility for national space activities and State liability for damage caused by space objects, it could be argued that these principles could be extended to include damage caused by harmful interference with radio frequencies. According to Professor Masson-Zwaan,

> [a] State could be held responsible for harmful interference under Article VI, and if damage occurs, it could be held liable for damage under Article VII. So far these articles have never been put to the test before an international tribunal, but it is not inconceivable that harmful interference could cause actual damage, giving rise to a claim under international law.[69]

Professor von der Dunk agrees but adds that

> [ultimately…] without either an authoritative interpretation at the international inter-State level of what Article XII of the [Liability] Convention is supposed to precisely mean or the judgment of an appropriate international court or tribunal on the issue, it is too early to determine exactly the extent to which the Liability Convention might present a useful tool for solving legal disputes on electronic interference with communication satellite operations and harm possibly resulting therefrom.[70]

The only article in the Outer Space Treaty that explicitly mentions the term "harmful interference" is Article IX. While it does not mention it specifically in the context of the use of the radio spectrum, it arguably would apply to harmful frequency interference. According to Article IX, States must conduct their activities in outer space "with due regard to the corresponding interests of all other State Parties to the Treaty" and must conduct international consultations before conducting activities that would cause potentially harmful interference.[71] Applying this to the radio spectrum, States must request consultations before carrying out a transmission that

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[69] Masson-Zwaan, *supra* note 10, at 64.

[70] Frans G. von der Dunk, *The 'Space Side' to 'Harmful Interference' – Evaluating Regulatory Instruments in Addressing Interference Issues in the Context of Satellite Communications, in* HARMFUL INTERFERENCE IN REGULATORY PERSPECTIVE – LEGAL RULES FOR INTERFERENCE-FREE RADIO COMMUNICATION – 3RD LUXEMBOURG WORKSHOP ON SPACE AND SATELLITE COMMUNICATION LAW 87, 93 (Mahulena Hofmann ed., 2015).

[71] Outer Space Treaty, *supra* note 62, art. IX.

might cause potentially harmful interference with transmissions of other States.

III. AVAILABLE DISPUTE RESOLUTION MECHANISMS

A. In the International Telecommunications Union's Instruments

As reviewed above, according to the Radio Regulations, to be notified on the Master International Frequency Register, an assignment should not cause harmful interference with a satellite system already notified. However, despite this rule, harmful interference does happen.

When a satellite operator experiences harmful interference, it reports it to its notifying administration.[72] Section VI of Article 15 of the 2020 Radio Regulations sets out the procedure that administrations should follow when they observe harmful interference.[73] Member States have to exercise the "utmost goodwill and mutual assistance"[74] and give "due consideration" to all factors involved "including the relevant technical and operating factors."[75] They "shall cooperate in the detection and elimination of harmful interference," if necessary with recourse to the international monitoring facilities described in Article 16.[76] Of course, an administration first has to identify the space object at the origin of the harmful interference, and then the responsible administration for the object in question.[77] According to Article 15.34,

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[72] Only the administrations have rights under the ITU instruments and take steps to resolve the incident of harmful interference in accordance with the corresponding ITU provisions.

[73] Radio Regulations, *supra* note 1, art. 15.

[74] *Id.* at art. 15.22.

[75] *Id.* at art. 15.23.

[76] *Id.* at art. 15.25. In accordance with Article 16, administrations agree to continue the development of monitoring facilities and, to the extent practicable, to cooperate in the continued development of the international monitoring system, taking into account the relevant ITU-R Recommendations.

[77] Jean-François Mayence, *Harmful Interference in Telecommunications under International and National Space Law, in* HARMFUL INTERFERENCE IN REGULATORY PERSPECTIVE – LEGAL RULES FOR INTERFERENCE-FREE RADIO COMMUNICATION – 3RD LUXEMBOURG WORKSHOP ON SPACE AND SATELLITE COMMUNICATION LAW 101, 110-111 (Mahulena Hofmann ed., 2015).

> [h]aving determined the source and characteristics of the harmful interference, the administration having jurisdiction over the transmitting station whose service is being interfered with shall inform the administration having jurisdiction over the interfering station, giving all useful information in order that this administration may take such steps as may be necessary to eliminate the interference.[78]

Article 15.39 of the 2020 Radio Regulations provides that "if the harmful interference persists in spite of the action taken in accordance" with Section VI of Article 15, "the administration having jurisdiction over the transmitting station whose service is being interfered with may address to the administration having jurisdiction over the interfering station a report of irregularity or infraction."[79] If these steps fail to produce favorable results, Article 15.41 allows the administration concerned to forward the details of the case to the ITU's Radiocommunication Bureau (Bureau).[80] The Bureau shall then send "its conclusions and recommendations to the administration reporting the case of harmful interference" and to the administration believed to be responsible for the source of harmful interference, together with a request for prompt action.[81]

Most harmful interference incidents can be resolved without official dispute resolution. As many cases of harmful interference are caused by human error, malfunction of equipment etc., they are easily resolved via communication between the concerned operators and administrations in accordance with the Radio Regulations.[82]

If the harmful interference persists despite the recommendations of the Bureau, either of the two administrations involved can escalate the case to the Radio Regulations Board (Board).[83] According to Article 10(1) of the ITU Convention, the Board shall "consider reports from the Director of the Radiocommunication Bureau on investigations of harmful interference carried out at the request of one or more of the interested administration; and formulate recommendations with respect thereto."[84] According to Article 10(2), it

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[78] Radio Regulations, *supra* note 1, art.15.34.
[79] *Id.* at art. 15.39.
[80] *Id.* at art. 15.41.
[81] *Id.* at art. 15.46.
[82] Sakamoto, *supra* note 6, at 36-37.
[83] ITU Convention, *supra* note 18, art. 10(1).
[84] *Id.*

shall "also, independently of the Radiocommunication Bureau, at the request of one or more of the interested administrations, consider appeals against decisions made by the Radiocommunication Bureau regarding frequency assignments."[85]

The Board can formulate recommendations but its process can take years and its enforcement powers are limited.[86] The Board's decisions are public, and there is international pressure on the concerned administrations to resolve the harmful interference, so most cases brought to the Board are resolved,[87] but the recommendations of the Board do not include any sanctions against the harmful interference except for cases of harmful interference caused by an assignment recorded in the Master International Frequency Register under Article 11.41 of the Radio Regulations.[88] Article 11.42 provides that

> "[s]hould harmful interference actually be caused by an assignment recorded under No. 11.41 to any recorded assignment which was the basis of the unfavorable finding, the administration responsible for the station using the frequency assignment recorded under No. 11.41 shall, upon receipt of a report providing the particulars relating to the harmful interference, immediately eliminate this harmful interference."[89]

Based on this provision, when an assignment recorded under Article 11.41 causes harmful interference to the assignment on which the unfavorable finding is based, the Board can decide to delete the entry in the Master International Frequency Register in accordance with Article 11.42A after its investigation:

> In applying No. 11.42 with respect to satellite networks, administrations involved shall cooperate in the elimination of harmful interference and may request the assistance of the Bureau, and shall exchange relevant technical and operational information required to resolve the issue. Should any administration involved in the matter inform the Bureau that all efforts to resolve the harmful interference have failed, the

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[85] *Id.* at art. 10(2).
[86] Sakamoto, *supra* note 6, at 38.
[87] *Id.* at 38.
[88] *Id.*
[89] Radio Regulations, *supra* note 1, art. 11.42 (footnote omitted).

> Bureau shall immediately inform other involved administrations and prepare a report, together with all necessary supporting documents (including comments from the administrations involved), for the next meeting of the Board consideration and any required action *(including the possible cancellation of the assignment recorded under No.41)*, as appropriate. The Bureau shall thereafter implement the decision of the Board and inform the administrations concerned.[90]

In case a dispute persists despite this procedure before the Bureau and the Board, the parties concerned can bring the matter to the next WRC in the hope of settling the dispute diplomatically.[91] Alternatively, Article 56 of the ITU Constitution sets out a dispute settlement mechanism available to the ITU Member States. According to Article 56:

> (1) Member States may settle their disputes on questions relating to the interpretation or application of this Constitution, of the Convention or of the Administrative Regulations by negotiation, through diplomatic channels, or according to procedures established by bilateral or multilateral treaties concluded between them for the settlement of international disputes, or by any other method mutually agreed upon.
>
> (2) If none of these methods of settlement is adopted, any Member State party to a dispute may have recourse to arbitration in accordance with the procedure defined in the Convention.
>
> (3) The Optional Protocol on the Compulsory Settlement of Disputes Relating to this Constitution, to the Convention, and to the Administrative Regulations shall be applicable as between Member States parties to that Protocol.[92]

It follows from Article 56(2) that if all concerned administrations agree, they can also have recourse to arbitration in accordance with Article 41 of the ITU Convention, or in accordance with Article 56(3), if all concerned administrations are parties to the Optional Protocol on the Compulsory Settlement of Disputes relating to the

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[90] *Id.* at art. 11.42A (emphasis added).
[91] Ventakatasubramanian, *supra* note 21, at 28.
[92] ITU Constitution, *supra* note 18, art. 56.

Constitution of the International Telecommunication Union, to the Convention of the International Telecommunication Union and to the Administrative Regulations, the Optional Protocol can be used. So far, neither Article 41 nor the Optional Protocol has ever been used in practice.[93]

The dispute settlement mechanisms contained in the ITU instruments are limited to ITU Member States and are not available to private parties except through diplomatic protection.[94] In any event, as Elina Morozova and Yaroslav Vasyanin point out, as a consequence *inter alia* of the length of the proceedings, the non-binding nature of the Board's decisions and its inability to order the payment of damages, private satellite operators might not want to rely on the proceeding foreseen in the Radio Regulations and might instead prefer to resort to alternative dispute settlement mechanisms,[95] as further discussed below.

B. In International Space Law

International space law is constituted of five main international treaties developed in the context of the United Nations Committee on the Peaceful Uses of Outer Space: the Outer Space Treaty and the Liability Convention already mentioned above, as well as the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space,[96] the Convention on Registration of Objects Launched into Outer Space[97] and the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies.[98] As mentioned above, only the Outer

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[93] Masson-Zwaan, *supra* note 10, at 62.

[94] As international treaties, the ITU instruments are not directly applicable to private parties.

[95] Elina Morozova & Yaroslav Vasyanin, *Mechanisms for Resolving Disputes Related to Violations of Coordination Agreements* (70th Int'l Astronautical Congress, 2019).

[96] Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, Apr. 22, 1968, 19 U.S.T. 7570, 672 U.N.T.S. 119.

[97] Convention on Registration of Objects Launched into Outer Space, Jan. 14, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15.

[98] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 18, 1979, 1362 U.N.T.S. 3 [hereinafter Moon Agreement]. The Moon Agreement has been ratified by too few States to gain the same relevancy as the previous space treaties. A list of the signatories of all the treaties can be found here: Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcommittee on its Sixty-First Session,

Space Treaty and the Liability Convention contain substantive rules that are relevant to the context of harmful interference.

The Liability Convention contains an explicit dispute resolution mechanism in the form of a Claims Commission (Articles XIV-XX), but its decisions are only recommendatory unless all of the parties to a dispute agree to render them binding.[99] In contrast, the Outer Space Treaty provides in its Article III that "States Parties to the Treaty shall carry on activities [...] in accordance with international law, including the Charter of the United Nations [...]" The United Nations' Charter, in Article 33, Chapter VI, lists "negotiation, enquiry, mediation, conciliation, arbitration, judicial settlement, resort to regional agencies or arrangements, or other peaceful means of their own choice" as possible dispute settlement mechanisms.[100]

C. In Domestic Law

In theory, space disputes, including over harmful interference, can be brought before domestic courts within national legal systems.[101] However, it is doubtful whether domestic courts are the most appropriate forum for harmful interference disputes. Harmful interference disputes are very technical and national judges might not have the necessary knowledge of ITU regulations to judge such disputes efficiently.[102] Moreover, harmful interference disputes are often international in nature, meaning that at least one of the parties would have to litigate in a court of a State and in a language that is not their own, in addition to any possible bias a court might have towards the party of its own nationality. Another difficulty of litigating harmful interference disputes in domestic courts can arise out of the impossibility to adequately protect confidential information as for example the information contained in coordination agreements.

Status of International Agreements Relating to Activities in Outer Space as at 1 January 2022, U.N. Doc. A/AC.105/C.2/2022/CRP.10 (2022).

[99] Liability Convention, *supra* note 67, art. XIX.

[100] U.N. Charter art. 33.

[101] A claim before a domestic court does not require the prior consent of the opposing party, although there might be questions over which national court is competent to hear a particular dispute.

[102] Morozova & Vasayanin, *supra* note 95, at 21.

Finally, in a domestic court it might be difficult to determine the applicable law to an international harmful interference dispute. As Elina Morozova and Yaroslav Vasyanin explain, "[a]nother legal challenge of adjudicating a dispute related to a coordination agreement would be to determine [the] governing law to be applied to each aspect of the dispute."[103]

IV. SPACE ARBITRATION AS AN EFFICIENT ALTERNATIVE

While the substantive law is clear on the need to prevent and resolve harmful interference, the result of a review of the available dispute settlement mechanisms to enforce these substantive rights is less clear. Both the dispute settlement mechanism of the ITU and the ones offered by general international space law present two fundamental deficiencies: they are not binding and not available to private parties. In a world in which there is a stark increase in space activities with a corresponding risk of disputes, including relating to harmful interference, and in which the private sector is becoming ever more involved, those are two serious disadvantages.

In the words of Gerry Oberst,

> At the end of the day, administrations and satellite operators that find themselves in a "disagreement" or "dispute" concerning ITU rules do not have any clear path to resolution [within the ITU system]. As radio spectrum becomes increasingly congested and scarce globally, the number of instances where it is simply not possible to resolve the conflicting claims of administrations will inevitably increase, and the corresponding need for an accessible, fair and transparent dispute resolution mechanism, well-suited to ITU matters, should become increasingly apparent to all parties concerned.[104]

A look at available international dispute settlement mechanisms draws the attention to international arbitration. It seems that international arbitration could be this "accessible, fair and transparent dispute resolution mechanism, well-suited to ITU matters."[105] In fact, international arbitration is a flexible mechanism

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[103] *Id.* at 20.
[104] Oberst, *supra* note 46, at 125.
[105] *Id.*

providing the parties to a dispute with a significant degree of autonomy over their proceedings.[106] This means that, in international arbitration, the parties are able to select their arbitrators, and therefore, have the possibility to choose individuals with experience and the necessary know-how to understand the dispute in question, including individuals with relevant experience in ITU matters. International arbitration also allows the parties to choose the place of arbitration and the language of their proceedings, to influence the procedural calendar and to commit to enhanced confidentiality.[107]

Importantly, in addition to its flexibility and adaptability to both the highly technical nature of harmful interference disputes and the international aspects of disputes that often involve parties from different jurisdictions, international arbitration is both available to private satellite operators and results in binding decisions.[108] By nature, international arbitration awards are final and binding and can be easily enforced internationally through the United Nations Convention on the Recognition and Enforcement of Foreign Arbitral Awards, also known as the New York Convention.[109] Moreover, because international arbitration is a private dispute settlement mechanism, parties can voluntarily agree to refer their dispute to arbitration. This can be done once a dispute has already arisen, but is most commonly done beforehand, for example in the form of an arbitration clause included in a contract. As a consequence, international arbitration is not only available to States and public entities but also to private satellite operators.[110]

These advantages are well known and many space contracts already contain arbitration clauses. For example, the European Space Agency provides for arbitration in Clause 35(2) of its General Clauses and Conditions for ESA Contracts[111] and arbitration clauses also seem to be routinely included into commercial space contracts by companies such as SpaceX, Avanti, Boeing, Airbus and

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[106] NIGEL BLACKABY ET AL., REDFERN AND HUNTER ON INTERNATIONAL ARBITRATION ¶¶ 1.04-1.12. (6th ed. 2015).

[107] *Id.*

[108] *Id.*

[109] The Convention on the Recognition and Enforcement of Foreign Arbitral Awards, June 10, 1958, 21 U.S.T. 2517, T.I.A.S. No. 6997, 330 U.N.T.S. 38.

[110] BLACKABY, *supra* note 106, ¶¶ 2.31-2.41.

[111] European Space Agency [ESA], *Regulations of the European Space Agency: General Clauses and Conditions for ESA Contracts,* ESA/REG/002 (July 5, 2019).

Arianespace.[112] A study undertaken by Vivasat Dadwal and Madeleine McDonald confirmed that international arbitration is the preferred mechanism by both State and non-State actors in the resolution of publicly-known space-related disputes, especially in the satellite industry.[113] In the past, satellite disputes that gave rise to international arbitrations have for example arisen out of the late delivery of satellites, the insertion of a satellite into a wrong orbit, defective satellites already in orbit, the lease of satellite capacity, the right to orbital positions and frequency bands, export control, and the cancellation of space contracts.[114]

As regards harmful interference disputes, arbitration clauses can be included in coordination agreements to provide for the possibility of arbitrating any dispute that might arise out of the violation of such agreement.[115] Indeed, as mentioned above, new or replacement satellites must be coordinated.[116] The results of this coordination process are usually recorded in so-called coordination agreements that are basically contracts signed by both operators.[117] Unfortunately, coordination agreements are commonly drafted by technical experts and therefore rarely contain arbitration clauses.[118] However, given the need for an efficient dispute settlement system for harmful interference disputes, foreseeing the possibility of arbitration can ensure the availability of a well-suited forum to settle a dispute if needed.

The fact of having agreed on an arbitration clause in their coordination agreement for example greatly benefitted Eutelsat S.A. (Eutelsat) and SES S.A. (SES) in 2012, when they were able to bring a dispute before an arbitration tribunal in a proceeding administered by the Court of Arbitration of the International Chamber of

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[112] Rachael O'Grady, *Dispute Resolution in the Commercial Space Age: Are All Space-Farers Adequately Catered For?,* 3 ICC DISP. RESOL. BULL. 55 (2021).

[113] Viva Dadwal & Madeleine McDonald, *Arbitration of Space-Related Disputes: Case Trends and Analysis* (71st International Astronautical Congress, 2020).

[114] Jan Frohloff, *Arbitration in Space Disputes,* 35 ARB. INT'L ¶¶ para. 2.1.1-2.1.6 (2019).

[115] Morozova & Vasayanin, *supra* note 95, at 23.

[116] Radio Regulations, *supra* note 1, at art.; Oberst, *supra* note 46, at 45.

[117] Morozova & Vasayanin, *supra* note 95, at 23.

[118] *Id.*

Commerce (ICC).[119] The dispute arose when SES, through an assignment from Media Broadcast GmbH, obtained the right to use the 500 MHz spectrum at 28.5° East, including frequencies that Eutelsat claimed were reserved to Eutelsat under an intersystem coordination agreement Eutelsat and SES had signed in 1999 (Coordination Agreement).[120] Eutelsat initiated ICC arbitration against SES on the basis of an arbitration clause contained in the Coordination Agreement itself.[121] The tribunal issued a partial award in September 2013 holding that the Coordination Agreement did not bar SES from using the disputed bands if and when Eutelsat did not hold the regulatory right to operate in these bands.[122] Eutelsat finally ceased to operate the disputed frequencies and the dispute was settled in 2014.[123]

Industry-specific arbitration rules, such as the Optional Rules for the Settlement of Outer Space Disputes of the Permanent Court of Arbitration[124] further contribute to rendering international arbitration a well-adapted dispute settlement mechanism for the space industry, including for the settlement of harmful interference disputes.

V. CONCLUSION

In conclusion, with the increase in satellites being launched, harmful interference is becoming a growing concern for private satellite operators. While harmful interference is illegal under international law, and the International Telecommunications Union instruments contain detailed provisions on the prevention and resolution of harmful interference, both the ITU and the international space treaties lack an efficient dispute settlement mechanism that

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[119] Kyriaki Karadelis, *Eutelsat Settles ICC Satellite Dispute,* GLOB. ARB. REV. (Jan. 30, 2014), https://globalarbitrationreview.com/article/eutelsat-settles-icc-satellite-dispute; Morozova & Vasayanin, *supra* note 95, at 23.

[120] Frohloff, *supra* note 114, ¶ 2.1.6.

[121] Based on information provided by Eutelsat S.A.

[122] *Eutelsat statement on operations at 28.5° East,* Eutelsat Communications (Sept. 30, 1998) https://www.eutelsat.com/files/live/sites/eutelsat-internet/files/contributed/news/press/en/PR%207313%20ICC-1.pdf.

[123] Karadelis, *supra* note 119.

[124] Permanent Court of Arbitration, Optional Rules for Arbitration of Disputes Relating to Outer Space Activities, available at https://docs.pca-cpa.org/2016/01/Permanent-Court-of-Arbitration-Optional-Rules-for-Arbitration-of-Disputes-Relating-to-Outer-Space-Activities.pdf.

is easily accessible for private parties to enforce their rights. With domestic courts in turn often lacking the necessary experience to efficiently address space disputes, international arbitration can present an interesting alternative. Satellite operators should keep this in mind when drafting their coordination agreements.

SATELLITE DATA AND IMAGERY AS EVIDENCE

Ronald J. Rychlak and Sean Patrick Taylor***

ABSTRACT

The first orbital satellite photographs of Earth were taken over Mexico on August 14, 1959, by the United States Explorer 6, "a small, spheroidal satellite designed to study trapped radiation of various energies, galactic cosmic rays, geomagnetism, radio propagation in the upper atmosphere, and the flux of micrometeorites."[1] In 1972, the United States started the Landsat program, "the longest continuous space-based record of Earth's land in existence."[2] Despite the passage of more than half a century and efforts to make exhibits readily accessible for litigants,[3] satellite data and imagery remains woefully underused in American courts. With this paper, the authors seek to encourage attorneys to consider exhibits featuring such information by, *inter alia*, explaining how they can effectively be used.

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[1] NASA Space Science Data Coordinated Archive, NSSDCA/COSPAR ID 1959-004A, available at https://nssdc.gsfc.nasa.gov/nmc/spacecraft/display.action?id=1959-004A (last visited Dec. 31, 2022). The first satellite photographs of the Moon were made on October 6, 1959, by the Soviet satellite, Luna 3, on a mission to photograph the far side of the Moon. *Id.* at https://nssdc.gsfc.nasa.gov/nmc/spacecraft/display.action?id=1959-008A (last visited December 31, 2022).

[2] *50 Years of Landsat Science,* NASA, https://landsat.gsfc.nasa.gov/ (last visited Dec. 31, 2022).

[3] *See* Ronald Rychlak, Joanne Gabrynowicz & Rick Crowsey, *Legal Certification of Digital Data: The Earth Resources Observation and Science Data Center Project*, 33 J. SPACE L. 195 (2007) (setting forth a new approach for government use of digital photos and the resulting change in chains of custody).

I. INTRODUCTION

Space-based remotely sensed imagery first became commercially available in 1972 with the advent of the United States' Earth Resources Technology Satellite (ERTS).[4] Since then, the commercial remote sensing satellite industry has blossomed. This growth has only been possible with the development of legal protocols relating to remote imaging and satellite data.[5]

Because of its military history and concerns about national security and confidential information, some nations originally claimed a proprietary interest in any imagery or information obtained about their country in this manner.[6] In 1986, the United Nations Committee on the Peaceful Uses of Outer Space reached agreement on a set of principles relating to remote sensing of Earth from space.[7] This opened the door for a wider variety of satellite imaging applications and greatly increased the use of geospatial data.

Satellite data is regularly used to analyze the global environment and to detect various land cover conditions. Commercial providers allow customers to locate and download advanced satellite

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[4] P.J. Blount, *Remote Sensing Law: An Overview of Its Development and Its Trajectory in the Global Context*, *in* 1 REMOTE SENSING HANDBOOK 605 (Prasad S. Thenkabail ed. 2015). The National Aeronautics and Space Administration (NASA) and the United States Department of the Interior through the United States Geological Survey (USGS) managed the Landsat program, starting in the early 1970s. This ultimately became the ERTS program. NASA built and launched satellites that captured images, and USGS collected an archive including of over three million such images that were provided to more than 180 nations and territories. The project provided great insight into how the Earth's surface changes over time.

[5] That, in fact, is the reason the United States Congress funded the National Center for Remote Sensing, Air, and Space Law (now the Center for Air and Space Law) at the University of Mississippi School of Law in 1999. Professor Rychlak had the honor of preparing the grant documents that resulted in that funding and of working with space law pioneer Professor Stephen Gorove in creating the Center.

[6] Diederiks-Verschoor, *Current Issues in Remote Sensing*, 5 MICH. J. INT'L L. 305 (1984), available at: https://repository.law.umich.edu/mjil/vol5/iss1/14, *citing* U.N. Doc. A/C.1/1047 (1974) (draft articles proposed by Argentina and Brazil to prohibit remote-sensing of one nation's natural resources by another without prior consent). *See also* Ray Purdy & Richard Macrory, *Satellite Photographs: 21st Century Evidence?* 153 NEW L.J. (Mar. 7, 2003).

[7] G.A. Res. 41/65, Principles Relating to Remote Sensing of the Earth from Outer Space (Dec. 3, 1986).

imagery and geospatial data for any location in the world.[8] The Environmental Protection Agency (EPA) regularly uses satellite data to assess the effect of greenhouse gases on the environment, global sea level, local rainfall amounts, the destruction of wetlands and the development of natural areas.[9] Other federal agencies have used satellite data to monitor compliance with their regulations, and the agriculture industry has also found many important uses for Earth observation data obtained from satellites.[10]

The same characteristics that make satellite data useful for scientific and agricultural purposes make them valuable for attorneys. For instance, *Commonwealth v. Suarez-Irizzary* considered a Pennsylvania law which increased the severity of sentencing for drug transactions which occurred within 1000 feet of a school.[11] The prosecutor sought to use Google Earth, a "computer-based satellite

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[8] *See, e.g.,* Up42, which permits users to access "access best-in-class satellite imagery." Up42, *High Resolution Satellite Data*, https://up42.com/goingup/high-resolution-satellite-data?utm_medium=ppc&utm_campaign=sc+-+NA+-+adwords+-+High_Resolution_Satellite_Data&utm_term=satellite%20imagery%20providers&utm_source=adwords&hsa_ad=621290329674&hsa_kw=satellite%20imagery%20providers&hsa_acc=4550935533&hsa_mt=e&hsa_src=g&hsa_ver=3&hsa_grp=138338318117&hsa_net=adwords&hsa_tgt=kwd-323756571507&hsa_cam=12560069706&gclid=Cj0KCQiA7bucBhCeARIsAIOwr-_q4r_pi9QZgYkIpo3Bx_1C7vtmOH1qWilPubj-n7u2hnRFqEj4DFAaArc3EALw_wcB (last visited Dec. 6, 2022).

[9] *See* Michael D. Coughlin, Jr., *Using the Merck-INBio Agreement to Clarify the Convention on Biological Diversity*, 31 COLUM. J. TRANSNAT'L L. 337, 359 n.100 (1993) (Satellite data, training, and equipment provided by NASA to the members of the Central American Commission on the Environment and Development to track land use, development, and pollution.). Another area of great potential for satellite data is identification of potentially responsible parties for purposes of hazardous waste cleanup enforcement under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), 42 U.S.C. § 9601 et seq. *See* RONALD J. RYCHLAK & DAVID W. CASE, ENVIRONMENTAL LAW 100-08 (2010); NutraSweet Co. v. X-L Eng'g Co., 227 F.3d 776 (7th Cir. 2000) (plaintiffs used aerial photographs to establish the dumping sequence in which Volatile Organic Compounds were dumped on X-L's land and then migrated through the groundwater onto NutraSweet's land).

[10] Some farmers collect their annual remote sensing information into databases, thus providing important production histories for their farms. In litigation, this database can be an important subject of discovery. Remote sensing has been used in cases involving herbicide applications. Such imagery can detect weed and insect pressure. It can also detect the presence or absence of moisture. *See* Evans v. Perry, 2011 WL 3667394 (Del. C.P. 2011) (in dispute over possession and ownership of his irrigation equipment, the court found "the satellite image as the best direct evidence of the tillable acreage").

[11] Commonwealth v. Suarez-Irizzary, 15 Pa. D. & C. 5th 106, 108 (C.P. Aug. 6, 2010).

imaging system" to establish the distance between the incidents and the school.[12] The court analyzed cases from Massachusetts, Connecticut, Ohio and Louisiana.[13] Ultimately, the court concluded that "[c]omputer-generated determinations of distance can be authenticated when an individual testifies that he/she verified the accuracy of the computer program by comparing a computer-generated distance between two known points with an independently determined calculation of the distance between the same two points."[14] Here, the police officer's prior calibration of Google Earth maps, finding them accurate to within one foot of his actual measurements on the ground, were sufficient to allow the officer to testify to his computer-generated satellite-based distance calculations.[15]

The International Court of Justice (ICJ) has allowed satellite imagery evidence in a number of cases, including a border dispute between Nigeria and Cameroon,[16] another dispute between Mali and Burkina Faso,[17] and one between Botswana and Namibia.[18] At the People's Tribunal on Sri Lanka, satellite imagery was used as evidence in court to show that the Sri Lanka military "purposely or intentionally" targeted a hospital.[19] Satellite imagery has also been used in the International Criminal Court (ICC). It was first used in international criminal proceedings during the Srebrenica trials at the International Criminal Tribunal for the former Yugoslavia.[20]

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[12] *Id.*

[13] *Id.* at 114-116.

[14] *Id.* at 116.

[15] *Id.* at 116-7. *See* John E. Bailey, *Google Earth for Remote Sensing, in* REMOTE SENSING HANDBOOK, *supra* note 4, at 565.

[16] Land and Maritime Boundary between Cameroon and Nigeria (Cameroon v. Nigeria), Judgment, I.C.J. Reports 2002 (Oct. 10, 2002).

[17] Frontier Dispute (Burkino Faso v. Mali), Judgment, I.C.J Reports 1986 (Dec. 22, 1986).

[18] Case Concerning Kasikili/Sedudu Island (Bots. V. Namib.), Judgment, I.C.J. Reports 1999 (Dec. 13, 1999).

[19] Satellite Imagery Evidence Showing Sri Lanka Military "Purposefully or Intentionally" Targeted PTK Hospital (Jan. 10, 2010), *available at:* https://www.yumpu.com/en/document/read/38901290/satellite-imagery-evidence-showing-sri-lanka-military-apurposely-or-

[20] Patrick Kroker, *Satellite Imagery as Evidence for International Crimes*, INT'L JUST. MONITOR (Apr. 21, 2015), https://www.ijmonitor.org/2015/04/satellite-imagery-as-evidence-for-international-crimes/.

Nevertheless, despite the great promise of this technology and its myriad of possibilities, use of satellite Earth observations in United States (US) courts is still in its infancy. This has to do both with its technical limitations[21] and the legal community's unfamiliarity with the capabilities of such systems.[22] It is time to change that.

Part II of this article seeks to explain the process of how information can be captured, preserved, and made usable and persuasive as exhibits in American courtrooms. Part of the process, also discussed in this section, is the effective use of "the" or "a" Geographic Information System (GIS).

Part III reviews different ways to take the developed information and turn it into effective courtroom exhibits. This involves obtaining the correct data, creating and storing admissible exhibits from that data, and remaining focused on evidentiary standards throughout.

Part IV reviews processing of information from space into images that can be used in court, including the use of colors or other effects to clarify the included information.

Parts V and VI deal with admissibility standards in American courts and the objections that an attorney using remote sensing exhibits should expect to encounter, including questions related to evidentiary foundations and the chain of custody.

Part VII deals with special concerns which, if not unique to remote sensing exhibits, are at least particularly tied to them. This would particularly include issues of privacy, national security, and fraudulent images.

Parts VIII and IX deal with using exhibits to get to the truth. This includes the use of plumes, which can present evidentiary concerns but are actually quite helpful in clarifying processes to a judge or jury. Part VIII also includes a few illustrative cases.

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[21] For instance, in Jones v. Global Annex, LLC, 136 N.E.3d 765 (Ohio Ct. App. 2019), a landowner attempted to prove an adverse possession claim using satellite imagery. The court rejected the claim, holding that the satellite images which jumped in time did not "clearly and convincingly demonstrate that he had exclusive possession that was hostile, open, notorious, continuous, and adverse" over the requisite time period. *Id.* at 772-3.

[22] *See* EVIDENCE FROM EARTH OBSERVATION SATELLITES: EMERGING LEGAL ISSUES (Ray Purdy & Denise Leung eds., 2013); Andrew Dempster, *GNSS Data as Court Evidence: Lessons from Remote Sensing*, Proceedings of the 31st International Technical Meeting of the Satellite Division of the Institute of Navigation (Sept. 24 - 28, 2018).

II. UNDERSTANDING THE PROCESS

It is not exactly as precise as depicted in spy novels, but modern satellites can detect and identify objects on Earth that are even smaller than one meter in size.[23] As such, satellite imagery has become a staple for industries such as agriculture, urban planning, mining and disaster assessment, as well as an innovative tool for technologically savvy litigators.[24]

While remote sensing data can be gathered from aircraft, they are more commonly obtained from satellites in orbit above the Earth.[25] The satellites have on-board navigational systems, and some are assisted by the global positioning system (GPS).[26] They transmit data back to receiving stations on Earth in digital format.[27]

It is important to recognize that satellite data provide information that is very different from that provided by traditional photography shot to film. Earth observation data from satellites are collected in digital form, and, in most cases, will never be used in the form of a photograph.[28] Satellite image production begins when digital data are transmitted from the satellite to a ground-based

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[23] According to L3 Communications, a leading satellite data provider, as of 2021 the highest maximum resolution commercially available was .03 meters. *High Resolution Satellite Imagery*, L3HARRIS GEOSPATIAL, https://www.l3harrisgeospatial.com/Data-Imagery/Satellite-Imagery/High-Resolution (last visited Apr. 14, 2021).

[24] In State v. Perry, No. E1999-00271-CCA-R3-CD, 2000 Crim. App. LEXIS 688 (Tenn. Crim. App. Sept. 5, 2000), the defendant was convicted of two counts of possession of cocaine within 1000 feet of a school and possession of marijuana. At trial, the State proved that the initial stop and defendant's residence were both within 1000 feet of a school through the testimony of Jeff Fleming, a city employee. Fleming testified that he was Manager of GIS for the city, and that as such he was in charge of using and applying a computer mapping system to assist with planning of city projects, and used GIS program to identify a 1000-foot buffer zone around each school." *Id.* at *8. On appeal, the court affirmed the defendant's convictions and sentences. *Id. See also* United States v. Lopez-Lopez, 282 F.3d 1 (1st Cir. 2002) (Customs Service agent could testify as expert in drug case to explain how drug importation schemes use the OR a Global Positioning System to facilitate air drops and boat-to-boat transfers); Johnson v. Hamrick, 155 F. Supp. 2d 1355 (N.D. Ga. 2001), *aff'd*, 296 F.3d 1065 (11th Cir. 2002) (black citizens brought action challenging city's at-large system for electing city council; plaintiffs tendered an expert who used GIS software to create a proposed districting system).

[25] *See* Rychlak et al., *supra* note 3, at 213-14.

[26] RONALD J. RYCHLAK, REAL AND DEMONSTRATIVE EVIDENCE: A REAL WORLD PRACTICE MANUAL FOR WINNING AT TRIAL 642-43 (4th ed. 2022).

[27] *Id.*

[28] *Id.*

receiving station and recorded onto a server or hard drive.[29] Data are archived at central distribution facilities and made available for purchase as raw data, corrected data or photographic representations of the data.[30]

The data can then be turned into effective exhibits with the use of a Geographic Information System (GIS).[31] A GIS is a framework for gathering, managing and analyzing data.[32] Developed out of the science of geography, GIS integrates various types of data.[33] By analyzing spatial location along with layers of information into visualizations using maps and 3D scenes, GIS provides insights into patterns, relationships and situations.[34] This information can be very valuable to scientists, business people, farmers and lawmakers, as well as the judicial system. GIS has long been used by professional mapmakers. Today, reasonably affordable computer

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[29] Rychlak et al., *supra* note 3, at 213-14.

[30] Raw data are information as initially detected by the sensor. Corrected data are adjusted for atmospheric and geographic shifting. For instance, the SPOT Historical archives contain images received in 1999 from the SPOT IMAGE Corporation. The French space agency, Centre National d'Etudes Spatiales (CNES), owns and operates the SPOT satellite system, but worldwide commercial operations are anchored by private companies (i.e., SPOT IMAGE Corp. of the United States). The photographic products for sale by SPOT are derived from corrected data. *See* Howard A. Latin et al., *Remote Sensing Evidence and Environmental Law*, 64 CALIF. L. REV. 1300, 1317 (1976). *See generally* Earth Resources Observation and Science (EROS) Center, *USGS EROS Archive - Commercial Satellites - SPOT Historical ACTIVE* (July 12, 2018) https://www.usgs.gov/centers/eros/science/usgs-eros-archive-commercial-satellites-spot-historical (last visited Dec. 31, 2022).

[31] *See* EVIDENCE FROM EARTH OBSERVATION SATELLITES: EMERGING LEGAL ISSUES, *supra* note 22. *See also* Waltraud Baier, et al., *Introducing 3D Printed Models as Demonstrative Evidence at Criminal Trials*, 63 J. FORENSIC SCIENCES 4 (July 2018) (noting the traditional thought that 3D printed models generally adequately represent anatomical features but are not sufficiently accurate to take measurements directly from, but noting that technologies have developed, and it may be possible to take highly accurate measurements from 3D models in the near future).

[32] The GIS system is computer-based and uses digital mapping information. Features such as land use and land cover, roads, zoning, threatened and endangered species habitat, streams and wetland coverages are all stored independently as a separate coverage or layer. The GIS system allows the user to select different coverages and layer them over each other to perform land use planning analyses.
In re Adoption of N.J.A.C. 7:15-5.24(b), 420 N.J. Super. 552, 561 (App. Div. 2011). *See also Wyoming v. U.S. Dept. of Agric.*, 661 F.3d 1209 (10th Cir. Oct. 21, 2011) (involving GIS maps depicting National Parks).

[33] *What is GIS? A Spatial System that Creates, Manages, Analyzes, and Maps All Types of Data,* ESRI, https://www.esri.com/en-us/what-is-gis/overview (last visited Dec. 31, 2022].

[34] *Id.*

software and hardware put its capabilities within the reach of any moderately ambitious computer operator.[35]

GIS offers the ability to link a variety of data (tabular, spreadsheet, database or other attribute information) and display the information based on various features.[36] Mapping the locations of elderly persons might, for instance, reveal those areas where special services are needed. Mapping customers' homes and work locations can help banks decide where to locate their automated teller machines. Mapping migration routes of birds may help protect endangered species. Mapping crime scenes can help reveal where there may be a need for increased police patrols or extra security for businesses.[37]

With the use of color, even more patterns may be brought out. For instance, an exhibit featuring accidents on a stretch of highway might start with a map of the highway. GIS might be used to mark locations of known accidents and they could be color-coded based upon the time of day when they occurred. One color might locate those accidents that took place in the morning, a second for those that occurred during the day, and a third might be used for the

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[35] Although GIS has many attractive features in the context of legal applications, there are still physical and technical restraints that can limit its usability as evidence. The central point is that, even if digital maps obtained via satellite leave small room for human error with respect to the production of the image, said room is much larger when we are dealing with interpreting the image. This means that, in practice, in those cases where satellite technology is used as evidence, judges are relying on the opinions of experts—who have been called to interpret the information—and not directly on the satellite information itself. Sylvia Maureen Williams, *La Información Satelital Como Prueba En Litigios Nacionales e Internacionales*, 75 REVISTA DEL COLEGIO DE ABOGADOS DE LA CIUDAD DE BUENOS AIRES 153 (2015). *See also* Leopoldo M. Godio, *Satellite Images and Data as Evidence in Local Administrative and Judicial Processes. Some Debates on its Admissibility and Autonomy,* EN LETRA, 181-195 (Aug. 2014) http://www.todaviasomospocos.com/aportes/las-imagenes-y-datos-satelitales-como-medios-de-prueba-en-procesos-administrativos-y-judiciales-locales-algunos-debates-sobre-su-admisibilidad-y-autonomia/.

[36] RYCHLAK, *supra* note 26, at 648 n. 25 ("In the simplest terms, GIS is the merging of cartography, statistical analysis, and database technology. Google Maps or Google Earth images are a composite of images and data captured at different times using satellites, aerial photographs, and remote sensing geographic information systems. They are not always current, and they may have limited resolution.")

[37] For a fascinating remote-sensing investigation of a twenty-year-old crime, *see* Carl Walter, *In the Pursuit of Justice and Closure, Twenty Years Later*, ESRI (Nov. 1, 2018), https://www.esri.com/about/newsroom/blog/gone-twenty-years-but-not-forgotten/.

night. This could reveal complex patterns that would otherwise be overlooked.

GIS software has become almost as user-friendly as word processing programs. The underlying digital maps and attribute data for different applications are widely available either for free or for a minimal charge.[38] These systems can overlap different map layers to create a trial exhibit that presents detailed information in an interesting, easy-to-understand way.

For courtroom purposes, if information is superimposed on a backdrop of an aerial photograph or satellite image, both of which are readily available from the federal government, an exhibit can give an extremely convincing presentation of a particular location. Furthermore, if the location of persons, substances, structures or property lines are further corroborated by Global Positioning System (GPS) "fixes," or the location of known geographical landmarks, the presentation gives a more-or-less irrefutable foundation or backdrop for the location of points of interest that are relevant to the offering party's case.[39]

In cases where there has been a release of gas, flood damage, or an oil or chemical spill, an aerial photograph or satellite image can be enhanced by merging it with GIS data so that the plume of gas or the oil slick can be seen in relation to the other matters.[40] This type of environmental exhibit can also be used effectively in mass tort actions, class actions and similar matters.[41] Because these exhibits are based on aerial photographs, real-time video, satellite images and mathematical models, they usually are easy to verify and have admitted into evidence.

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[38] *See* GISGeography, *13 Free GIS Software Options: Map the World in Open Source* (last updated May 29, 2022), available at (last visited Dec. 31, 2022).

[39] Scott D. Makar & Michael R. Makar, Jr., *Geographic Information Systems: Legal and Policy Implications*, 69 FLA. BAR J. 44, 44 (1995) (citations omitted).

[40] Andrew C. Wilson, et al., *Tracking Spills and Releases: High-tech in the Courtroom*, 10 TUL. ENV'T L.J. 369, 371 (1997). *See* Sharon Hatch Hodge, *Satellite Data and Environmental Law: Technology Ripe for Litigation Application*, 14 PACE ENV'T L. REV. 691 (1997), citing Warren Ferster, *Courts Learning Strengths of Remote-Sensing Imagery*, SPACENEWS, Jan. 16-22, 1995, at 19; Purdy & Macrory, *supra* note 6.

[41] Bloomberg Law, *Insight: Geographic Information Systems for Environmental Litigation* (Sept. 18, 2018) https://news.bloomberglaw.com/environment-and-energy/insight-geographic-information-systems-for-environmental-litigation.

III. PREPARATION OF THE EXHIBIT

A. Finding the Data

Since the National Oceanographic and Atmospheric Administration (NOAA) issued the first operating license in 1993,[42] several American companies have placed commercial remote sensing satellites into orbit.[43] Imaging companies now have high-resolution commercial satellites that provide a steady source of imagery data for a broad range of commercial and government customers.

If a satellite image exhibit might be of benefit to a case, it is crucial to examine this possibility as early as possible. The purchase price of raw satellite data, image processing costs and expert fees for interpretation and testimony can be substantial. As such, these costs should be considered before making commitments. Fortunately, a great deal of information is available to practitioners which enables the preparation of very persuasive exhibits at reasonable expense.

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[42] Under the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (Outer Space Treaty), private U.S. entities in outer space require the "authorization and continuing supervision" of the United States Government. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, art. VI Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty]. In the United States, the Land Remote Sensing Policy Act of 1992 (51 U.S.C. 60101 et seq.) authorizes the Secretary of Commerce to fulfill this responsibility by issuing and enforcing licenses. The Secretary's authority is currently delegated to the NOAA Assistant Administrator for Satellite and Information Services. Regulations.gov, *Licensing of Private Remote Sensing Space Systems*, posted by the National Oceanic and Atmospheric Administration on May 13, 2019, available at https://www.regulations.gov/document/NOAA-NESDIS-2018-0058-0011(last visited Dec. 31, 2022) ("Under its regulations implementing the Act, found at 15 CFR part 960, NOAA has issued licenses for over 1,000 imaging satellites.") See also Center for Strategic & International Studies, *Commercial Space Remote Sensing and Its Role in National Security* (Feb. 2, 2022) https://www.csis.org/analysis/commercial-space-remote-sensing-and-its-role-national-security.

[43] There are thousands of satellites in the sky above us at this moment, orbiting Earth. Satellites have many uses for the government, military, and even civilians. They provide us the ability to have things like Internet access, television, GPS, and much more. They also have scientific purposes such as Earth and space observation and provide the means for high-level technology development. More than half of the 4,550 satellites orbiting Earth are used for communications purposes . . .
DEWESoft, *Every Satellite Orbiting Earth and Who Owns Them* (Jan. 18, 2022) https://dewesoft.com/daq/every-satellite-orbiting-earth-and-who-owns-them (identifying the 50 owner/operators of the most satellites orbiting earth).

Digital maps and usable data for many projects are available from several sources, either for free or for a nominal charge. For example, the US Geological Survey (part of the Department of the Interior) lists a variety of geological information, such as maps showing locations of earthquakes, oil discoveries and much more at their web site—usgs.gov. The Department of the Interior also has a site called *Earth Explorer* that provides access to maps of the US and the various individual states. With some basic navigation, visitors to the site can display maps illustrating data such as relative income, crime rates, cancer, agriculture output and more in different parts of the nation and particular states.[44]

Although it is unlikely, an attorney might get lucky and find that satellite data was collected at the precise time relevant to a legal case. For instance, in *ANR Production Co. v. M/V Mekhanik Dren*,[45] satellite photographs taken 34 minutes before and four minutes after a collision between a ship and an oil platform off the coast of Dubai, United Arab Emirates, precisely showed the weather conditions in the vicinity at the time of the accident, which helped resolve the case.

Even if data of that quality is not available, relevant archived photos or even older, public domain images may be available. However, attorneys should not wait too long to find this data, or there is the risk of not having all exhibits prepared in time. Moreover, circumstances may have changed dramatically since the incident making it difficult to locate archived images and impossible (or at least very difficult and expensive) to create a new exhibit.

B. Obtaining the Right Data

When contracting with an imaging company to prepare an exhibit, an attorney should be sure to discuss the case in detail. Experts may have ideas, but the attorney is in control and must deliver the right level of precision as well as give clear instructions about the size of the geographic area to be presented. Effective exhibits show the important features but do not distract with

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[44] *See Maps*, USGS, https://www.usgs.gov/products/maps/overview (last visited Apr. 15, 2021).

[45] *ANR Prod. Co. v. M/V Mekhanik Dren*, No. G-87-304, 1989 WL. 180064 (S.D. Tex. July 14, 1989) (case arose from damages to an oil platform sustained from the collision with defendant's ship).

irrelevant details. If there are several important features the jury needs to see and understand, the use of more than one exhibit may be necessary. The exhibits should be constructed so that each one focuses on different important details.

An image created with satellite data can be very cost-efficient, depending on the area of coverage required, the type of information needed, the age of the image and the means of display. Sometimes, cost will not be the most important concern because remote sensing may be the *only* way to prove a point.[46] This is particularly likely if the satellite archive contains the only image of the scene on a critical date and time.

C. Evidentiary Concerns

From an evidential weight point of view, there are three important stages in the use of images: creation, transmission, and storage.

i. Image Creation

When an image is created, information needs to be captured as part of an image identification process. For example, it may be necessary to prove the time at which the image is captured, the location of the scene being captured and the location of the capture system. Processes must be in place to preserve this information (image metadata) and demonstrate accuracy. Such processes may depend upon accurate time clocks and GPS systems.

ii. Image Transmission

Once an image has been created, it needs to be transferred to a storage system. As part of the evidential weight issue, it may be necessary to demonstrate that the storage system received the image and the associated metadata without significant

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[46] Commercial satellite systems provide data from various channels of the electromagnetic spectrum and have worldwide coverage at regular intervals. *See* Jeffrey Bardin, *Satellite Cyber Attack Search and Destroy in* CYBER SECURITY AND IT INFRASTRUCTURE PROTECTION, (John R. Vacca. ed. 2014), https://www.sciencedirect.com/book/9780124166813/cyber-security-and-it-infrastructure-protection. *See also* DAVID S. WILKIE & JOHN T. FINN, REMOTE SENSING IMAGERY FOR NATURAL RESOURCES MONITORING 46 (1996); Purdy & Macrory, *supra* note 6.

loss/corruption. It may also be necessary to authenticate the source of the images using a secure identification process.

iii. Image Storage

Finally, once captured within a storage system, it may be necessary to demonstrate that the images have not been compromised during storage. This involves a review of the security processes applied to the storage system, including virus protection and accidental/deliberate actions related to the technology implementation and to the organizational processes applied to the systems. There may also be issues where images are moved from one storage system to another (migration) or from one storage format to another (conversion).[47]

IV. PROCESSING SATELLITE DATA

A. Not "True" Photographs

While it is tempting to think of satellite imagery in terms of photographic prints, it is important to recognize that the data from satellites provide information that is very different from that provided by traditional photography.[48] Satellite data is produced in digital form and, in most cases, it will never be used in the form of a traditional photograph.[49]

The operator of a geographic information system (GIS) receives the satellite data and analyzes it along with multiple layers of data of the same scene from other sources.[50] In this way, GIS

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[47] *See generally,* EVIDENCE FROM EARTH OBSERVATION SATELLITES: EMERGING LEGAL ISSUES, *supra* note 22.

[48] That is why an officer mis-read a satellite photograph and, as a result, the search warrant erroneously described the target building's color. State v. Spivey, No. W2010-01853-CCA-R3-CD, 2011 WL 4346653 (Tenn. Crim. App. Sept. 19, 2011).

[49] In fact, a true "photographic" type of exhibit taken from that altitude of a satellite would not be very helpful. Details would be lost and it might end up confusing the jury. Traditional photography is limited to a spectral range much more narrow than multispectral satellite data. At best, photographic systems have a spectral range of 0.4 to 1.3mm, whereas multispectral scanners found on satellite systems range from 0.3 to 12.5 and beyond. *See* WILKIE & FINN, *supra* note 46, at 21 tbl. 2.4, 65, 265, 273.

[50] A geographic information system, geographical information system, or geospatial information system is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographically referenced data. In the simplest terms, GIS is the merging of cartography, statistical analysis, and database technology. Google Maps or

technology complements satellite imagery by integrating diverse data from satellite and aerial imagery, digitized maps, tabulated information and other digital data into one single exhibit.[51] By combining this data and using the global positioning system databases, attorneys and their experts can prepare highly visual and persuasive exhibits that look like traditional charts, maps or other drawings.[52] The results can be displayed on a screen, monitor or in hard copy format.[53]

B. Data Subject to Alteration

Although remote sensing and other digital image data have proven to be valuable as evidentiary tools in enforcement actions and alternative dispute resolution, evidentiary concerns remain. Satellite data is digital data, which means it is subject to alteration. Moreover, although this is not true photographic evidence jurors

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Google Earth images are a composite of images and data captured at different times using satellites, aerial photographs, and remote sensing geographic information systems. See Walters v. State, 206 So.3d 524, 526 (Miss. 2016) (court did not err in admitting Google Earth images of property, because the State made a *prima facie* showing that they accurately depicted the property on the dates at issue); Commonwealth v. Suarez-Irizzary, 15 Pa. D. & C. 5th 106 (C.P. Aug. 6, 2010), in which the court concluded that the police officer's prior calibration of Google Earth maps, finding them accurate to within one foot of his actual measurements on the ground, were sufficient to allow the officer to testify to his computer-generated satellite-based distance calculations in this case.

[51] Raw data are processed, or enhanced, for several reasons: (1) to clarify the visible contents; (2) to emphasize features without significantly altering the content of the data; and (3) to classify into a discrete number of surface feature categories from the values possible from the scanner. Wyoming v. U.S. Dep't of Agric., 661 F.3d 1209 (10th Cir. 2011) (involving GIS maps depicting National Parks).

[52] The exhibit might include information derived from satellite imaging, aerial photographs, land-based photography, eyewitnesses, scientific models developed by expert witnesses, or other sources. The idea is to be as accurate as possible while remaining persuasive and uncluttered. Imaging firms known as value-added resellers (VARs) buy and resell data for international satellite systems and convert the raw remotely sensed data into exhibits tailored for their customers' requirements. *See*, e.g., Surfrider Found. v. Dalton, 989 F. Supp. 1309 (S.D. Cal. 1998) ("The GIS surveys are digitized documents that draw from 60 years of aerial photographs, 70 years of water resource data, and 25 years of natural and cultural data.")

[53] "The GIS system is computer-based and uses digital mapping information. Features such as land use and land cover, roads, zoning, threatened and endangered species habitat, streams and wetland coverages are all stored independently as a separate coverage or layer. The GIS system allows the user to select different coverages and layer them over each other to perform land use planning analyses." *In re* Adoption of N.J.A.C. 7:15-5.24(b), 420 N.J. Super. 552 (App. Div. 2011).

might come to think of it as such, therefore there is a higher chance of prejudicial impact than is common with other exhibits. As a result, "[t]he admissibility of remote sensing information must be examined within the context of the general requirements for admission of scientific evidence and expert opinion."[54]

Processing satellite data to enhance the clarity of the final product is common, and it usually involves the application of mathematical algorithms that cluster the pixel values representing the edges of two surface features.[55] Essentially, the data is corrected geometrically and adjusted for atmospheric interference.[56] In other words, this kind of process does not impair the validity of the image. In fact, since the processes are mathematically-based and do not involve subjective manipulation, they actually make the exhibit *more* reliable.[57] Traditional photographs have long been used as evidence and are routinely admitted, even though there is a development process that the film has to go through.[58]

In addition to processing for clarification, satellite data may be enhanced, emphasizing particular features by adjusting pixel values.[59] This is essentially akin to highlighting a particular area of the exhibit. Attorneys must exercise care so that this is not done in a misleading way. However, done properly, this can create a very effective, admissible exhibit.

Unfortunately, satellite data is also susceptible to the kind of manipulation that could render an exhibit "very convincing indeed—yet very inaccurate."[60] An expert witness must be able to authenticate the data and explain how the image was created.[61] In

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[54] Latin et al., *supra* note 30, at 1304.

[55] RYCHLAK, *supra* note 26, at 649.

[56] *See* THOMAS M. LILLESAND & RALPH W. KIEFER, REMOTE SENSING AND IMAGE INTERPRETATION 558-59 (4th ed. 2000).

[57] *See* Bruce S. Marks, *Dispute Resolution in the Space Age: Forensic Applications of Earth Observation Satellite Data Through Adaptation of Technical Standards Similar to DNA Fingerprinting Protocols*, 5 OHIO STATE J. ON DISP. RESOL. 19, 51 (1989).

[58] *See also* Hodge, *supra* note 40 (noting that the EPA generally prefers to use photographs as compared to images produced from digital data due to the requirements for proving chain of custody and assuring that the images have not been manipulated.) *See also* Rychlak et al., supra note 3 (setting forth a new approach for government use of digital photos and the resulting change in chains of custody).

[59] *See* Latin, *supra* note 30, at 1440-41.

[60] Jon L. Roberts, *Admissibility of Digital Image Data & Animations: Courtroom Concerns*, ADVANCED IMAGING 105 (Aug. 1995).

[61] *See* FED. R. EVID. 702.

other words, he or she must be able to explain the processing that was done and justify it. In the end, satellite imagery should be admissible and persuasive if proper procedures are followed.

V. FOUNDATION FOR ADMISSION

Courts are already familiar with aerial photographs. Like other photographs, they are admitted if relevant, accurate and a proper foundation is laid.[62] Satellite images are similar. They can assist a jury in understanding the issues and help maintain interest in explanations of complex information. Observations by witnesses, photographs or other evidence, known as "ground-truthing," may be an additional method to not only authenticate the remote satellite imagery, but also provide the court with more familiar forms of evidence that may tend to corroborate the satellite information and make admission more likely.[63] In addition, these pictures are often the only evidence that fully captures an event.[64]

In order to use satellite data, an attorney must: qualify the expert witnesses; authenticate and prove the contents of the data; and establish that proper and accepted digital imagery processing techniques were used. The need for the latter two steps arises particularly because satellite data are almost always manipulated.

By itself, information from space data can be impossible to understand and would certainly not be useful as an exhibit. With GIS technology, however, data can be enhanced to bring out features of

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[62] Hubert v. City of Marietta, 164 S.E.2d 832, 834 (Ga. 1968) (foundation laid when knowledgeable witness testified that aerial photograph was accurate); Dillon v. Reid, 717 S.E.2d 542 (Ga. App. Ct. 2011) ("Notwithstanding that he did not have the exact same aerial view as the tendered photographs, Brad Reid explained the basis for his testimony as to the date of the photographs, and he testified that the photographs accurately depicted those locations as of those time periods. Accordingly, it was within the broad discretion of the trial court to allow the photographs to be introduced….")

[63] EVIDENCE FROM EARTH OBSERVATION SATELLITES: EMERGING LEGAL ISSUES, *supra* note 22, at 84.

[64] *See, e.g., NutraSweet*, 227 F.3d at 788 (plaintiffs used aerial photographs to establish the dumping sequence in which Volatile Organic Compounds were dumped on X-L's land and then migrated through the groundwater onto NutraSweet's land); St. Martin v. Mobil Expl. & Producing U.S. Inc., 224 F.3d 402 (5th Cir. 2000) (plaintiffs introduced aerial photographs to show open ponds produced by the oil companies that were eroding their marsh, presenting a series of photographs that showed the progression of the deterioration of the marsh).

interest.[65] Judges understand that this must be done and jurors will also accept it, but these processes leave the data open to potential misuse. Therefore, in addition to the relatively easy task of having a qualified expert authenticate the contents of the data, an attorney must prove that proper, accepted digital imagery processing techniques were employed.[66] An attorney must also trace its chain of custody to prove that it was not later manipulated or altered.

In general, the reliability of evidence derived from a scientific theory or principle depends on: 1) the validity of the underlying theory, 2) the validity of the technique applying that theory, and 3) the proper application of the technique on a particular occasion.[67] This includes: ensuring the proper working order of instrumentation; following proper procedures; and employing properly qualified persons using the technique and interpreting the results. Federal Rule of Evidence 901(B)(9) allows "[e]vidence describing a process or system used to produce a result and showing that the process or system produces an accurate result."[68] This may be established by testimony that the satellite data collection company and the transporter properly handled the data and that the expert who processed and interpreted the data used an approved scientific method.

It is necessary to have a witness(es) who can: 1) testify about the accuracy and reliability of the technology, the equipment and the processing techniques; 2) certify the data supplier's possession and transfer of custody of the images prior to trial; and 3) reference more conventional data (aerial photographs, maps) and other factors that dispel the fear of manipulation of the images. The best witnesses, of course, would be able not only to authenticate the data but also to explain it in a manner that the average juror can understand.

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[65] Unlike the satellite data, GIS data consist of an accumulation of governmental data bases. In other words, these data are essentially business or public "records" or a "data compilation" such that they should satisfy the hearsay exceptions set forth in Rules 803(6) and 803(8). *See* United States v. Asarco Inc., 214 F.3d 1104 (9th Cir. 2000) (GIS database was part of the EPA's administrative record). At the same time, since GIS is not scientific evidence but rather a form of map, "the test for its admissibility should be whether it accurately represents what it purports to represent." Commonwealth v. Al Hamilton Contracting Co., 665 A.2d 849, 852 (Pa. Commw. Ct. 1995). *See* Marks, *supra* note 57.

[66] *See* Marks, *supra* note 57, at 49-50. *See also* Roberts, *supra* note 60, at 165.

[67] PAUL C. GIANNELLI & EDWARD J. IMWINKELRIED, SCIENTIFIC EVIDENCE 1-2 (1993).

[68] FED. R. EVID. 901(b)(9).

An authenticating witness does not have to be a programmer involved in developing software, but he or she must be familiar with the field and office procedures that produced the exhibit and be able to explain why errors and mistakes are unlikely to have crept into the system.[69] The data suppliers should be able to certify that proper, accepted digital imagery processing techniques were employed and that the satellite images were produced by the data processor in a routine way.[70]

VI. ANTICIPATING OBJECTIONS

A. Generally

Satellite images can be presented as substantive evidence in charts, summaries or calculations and introduced as summary evidence under Federal Rule of Evidence 1006.[71] The data may also be presented as an illustration of a witness's testimony.[72] If an enhanced image is submitted as independent evidence (as opposed to an illustration of testimony), the best evidence rule applies, and the data must be authenticated.[73] Attorneys should consider local court rules and be sure to preserve the exhibit for the record. Attorneys should also expect a hearsay objection when the images produced from digital data are offered in court for the truth of the matter asserted.[74] With some advance planning,[75] however, an attorney should be able to overcome this objection.

Other objections to anticipate regarding exhibits (or to consider regarding an opponent's exhibits) include the credentials of

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[69] *See* Velsicol Chem. Corp. v. State, 442 A.2d 1051 at 1052, 1054 (N.J. Super. Ct. App. Div. 1982) (finding "maps and overlays showing the incidence of mean high tide flow, based upon infrared aerial photographs," which were themselves based upon a report of natural color photography and of field observation, insufficient to sustain State's burden of proof where no witnesses responsible for preparation of the report testified to the application of biological methodology, or the gathering, collating and analysis of scientific data.)

[70] FED. R. EVID. 406. *See also* Carole E. Powell, *Computer Generated Visual Evidence: Does Daubert Make a Difference?*, 12 GA. ST. UNIV. L. REV. 577, 585 (1996).

[71] *See* ARMY REGULATION 15-6: PROCEDURES FOR ADMINISTRATIVE INVESTIGATIONS AND BOARDS OF OFFICERS, ARMY PUBL'G DIRECTORATE (2016). *See also* Purdy & Macrory, *supra* note 6.

[72] *See* Latin, *supra* note 30, at 1441.

[73] FED. R. EVID. 901(b)(9).

[74] Hodge, *supra* note 40; Purdy & Macrory, *supra* note 6.

[75] See, e.g., RYCHLAK, *supra* note 26, at 164 ("Planning in Advance for Objections").

the expert offering the testimony, the procedures used to manipulate the data and whether the techniques used in evaluating data are generally used by the profession.[76] Objections can also relate to distortion, over- or under-inclusion of details or inclusion of details that are beyond the capabilities of the GIS operator. If the foundation has been established, all of these matters should have been disposed of during the operator's testimony. Attorneys should make certain that the images created for presentation at trial, like all other testimony aids, are not overly "argumentative." Suggestive colors or labels should be avoided. If there is anything unusual about the scale or the way the scale is represented, it must be addressed when laying the foundation. Properly handled, this should help avoid any serious problems.[77]

It is instructive to review examples of problems that arise when attempting to lay the foundation for a satellite data-created exhibit. According to retired Vermont judge, Merideth Wright, a 2008 case brought in New York, raised the question of whether certain wetlands had been modified due to excavation or dredging.[78] The plaintiff's expert compared two sets of aerial photographs, one from 1994 and the other from 2001.[79] Both had been taken by the US Geological Survey and both were stored in digital form as data sets.[80] The expert attempted to explain that he had processed both sets into photographic form, enhancing certain spectra characteristic of vegetation so that the ditches or tracks of heavy machinery would be more visible.[81] Although the witness explained that the

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[76] Roberts, *supra* note 60, at 161. Of course, relevancy is always a concern. *See generally id.* at chapter 6.

[77] Why should terrestrial photographic evidence, collected three years after commission of the offence, be accepted over high-resolution EO imagery captured just after clearing has occurred? Accurate measurements can readily be taken from geo-referenced EO images but this is not the case for terrestrial photographs taken using non-professional cameras. *See generally* EVIDENCE FROM EARTH OBSERVATION SATELLITES: EMERGING LEGAL ISSUES, *supra* note 22.

[78] Merideth Wright, *The Use of Remote Sensing Evidence at Trial in the United States—One State Court Judge's Observations*, in EVIDENCE FROM EARTH OBSERVATION SATELLITES: EMERGING LEGAL ISSUES, *supra* note 22, at 315, (*citing* her conversation with plaintiffs' attorney Karl S. Coplan, September 23, 2011 and Peconic Baykeeper v. Suffolk County, N.Y., CV-04-4828 (ADS) (U.S. Dist. Ct., E.D.N.Y.)(trial transcript 615–639, April 24, 2008)).

[79] *Id.*

[80] *Id.*

[81] *Id.*

technique is common and done in order to "enhance or amplify" the contrast between the land and the water surfaces, he used the term "false color photograph."[82] The judge did not "understand how these photographs were conceived," and he concluded that "[t]his enhancement of the information, enhancement of the color, false colors, all of this is disturbing and would indicate to me that these photographs are not admissible..."[83]

B. Chain of Custody

Under Federal Rule of Evidence 901(a), the chain of custody must be shown when the condition of the evidence is at issue.[84] This *can* be an issue when the evidence is satellite data. To establish the chain, it is necessary to show: 1) the accuracy and reliability of the data, including all formulas, calculations and assumptions used in defining and analyzing it, 2) the accuracy of the data as it was entered into the computer, 3) the reliability and capability of the computer hardware and software, 4) the process of software used for the computer graphics and 5) the reliability of the final presentation. Links in the chain can usually be supported with certification of the data by the data supplier.[85]

Experts who process the data are probably in the best position to describe the system used to produce the exhibits. They are probably also in the best situation to lay the chain of custody and thereby establish the foundation.[86] The data suppliers should be able to demonstrate that data security within the workplace was maintained at all times. If the court requires proof that the evidence is what it purports to be, proof can be provided by reference data gathered on the ground, traditional aerial photographs and maps.[87]

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[82] *Id.*

[83] *Id. See* Peconic Baykeeper, Inc. v. Suffolk County, 600 F.3d 180 (2d Cir. 2010).

[84] FED. R. EVID. 901(a)

[85] Hodge, *supra* note 40; Purdy & Macrory, *supra* note 6.

[86] In Velsicol, the court found that maps and overlays which showed the incidence of mean high tide flow, based upon infrared aerial photographs, and which were based upon a report of natural color photography and of field observation was insufficient to sustain State's burden of proof where no witnesses responsible for preparation of report testified to application therein of biological methodology, its gathering, collating and analysis of scientific data. Velsicol, 442 A.2d at 1052.

[87] *See* LILLESAND & KIEFER, *supra* note 56, at 23-26. *See also* Bayou Des Familles Dev. Corp. v. U.S. Corps of Eng'rs, 541 F. Supp. 1025 (E.D. La. 1982) (expert used remote sensing to show indications of wetland hydrology).

In addition, Federal Rule of Evidence 406 can be used to support the chain of custody.[88] Finally, a chain of custody document (manifest) can be developed which allows a supervisor to confirm the chain.

C. Illustrating Testimony

If all else fails, and an exhibit is inadmissible due to failure to meet a hearsay exception or failure to meet authentication requirements, it may still be possible to use it to illustrate the testimony of witnesses. In fact, this is usually the easiest way to use such an exhibit.[89]

VII. SPECIAL CONCERNS

A. Privacy, National Security and Admissibility

Data with limited pixel clarity have been used for a long time to monitor agriculture and forestry. Using GIS to combine social and economic data with Earth Observation (EO) data creates the potential to identify individuals and their characteristics from the interpretation of databases.[90] Today, with ultra-high-resolution data, individual privacy issues have become a significant concern.[91]

The admissibility of domestic satellite evidence that might otherwise be considered confidential was addressed in the landmark case of *Dow Chemical Company v. United States*.[92] In that

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[88] FED. R. EVID. 406 (Routine Practice of Person or Organization).

[89] In *State ex rel. J.B.*, No. FJ-19-337-08, 2010 WL 3836755 (N.J. Super. Ct. App. Div. Sept. 27, 2010), a juvenile was accused of burglary. The prosecutor sought to show the juvenile's location at time of the burglary by showing that cell phone calls made by him at the time of the burglary were routed through a tower closer to the burglarized residence rather than through a tower closer to the juvenile's own residence. Satellite photographs generated by Google Earth were allowed because they were not being offered as substantive proof of the distances between the residences and the cell towers, but merely as illustrative aids to the witness' testimony. *See also* Swayden v. Ricke, No. 103250, 2010 WL 4977158 (Kan. Ct. App. Nov. 19, 2010).

[90] See Meenal Dhande, *Integrated Earth Observation and Geospatial Information: Empowering SDGs*, GEOSPATIAL WORLD (Jan. 24, 2017), https://www.geospatialworld.net/blogs/earth-observation-geospatial-information-sdgs/. *See generally* JONATHAN WILLIAMS, GIS PROCESSING OF GEOCODED SATELLITE DATA (2001).

[91] The current maximum resolution commercially available is 0.3 m. *See High Resolution Satellite Imagery*, *supra* note 23.

[92] Dow Chem. Co. v. United States, 476 U.S. 227 (1986).

case, Dow objected to the use of aerial photography that provided excellent, detailed images of a large industrial complex.[93] The Court focused on Dow's expectations of privacy. The trial court found aerial remote sensing more invasive than the human eye and concluded that the information that could be derived from the data violated Dow's expectation of privacy.[94] The Supreme Court, however, held that "the mere fact that human vision is enhanced somewhat ... does not give rise to constitutional problems."[95] The aerial search of a large industrial complex for investigatory purposes did not violate Dow's protection against warrantless searches or expectation of privacy.[96]

Nevertheless, sensors with the power to penetrate surfaces, rather than merely detect surfaces, may violate an individual's right to privacy. In *Kylo v. United States*,[97] the Supreme Court ruled that use of a device to detect the temperature of an exterior wall to detect criminal activity inside a home did indeed violate the fourth amendment to the Constitution.[98] Typical satellite-style remote sensing, however, uses sensors that merely detect surface energy and reflectance; it does not penetrate the sensed objects, structures or materials.[99]

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[93] *Id.* at 229, 238.

[94] *Id.* at 230.

[95] *Id.* at 238 (noting privacy expectations for the private residence are higher because that is the place of "intimate activities associated with family privacy," and the expectation of such privacy is not reasonably or legitimately extended to an industrial complex).

[96] In *State v. Jackson*, 46 P.3d 257 (Wash. Ct. App. 2002), the defendant was convicted of first-degree murder, and he appealed. The Court of Appeals held, in part, that: "in a matter of first impression, police installation of Global Positioning System (GPS) tracking device on defendant's vehicles did not offend either Fourth Amendment or state constitutional provision protecting a person's home and private affairs from warrantless searches; (4) seeking grant of judicial permission in form of search warrant to install GPS tracking devices on defendant's vehicles was appropriate." "Defendant's privacy interests were insufficient to require warrants, given that monitoring of his public travels in his truck by use of GPS device was merely sense augmenting, revealing open view information of what might easily have been seen from lawful vantage point without such aids."

[97] Kyllo v. United States, 533 U.S. 27 (2001).

[98] *Id.* at 40.

[99] It is possible that such information could violate Constitutional rights. In general, however, the type of information discussed in this chapter should not create problems along these lines. *See also* Yankton Sioux Tribe v. U.S. Army Corps of Eng'rs, 83 F. Supp. 2d 1047 (D.S.D. 2000). Some sensors can detect anomalies under the ground and other such information. *See* Kline v. Green Mount Cemetery, 677 A.2d 623 (Md. Ct. Spec. App. 1996) (petition to have the body disinterred from grave of John Wilkes Booth; a forensic

State v. Gordon,[100] involves a defendant who pled guilty to statutory rape, rape, taking indecent liberties with a child, assault and kidnapping. The sentencing court issued an order mandating that the defendant enroll in lifetime satellite-based monitoring under a state statute following his eventual release from prison.[101] The State made no showing as to the intrusion or the information that would be revealed under the program, whether the monitoring device in the future would be similar to those used now, or whether defendant would be on supervised or unsupervised release.[102] The order was vacated because the State could not establish that his submission to such monitoring would constitute a reasonable Fourth Amendment search in 15 to 20 years when he would be released from prison. Moreover, the State was unable to adequately establish the government's need for such search.[103]

National security and industrial trade secrets can also affect admissibility. Domestic security issues should not be of serious concern because commercial satellite data vendors in this country are required to hold a license from the Department of Commerce to operate a satellite system.[104] The licensing regime imposes restrictions on remote sensing system operators.[105] For example, courts have upheld federal regulations that restricted access to satellite data over militarily sensitive areas during Operation Desert Shield.[106]

Trade secret violations should be treated as an issue of privacy similar to the concerns for the individual.[107]

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scientist testified that ground-penetrating radar simply indicates an anomaly under the surface of the soil; it then becomes a question of interpretation); *Yankton Sioux Tribe*, 83 F. Supp. 2d at 1052 (remote sensing to find graves).IS THIS CITED CORRECTLY AND ITALICIZED CORRECTLY? IT IS CITED IN THIS FN ALREADY.

[100] State v. Gordon, 820 S.E.2d 339, 341 (N.C. Ct. App. 2018). *See also* Park v. State, 825 S.E.2d 147, 150 (Ga. 2019) (holding lifetime satellite-based monitoring of a sex offender unconstitutional where offender was no longer serving any part of his sentences).

[101] State v. Gordon, 820 S.E.2d at 248.

[102] *Id.* at 257-59.

[103] *Id.*

[104] 15 C.F.R. § 960.1 (2020).

[105] *See supra,* note 42 (reviewing the licensing process and citing to government programs that set forth the demands put upon licensees).

[106] *See* Nation Mag. v. U.S. Dep't of Def., 762 F. Supp. 1558, 1580 (S.D.N.Y. 1991); Students Against Genocide v. Dep't of State, 257 F.3d 828 (D.C. Cir. 2001).

[107] The Supreme Court of Indiana addressed concerns for trade secret protection involving the use of remote sensing in a 1993 case involving oil exploration. The trade

B. Fraudulent Images

An unusual cause for concern was revealed when a commercial satellite imagery company was investigated on suspicion of fraud for selling a bogus image purported to be taken at a critical moment of an alleged murder conspiracy. The company claimed that the image was made from satellite data, when in fact it turned out to be an aerial photograph taken at a time not relevant to the case.[108]

The company in question, Psytep Corporation supplied the Kansas Bureau of Investigations (KBI) with a photograph which helped convince a grand jury that two murder suspects lied about their whereabouts at the time a murder was committed.[109] The image came under suspicion when the KBI consulted with experts in remote sensing as to the resolution of the image.[110] Psytep claimed it could take data capable of 18-meter resolution and enhance it to a resolution of 2 to 5 meters.[111] When the KBI tried to verify the data in preparation for trial, agents began to suspect fraud.[112] Several experts told them that there was no commercial satellite capable of producing images of resolution high enough to detect automobiles.[113] When authorities concluded that the image was a fake, they dropped the indictments against the murder suspects.[114] Psytep's Chief Executive Officer pleaded no contest to false advertising.[115]

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secret protection issues in that case were the management decisions that led up to the use of remote sensing data and the focused geographic areas of the remote sensing investigation. *See* Amoco Prod. Co. v. Laird, 622 N.E.2d 912 (Ind. 1993).

[108] *See* Atsuyo Ito, *Improvement to the Legal Regime for the Effective Use of Satellite Remote Sensing Data for Disaster Management and Protection of the Environment*, 34 J. SPACE L. 45, 57 (2008) (*citing* Warren Ferster, *Firm Suspected of Misrepresenting Imagery*, SPACE NEWS, Jan. 16, 1995).

[109] *Id.*

[110] *Id.*

[111] *Id.*

[112] *Id.*

[113] *Id.*

[114] David Clouston, *Firm Pleads to Offering Fake Photo*, THE SALINA (KANSAS) J. (Dec. 20, 1995) https://www.newspapers.com/image/1893301/?clipping_id=31572728&fcfToken=eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJmcmVlLXZpZXctaWQiOjE4OTMzMDEsImlhdCI6MTY3MjU5OTU4NiwiZXhwIjoxNjcyNjg1OTg2fQ.wuHUatTXPMWuFsYNDoubmtmfI7RcQUXB29oW4KnHj0. *See also* Flynn v. Psytep Corp., 175 F.R.D. 691 (D. Kan. 1997) (voluntary dismissal of civil case against Psytep Corp.)

[115] Clouston, *supra* note 114. *See also* Terry Hatcher Quindlen, *Sale of Bogus Imagery Draws $50,000 Fine*, SPACENEWS, 2 (Jan. 8-14, 1996); Karen Geer, *The Constitutionality*

VIII. STILL A MEANS OF GETTING AT THE TRUTH

A. Timing, Modeling and Plumes

Although it is unlikely that a satellite will be directly overhead at the precise time a disaster or crime strikes, it sometimes does happen. Importantly, however, post-accident imagery can be very valuable even in cases where there is no image from the exact moment in question. It could be indispensable in mass tort litigation.

In most situations, the evidentiary value of satellite imaging will depend on having some form of pre-event imagery to serve as a comparative baseline. Imagery from space and airborne platforms already archived can provide a valid pre-accident baseline for most areas of the US. By comparing pre- and post-disaster images, it is possible to track the results of an event[116]—this is most commonly used with respect to oil spills and gas or smoke plumes.

Tracking of some plumes, especially chemical plumes, requires a more advanced technology, commonly called hyperspectral imaging systems. These systems use spectrographic analysis, which permits experts to use a mathematical equation or "model" to determine where the gas, smoke or chemical drifted following release.[117] A trial expert can also develop a colorized "plume model" depicting the release. In many situations, traditional satellite imagery can serve as a valuable backdrop that helps establish the geographic boundaries for a dramatic and persuasive exhibit.

Holli Riebeek notes satellite images "are like maps: they are full of useful and interesting information, provided you have a

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of Remote Sensing Satellite Surveillance in Warrantless Environmental Inspections, 3 FORDHAM ENV'T L. REP. 43 (1991).

[116] Smoke is sometimes visible by satellite imagery especially against a distinct background such as fresh snow, but until recently it was very hard to track plumes unless the plume was huge. The problem had to do both with resolution and frequency of a satellite fly over of the same spot. With better resolution and more frequent overflights, satellite tracking of smoke plumes and oils spills is easier today. When they are available, exhibits like this accurately depict the scene and are very persuasive.

[117] *See generally EPA Handbook: Optical and Remote Sensing for Measurement and Monitoring of Emissions Flux of Gases and Particulate Matter,* U.S. ENVIRONMENTAL PROTECTION AGENCY OFFICE OF AIR QUALITY PLANNING AND STANDARDS AIR QUALITY ASSESSMENT DIVISION MEASUREMENT TECHNOLOGY GROUP (Sept. 1, 2018) https://www.epa.gov/sites/default/files/2016-06/documents/gd-052.pdf.

key."[118] These images can show how a city has changed, how crops are growing, where a fire is burning and when a storm is coming. To unlock this information, you need to:

1. Look for a scale;
2. Look for patterns, shapes and textures;
3. Define the colors (including shadows);
4. Find north;
5. Consider your prior knowledge.[119]

These tips come from NASA Earth Observatory, whose mission is to "share with the public the images, stories, and discoveries about the environment, Earth systems, and climate that emerge from NASA research, including its satellite missions, in-the-field research, and models."[120] They are an excellent starting point when trying to examine what visualization options might be available.

B. Illustrative Cases: Adams, Avenal and Rivera

In *Adams, et al. v. Marathon Oil Co.*,[121] the court used a plume footprint to decide the parameters of the class of claimants who would be entitled to proceed in an action for damages suffered due to a release of an excessive level of a chemical odorant used in natural gas.[122]

Dr. Bruce Turner, an expert witness for the defense, used meteorological data, the testimony of fact witnesses, and reports with the Department of Environmental Quality to develop various diagrams of the path of the plume of ethyl mercaptan, which provided estimated concentrations of the substance in question.[123] He noted

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[118] Holli Riebeek, *How to Interpret a Satellite Image: Five Tips and Strategies*, NASA EARTH OBSERVATORY (Nov. 18, 2013) https://earthobservatory.nasa.gov/features/ColorImage.

[119] *Id.*

[120] *About the Earth Observatory*, NASA EARTH OBSERVATORY, https://earthobservatory.nasa.gov/about#:~:text=The%20Earth%20Observatory's%20mission%20is,%2Dfield%20research%2C%20and%20models (last visited Jan. 1, 2023).

[121] Adams v. Marathon Oil Co., 688 So.2d 75, 82 (La. App. 5 Cir. 1/15/97).

[122] *Id.*

[123] *Id.*

the highest concentration of ethyl mercaptan would be the area at the plant, around the sump at the time of its release.[124] Additionally, there were no indications of concentrations above 50 parts per billion off Marathon's property.[125] As such, those individuals "located outside of the plume as shown in the GIS tracking graphic offered by the defendant were excluded from the class."[126]

Evidence like this was also admitted in a class action related to oyster lease damages. In *Avenal v. State of Louisiana*,[127] the plaintiffs alleged that their oyster leases were damaged by the freshwater outfall from the Caernarvon freshwater diversion structure located on the lower Mississippi River in Plaquemines Parish.[128] Although the court initially certified a class of all plaintiffs in the Breton Sound area, the court later concluded that many plaintiffs' leases within the class had not been damaged, based in part on GIS tracking data presented by the defendant, the state of Louisiana.[129]

In *Rivera v. United Gas Pipeline Co.*,[130] residents of a neighborhood were evacuated as a result of a natural gas leak. They filed a class action against the owner of the pipeline as well as against a contractor who was working on the pipeline at the time of the incident.[131] As part of the defense, the defendants presented a computerized plume showing the extent of the natural-gas leak and the limited exposure of residents of the community.[132] This plume was superimposed on a backdrop of a color photograph of the area that was, in turn, integrated with a GIS database.[133] This allowed counsel to demonstrate the location of both the parameters of the plume as well as the residents of the neighborhood with considerable

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[124] *Id.* (The concentration at this location was calculated to be less than 500 parts per billion).

[125] *Id.*

[126] Wilson et al., *supra* note 40, at 392-93 (1997).

[127] Avenal v. State, 668 So.2d 1150 (La. App. 4 Cir. 11/30/95).

[128] *Id.* at 1151.

[129] Avenal et al. v. State, 2001-CA-0843 (La. App. 4 Cir. 10/15/03, https://caselaw.findlaw.com/la-court-of-appeal/1133959.html.

[130] Rivera v. United Gas Pipeline Co., 697 So.2d 327 (La. App. 5 Cir. 6/30/97).

[131] *Id.* at 332.

[132] Wilson et al., *supra* note 40, at 393, *citing* Rivera v. United Gas Pipeline Co., C.A. No. 23908 "Div. C" (40th J.D.C., Parish of St. John the Baptist, State of Louisiana (June 7, 1995)).

[133] *Id.*

accuracy.[134] The exhibit showed that few if any of the residents were exposed to dangerous levels of the gas.[135] As a result, the jury returned only a nominal verdict for the plaintiffs and held that they were not entitled to punitive damages.[136]

IX. PERSUADING THE JURY

Like any computer evidence, satellite data can be presented to the jury in printout format or as an animation (on a video screen or via a projector), a slide or a static photograph. With satellite data, however, new concerns are raised. While the trial judge has the task of determining which evidence is reliable and relevant, in a jury trial, the jurors will base their decisions on all the evidence that has been admitted. Exhibits must be easy to understand. Therefore, when preparing the exhibit, and laying the foundation for them in court, attorneys must be conscious of how such exhibits will be received by the jury.

Although most jurors appreciate that great reliance is placed on x-ray images and weather satellite pictures, the use of multi-spectral scanner data is not well understood. Thus, experts with specialized training can be indispensable. Experts can interpret the data as long as their opinion is based upon information reasonably relied upon by experts in the remote sensing community, even if the opinion goes to an ultimate issue in the case.[137] Of course, the expert must be prepared to disclose underlying facts or data supporting the opinion.[138]

The role of the expert is to teach the jurors the general principles of satellite remote sensing technology and convince them of its validity. The exhibit's credibility will depend on the answers to a few questions: First, why is the expert qualified to testify about satellite data and its applications?[139] Second, is the data reliable? At the risk of becoming too technical, the expert should demonstrate

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[134] *Id.*

[135] *Id.*

[136] *Id.*

[137] *See* FED. R. EVID. 704 (Opinion on Ultimate Issue);

[138] *See* FED. R. EVID. 705 (Disclosure of Facts or Data Underlying Expert Opinion).

[139] The "knowledge, skill, experience, training, or education" and participation (including publication of peer reviewed articles) in professional organizations impress a trier of fact that the expert is reasonably reliable. THOMAS A. MAUET, FUNDAMENTALS OF TRIAL TECHNIQUES 121-22 (1992).

that comparable data is regularly used in all kinds of other applications.[140] Finally, the expert has to explain what processing steps were undertaken in order to make the exhibit that is being considered. This means addressing whether the satellite data (and the images produced from them) have been overly manipulated so that they no longer reflect the truth. Expert witnesses can provide supporting evidence, including accurate maps, aerial photography[141] and sample measurements or observations (including photographs) taken by experienced trained scientists that verify the expert's interpretation of the results.[142]

Simply put, each jury needs a brief introduction to the principles of remote sensing along with image processing and interpretation. Illustrations showing common applications of the principles will help connect the unfamiliar technology to the collective "everyday" experience. Although the technology is sophisticated, if the evidence is presented properly, the jurors' familiarity, comfort with and, ultimately, confidence in the evidence will most likely be gained. For this reason, presenting the basic principles as a solid foundation is crucial for the acceptance of novel scientific evidence.[143]

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[140] FED. R. EVID. 703 (Bases of Opinion Testimony by Experts). The expert should explain that this kind of data has been relied upon by military and civilian government agencies and businesses for years, and the fact finder should therefore be comfortable relying upon it.

[141] Using aerial photography to support the validity of the satellite data also helps tie the novel science to the familiar experiences of a juror or judge. Hundreds of cases over the past forty years reported using aerial photography as evidence. *See* Hodge, *supra* note 40; Purdy & Macrory, *supra* note 6.

[142] *See* Timothy W. Foresman & David R. Williams, *Remote Sensing: An Environmental Enforcement Tool*, *in* EARTH OBSERVATION SYSTEMS: LEGAL CONSIDERATIONS FOR THE '90S 30, 39 (1990). *See also* State v. Wright, 752 A.2d 1147, 1157 (Conn. App. Ct. 2000) ("Through his testimony, [the prosecution's expert witness] indicated that he went to the actual locations depicted on the map to determine the actual locations and then entered the data into the computer that generated the map. He further testified that the program utilized to generate the map included formulas created by others to generate the distance between the school and the location where the defendant was arrested. He also testified that the coordination method that is the basis for the entire system was checked by the state of Connecticut and private engineering companies. He pointed out that the coordination system was not, in fact, displayed on the map entered into evidence, but the result was checked against the coordination system. Finally, he testified that the map was a fair and accurate representation of the distance from St. Mary's school to 19 Walnut Street.") *Id.*

[143] *See* Hodge, *supra* note 40; Purdy & Macrory, *supra* note 6.

X. CONCLUSION

Modern science has had numerous impressive breakthroughs that create tremendous opportunities for engaged litigators. Among the most interesting is the availability of satellite imagery. Related exhibits are the result of complex technical and methodological processes, but they can be understood, and they can be explained to judges and jurors. When handled properly, such evidence can be very helpful in finding and proving the truth.

It is impossible to predict what science will bring in the future, but effective litigators need to keep up with the science. It is true that every new technology creates new legal problems, but it is also true that new technologies—like many of those described in this article—can lead to new exhibits to help attorneys better represent their clients. Remote sensing and satellite data, especially when developed with GIS, is already available and waiting to be used.

THE DEVELOPMENT OF LABOR LAW IN OUTER SPACE - A COMPARISON WITH THE AMERICAN FRONTIER AND THE HIGH SEAS

Connor Hogan[*]

ABSTRACT

As industry and commerce develop above the Earth's atmosphere, it is conceivable that we may see communities of people living and working in outer space before the end of this century. The space environment presents serious challenges for workers: it is instantaneously lethal; remote from the international community and regulatory bodies; and any oversight or enforcement of existing labor law is extremely difficult. This article examines these challenges and explore two cases of developing labor law in similarly remote environments: the American frontier over the course of the 19th to early 20th centuries; and the modern high seas. The article suggests that the development and enforcement of a legal regime to protect workers in extreme frontier environments are characterized by a relative lack of compliance with regulation. Additionally, workers' ability to effectively organize, engage in dispute resolution, and dissent is diminished in a remote and dangerous context. Finally, the development of labor law in extreme environments is also influenced by the often-specialized nature of the work performed there. The article concludes that the environment of outer space is analogous to these cases, and thus pre-emptive legal measures will be needed to ensure the rights and dignity of workers as the space industry continues to develop.

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I. INTRODUCTION

"I want to thank every Amazon employee and every Amazon customer, because you guys paid for all of this"

- Jeff Bezos, CEO of Amazon, on returning from his first private spaceflight.[1]

The 21st century is set to see an increase in the amount of people living and working in space. Several developments give us reason to suppose this: National Aeronautics and Space Administration's (NASA) continued development of its Artemis lunar program;[2] the completion of China's new Tiangong space station; preparations to send taikonauts to the Moon in the 2020s;[3] the rise of private actors like SpaceX, Blue Origin and Virgin Galactic (all of which intend to develop a space tourism industry);[4] the European Space Agency's (ESA) recruiting of astronauts for the first time in a decade;[5] India's development of a crewed space program;[6] and legislation in the United States[7] (US) and Luxembourg,[8] among others in anticipation of asteroid mining in the near to medium term. If these developments continue apace, it is conceivable that an

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[1] Tyler Sonnemaker et al., *Amazon Workers React to Jeff Bezos Thanking Them After Space Flight*, BUS. INSIDER (July 20, 2021), https://www.businessinsider.com/amazon-workers-react-jeff-bezos-thanks-blue-origin-space-flight-2021-7 (quoting Jeff Bezos).

[2] Parul Agrawal., *Returning to the Moon: NASA's Artemis Missions*, NASA (Jan 5, 2023), https://ntrs.nasa.gov/api/citations/20230000123/downloads/Artemis%20Orion%20Presentation.pdf.

[3] Ling Xin, *China Astronauts Say Hello from Completed Tiangong Space Station*, S. CHINA MORNING POST (Nov. 3, 2022), https://www.scmp.com/news/china/science/article/3198266/china-astronauts-say-hello-completed-tiangong-space-station; Andrew Jones, *China Unveils Lunar Lander to Put Astronauts on the Moon*, SPACE NEWS (Feb 27, 2023, https://spacenews.com/china-unveils-lunar-lander-to-put-astronauts-on-the-moon/.

[4] *See generally* CHRISTIAN DAVENPORT, THE SPACE BARONS: ELON MUSK, JEFF BEZOS, AND THE QUEST TO COLONIZE THE COSMOS (2019).

[5] Tereza Pultarova, *Astronauts Wanted: Engineers With Nerves of Steel Welcome*, 16 ENG. & TECH, 1 (May 2021).

[6] Chethan Kumar, *India Has Been Quietly Working on Key Technology to Enable Space Station*, THE TIMES OF INDIA, (June 13, 2019), https://timesofindia.indiatimes.com/india/india-has-been-quietly-working-on-key-technology-to-enable-space-station/articleshow/69775029.cms.

[7] 51 U.S.C. §§ 51301-51303 (2023).

[8] *Loi du 20 juillet 2017 sur l'exploration et l'utilisation des ressources de l'espace*, Journal Officiel du Grand Luxembourg, July 20, 2017 (entered into force J uly 20, 2017), https://data.legilux.public.lu/ file/eli-etat-leg-loi-2017-07-20-a674-jo-fr-pdf.pdf.

increasingly large and varied population of people may begin working and living in space over the course of this century. Such communities will exist in a working environment that is "instantaneously lethal."[9] Under these uniquely challenging circumstances, there will be potentially no remit for disobedience or collective bargaining, as the precarity of the labor force will consist of not only the need to eat, drink and be sheltered, but to simply exist.

Furthermore, the relative remoteness of space from the international community and regulatory bodies means that oversight and enforcement of any existing legislation is an immense challenge,[10] and future workers may find themselves marooned without a stringent, pre-emptive response. The problem of enforcement is a known issue within space law and policy, and the foundational Outer Space Treaty[11] which governs activities above the Earth's atmosphere has found itself under strain in recent years.[12] Contemporary discourse in this regard has mainly focused on the role of States and private companies, with little discussion of the relative position of human individuals and communities of workers.

This article will explore the primary factors influencing the development, effective enforcement and protection of labor rights in extreme and remote contexts, to make inferences about a possible future configuration in the early decades of a space-based economy. To do so, the article will examine two analogous cases in which remote, extreme and dangerous spheres became regulated, and a

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[9] CHARLES S. COCKELL, DISSENT, REVOLUTION AND LIBERTY BEYOND EARTH 1 (Charles S. Cockell ed., 1st ed. 2016).

[10] For more detail, *see* Matthew C. Weinzierl, *Space, The Final Economic Frontier*, 32 J. OF ECON. PERSPECTIVES. 173, 173-92 (2018); Tony Milligan, *Constrained Dissent and the Rights of Future Generations, in* DISSENT, REVOLUTION AND LIBERTY BEYOND EARTH 7-20 (Charles S. Cockell ed., 2016); Kurt Mills, *Who Will Own Outer Space? Governance Over Space Resources in the Age of Human Space Exploration*, *in* HUMANS IN OUTER SPACE – INTERDISCIPLINARY PERSPECTIVES 23 (Ulrike Landfester, et al. eds., 2012); Patrick Lin, *Look Before Taking Another Leap For Mankind—Ethical and Social Considerations in Rebuilding Society in Space*, 4.3 ASTROPOLITICS 281, 281-294 (2006).

[11] 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].

[12] *See* ANNETTE FROEHLICH, A FRESH VIEW ON THE OUTER SPACE TREATY (Annette Froehlich ed. 1st ed. 2018); RAM S. JAKHU & JOSEPH N. PELTON, GLOBAL SPACE GOVERNANCE: AN INTERNATIONAL STUDY 19-52 (Douglas A. Vakoch et al eds., 1st ed. 2017); Karl Leib, *State Sovereignty in Space: Current Models and Possible Futures*, 13.1 ASTROPOLITICS 1, 1-24 (2015).

legal regime of labor rights and protections developed for workers within them: the American frontier over the course of European expansion; and the modern high seas. By tracing the mechanisms and challenges which informed the development, enforcement and protection of labor rights in these instances, the article develops a conceptual lens through which to examine similar challenges in outer space.

Part II of this article surveys the current literature on space regulation, governance and the international treaties, the role of individuals and workers, and highlights the need for an empirical study on labor rights. This part also introduces the established analogues between outer space and other frontiers in the literature, and contemporary maritime labor law. Part III outlines the central theory of the article, that the development and enforcement of a legal regime to protect workers in extreme environments are characterized by a relative lack of compliance with regulation in the absence of effective oversight, the diminished bargaining power of workers in a physically perilous context, and the often-specialized nature of the work performed there. Part IV outlines the methodology employed. Finally, Part V presents the results of this research, and provides a detailed account of both case studies from within the conceptual framework outlined in the theory section, applying them both to the context of outer space. Finally, the article concludes with preliminary recommendations.

II. CURRENT CONTEXT

Shortly after the launch of Sputnik-1 in 1957, an international norm was established for outer space which emphasized scientific use and limitation of arms.[13] This norm formed the bedrock of international space policy and law, and is the foundation of the Outer

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[13] *See e.g.,* International Cooperation in the Peaceful Uses of Outer Space, G.A. Res. 1472 (XIV) (Dec. 12, 1959); International Cooperation in the Peaceful Uses of Outer Space, G.A. Res. 1721 (XVI) (Dec. 20, 1961); Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space, GA Res. 1962 (XVIII) (Dec. 13, 1963). For an extended analysis of this history, *see* Franz von der Dunk, *International Space Law*, *in* HANDBOOK OF SPACE LAW 1-28, 35-7 (Franz von der Dunk & Fabio Tronchetti eds., 2015)

Space Treaty.[14] Article II of the Treaty famously states that: "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."[15]

Other widely ratified space treaties (including the Rescue Agreement,[16] the Space Liability Convention[17] and the Registration Convention[18]) similarly uphold the extraterritorial nature of space. In practice, this means that outer space and bodies like the Moon remain a *terra nullius* in international law. Much of the debate within the space governance literature concerns the so-called "common heritage [of humankind] principle"[19] and State sovereignty[20] particularly in the context of private actors,[21] developing nations[22] and national security.[23] Whereas the previously small number of State actors in the space industry meant that legal and regulatory problems could be solved on an *ad hoc* basis, the increasing number

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[14] Outer Space Treaty, *supra* note 11. *See* Franz von der Dunk, *International Space Law*, *in* HANDBOOK OF SPACE LAW 35-7 (Franz von der Dunk and Fabio Tronchetti eds., 2015).

[15] Outer Space Treaty, *supra* note 11, art. II.

[16] The Agreement on the Rescue of Astronauts, The Return of Astronauts and The Return of Objects Launched into Outer Space, Apr. 22, 1968, 672 U.N.T.S. 119.

[17] The Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 961 U.N.T.S. 187.

[18] The Convention on Registration of Objects Launched into Outer Space, June 6, 1975, 1023 U.N.T.S. 15 [hereinafter Registration Convention].

[19] *See* FRANCIS LYALL & PAUL B. LARSEN, SPACE LAW: A TREATISE 330-36 (2nd ed. 2020); Mills, *supra* note 10, at 16.

[20] LYALL & LARSEN, *supra* note 19, at 263-90. *See also* FROEHLICH, *supra* note 12; Leib, *supra* note 12; Christophe Venet, *The Political Dimension*, *in* OUTER SPACE IN SOCIETY, POLITICS & LAW 73-91 (Christian Brünner & Alexander Soucek eds., 2011); Carol R. Buxton, *Property in Outer Space: The Common Heritage of Mankind Principle vs. the First in Time, First in Right, Rule of Property*, 69 J. AIR L. AND COM. 689, 689-91 (2004).

[21] *See e.g.,* LEWIS D. SOLOMON, THE PRIVATIZATION OF SPACE EXPLORATION: BUSINESS, TECHNOLOGY, LAW & POLICY (2017); Gbenga Oduntan, *Aspects of the International Legal Regime Concerning Privatization and Commercialization of Space Activities*, 17 GEO. J. INT. AFF. 79, 79-90 (2016).

[22] *See e.g.,* Timiebi Aganaba-Jeanty, *Introducing the Cosmopolitan Approaches to International Law (CAIL) Lens to Analyze Governance Issues as They Affect Emerging and Aspirant Space Actors*, 37 SPACE POL'Y. 3, 3-11 (2016); Joel A. Dennerley, *Emerging Space Nations and the Development of International Regulatory Regimes*, 35 SPACE POL'Y. 27, 27-32 (2016).

[23] *See, e.g.,* BLEDDYN E. BOWEN, WAR IN SPACE: STRATEGY, SPACEPOWER, GEOPOLITICS (2020).

of active participants means that a more robust international framework is needed.[24]

In addition to the international treaties, "soft law" has played an increasing role in the contemporary governance of outer space as the number of actors in the industry continues to rise.[25] In essence, certain international norms and aspirations (such as the need to reduce space debris) have been encouraged and expressed on a national, voluntary basis, effectively preceding binding resolutions.[26] It is from within this emerging context (the continuing but contested role of the international space treaties and increasing number of active entities in the industry) that this article locates the issue of labor rights.

Whereas some work has been done on the jurisdiction of individuals within space,[27] an empirical investigation of the potential relationship between individuals and more powerful State and private actors is needed. In his discussion of space ethics, Patrick Lin highlights the urgent need for scholars of space law and policy to engage with questions of social organization, warning that without a "big picture" strategy for space settlement, future generations may be at the mercy of unaccountable actors.[28]

While outer space and celestial bodies remain beyond State sovereignty in international law,[29] Article VIII of the Outer Space Treaty states that: "[a] State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body."[30] Thus, space vessels remain tied to their State of origin's national laws in a manner

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[24] Katrin N. Metcalf, *A Legal View on Outer Space and Cyberspace: Similarities and Differences*, 10 TALLINN PAPERS 1, 4-9 (2018).

[25] CASSANDRA STEER & MATTHEW HERSCH, WAR AND PEACE IN OUTER SPACE: LAW, POLICY, AND ETHICS 98 (2020); JAKHU & PELTON, *supra* note 12, at 45-51.

[26] JAKHU & PELTON, *supra* note 12, at 45-51.

[27] *See e.g.,* P.J. Blount, *Jurisdiction in outer space: challenges of private individuals in space*, 33 J. SPACE L. 299 (2007).

[28] Lin, *supra* note 10, at 292. Lin advocates employing a Rawlsian Original Position to the question of space development and argues that "applying the veil of ignorance to rules in space helps ensure that the processes we set up are fair and consider the interests of all people, including protecting the worst-off people from an even worse and uncaring fate." *Id.*

[29] *See* LYALL & LARSEN, *supra* note 19, at 263-90.

which is in some ways analogous to modern maritime law.[31] However, the exact status of individuals working in space remains unclear, [32] and as the law currently stands, there are "jurisdictional lacunae" in which individual workers may soon find themselves. [33]

Some theoretical work has been done on the inherent challenges to liberty that the space environment presents,[34] however there is yet to be an empirically grounded investigation on labor rights in a space-based economy. James S. Schwartz has written on labor relations within a lunar colony and raises some of the key challenges, most notably the management of critical systems, such as air supply, and the effect that this may have on relative bargaining power.[35] However again this is theoretical, and a comparative analysis is needed to develop this perspective further.

Comparisons are often drawn between the "final" frontier of outer space, and the American frontier over the course of westward expansion.[36] Indeed, it has been noted that the formative ethical and social debates that took place in the "chaos of the Wild West" are comparable to debates currently emerging in space law and policy.[37] Of course, this discussion omits the experiences of the indigenous population of the Americas prior to and during colonization—an important distinction when considering outer space, which has hitherto been totally uninhabited by humans. As discussed in Part V, the focus of this paper is on formal, waged work which characterized European westward expansion in the context of territorial incorporation into the Westphalian State system, as this is the most useful analogue to a near-future space-based economy.

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[31] Armel Kerrest, *Space Law and the Law of the Sea*, *in* OUTER SPACE IN SOCIETY, POLITICS & LAW 247, 249 (Christian Brünner & Alexander Soucek eds., 2011).

[32] Blount, *supra* note 27**Error! Bookmark not defined.**, at 311-2.

[33] *Id.* at 301.

[34] David C. Reed, *Extraterrestrial dictatorship or democracy?,* MIT MEDIA LAB (Oct. 11, 2019), https://www.media.mit.edu/posts/dcrspacelaw.1. *See* COCKELL, *supra* note 9.

[35] James S. Schwartz, *Lunar Labor Relations*, *in* DISSENT, REVOLUTION AND LIBERTY BEYOND EARTH 41-58 (Charles S. Cockell ed., 2016).

[36] *See generally* ROGER D. LAUNIUS, HISTORICAL ANALOGS FOR THE STIMULATION OF SPACE COMMERCE (2014). *See also*: Catherin L. Newell, *Without Having Seen: Faith, the Future, and the Final American Frontier*, 12.2 ASTROPOLITICS. 148, 148-166 (2014).; Roger D. Launius, *The Railroads and the Space Program Revisited: Historical Analogues and the Stimulation of Commercial Space Operations*, 12.2 ASTROPOLITICS. 167, 167-179 (2014).; Weinzierl, *supra* note 10, at 185.

[37] Lin, *supra* note 10, at 282-88.

The concurrent problem of oversight and deregulation has also been raised.[38] Roger Launius explores how the system of government subsidies and land grants (and crucially for our purposes lax labor regulations) which helped facilitate transcontinental railroad construction in the US is analogous to the contemporary public-private initiatives and subsidy incentives in the space launch industry.[39]

Given that space is widely considered a global commons, the high seas have often been employed as a legal and political analogue.[40] However, whereas space regulation has historically been formulated in anticipation of events and technological developments, contemporary maritime regulation and policy is the result of centuries of history and has always involved a broad multiplicity of competing States and private actors. Thus "[a]n evolution in this older field may help to foresee the evolution in the newer,"[41] and there is a possibility of "using analogy to solve legal problems."[42]

Modern international maritime law is embodied in the United Nations (UN) Convention on the Law of the Sea[43] (Law of the Sea or UNCLOS) The idea of negated sovereignty also exists in maritime law in the form of the "freedom of the sea" (*mare liberum*)—an international principle enshrined in the Law of the Sea[44] which prohibits national appropriation beyond 200 nautical miles (230 miles; 370 kilometers) from a State's shoreline,[45] with similar debates surrounding its implications and maintenance.[46]

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[38] *See* Mills, *supra* note 10.

[39] LAUNIUS, *supra* note 6, at 36-46.

[40] *See* Kerrest, *supra* note 31; Jennifer Frakes, *The Common Heritage of Mankind Principle and Deep Seabed, Outer Space, and Antarctica: Will Developed and Developing Nations Reach a Compromise?,* 29 WIS. INT'L L.J. 409 (2003).

[41] Kerrest, *supra* note 31, at 248.

[42] *Id.*

[43] United Nations Convention on the Law of the Sea, Dec. 10, 1982, 3 U.N.T.S 1833 [hereinafter the Law of the Sea].

[44] *Id.*, art. 87 ¶ 1.

[45] This is defined as the State's "exclusive economic zone" or (EEZ) and could be considered as analogous with the Kármán line (approximately 100 kilometers or 62 miles from sea level) in regards to space. Notably, however, there is no current agreed upon boundary in international law between outer space and national air space. *See* LYALL & LARSEN, *supra* note 19, at 263-75.

[46] *See* Jonathan S. Koch, *Institutional Framework for the Province of all Mankind: Lessons from the International Seabed Authority for the Governance of Commercial Space Mining*, 16 ASTROPOLITICS 1, 1-27 (2018); Aline Jaeckel et al., *Conserving the Common*

The Maritime Labour Convention provides specific protection to workers at sea and covers basic employment rights (*inter alia* minimum age requirements, fair and regular wages, right to rest and take leave).[47] The Convention makes reference to the separate but related responsibilities of flag States (vessels' country of origin), port States and labor agencies in maintaining its provisions, in a manner that may be useful in formulating future regulatory regimes for workers in outer space.

In addition to international treaties, a system of legal norms and customs has also informed the formation of international maritime law.[48] This article will therefore take account of legal norms and customs, in addition to codified international and domestic law.

The inherent challenges to labor organization in the remote and dangerous environment of the high seas has also been explored,[49] as has the bargaining leverage that can be utilized at critical points in the supply chain by seafarer unions.[50]

In sum, there are ongoing debates in the space law and policy literature regarding the Outer Space Treaty, state sovereignty, and the roles of private and public actors. However, the role of individual workers in a space-based economy has thus far been unexplored, at least in an empirically grounded manner. Some work has been done which outlines the main challenges in this context,[51] but a comparative analysis is needed to develop this perspective and make valid inferences. Comparisons with the American frontier and space colonization are common in the literature and help provide an initial insight into the broad challenges facing social organization in remote settlements, however, there has thus far been no

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Heritage of Humankind – Options for Deep-Seabed Mining Regime, 78 MARINE POL'Y 150-7 (2017); Frakes *supra* note 40.

[47] Maritime Labour Convention, *opened for signature* Feb. 24, 2006, 2952 U.N.T.S. 3, I.L.O C186 (entered into force Aug. 20, 2013) [hereinafter MLC].

[48] JAMES HARRISON, MAKING THE LAW OF THE SEA: A STUDY IN THE DEVELOPMENT OF INTERNATIONAL LAW 5-22 (2011).

[49] Peter Fairbrother & Victor O. Gekara, *Multi-Scalar Trade Unionism: Lessons from Maritime Unions*, 71.4 INDUS. REL. 589, 589-610 (2016).

[50] *See* Nathan Lillie, *Seafarers' Strikes in American History*, *in* THE ENCYCLOPAEDIA OF STRIKES IN AMERICAN HISTORY 534-46 (Aaron Brenner et al. eds., 2nd ed. 2015); NATHAN LILLIE, A GLOBAL UNION FOR GLOBAL WORKERS: COLLECTIVE BARGAINING & REGULATORY POLITICS IN MARITIME SHIPPING [hereinafter A GLOBAL UNION FOR GLOBAL WORKERS] (2006); Nathan Lillie, *Union Networks and Global Unionism in Maritime Shipping*, 60 INDUS. REL. 88, 88-111 (2005).

[51] *See e.g.,* COCKELL *supra* note 9.

empirical comparison of the mechanisms which led an historically unregulated space to become regulated as regards legally enshrined labor rights. Similarly, comparisons have often been made between outer space and the high seas,[52] and the international framework governing both is similar in many ways. However, as with the American frontier, an analytic comparison is needed to develop this perspective, in order to identify the key mechanisms at play in extreme environments, and to make preliminary recommendations for future workforces in outer space.

III. THEORY

The central claim of this article is that there are inherent, unique and serious challenges to labor in extreme frontier environments, and thus lawmakers and scholars should work pre-emptively on a framework to protect workforces in outer space. For the purposes of this thesis, this article will employ a broad definition of "labor rights" as encompassing:

- The right to freely choose work without coercion.
- The right to equal pay for equal work, without discrimination.
- The ability to express grievances and engage in collective bargaining for better conditions.
- The right to democratically organize (i.e., form trade unions).
- The right to dissent (i.e., to strike).

The above is drawn from Articles 23 and 24 of the UN Universal Declaration of Human Rights[53] and Articles 6 to 8 of the International Covenant on Economic, Social and Cultural Rights,[54] both of which specifically address labor rights. For the purposes of this article, "enforcement" of labor rights is defined as available legal recourse to ensure the above rights against non-compliance or

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[52] *See e.g.,* Kerrest *supra* note 31.

[53] G.A. Res. 217A (III), arts. 23 & 24. (Dec. 10, 1948).

[54] International Covenant on Economic, Social and Cultural Rights, arts. 6-8, Dec. 16, 1966, 993 U.N.T.S. 3.

negligence, and "protection" as the effective maintenance of these rights over a sustained period, and for all members of a given workforce.

This article hypothesizes that the legal enforcement and protection of labor rights in extreme frontier environments are characterized by:

> H_1: A relative lack of oversight from the international community and regulatory bodies, resulting in reduced enforcement, accountability and compliance with labor regulations. The author theorizes that there is an information asymmetry between regulatory bodies and remote vessels/outposts, in that it is physically or logistically challenging to undertake effective action to oversee or enforce established law. Thus, malpractice is expected to be more prevalent in frontier environments than in the status quo.
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> H_2: Reduced bargaining power and ability to express grievances, organize or dissent in the context of a remote and/or perilous environment, especially where one is dependent on the vessel or parent company to survive. Workers are theoretically less able to engage in collective action when the costs of doing so are heightened by the danger of failure in an extreme environment, and a relative dependency on the employer to provide physical protection and support in that environment.
>
> H_3: The often-specialized nature of the work performed at the frontiers. It is expected that in conjunction with $H_{1\text{-}2}$, the specialized nature of the work in these environments can afford some leverage to the workers there, when they are relatively difficult for employers to replace. Labor shortages (due to both the nature of the work and the environment itself) may provide additional leverage.

The above are the primary theoretical factors (summarized in Table 1), though there are contextual aspects that may also drive variation in one case and not in the other, which will be accounted for, when necessary, unless beyond the scope of the central thesis.

Table 1: Theoretical factors affecting the enforcement and protection of labor rights in frontier and extreme environments

Factor	Metric
Lack of oversight from regulatory bodies.	Overall compliance with established labor law, norms and customs.
Diminished bargaining power.	Effective ability to express grievances and engage in collective bargaining for better conditions; ability to dissent; relevant instances of collective action.
Specialized work.	Instances of industrial leverage employed by specialized workers; relevant instances of collective action.

"Non-compliance" in this instance refers to employers engaging in labor practices that are illegal, defy prevailing norms and customs, and which harm the wellbeing or relative autonomy of the workforce. The "effectiveness" of the workers' ability in this context is measured by their ability to influence outcomes (i.e., win concessions from their employers), and to engage in collective action without legal or physical impediments (intimidation, violent suppression). "Industrial leverage" refers to instances wherein the employer is incentivized to make concessions as they are reliant on the specific skill set of the workforce and cannot easily replace them.

Having outlined the current law and introduced the central theory of this article, the following section will outline the methodology used, before discussing the cases in detail.

IV. METHODOLOGY AND DATA

The following is a small-N comparative case study, in which the author has employed qualitative methods (process tracing)[55] to explore two pathway[56] cases of labor in extreme contexts. The author has chosen the comparative method because there are a small number of similar, independent cases where labor has faced challenges in an extreme, frontier environment, which differ from cases of labor rights under regular circumstances and are thus of interest as we theorize forms for outer space. This case study is "diagnostic," in that it seeks to test a set of specific, causal hypotheses ($H_{1\text{-}3}$) among a small number of cases, in order to deduce the operative mechanisms and what scope conditions may apply.[57] By linking the effective protection and enforcement of labor rights (our dependent variable, measured by the factors summarized in Table 1) with the environment itself (the independent variable), the author hopes to offer a robust, representative and generalizable theory of labor in extreme contexts.

In this study, a close comparative reading of the cases is provided, using data from labor law and regulation journals, international treaty law, domestic case law, secondary historical accounts, archival and historiographical research, as well as ethnographic studies. From the sources, the author has extracted information on the aforementioned underlying variables, and compared them in the results section.

Having now outlined the methodology used, the following Part V will present the results of the study. The section is structured as follows: the first part introduces the American frontier case, before analyzing each of the theoretical factors outlined and assessing them in regard to $H_{1\text{-}3}$. The second part of this section will then present the results for the high seas. The author will use the results of both cases throughout to make inferences about the theoretical case of outer space.

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[55] *See* DEREK BEACH & RASMUS BRUN PEDERSEN, PROCESS-TRACING METHODS: FOUNDATIONS AND GUIDELINES (2nd ed. 2019); JOHN GERRING, CASE STUDY RESEARCH: PRINCIPLES & PRACTICES (2nd ed. 2017).

[56] *See* GERRING, *supra* note 55, at 105. He describes pathway cases as those in which "the apparent impact of X on Y conforms to theoretical expectations and is strong (in magnitude), while background conditions (Z) are held constant or exert a 'conservative' bias."

[57] *Id.* at 40-55, 98-117.

V. RESULTS

A. The American Frontier

The American frontier can be defined as the area of the North American continent "west of the 100th meridian, except Hawaii,"[58] which witnessed a relatively high level of European settlement and colonial expansion from the beginning of the nineteenth and into the early twentieth centuries.[59] In this time, a vast area (approximately five million square kilometers, or three million square miles) which had previously laid beyond the international system of States and commerce became more fully incorporated, and with this process arose foundational questions of political and legal organization.[60] The frontier's particular remoteness and relatively late incorporation meant it had a "separate set of historical and legal developments"[61] from the rest of the US, including early "extralegal institutions"[62] for establishing property rights and ownership in the absence of federal oversight.

The vast majority of work performed at the frontier was waged,[63] and took place in remote areas with relatively small populations, in "mining towns, lumber camps, cattle ranches, canneries, fishing villages, and in the mobile encampments of railroad workers," as well as on rotational crop farms and along waterways.[64] The work was "seasonal and economically unstable," relied heavily on transient young men[65] and was often extremely hazardous.[66] It was from within this context that frontier "company towns"

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[58] Charles F. Wilkinson, *The Law of the American West: A Critical Bibliography of the Nonlegal Sources*, 85 MICH. L. REV. 953, 956 (1987).

[59] Guillaume Vandenbroucke, *The US Westward Expansion.* 49 INT'L ECON. REV. 81 (2008).

[60] *See* Lin, *supra* note 10.

[61] Wilkinson, *supra* note 58, at 956.

[62] Terry L. Anderson & Peter J. Hill, *Privatizing the Commons: An Improvement?* 50 SO. ECON. J. 438, 444 (1983).

[63] Carlos A. Schwantes, *The Concept of The Wageworkers' Frontier: A Framework For Future Research*, 18 W. HIST. Q. 39, 39-55 (1987).

[64] James N. Gregory, *The West and Workers, 1870–1930, in* A COMPANION TO THE AMERICAN WEST 240, 245 (William F. Deverell ed., 2004).

[65] *Id.*

[66] HARDY GREEN, THE COMPANY TOWN: THE INDUSTRIAL EDENS AND SATANIC MILLS THAT SHAPED THE AMERICAN ECONOMY 86-87 (2010).

began to proliferate.[67] The article places particular focus on this phenomenon in the following sections, to the degree that it was widespread, inherent to the remoteness of the environment itself, and forms an important comparison for prospective labor relations in a space-based economy.

As will be discussed, the frontier was largely unregulated for much of the expansion period,[68] and workers had very little by way of legally recognized rights.[69] Nevertheless, the First Amendment of the US Constitution (adopted in 1791) explicitly protects the rights of all citizens to assemble,[70] and the Fourteenth Amendment (1868) to do so without discrimination.[71] Institutionalized slavery was abolished in 1865, and was historically much more prevalent in the relatively populated, agricultural south.[72] Thus, frontiersmen were in theory free to at least work (or not work) for whomever they chose, without coercion or discrimination. As we shall see however, this was often not the case.

1. Lack of Oversight: A Legal Wild West

For much of the 19th century, the American frontier was characterized by a "hands off" approach to legal issues, in which there was "virtually no federal restraint on private uses of public land and resources."[73] Thus, in response to the absence of formal government in the earlier years of expansion, "institutional innovations"[74] would occur at the frontier to regulate property, society and labor. Remote mining settlements and cattlemen associations "adopted

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[67] Marcelo J. Borges & Susana B. Torres, *Company Towns: Concepts, Historiography, and Approaches*, *in* COMPANY TOWNS: LABOR, SPACE, & POWER RELATIONS ACROSS TIME & CONTINENTS 1 (Marcelo J. Borges & Susana B. Torres eds., 2012).

[68] Wilkinson, *supra* note 58, at 963-4.

[69] ALEXANDER JAMES COLVIN ET AL. AN INTRODUCTION TO US COLLECTIVE BARGAINING & LABOR RELATIONS 20-24 (2017).

[70] U.S. CONST. amend. I, § 1.

[71] *Id.,* amend. XIV, § 1.

[72] *See* JAMES OAKES, FREEDOM NATIONAL: THE DESTRUCTION OF SLAVERY IN THE UNITED STATES, 1861-1865 480-8 (1st ed. 2013). Almost all States comprising the frontier (with the exception of Texas) had prohibited slavery at or near the start of the westward expansion period in the 19th century. Thus, the system of work that came to predominate in the West was that of the precarious wage worker. The historian Carlos Schwantes coined the term "Wageworkers Frontier" to describe the centrality of wage work to the development of the American West, Schwantes, *supra* note 63, at 39-40.

[73] Wilkinson, *supra* note 58, at 963-4.

[74] Anderson & Hill, *supra* note 62, at 444.

their own constitutions and bylaws, elected officers, and established rules for adjudicating disputes and procedures for the registration of claims."[75] In the case of mining, this constituted a "brief moment in the sun" for workers before larger corporate actors came to dominate.[76] Indeed, it was from within this context (of a diffuse, unregulated precariat in a vast, isolated and dangerous environment, combined with a lack of federal oversight) that the phenomenon of company towns began to appear and spread across the frontier.[77]

2. Company Towns

I loaded sixteen tons, I tried to get ahead,
Got deeper and deeper in debt instead.
Well they got what I made, and they wanted some more,
And now I owe my soul to the company store.

- Merle Travis, 1947.[78]

Company towns were settlements "completely owned, built and operated by an individual or corporate entrepreneur."[79] They had hitherto existed in different forms elsewhere in the world, but in the American frontier were unique for their isolation and distance from the central government,[80] and were specifically employed as a means of attracting a sufficient workforce to isolated mines, plants and refineries.[81] They were characterized by a particular type of industrial paternalism and socio-economic control. The corporate administrators of the settlements would "[take] the place of government,"[82] collecting rent on company-owned

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[75] *Id.*

[76] Wilkinson, *supra* note 58, at 662-3.

[77] *See* Borges & Torres, *supra* note 67; GREEN, *supra* note 66.

[78] AZ LYRICS, *Tennessee Ernie Ford Lyrics,* https://www.azlyrics.com/lyrics/tennesseeernieford/sixteentons.html (last visited March 22, 2023). Merle Travis composed this song, "Sixteen Tons," in 1947, inspired by his father who had worked in a coal mining company town. *See* GREEN, *supra* note 66, at 82-5. The "sixteen tons" is a reference to the daily work quota. *Id.*

[79] John D. Porteous, *The Nature of the Company Town*, 51 TRANSACTION OF THE INST. OF BRIT. GEOGRAPHERS 127, 127 (1970).

[80] GREEN, *supra* note 66, at 9-11.

[81] Lawrence W. Boyd, *The Company Town*, EH.NET, http://eh.net/encyclopedia/the-company-town/ (last visited Jan. 30, 2023).

[82] GREEN, *supra* note 666, at 9.

accommodation, and often controlled the town's entire internal economy, law enforcement and even places of worship.[83] Employees were not permitted to buy their own housing, and any commercial enterprises outside of the company risked arrest for trespassing.[84] Moreover, because of their remoteness—not only from the federal government, but from populated civilization—the owners of company towns were under less pressure to adhere to existing legal statutes, norms and customs regarding labor rights and liberty.[85] Indeed, in their in-depth study of labor, space and power-relations within company towns, Borges and Torres concluded that "in those cases in which isolation was more pervasive and lasted longer, the loss of workers' relative autonomy was more evident." [86] Thus, the "near-totalitarian, super exploitative"[87] conditions of the American company town were in part a function of their remoteness.

One of the most pernicious manifestations of this paradigm was the widely employed system of "scrip" payment.[88] David Corbin, in his archival historiography of American coal mining describes the system as follows:

> If a coal miner survived a month of work in the mines, he was paid not in U.S. currency but in metals and paper (called coal scrip), which was printed by the coal company. Because only the company that printed the coal scrip honored it, or would redeem it, the coal miner had to purchase all his goods – his food, clothing, and tools-from the company store.[89]

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[83] *Id.,* at 69-102; Borges & Torres, *supra* note 67, at 9-23; Roxanne T. Johnson, *Scrip: The Alternative Unit-of-Measure in Company Towns,* 16 ACCT. HISTORIANS NOTEBOOK 1, 6 (1993); John D. Porteous, *Social Class in Atacama Company Towns*, 64 ANNALS OF THE ASS'N OF AM. GEOGRAPHERS 409, 410-11 (1974); Porteous, *supra* note 79, at 140-2.

[84] GREEN, *supra* note 66, at 69.

[85] *Id.,* at 9-10.

[86] Borges & Torres, *supra* note 67, at 11

[87] GREEN, *supra* note 66, at 69.

[88] Johnson, *supra* note 83, at 6-8.

[89] DAVID CORBIN, LIFE, WORK, & REBELLION IN THE COAL FIELDS: THE SOUTHERN WEST VIRGINIA MINERS 1880-1922 2 (Ronald L. Lewis et al., eds., 2nd. ed. 2015). The company town system was not limited to coal mining, however. Virtually all frontier industries adopted the model in some form, including gold, copper and silver mining. *See* GREEN, *supra* note 66, at 7-9; Porteous, *supra* note 83, at 130). It also included was adopted in the lumber industry. *See* Borges & Torres, *supra* note 67, at 1-4; GREEN, *supra* note 66, at 52-7; Johnson, *supra* note 83, at 7. And railroad construction companies adopted it as well. *See* Porteous, *supra* note 79, at 140-2.

Company stores in particular have been linked with a monopolistic socio-economic control over frontier workers' lives, as goods would be "habitually priced 5% to 20% higher than competitors."[90] This would not only effectively syphon their earnings back to the parent company, but often resulted in a form of debt slavery, as workers could pay in credit to their next wage packet.[91] Such a system of peonage could only be sustained in a remote environment, where a journey to the next town for goods was unfeasible. It also affected workers' ability to choose work freely, as those who sought to leave town would have to exchange their scrip for cash at an unrelated store, for as low as 10-20% the face value of the token.[92]

It is notable that those company towns that did exist in the Eastern part of the US generally had more favorable conditions than their frontier counterparts.[93] The proportion of laborers living in company towns was lower in settled areas than in the West, where the practice was much more widespread.[94] Indeed, at their height, an estimated 2,500 single-enterprise towns dotted the frontier,[95] and even at the onset of their decline in the early 1920s, 65-80% of coal miners in the Rocky Mountains still lived in company towns.[96]

Efforts to reform the company town system through legal means, which started with an act by the Pennsylvania General Assembly in 1881, were virtually ignored in the remote outposts.[97] In 1898 the Illinois Supreme Court declared company towns to be "un-American."[98] Yet the practice continued into the twentieth century, declining only with the company towns themselves, in the 1920s and 30s.[99]

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[90] Johnson, *supra* note 83, at 7.

[91] CORBIN *supra* note 89, at 1-125; GREEN, *supra* note 66, at 69-120.

[92] Johnson, *supra* note 83, at 7.

[93] Julie D. Clark, Company Towns in America 1880 to 1930 3-14 (May, 2006) (Master's thesis, Humboldt State University) (on file with Humboldt State University Library system).

[94] Boyd, *supra* note 81.

[95] GREEN, *supra* note 66, at 9.

[96] Boyd, *supra* note 8181.

[97] Johnson, *supra* note 83, at 7-8.

[98] People v. Pullman's Palace Car Co., 175 Ill. 125, 51 N.E. 664, 175 Il. 125 (1898). *See also* Christopher Mellon & Dennis Wille, *Space Settlements Could End Up Being Company Towns*, SLATE (Aug. 07, 2019), https://slate.com/technology/2019/08/space-settlements-company-towns-bezos-musk-the-expanse.html.

[99] Johnson, *supra* note 83, at 8.

Consistent with H_1, the physical and institutional isolation of the American frontier resulted in a lack of oversight from regulatory bodies, and labor abuses were relatively common. Yet consider that the isolation of the frontier company town is nothing compared to that of potential future space settlements. Denizens of future enterprises may be many millions of miles away from the international community, with zero means of exit. Under these circumstances, it is easy to see how the systems of monopolistic control, debt peonage and entrapment which characterized the company towns could emerge. The problem is particularly acute when one considers private space companies in a profit-oriented market economy. David Colby Reed, a researcher at the Space Enabled Research group at the MIT Media Lab notes that "the leaders of space exploration companies will set the objectives, rules, and sanctions that govern space habitations and missions, likely with profit maximization as the goal . . . . This is business-as-usual on Earth, but, in space, such private government becomes totalizing."[100]

Rather ominously, SpaceX has already expressed a view that Earth-based laws should not extend to Mars.[101]

3. Diminished Bargaining Power at the Frontier

Prior to the mid-19th century, unions were *de facto* illegal in the US.[102] Although "combinations" of workers were in principle allowed to organize themselves together, any collective action for better conditions was regarded as "unlawful conspiracy."[103] Early labor cases such as *Commonwealth v. Pullis*[104] (1806), which held that Philadelphia shoemakers were engaging in an illegal conspiracy by striking for better wages (though their organization was legal) attest to this fact.[105] However, a consensus towards a (nominal)

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[100] *See* Miriam Kramer & Bryan Walsh, *The Push to Define Workers' Rights in Space*, AXIOS (Apr. 13, 2021), https://www.axios.com/2021/04/13/workers-rights-space-private-companies (quoting David Colby).

[101] Richard Speed, *SpaceX Small Print on StarLink Insists no Earth Government Has Authority or Sovereignty Over Martian Activities,* THE REGISTER (Feb. 23, 2021), https://www.theregister.com/2021/02/23/starlink_moon.

[102] COLVIN ET AL, *supra* note 69, at 24.

[103] WILLIAM B. GOULD IV, A PRIMER ON AMERICAN LABOR LAW 9-12 (6th ed. 2019).

[104] *Commonwealth v. Pullis*, 3 Doc. Hist. 59, *reprinted in* A DOCUMENTARY HISTORY OF AMERICAN INDUSTRIAL SOCIETY: VOLUME 3, LABOR CONSPIRACY CASES, 61-248 (John R. Commons et al., eds., 1910).

[105] *Id.,* at 143-51, 236.

legality for unions was emerging, and in 1842, the landmark *Commonwealth v. Hunt* case in Massachusetts ruled in favor of striking bootmakers in Boston, establishing a new legal precedent across the Union.[106] Thus, by the time of the Gold Rush in the mid-19th century the judicial consensus was that it was legal for workers to form collectives, though laws concerning the intent, motive and actions of such associations (as well as anti-trust legislation) would be employed to continue to suppress nascent trade unions.[107]

The history of organized labor on the American frontier is much less legalistic, and was in the nineteenth century an incredibly violent struggle which often resulted in failure.[108] The history of this period is dominated by the Industrial Workers of the World (IWW, the so-called "Wobblies"), a radical, syndicalist union, which aspired to organize "down-and-outs, miners, lumberjacks, oil-field roustabouts, and immigrant textile workers" into "One Big Union."[109] Early labor shortages at the frontier (discussed in the following section) gave the unions a comparative advantage, however this became much less pronounced after the Civil War period, whereafter industrial capitalists were more prepared to use violent repression to curtail collective action.[110]

Unlike in more settled areas—where laborers could arrange their own housing and provision of goods, and could draw from a local network of support—frontier workers were to varying degrees dependent on the parent corporation for survival.[111] Thus, employers in this context had vastly disproportionate relative bargaining power, often resulting in a near-feudal power-dynamic.[112] Workers suspected of unionizing in company towns could simply be dismissed from their jobs, which automatically meant eviction from their homes (and the town itself) and the very real possibility of

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[106] *Commonwealth v. Hunt*, 45 Mass. 111, 45 M.A. 111 (1842).

[107] *See e.g., Loewe v. Lawlor*, 208 U.S. 274 (1908), in which the Supreme Court ruled that antitrust laws could be applied to the actions of trade unions. *See also* GOULD, *supra,* note 103, at 14-7.

[108] GREEN, *supra* note 66,66 at 72-4; Gregory, *supra* note 6464, at 240-55.

[109] GREEN, *supra* note 6666, at 7-9; CORBIN *supra* note 89, at 87-105; Gregory, *supra* note 64, at 240-1.

[110] Gregory, *supra* note 6464, at 243.

[111] Borges & Torres, *supra* note 6767, at 10-16.

[112] GREEN, *supra* note 66, at 70-73.

severe deprivation in a remote and unpopulated wilderness.[113] The same applied to workers who became injured and unable to work, or the family of a worker who had died.[114] Isolation also made it difficult for external labor organizations to make contact. Company towns in Colorado employed armed guards and barbed-wire fencing specifically to keep union representatives out.[115] Thus, in the case of mining, "the dispersed nature of the mines . . . and the isolation of the miners meant that many struggles were local, spontaneous, and short-lived."[116]

Although early unions were active during this period, the effective bargaining power of workers at the American frontier was fundamentally diminished by the nature of the environment and dependence on the parent company.

4. Striking in the American Frontier

Despite the above limitations, strike action did occur. However, industrial magnates were able to divert hundreds of thousands of dollars of profit into funding anti-union private police, which could number in the hundreds for an individual corporation, and were able to operate in an environment largely free from federal oversight.[117] Thus, the late 19th century is littered with incredibly violent acts of union repression and failed industrial actions. To name three paradigmatic examples:

1. The 1886 Great Southwest railroad strike. One of the largest instances of industrial action in the period, the strike involved over 200,000 workers against the industrial magnate, Jay Gould, who owned the Union Pacific and Missouri Pacific

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[113] *See* Borges & Torres, *supra* note 67, at 9-11; Porteous, *supra* note 83, at 410-7. Green notes that remoteness could occasionally induce company owners to pursue benevolent policies, as new recruits were harder to source (discussed below). However, the comparative risk (losing an employee versus imminent destitution in the wilderness), combined with the barriers of exit discussed in this section would suggest that workers in frontier company towns endured a net loss in bargaining power, relative to their settled counterparts. GREEN, *supra* note66, at 239. Indeed, Green himself is clear that the dynamic went both ways, and that the same owners employed a variety of strategies to prevent exit: "If the location is remote, who's to notice if workers and communities are treated poorly?" *Id.*, at 241.

[114] GREEN, *supra* note 66, at 69-70.

[115] *Id.*

[116] *Id.* at 87.

[117] *Id.* at 71.

> railroads. Strike action was sparked at the dismissal of a union member. The strike was defeated within two months, with at least seven railroad workers killed by private mercenaries.[118]
>
> 2. The 1892 Coeur d'Alene labor strike. A strike was initiated when workers in a relatively remote Idaho mine discovered that they had been infiltrated by a corporate spy, sent to monitor union activity. The miners (who were already agitating for better wages) refused to work, and in the resulting confrontation four were shot. Tensions would flair again in 1899, culminating in a mass-arrest of around 1,000 men, who were put in a makeshift prison camp. Three men would die due to the conditions there.[119]
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> 3. The Ludlow Massacre. Approximately 1,200 striking coal miners and their families were attacked by anti-striker militia employed by the Colorado Fuel and Iron Company, on April 20, 1914. The militia comprised private mercenaries, as well as the members of the National Guard, who sprayed the tents with machine gun and rifle fire, as well as setting them alight. Numbers vary, but it is thought that around twenty-five people were killed, including twelve children. Four hundred miners were later arrested.[120]

Consistent with H_2, the effective bargaining power of workers at the frontier was fundamentally diminished by the nature of the environment and dependence on the parent company. The effect was compounded by their relative isolation from networks of support and solidarity, and the comparative wealth of resources which company owners could use in suppressing labor movements.

Regarding outer space, the instantaneously lethal environment suggests that future space enterprises could leverage their isolation to diminish the relative bargaining power of their workforce even further. As Ed Finn of Arizona State University notes,

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[118] THERESA A. CASE, FREE LABOR ON THE SOUTHWESTERN RAILROADS: THE 1885–1886 GOULD SYSTEM STRIKES (2002) (PHD Thesis, University of Texas) (on file with the University of Texas).

[119] ROBERT W. SMITH, THE COEUR D'ALENE MINING WAR OF 1892: A CASE STUDY OF AN INDUSTRIAL DISPUTE (1st ed.1961).

[120] Mark Walker, *The Ludlow Massacre: Class, Warfare, and Historical Memory in Southern Colorado*, 37.3 HIST. ARCHAEOLOGY 66, 69-70 (2003).

"staging a walk-out is tricky when the only place to go is the pitiless void on the other side of the airlock."[121]

The ability to dissent and engage in strike action is diminished further in this context when one considers the need to maintain vital life support systems—making sabotage or even inactivity a much more dangerous (or even unrealistic) proposition than on Earth.[122]

5. Specialized Work: Early Labor Shortages

In the American frontier, early labor strikes most often took place in mines and railroad camps, which as well as being dangerous, were also at vital parts of a larger supply chain.[123] Prior to the Civil War and the rise of company towns, proprietary mining operations would often subcontract skilled miners.[124] The relatively small number of workers in the industry at this stage allowed comparative autonomy in their work,[125] and a similar dynamic played out in the early years of the Gold Rush.[126] In his study of American company towns, Hardy Green concludes that the managers of the towns were constrained in how they could treat their employees by market forces, and were thus inclined to "more benevolent" policies when the necessary workers were rare and relatively specialized (as in early mining).[127] This is consistent with H_3, that the specialized work at the frontier may provide some initial leverage to workers there, when they are relatively difficult to replace.

By the 1870s however, the advent of large, organized industrial corporations and the proliferation of more efficient extraction machinery meant that this comparative advantage was lost. Even though coal workers remained in short supply from the 1880s to the

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[121] Kramer & Walsh, *supra* note 100100 (*quoting* Ed Finn).

[122] *See generally* COCKELL, *supra* note 9.

[123] *See* Aaron Brenner, *Introduction to the Encyclopedia of Strikes in American History*, *in* THE ENCYCLOPAEDIA OF STRIKES IN AMERICAN HISTORY XXXI-II (Aaron Brenner et al. eds., 2nd ed. 2015). *See also*, *IWW Strikes 1905-1920*, IWW HISTORY PROJECT, https://depts.washington.edu/iww/strikes.shtml (last visited Sept. 13, 2023).

[124] Sean P. Adams, *The US Coal Industry in the Nineteenth Century*, EH.net, https://eh.net/encyclopedia/the-us-coal-industry-in-the-nineteenth-century-2/ (last visited Jan. 20, 2023). *See also* COLVIN ET AL, *supra* note 69, at 21.

[125] Adams, *supra* note 124124.

[126] Gregory, *supra* note 64, at 241.

[127] GREEN, *supra* note 66, at 239-42.

1920s,[128] the work was no longer as specialized, and miners (as well as railroad workers, lumberjacks and other frontiersmen) were seen and treated as disposable, particularly as the net labor supply increased in the later years of expansion.[129]

Interestingly, there is one purported real-life example where the initial part of this dynamic was perhaps demonstrated in outer space. In 1973, the crew of Skylab-4 protested their 16-hour workdays and micromanagement from NASA by taking an unscheduled day off, and turning off their radio communications.[130] The next day, the crew presented a list of demands, including more control over their work, downtime and uninterrupted meals.[131] Although the exact details of this account—and the extent to which it was an actual mutiny—are very much debated, NASA did change the schedule for Skylab-4 following the incident, and downtime became a mandatory element of all future missions.[132] Notably however, none of the Skylab-4 crew were ever selected for another mission—an action which one commentator called "vindictive."[133] Though this early example shows the potential for specialized labor in space, we can also see how in a future space-based economy with a larger labor supply, workers may have less leverage, and the alleged blacklisting which the Skylab-4 astronauts endured may have much more of an impact on their effective bargaining power.

In sum, the relative remoteness and isolation of the American frontier influenced our three factors in a manner which supports $H_{1\text{-}3}$, with significant implications for outer space. However, whereas the American frontier was eventually settled and incorporated into the international State system,[134] the contemporary high seas (like outer space) remains beyond the reach of State

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[128] *Id.* at 84.

[129] *Id.*, at 240-42; Gregory, *supra* note 64, at 243. *See also* Gerald Friedman, *Strike success and Union Ideology: The United States and France, 1880–1914*. 48.1 J. ECON. HIST. 1 (1988).

[130] Mukesh C. Bhatt, *Space for Dissent: Disobedience on Artificial Habitats and Planetary Settlements, in* DISSENT, REVOLUTION AND LIBERTY BEYOND EARTH 78-9 (Charles S. Cockell ed., 2016); Mellon & Wille, *supra* note 98.

[131] Bhatt, *supra* note 130, at 78.

[132] *Id.* at 79.

[133] Joseph Kay, *Class War in Space—The Skylab 4 mutiny*, LIBCOM (April 4, 2014), https://libcom. org/history/1973-skylab-4-mutiny.

[134] *See generally* Vandenbroucke, *supra* note 59.

sovereignty[135] and without permanent human settlement. In the following section, this article will explore how the remote and dangerous nature of the high sea's environment has affected the protection and enforcement of labor rights, and the implications for outer space thereof.

B. The High Seas

> No man will be a sailor who has contrivance enough to get himself into a jail; for being in a ship is being in a jail, with the chance of being drowned . . . a man in a jail has more room, better food, and commonly better company.
>
> - Samuel Johnson[136]

As outlined in Part II, modern international maritime law is embodied in the UN Law of the Sea, and since coming into force in 2013, the Maritime Labour Convention (MLC) has provided specific protection for workers' rights. The MLC is central to contemporary maritime labor regulation, and includes minimum age requirements, fair and regular wages, the right to rest and take leave and to sanitary and safe conditions.[137] It applies to all vessels entering the harbors of parties to the Convention (port States), as well as to ships flying the flag of a State that is party to the Convention (flag States), and now covers nearly 1.2 million seafarers, or 90% of the world's shipping fleet.[138] The MLC defines a seafarer as "any person who is employed or engaged or works in any capacity on board a ship to which [the MLC] applies."[139] This includes workers on private merchant fleets, which are the majority of those at sea,[140] maritime oil and gas workers, and those on passenger and cruise

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[135] The Law of the Sea, *supra* note 43, art. 87 ¶ 1.

[136] *See* JAMES BOSWELL, THE LIFE OF SAMUEL JOHNSON 299 (David Womersley ed., 1st ed. 2008)

[137] *See generally* MLC, supra note 47.

[138] Marina L. Fotteler et al., *Seafarers' Views on the Impact of the Maritime Labour Convention 2006 On Their Living and Working Conditions: Results from a Pilot Study,* 69 INT'L MAR. HEALTH 257 (2018).

[139] MLC, *supra* note 4747, art. II ¶ 1f.

[140] INTERNATIONAL CHAMBER OF SHIPPING, *Shipping and World Trade: Global Supply and Demand for Seafarers*, https://www.ics-shipping.org/shipping-fact/shipping-and-world-trade-global-supply-and-demand-for-seafarers (last visited Aug. 2, 2022).

ships[141] —all of which are useful analogues if we consider that the most widely anticipated near-future space industries are the extraction and transport of celestial resources, and tourism.

1. Lack of Oversight and Enforcement on the High Seas

As mentioned, the MLC applies to both flag and port States, both of which carry responsibilities regarding oversight and compliance. According to the Convention, States are responsible for ensuring compliance upon their flag ships through "regular inspections, reporting, monitoring and legal proceedings under the applicable laws."[142] Furthermore, States are required to ensure that their ships carry a "maritime labour certificate" to prove compliance.[143] Port States are required to ensure that any ships (from both party and non-party States) are compliant when in their ports, and are entitled to inspect them when harbored.[144] This inspection regime is known as "port State control" (PSC), and the majority of PSCs worldwide are divided and regulated under regional Memoranda of Understanding (Paris MoU).[145] PSC officers are in charge of inspecting ships to ensure that they are compliant with national standards (including the MLC). Regarding violations, the responsibility lies with member States to "establish sanctions or require the adoption of corrective measures under its laws which are adequate to discourage such violations" in accordance with international law.[146]

The MLC was designed to harmonize what had previously been a complex array of differing legal mechanisms, and create a "single, coherent instrument" for workers' rights.[147] However, given the inherent dangers, complexity and globalized nature of the

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[141] Notably, the MLC excludes workers on naval and fishing vessels—the latter of which experience some of the highest levels of exploitation. This has been attributed to fishing crews' low levels of unionization and resultant lack of "political clout." *See* IAN URBINA, THE OUTLAW OCEAN: CRIME & SURVIVAL IN THE LAST UNTAMED FRONTIER 149, 185 (1st ed. 2019).

[142] MLC, *supra* note 47, art. V ¶ 2, 4.

[143] *Id.* ¶ 3.

[144] *Id.* at regulation 5.2.

[145] Luka Grbić et al., *Detainable Maritime Labour Convention 2006-Related Deficiencies Found by Paris MoU Authorities*, 29 POMORSTVO, SCI. J. OF MAR. RSCH. 52, 52-27 (2015).

[146] MLC, *supra* note 47, art. V ¶ 6.

[147] *Id.* at Preamble.

industry, effective enforcement and oversight on the high seas is still a unique challenge.[148] In their initial assessment of the MLC, maritime studies experts Francisco Piniella, José María Silos and Francisca Bernal highlighted that this challenge remains unresolved, and although flag States will make a formal commitment to ensuring workers' rights by ratifying treaties, in practice "they either disregard them for want of political will or fail to comply for lack of the human and physical resources needed to exercise control over ships flying their flag."[149]

A more recent study on seafarers' perception of the impact of the MLC on their social and labor rights found that:

> Remarkably, one third of the respondents pointed out a complete lack of improvement, while 43.6% stated that the [MLC] had improved their working and living conditions "somewhat" and only 7.3% "to a great extent." The focus group participants agreed that the [MLC] did not improve working conditions but mostly increased paperwork.[150]

The researchers also found that seafarers in their sample experienced an increased rate of mortality, illness and accidents when compared with the rest of the population,[151] which is consistent with previous research.[152] An even more recent analysis of PSC inspection data found that although greater attention has been placed on workers' rights since the MLC was adopted, a decline in violations on the high seas could not be determined.[153] Difficulties in implementation at the flag State level have been cited as a potential reason for this,[154] and the "inadequacy of available knowledge and

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[148] Georgios Exarchopoulos et al., *Seafarers' Welfare: A Critical Review of the Related Legal Issues Under the Maritime Labour Convention 2006*, 93 MARINE POLICY. 62, 62-70 (2018); David Walters et al., *Supply Chain Leverage and Regulating Health and Safety Management in Shipping*, 71 INDUS. REL. 33, 33-56 (2016).

[149] Francisco Piniella et al., *Who Will Give Effect to the ILO's Maritime Labour Convention, 2006?*, 152 INT'L. LAB. R. 59, 60-1 (2013).

[150] Fotteler et al., *supra* note 138, at 257.

[151] *Id.* at 258.

[152] *See* Walters et al., *supra* note 148.

[153] Marina L. Fotteler et al., *The Impact of the Maritime Labor Convention on Seafarers' Working and Living Conditions: An Analysis of Port State Control Statistics,* 20 BMC PUB. HEALTH. 1, 1-9 (2020).

[154] Francisco Piniella et al., *The Implementation of a New Maritime Labour Policy: the Maritime Labour Convention (MLC, 2006)*, *in* SAFETY OF MARINE TRANSPORT:

difficulty to reach seafarers" hindering effective oversight and enforcement.[155] As proposed in H_1 and explored further below, there is an information asymmetry between regulatory bodies and workers on the high seas, as a result of the difficult and remote nature of the environment.

2. Widespread Non-Compliance

A recent report on inspection and enforcement data in three maritime countries (Finland, Poland and Spain) found that the most common violations on the high seas concerned non-compliance with collective bargaining agreements, breaches of contract, unpaid wages, inadequate medical care and non-compliance with MLC standards—with no noticeable decline as a result of inspection.[156] Interestingly for our purposes, the report also found that in Finland, effective oversight was heavily affected by the remoteness of a given vessel or maritime outpost, as well as by extreme environmental conditions, with the number of inspectors dropping effectively to zero in the winter, as a result of the logistical effort required to undertake their work.[157] A 2015 study of ships detained under PSC inspection in the jurisdiction of the Paris MoU found that the most common detainable deficiencies concerned conditions on-board (e.g. sanitation, adequate space) and conditions of employment, with wage infractions (late payment, insufficient payment, administration of pay slips among others) being the number one offense for which ships were being detained in the sample, at 29%.[158] In 2018, the International Transport Workers' Federation (ITF), a global federation of transport workers' unions, uncovered issues in 7,449 ship inspections, of which 40.1% concerned problems with

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MARINE NAVIGATION AND SAFETY OF SEA TRANSPORTATION 197 (Adam Weintrit & Tomasz Neumann eds., 2015).

[155] *See* Fotteler *supra* note 138.

[156] SANNA SAKSELA-BERGHOLM, THE INSPECTORATE NETWORK OF THE INTERNATIONAL TRANSPORT WORKERS FEDERATION: A COMPARISON OF A TRANSNATIONAL UNION ENFORCEMENT ACTION IN FINLAND, POLAND AND SPAIN (Nov. 2020) *available at* https://www.jyu.fi/hytk/fi/laitokset/yfi/en/research/projects/research-groups/splin/splin-itf-synthesis-report-nov-2020-edited-final-3.pdf.

[157] *Id.,* at 21.

[158] Grbić et al, *supra* note 145, at 52-6.

agreements, followed by owed wages (19.2%) and breach of contract (19%).[159]

3. Flags of Convenience

As the "freedom of the sea" (*mare liberum*) is enshrined in the UN Law of the Sea, the high seas remain beyond sovereign jurisdiction. Thus, a legal framework was required to regulate the activity of ships sailing beyond their State's exclusive economic zone (EEZ), and this emerged in the form of the ship registry system.[160] Under this system, all ships must be legally documented and registered with a State (its flag State) and are subject to its laws. The registry system is therefore a means by which vessels and personnel entering an area beyond sovereign jurisdiction remain answerable to national and international law, and is analogous to the aforementioned Article VIII of the Outer Space Treaty (1967).[161]

In recent decades however, a combination of globalization and deregulation has allowed a "flag of convenience" (FOC) system to predominate in global shipping.[162] This is a business practice whereby owners of foreign merchant ships can choose to register their vessel in a State other than their own. In essence, this means that operators "choose the sovereign regulatory regime under which they will operate,"[163] and is generally done to avoid regulation, cut costs and combat unionization.[164] The scale of this practice on the contemporary high seas is staggering. In 2019 more than 75% of merchant ships globally were registered under an FOC—with over 50% of all global shipping (30,000 vessels) being registered in just

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[159] INTERNATIONAL TRANSPORT FEDERATION, *Seafarers' Bulletin 32*, (2018), https://www.itfglobal.org/en/reports-publications/seafarers-bulletin-2018 (last visited Aug. 18, 2022) [hereinafter ITF Report].

[160] *See* EDWARD WATT, SHIP REGISTRATION: LAW & PRACTICE (Richard M. F. Coles ed., 3rd ed. 2019).

[161] Registration Convention, *supra* note 18, art. II. Additionally, a register of objects launched into space is maintained by the Secretary-General of the United Nations, and it is mandatory for all space operators to comply with it. *Id.*

[162] Piniella et al., *supra* note 154, at 69-70; Helen Sampson, *Powerful Unions, Vulnerable Workers: The Representation of Seafarers in the Global Labour Market*, SIRC. 1, 3-4 (Cardiff University, 2003) (on file with author).

[163] SAKSELA-BERGHOLM, *supra* note 156, at 1.

[164] *See* Lillie, *Seafarers' Strikes in American History*, *supra* note 50, at 534.

three countries: Panama, Liberia and the Marshall Islands.[165] The practice is so common that it is "often impossible to determine the nationality (let alone the identity) of the owners of many of the merchant ships currently afloat,"[166] leaving a large portion of seafarers "disembedded from any unified national regulatory or social context,"[167] and thus at the mercy of company owners when on the high seas. Abolishing or reforming the FOC system is the central fight for modern maritime unions, most notably the ITF.[168]

As the volume of crewed space vessels increases, we may conceivably see similar flag-versus-port provisions to ensure compliance, in a similar fashion to the maritime industry. Space vessels could be required to carry something akin to a maritime labor certificate, and spaceport authorities may be given similar inspection powers as under the PSC system. However, as discussed above, such measures have been largely ineffective, given the difficulty in undertaking effective inspection in extreme and remote circumstances, and the lack of enforcement even when inspection is possible.

A flag of convenience system whereby employers can effectively sidestep international legislation is also conceivable in the realm of outer space. In 2017, Luxembourg passed a law which gives private space companies the right to resources extracted from asteroids.[169] Interestingly, as Étienne Schneider, the Deputy Prime Minister and Minister of the Economy at the time, stressed, future asteroid mining enterprises "need not be based in Luxembourg to take advantage of [the law's] provisions."[170] As the law was passed, Luxembourg committed to invest around €200 million in asteroid

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[165] UK DEPT. OF TRANSPORT, *Shipping Fleet Statistics*, (2019), https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/967906/shipping-fleet-statistics-2019.pdf (last visited Aug. 22, 2022); Exarchopoulos et al., *supra* note 148, at 64.

[166] Piniella et al., *supra* note 149, at 69.

[167] *See* Lillie, *Union Networks and Global Unionism in Maritime Shipping*, supra note 50, at 89.

[168] *See* Lillie, *Seafarers' Strikes in American History*, *supra* note 50, at 535, 544-5

[169] *Loi du 20 juillet 2017, supra* note 8. Although controversial, it was argued that it was not in contravention of the Outer Space Treaty (1967), as it does not allow for the appropriation of celestial bodies, but simply the resources on them. Additionally, the Treaty makes no specific reference to private companies.

[170] *Id.* Jeff Foust, *Luxembourg Adopts Space Resources Law*, SPACE NEWS (2017), https://spacenews.com/luxembourg-adopts-space-resources-law (last visited Aug. 18, 2022) (quoting Étienne Schneider)

mining companies in exchange for them setting up offices in the country.[171] At this stage, Luxembourg is creating a "business-friendly setting"[172] to attract investment in a growing industry. However, we can see from the above discussion how the registry system for space objects could allow for something similar to maritime flags of convenience in the future, with similar results for oversight and enforcement of labor law.

4. Diminished Bargaining Power on the High Seas

i. History of Maritime Labor Organizing

Up until the early 20th century, seafarers were among the most exploited workforces in the world, "underfed, underpaid and overworked" and "considered workmen beyond the usual recourses of the law."[173] In 1830, around 20% of all American seafarers died at sea, with a mortality rate as high as 70% for some coal routes.[174] Sailors were jailed for refusing to work on ships they deemed unsafe.[175] "Shanghaiing," a practice whereby a person was kidnapped, put aboard a ship, and then "effectively enslaved for the length of a voyage" was relatively commonplace.[176] Captains on-board had ultimate authority, and mutinies were punishable by flogging or death.[177] Moreover, early attempts at reform were hindered by the nature of the work itself. "Sailors found themselves in foreign cities, with changing crews and few local ties,"[178] and early strike action was limited to ports specifically because of crews' virtually non-

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[171] Foust, *supra* note 170.

[172] Weinzierl, *supra* note 10, at 189.

[173] John Bunker, *A History of the SIU*, SEAFARERS INTERNATIONAL UNION (2018), https://www.seafarers.org/about/siu-information/siu-and-maritime-history/ (last visited Aug. 15, 2022).

[174] LEON FINK, SWEATSHOPS AT SEA: MERCHANT SEAMEN IN THE WORLD'S FIRST GLOBALIZED INDUSTRY, FROM 1812 TO THE PRESENT 67 (2011).

[175] *Id.*

[176] *See* Lillie, *Seafarers' Strikes in American History*, *supra* note 50, at 545; Sampson, *supra* note 162, at 3.

[177] Fink, *supra* note 174, at 3-5; Michael Reagan, *Maritime Workers and their Unions,* THE WATERFRONT WORKERS HISTORY PROJECT, (2010) https://depts.washington.edu/dock/maritime_intro.shtml.

[178] Reagan, *supra* note 177.

existent bargaining power while at sea, where collective action was "punishable by imprisonment or death."[179]

The creation of the International Labour Organization (ILO) after WWI and the emergence of transnational union federations represented a turning point, and for the first time began to create a framework for international regulation of maritime labor.[180] However, as labor organization is "inherently geographical" and usually draws support from a local, fixed community,[181] the inherent difficulties of organization on the high seas continued to be a problem, later exacerbated by the pressures of globalization and proliferation of the FOC system described above.[182]

ii. Collective Action on the Modern High Seas

Although the maritime industry is one of the most regulated industries in the world,[183] the ability of workers to effectively organize remains diminished. One three-year study analyzed by Sampson incorporated ethnographic voyages aboard 14 vessels of different sizes and trades concluded that although the ITF is considered powerful institutionally, "it nevertheless fails to successfully prevent the exploitation of large numbers of seafarers at the hands of employers, agents, and even national trade union affiliates,"[184] because company owners are able to exploit not only legal loopholes, but also the isolation and remoteness of long haul journeys to reduce effective bargaining power.[185] Ships are "remote and dangerously isolated work sites" which can become "like prisons" for seafarers on-board, unable to return ashore for long periods.[186] Though the speed of ships has increased, many seafarers in the 21st century spend on average more time at sea than those in centuries previous, and their experience is similarly characterized by

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[179] *See* Lillie, *Seafarers' Strikes in American History*, *supra* note 5050, at 545.

[180] Sampson, *supra* note 162, at 1-3, 7.

[181] Leah L. Carmichael & Andrew Herod, *Dockers and Seafarers: What the Politics of Spatial Embeddedness and Geographical Scale Have Meant for Union Organizing in the European Maritime Trades*, 37 LABOR STUD. J. 203, 204-8 (2012).

[182] *See* Sampson, *supra* note 162.

[183] Exarchopoulos et al., *supra* note 148, at 62.

[184] Sampson, *supra* note 162, at 5.

[185] *Id.*; SAKSELA-BERGHOLM, *supra* note 156, at 10; Reagan, *supra* note 177.

[186] Sampson, *supra* note 162, at 5-6.

"isolation, tedium, and confinement."[187] Multi-national, itinerant crews who are thousands of miles away from their States of origin "do not have the kinds of community resources on hand on which they can draw to sustain themselves through what may be long disputes with their employers."[188] This effect is compounded by the hiring of low-cost "crews of convenience" to undercut unionized workers, and an increasing tendency to outsource inspection and certification services, leading to a massive reduction in the presence of trade union representatives among crews.[189]

When at sea, crews are dependent on the vessel to survive, and so "the length of voyage, wage levels, and job security are all dependent on the specific employer for whom a seafarer works."[190] Moreover, maritime workers, the majority of whom hail from the Global South, are more disposable than in other industries, and blacklisting of unionizing workers remains widespread.[191] Some ship owners reportedly charge crewmembers a deposit before stepping aboard a work vessel, which they will only get back if they refrain from engaging in disruptive forms of collective action while at sea.[192]

In their study of union organization among European dockworkers and seafarers, Carmichael and Herod found that the former had a much higher degree of industrial leverage, because of the fixed nature of capital at docks (buildings and equipment with sunken costs for employers) and the fact that dockers tended to be embedded in a local community from which they could draw support and solidarity. [193] The mobile, remote and itinerant nature of seafaring on the other hand made it much more difficult for maritime workers to make gains. Despite having formal representation to the European Commission and intense lobbying, seafarers were unable to prevent the withdrawal of the Directive on a common policy on manning of regular passenger and ferry services operating in

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[187] *Id.*; *See* Exarchopoulos et al., *supra* note 148.

[188] Carmichael & Herod, *supra* note 181, at 220.

[189] Piniella et al., *supra* note 154, at 59; Walters et al., *supra* note 148, at 35.

[190] Sampson, *supra* note 162, at 11.

[191] Carmichael & Herod, *supra* note 181, at 220; Sampson, *supra* note 162, at 8.

[192] Sampson, *supra* note 162, at 8.

[193] Carmichael & Herod, *supra* note 181, at 220. *See also* Lillie, *Union Networks and Global Unionism in Maritime Shipping*, supra note 5050, at 89.

and between European Union member States,[194] which would have improved and standardized EU labor regulations on seaways, in the face of opposition from shipping company owners.[195] By contrast, and despite no formal representation at the Commission, dockers successfully blocked two deregulation packages of the European Union's Common Transport Policy.[196]

The spatial nature of maritime work also results in unique forms of labor abuse. A 2018 report referred to abandonment of crews as a "blight" that "plagues the maritime industry."[197] This is where a shipowner fails to cover the costs of repatriating a worker or workers after their contract has finished, or even severs ties altogether, often taking unpaid wages with them.[198] As movement in ports is often highly restricted and shore leave far from guaranteed,[199] workers can be marooned and unable to even leave their ship—sometimes for as long as two years, with little or no legal or organizational recourse.[200] Even when at port, the special circumstances inherent to work on the high seas affects the ability of crews to organize and barter effectively.

Thus, in the isolated and remote environment of the high seas, strikes and other forms of collective action are "few in number, and short in duration."[201] As per H_2, collective action is a greater

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[194] Communication on a Common Policy on Manning of Regular Passenger and ferry Services Operating in and Between Member States, COM (98) 251 (Apr. 29, 1998), available at http://aei.pitt.edu/10543/.

[195] Carmichael & Herod, *supra* note 181, at 212-22.

[196] *Id.*, at 212-22. The European Transport Workers' Federation (ETF) successfully resisted Port Packages I and II, which were proposals to liberalize elements of the European Union's Common Transport Policy – specifically regarding rules around employing non-union cargo handlers. The ETF lobbied their representatives to the European Parliament and Commission, then organized Europe-wide protests through affiliated national unions. Despite both groups being affected, European dockers were much more successful than maritime workers in resisting deregulation, in part because they were able to use "their employers' geographical immobility, manifested through the spatial embeddedness of [their] capital investments in ports" (*Id.*, at 218) against them. Seafarers, by virtue of the remote and mobile nature of their work, found themselves at a comparative disadvantage, and were unable to engage in similarly successful collective action.

[197] ITF Report, *supra* note 159, at 1-3.

[198] *Id.* at 13. *See also* Gang Chen & Desai Shan, *Seafarers' Access to Jurisdictions Over Labour Matters*. 77 MARINE POL'Y 1, 2-6 (2017).

[199] Exarchopoulos et al., *supra* note 148, at 67-8.

[200] *Id.* at 14-6. *See* Chen & San, *supra* note 198.

[201] Sampson, *supra* note 162, at 8.

challenge far from port, and the relative bargaining power of seafaring workers is diminished—especially on long voyages where the crews are dependent not only on the company, but on the vessel to survive. Companies have a disproportionate amount of power over workers under these circumstances, and can even leave crews abandoned and unpaid, with much less recourse available to them than in other environments.[202]

Future workforces in outer space may face voyages which are an order of magnitude longer in both duration and distance, and thus we may expect the effect of H_2 to be amplified. Moreover, in future commercial space enterprises, the parent company may conceivably have ownership not just over the vessel itself, but over the actual means of existence: air, temperature and pressure. In such an environment, the effective bargaining power of potential workers may be reduced from very little, to zero.

iii. Specialized Work and Supply Chain Leverage

Though seafarers have diminished bargaining power when at sea, the critical importance of the industry for global trade[203] and "skilled craft nature of many shipboard tasks" allows for some leverage when industrial action is able to be successfully coordinated.[204] As a result of improvements in shipping and container technology, modern shipping requires smaller crews than before,[205] and although this reduces the net strength and resources of maritime unions,[206] a smaller, more specialized and strategically placed workforce can allow for some increased bargaining power by "[idling] expensive equipment,"[207] in a manner consistent with H_3. In addition to logistical importance and specialization, sea work is time sensitive, as cargo is frequently perishable, which can afford worker's additional leverage.[208]

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[202] ITF Report, *supra* note 159159, at 1-3, 13; URBINA, *supra* note 141, at 142-3.

[203] An estimated 80% of all commerce is transported by sea. *See* UNCTAD, *Review of Maritime Transport*, (2019), https://www.un-ilibrary.org/content/books/9789210043021 (last viewed Aug. 21, 2022).

[204] Lillie, *Seafarers' Strikes in American History*, *supra* note 50, at 534.

[205] Exarchopoulos et al., *supra* note 148148, at 66-7.

[206] Reagan, *supra* note 177.

[207] LILLIE, A GLOBAL UNION FOR GLOBAL WORKERS, *supra* note 50, at 31.

[208] Lillie, *Seafarers' Strikes in American History*, *supra* note 50, at 534.

As we have seen however, this leverage must meet the challenges inherent to labor on the high seas or limit itself to actions at port. The ITF has increasingly exploited interdependencies in maritime supply chains (i.e., between the critical juncture of ports and the specialized work at sea) to negotiate minimum standard pay agreements, as well as to counter union busting in harbors.[209] It is crucial to the success of such a strategy that there is a relatively high-level of coordination between seafarers and dockers,[210] and that such coordination is global in scope.[211] In other words, the specialized nature of the work on the high seas can provide seafarers with a unique strategic advantage, but not in isolation.

It seems likely that early crews in outer space will have an advantage by virtue of their specialization. Indeed, in the Skylab-4 incident, a small, specialized workforce was able to leverage their position in a matter similar to the crews on modern container ships idling expensive hardware.[212] Yet in a more expansive space-based economy with a relatively large supply of labor, successful, broad-based collective action will likely require strategic coordination and cooperation between sectors (both space-based and terrestrial), as demonstrated by modern seafarers' unions.

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[209] *Id.;* LILLIE, A GLOBAL UNION FOR GLOBAL WORKERS, *supra* note 50, at 65-88.

[210] *See* Carmichael & Herod, *supra* note 181; Lillie, *Seafarers' Strikes in American History*, *supra* note 50.

[211] *See* Fairbrother & Gekara, *supra* note 4949; LILLIE, A GLOBAL UNION FOR GLOBAL WORKERS, *supra* note 50.

[212] *See* Bhatt, *supra* note130; LILLIE, A GLOBAL UNION FOR GLOBAL WORKERS, *supra* note 50, at 31; Mellon & Wille, *supra* note 98.

Table 2: Summary of findings

	Lack of Oversight	Diminished Bargaining Power	Specialized Work
The American Frontier	Company towns were able to ignore constitutional, federal and state laws regarding basic labor rights as a result of their isolation, and successfully evaded efforts to reform.	Frontier workers' bargaining power was effectively reduced by their isolation, dependence on a parent company, and the resources which owners could deploy against them.	Labor shortages due to the specialized nature of early frontier work gave workers a comparative advantage, however this would be erased as industry expanded.
The High Seas	Non-compliance with labor law is comparatively common on the high seas, and both flag and port States have been able to avoid enforcement. This is compounded by the FOC system.	Dependence on the vessel while on long voyages limits crews' effective bargaining power, and practices such as blacklisting and abandonment are relatively common.	Seafaring unions have been able to exploit supply chain leverage, but only in conjunction with port workers. Small container ship crews have a comparative advantage.

Outer Space	Extreme isolation from the international community could reproduce a company town system on space settlements. A similar flag/port State inspection regime could pertain; however compliance issues will likely persist.	Dependence on the parent company/vessel for survival, virtually impassable barriers of entry and extreme remoteness will potentially reduce effective bargaining power to zero.	Specialized work will likely provide initial leverage, however strategic co-ordination between sectors will be necessary as industry expands and this initial advantage is lost.

VI. DISCUSSION

No Earth-based government has authority or sovereignty over Martian activities.

– Section 12 of *SpaceX*'s StarLink (2023) Terms of Service.[213]

The industrialization of outer space is still in its earliest stages, and thus an investigation into workers' rights may seem premature to some. Yet decisions made today regarding social and political organization, of space law and policy, will influence future individuals and communities, and it is within this context that a discussion on the enforcement and protection of labor rights is

[213] STARLINK, *Starlink Pre-Order Agreement*, https://www.starlink.com/legal/documents/DOC-1026-18522-63?regionCode=GB (last visited Mar. 4, 2023). StarLink is a constellation of SpaceX satellites offering broadband services. The above-quoted clause was interpreted as a joke by many when originally published, and Dr. Bleddyn Bowen of the University of Leicester notes that it contravenes the Outer Space Treaty. Speed, *supra* note 101 (*quoting* Dr. Bowen). One journalist noted that this might not ultimately matter however, as "[Musk will] have the keys to the airlock, after all." *Id.*

essential. Indeed, the question of labor in outer space becomes even more pertinent when we consider the present rise of the private space corporations, led by CEOs who are publicly hostile to organized labor, and under whose terrestrial stewardship labor abuses have already reportedly occurred.[214]

This article proposed that the development and enforcement of a legal regime to protect workers in extreme environments are characterized by a relative lack of compliance with regulation in the absence of effective oversight, the diminished bargaining power of workers in a physically perilous context, and the often-specialized nature of the work performed there ($H_{1\text{-}3}$). To investigate these hypotheses, the author conducted a study of two cases of developing labor rights in such environments: the historical American frontier and the contemporary high seas. The results are summarized in Table 2.

As we can see, these conditions create serious challenges for workers' rights, as effective oversight and enforcement of existing labor law is difficult, and bargaining power is diminished. Some leverage may be available, as was the case in the early years of the American frontier and on modern container ships. However, the overarching problem of oversight may only become worse the further one strays from Earth. Without some means of effective enforcement and protection of labor rights going forward, the next stage of space development could be one of company towns and flags of convenience, with disastrous outcomes for workers.

Further research will be needed in order to formulate a response to these challenges. Some preliminary recommendations:

- A global forum (akin to that which formed the Outer Space Treaty and the UN Law of the Sea), which involves stakeholders from all levels of the space industry, as well as international labor organizations, in order to engage with these issues.

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[214] *See* Sonnemaker, *supra* note 1. *See also* Robert Reich, *In Space, No One Will Hear Bezos and Musk's Workers Call for Basic Rights*, THE GUARDIAN (Apr. 25, 2021), http://www.theguardian.com/commentisfree/2021/apr/25/elon-musk-jeff-bezos-space-moon-mars-workers-rights-unions; Paddy Hannam, *The Brass Neck of Richard Branson*, SPIKED (Apr. 21, 2020), https://www.spiked-online.com/2020/04/21/the-brass-neck-of-richard-branson.

- Broad-based union strategies which unite workers in other sections of the space industry (spaceports, spaceship manufacturers, scientific researchers), with those in outer space.

- The promotion of democratization of the workplace, both in outer space and on the high seas, as well as the right to dissent.

This study is limited to two comparative cases, and so further work will be needed to confirm any inferences and to strengthen the conclusions and recommendations. Additional areas for future research include the democratization of remote workplaces, the potential for self-regulation in extreme environments, and the effects of automation on labor rights in these environments.

Hopefully this research offers an insight into the inherent challenges labor will face in outer space. If we are at the dawn of a new Space Age, and its antecedent conditions are indeed comparable to the cases explored here, then lawmakers, scholars and labor activists should act proactively and pre-emptively, to prevent the outcomes that this study suggests are possible, and to ensure the dignity, safety and autonomy of future workers in outer space.

A NEW GOLD MINING RUSH?

Aikaterini Vakaki[*]

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.

AVOIDING CONFLICT IN ASTEROID RESOURCE EXTRACTION

Gregory Radisic and Connor Haffey***

I. INTRODUCTION: AN OPPORTUNITY WITH ASTRONOMICAL POTENTIAL

Asteroids are brimming with critical and strategic minerals – considered vital for the economic well-being of the world's major and emerging economies – and are seen by many as a solution to these minerals' terrestrial depletion.[1] Solar panels, electric car batteries, and new advances in technology all increasingly rely on these rare minerals; new mines in space could provide a much-needed new source of the rare elements required to assuage Earth's current environmental crisis.

While mining in space may be a concept considered "out of this world" for most, the terrestrial mining industry is showing interest considering the potential astronomical profits. Of the identified asteroids, there are 711 known asteroids with an estimated value exceeding $100 trillion each.[2] The three "most cost effective" asteroids alone have an estimated combined value of over US$100 billion.[3] What's more, some of these asteroids have orbits that pass between

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[1] Ezzy Pearson, *Space Mining: The New Goldrush,* BBC SCIENCE FOCUS (Dec. 11, 2018).

[2] *See* ASTERANK, http://www.asterank.com/ (last visited Dec. 15, 2022). Asterank is a scientific and economic database that compiles data from the NASA Jet Propulsion Laboratory's Small Body Database and the Minor Planet Center to rank asteroids by likely potential value, cost effectiveness for mining, and other metrics [hereinafter Asterank].

[3] *Id.*

Earth and the Moon. For example, the Ryugu Asteroid's minimum orbital intersection distance is 95,400 km, equivalent to 0.23 lunar distances – requiring significantly less fuel to get to and yielding more profit than scientific missions to the Moon or Mars.[4]

Although not yet economical, a significant hindrance to asteroid mining investments are the risks associated with uncertain legal interpretations. Two, once promising, asteroid mining start-ups have failed at their goal of cultivating extraterrestrial mines due to difficulties in maintaining the high amount of investment needed. The first, Planetary Resources, flew some successful tests in Earth's orbit, inducing initial investments from high-profile businesspeople,[5] but eventually ran out of that funding amid uncertainty in the legal realm as to private property rights of the proposed resources.[6] Planetary Resources was acquired by blockchain company Consensys in 2018 to incorporate their technology into an open-source real-time satellite tracker called TruSat.[7] The second start-up, Deep Space Industries, was sold to Bradford Space without any clear indication of continuing asteroid mining purposes.[8] Nonetheless, commercial entrepreneurship in this sector is proving persistent with Astroforge, an asteroid mining start-up formed in January 2022, recently announcing initial funding of US$13 million and a test-run of its new asteroid-processing technology on a SpaceX Falcon 9.[9]

While exploration costs and technological challenges still exist, it is foreseeable that these challenges will have solutions in the near future.[10] However, the legal challenges may not be amenable to as

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[4] JAPAN AEROSPACE EXPLORATION AGENCY, *What Kind of Asteroid is Ryugu?,* https://www.hayabusa2.jaxa.jp/topics/20180404_e/ (last visited Dec. 15, 2022).

[5] Associated Press, *Asteroid Mining Venture Backed by James Cameron, Google CEO Larry Page,* CBS NEWS (Apr, 24, 2012), https://www.cbsnews.com/news/asteroid-mining-venture-backed-by-james-cameron-google-ceo-larry-page/.

[6] Nikola Schmidt & Martin Svec, *Breaking the Deadlock in the Space Mining Legal Debate*, 10 NEW SPACE 115, 119 (2022).

[7] Jemayel Khawaja, *Moonshot 3.0 – Inside ConsenSys Space and TruSat*, Consensys Blog (Nov. 4, 2019), https://consensys.net/blog/news/moonshot-3-0-inside-consensys-space-and-trusat/

[8] *See* Schmidt & Svec, *supra* note 6, at 119.

[9] Mike Wall, *Asteroid-mining Startup AstroForge Raises $14 Million, Books Launch for Test Mission*, SPACE.COM (May 26, 2022), https://www.space.com/asteroid-mining-startup-astroforge-2023-launch.

[10] *See* Andrew Zaleski, *How the Space Mining Industry Came Down to Earth*, FORTUNE (Nov. 24, 2018), https://fortune.com/2018/11/24/asteroid-mining-space-planetary-resources/.

straightforward a solution. Can any nation or company simply travel to space and stake a claim over space-based resources? How will ownership of these resources be determined upon return? This paper will assess the current international and national legal frameworks that exist for asteroid mining, analyze the implications of various legal approaches for the industry moving forward and briefly address how conflicts among differing approaches may be mitigated. Ultimately, it concludes that a trilateral approach that includes the input of private space actors, national legislators, and the international community could result in a successful implementation of uniform or at least mostly uniform asteroid mining frameworks.

II. BACKGROUND

A. Commercial Space Actors are Guiding the Future of Sovereignty in Space

Commercial space actors are growing in prominence, especially in the United States, where these entities have proven their ability to complete complicated missions at competitive rates.[11] However, international space law treaties have left the legality of mining asteroids open to interpretation. Varying analyses have led to contentious debates over whether the current treaty regime allows for asteroid resources to be legally extracted and owned.

In 2018, legal experts held a workshop to discuss the national authority to govern space mining.[12] The arguments expressed at the workshop still persist, with some arguing that national laws are contrary to international customary law and others viewing the national laws as a step toward new international custom.[13]

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[11] *See generally,* Mischel Carmen Belderrain et al., *The Road to Privatization of Space Exploration: What is Missing?*, presented at 64th IAC (2013), https://www.researchgate.net/profile/Mischel-Neyra-Belderrain/publication/289635460_The_road_to_privatization_of_space_exploration_What_is_missing/links/5af968bc0f7e9b026bf73382/The-road-to-privatization-of-space-exploration-What-is-missing.pdf.

[12] The Workshop was a part of the 34th Space Symposium and brought space experts from various walks of life together to debate whether national law or international law should govern space mining. This topic is also discussed *infra*, at Section V.

[13] Debra Werner, *Space-Law Workshop Exposes Rift in Legal-community Over National-authority to Sanction Space-mining*, SPACENEWS (April 17, 2018),

Nonetheless, this uncertainty of interpretation creates the possibility of stoking international tension.

Arguably, if legal scholarship and multilateral treaty building do not fill the gaps in the law, private industry will. An example can be found with SpaceX, currently the largest privately owned space company, which has been criticized for conducting risky and abnormal space faring activities. For example, in 2019, SpaceX declined to alter the orbital path of its new Starlink satellite constellation, even though it was at risk of collision with a European Space Agency (ESA) satellite's well-established orbital path.[14] In December 2021, Josef Aschbacher, the ESA Director General, warned that commercial space actors are being allowed to "make the rules" in space.[15] Highlighting Elon Musk's recent activities through his company SpaceX, Aschbacher warned that:

> You have one person owning half of the active satellites in the world. *De facto*, he is making the rules. The rest of the world including Europe … is just not responding quick enough. At the speed he is putting [objects] into orbit, he is almost owning those orbital-planes, because no one can get in there. He is creating a Musk sovereignty in space.[16]

As commercial actors are increasingly leading their own space missions without hands-on governmental oversight, the need for clear international guidelines and regulations has become increasingly necessary. More robust, universally accepted outer space rules and regulations would likely serve to deconflict future space activities. Not only would clarifying rules and regulations prevent conflict between nations, but also between nations and the commercial space industry.

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https://spacenews.com/space-law-workshop-exposes-rift-in-legal-community-over-national-authority-to-sanction-space-mining/.

[14] Jonathan O'Callaghan, *SpaceX Declined yo Move A Starlink-Satellite At Risk Of Collision With A European-Satellite*, FORBES (Sept. 2, 2019), https://www.forbes.com/sites/jonathanocallaghan/2019/09/02/spacex-refused-to-move-a-starlink-satellite-at-risk-of-collision-with-a-european-satellite/?sh=7dd8b4651f62.

[15] Peggy Hollinger & Clive Cookson, *Elon Musk Being Allowed to 'Make-the-rules' in Space, ESA-chief Warns*, FINANCIAL TIMES (Dec. 6, 2021), https://www.ft.com/content/7d561078-37c7-4902-a094-637b81a26241.

[16] *Id.*

B. The Risks of Inaction: The Need to Deconflict Future Asteroid Mining Activities

Inaction with respect to the establishment of a decisive regulatory framework for asteroid mining could have long-lasting effects universally. Private investment in space mining has amounted to billions of dollars.[17] Historically, commercial investors have placed an emphasis on driving profits on their investments over international goals like peace, security and global development.[18] Bohacek notes that an unrestrained race for control over space-based resources – alongside inadequate regulatory mechanisms surrounding property ownership, profit sharing and safety measures – can lead to conflict.[19] These conflicts could materialize in various forms, including, *inter alia*: legal disputes; transnational rifts; or disruptions in terrestrial technological operations or space operations.[20]

Private space companies are inherently headquartered in a nation and, under international law, that nation is responsible for the authorization of a space company's activities. Geopolitical disputes could arise if these companies were to claim large swaths of celestial bodies without clear legal frameworks having first been agreed to on a global scale. Thus, the inherent risk of allowing private companies to engage in asteroid mining without the proper regulatory frameworks in place is that a larger conflict could be created. In turn, it is important to solve the current deadlock that exists between the interpretation of present space treaties and their interaction with national legislations that allow for space mining.

III. EXISTING INTERNATIONAL SPACE TREATIES AND AGREEMENTS

A number of international treaties and agreements on the peaceful and scientific uses of space have been proposed and

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[17] Mehak Sarang, *The Commercial Space Age is Here*, HARVARD BUS. REV. (Feb. 12, 2021).

[18] *See* Schmidt & Svec, *supra* note 6, at 123.

[19] Petr Bohacek et al., *Benefit-Sharing as Investment Protection for Space Resource Utilization*, 10 NEWSPACE 127, 128 (2022).

[20] David Thompson, et al., *Space as a War-fighting Domain*, 32 AIR & SPACE POWER J. 2, 4 (2018).

adopted with varying degrees of international acceptance.[21] The most widely accepted of these treaties, the Outer Space Treaty,[22] culminated among the Cold-War era apprehension that the first nation to set foot on the Moon would use that high ground to propel further military conflict.[23] Although all existing treaties were agreed upon to enable international cooperation in the exploration and uses of space, while also ensuring space does not become a forum for war, none of these treaties explicitly create a unified and mutually agreed upon framework for mining rights to resources in outer space.[24] The Outer Space Institute, a Canadian-run network of space experts, recently urged the United Nations to quickly begin work on a "Multilateral Agreement on Space Resource Utilization" through an open letter signed by 142 space professionals.[25] Considering this, and before discussing potential frameworks in higher detail, it is first important to assess the relevant international agreements as they relate to mining space resources.

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[21] *See generally* 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]; Convention on the International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S 187 [hereinafter Liability Convention]. Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, Apr. 22, 1968, 19 U.S.T. 7570, 672 U.N.T.S. 119 [hereinafter Rescue Agreement]; Convention on Registration of Objects Launched into Outer Space, Jan. 14, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15 [hereinafter Registration Convention]; Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 18, 1979, 1362 U.N.T.S. 3 [hereinafter Moon Agreement].

[22] *See* Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcommittee on its Sixty-First Session, Status of International Agreements Relating to Activities in Outer Space as at 1 January 2022, U.N. Doc. A/AC.105/C.2/2022/CRP.10 (2022) [hereinafter Status of International Space Agreements]

[23] Joseph Crombie, *Mining of Celestial Bodies*, 10 SPACE & DEFENSE 9, 19 (2017); Hope M. Babcock, *The Public Trust Doctrine, Outer Space, and the Global Commons*, 69 SYRACUSE L. REV. 191, 208 (2019); Olaf Steffen, *Explore to Exploit: A Data-Centered Approach to Space Mining Regulation*, 59 SPACE POL'Y 101459, 101460 (pg.2) (2022).

[24] *See* Ram S. Jakhu & Yaw Otu Mankata Nyampong, *Some Legal Aspects of Space Natural Resources*, 18 EUR. J.L. REFORM 86, 88-89 (2016).

[25] Letter from U. British Columbia Outer Space Inst regarding Multilateral Agreement on Space Resource Utilization, to Tijani Muhammad-Bande, UNGA President (Aug. 31, 2021), http://www.outerspaceinstitute.ca/docs/InternationalOpenLetterOnSpaceMining.pdf.

A. The Outer Space Treaty of 1967

The Outer Space Treaty was formed to create a basic international legal framework for the peaceful uses of space.[26] Among other provisions, the Treaty bans military installations on celestial bodies,[27] creates liability for damage caused by a State Party's space object,[28] and stipulates that every nation has a right to the free exploration of space. Four provisions in particular carry a significant amount of weight in any future mining of critical and strategic minerals from asteroids – these are Articles I, II, VI and IX.

Article I states the exploration and use of outer space, including the Moon and other celestial bodies, should be carried out for the benefit of all [hu]mankind and shall be free for all States.[29]

Article II prohibits national appropriation of outer space including the Moon and other celestial bodies.[30]

Article VI declares State Parties shall bear responsibility for national activities in outer space regardless of whether such activities are carried out by governmental or non-governmental entities and that activities by non-governmental entities require authorization and continuing supervision by the appropriate State.[31]

Article IX creates three obligations: (1) to avoid harmful contamination; (2) to undertake consultations with a potentially affected State if there is belief an activity may harmfully interfere with that State Party's space activity, and; (3) to act with due regard to the interests of others.[32]

When combining the effects of Articles I and II, it is clear that every State is free to explore and use outer space, however, no State may exercise ownership rights over outer space including the Moon and celestial bodies.[33,] This generates the question, then, as to how profits may be earned through extracting asteroid resources, when ownership of celestial bodies is prohibited. For example, Article II could preclude staking a claim over asteroid resources, as this would carry quasi-sovereign rights, such as sole use over an

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[26] *See* Outer Space Treaty, *supra* note 21, at Preamble.
[27] *Id.* at art. IV.
[28] *Id.* at art. VII.
[29] *Id.* at art. I.
[30] *Id.* at art. II
[31] *Id.* at art. VI.
[32] *Id.* at art IX.
[33] *See* Jakhu & Nyampong, *supra* note 24, at 91.

unclaimed area for a potential mining site.[34] Some extremely profitable near-Earth celestial objects, such as the aforementioned Ryugu Asteroid, are only a few kilometers in diameter.[35] While staking a claim over the entirety of a relatively small celestial object could be possible within the precedents set from current large-scale mining operations on Earth, this would create significant tension with Article II of the Outer Space Treaty.[36]

Considering the stakes of the Cold War, it is possible the drafters of the Outer Space Treaty did not fully contemplate the legal nuances of a private, commercialized space industry.[37] It can thus be argued that the Outer Space Treaty does not create an international prohibition of the exploitation of space resources because mining operations are not specifically noted in the Treaty. Article IX suggests that as long as your mining activities do not create harmful contamination in space, and do not harm the activities of other Member States in space, that the operation can go ahead without consultation since there would be no potentially affected parties.[38] Moreover, it is arguable that space-based mining has already occurred without consultation with the United Nations, as, for just one example, the United States has already mined and brought to Earth approximately 842lbs of lunar rocks and soil over the course of six lunar missions.[39]

Finally, and most importantly, the boundaries for "harmful contamination" in space could be extremely narrow or even restricted to larger celestial objects such as quasi-habitable planets and moons.[40] For instance, most asteroids are often highly irradiated rocks with little discernable environmental features to protect

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[34] BIN CHENG, *Studies in International Space Law*, at 233 (1997); Frans G. von der Dunk, *Private Property Rights and the Public Interest in Exploration of Outer Space*, 13 Biological Theory 142, 2 on online PDF (2018), https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1095&context=spacelaw.

[35] Asterank, *supra* note 2.

[36] Khaled Abdel-Barr & Karen MacMillan, *The International Comparative Legal Guide on Mining Laws and Regulations*, GLOBAL LEGAL GROUP (2021).

[37] Babcock, *supra* note 23, at 209; von der Dunk, *supra* note 34, at 3.

[38] *See* Fengna Xu, *Environmental Protection in the Exploitation and Use of Space Resources*, 565 IOP CONF. SER: EARTH & ENVIRON. SCIENCE 012003, at 4 (2020), https://iopscience.iop.org/article/10.1088/1755-1315/565/1/012003/pdf.

[39] NASA, *Lunar Rocks and Soils from Apollo Missions*, CURATION LUNAR (Sept. 1, 2016), https://curator.jsc.nasa.gov/lunar/.

[40] *See* Xu, *supra* note 38.

and thus may not be subject to "harmful contamination" depending on its interpretation. An argument can even be made that the complete depletion of asteroids in near-Earth orbit may be in the best interest of all humankind, as these rocks can pose a greater threat of Earth-impact over years as their orbits are altered by the gravities of other celestial bodies.[41] Stemming from the varying interpretations of the Outer Space Treaty, the legal debate surrounding the mining of space resources still lacks consensus or clarity on an international scale. Major points still need to be clarified, such as whether the extraction of asteroid resources is considered national appropriation and whether national laws allowing entities to own asteroid resources can coincide with international obligations.

B. The Moon Agreement of 1979

The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Agreement) sought to reaffirm provisions within the Outer Space Treaty while attempting to create an international governing regime for the exploitation of outer-space resources.[42] However, the agreement is not binding except to the small number of States that ratified it – most spacefaring nations did not sign this agreement, including the United States, China, Russia, India, and Canada.[43] While some attempted to compare the Moon Agreement to mining rights in the United States, another major critique of was that the agreement was opposed to free enterprise and private property rights.[44] Nonetheless, the Moon Agreement does attempt to set an international legal precedent on the mining of resources in outer space through Article XI. This Article states "[t]he moon and its natural resources are the common heritage of [hu]mankind" and that an international regime should be established to govern the orderly and safe development, rational management, and equitable sharing of "the natural

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[41] NASA, *Solar System Exploration: Asteroids* (July 19, 2021), https://solarsystem.nasa.gov/asteroids-comets-and-meteors/asteroids/in-depth/#:~:text=The%20orbits%20of%20asteroids%20can,orbits%20of%20the%20other%20planets.

[42] Moon Agreement, *supra* note 21.

[43] Status of International Space Agreements, *supra* note 22.

[44] Vidvuds Beldavs, *Simply fix the Moon Treaty*, SPACE REVIEW (Jan. 15, 2018); *see also*, *Hearing on S. Rept 96-*567 *Before the Subcomm. On Science, Technology, and Space*, 96th Cong. (1980).

resources of the moon."[45] However, likely due in part to the lack of specificity contained within the "equitable sharing" of resources provision, the Moon Agreement lacked sufficient support to create a lasting international framework for the exploitation of space resources.

C. The Artemis Accords of 2020

As of this paper's publication, the United States-led Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids (Artemis Accords) has 27 signatories.[46] The Artemis Accords cover a variety of topics from inter-governmental transparency through data sharing,[47] to the protection of space heritage sites,[48] the registration of lunar technologies deployed, and indeed the use of space resources.[49] The Artemis Accords were not created through any United Nations entity, but are rather principles to which the signatories subscribe a political commitment.[50] The Accords outline that space resource extraction and utilization can be conducted under the auspices of the Outer Space Treaty.[51] Specifically, the ability to mine and zone areas on the Moon, Mars, and asteroids is emphasized under Paragraph 2 of Section 10 and Paragraphs 6 and 11 of Section 11 in the Artemis Accords.

Paragraph 2 of Section 10 in the Artemis attempts to create an internationally recognized interpretation of the Outer Space Treaty by stating:

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[45] Moon Agreement, *supra* note 21, art. XI.

[46] The Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids, NASA, https://www.nasa.gov/specials/artemis-accords/img/Artemis-Accords-signed-13Oct2020.pdf [hereinafter Artemis Accords]; As of December 2022, the current Artemis Accords signatories include Australia, Bahrain, Brazil, Canada, Colombia, Czech Republic, Ecuador, France, India, Israel, Italy, Japan, Luxembourg, Mexico, New Zealand, Nigeria, Poland, Republic of Korea, Romania, Rwanda, Saudi Arabia, Singapore, Spain, Ukraine, United Arab Emirates, the United Kingdom, and the United States.

[47] *See* Artemis Accords, *supra* note 46, § 8.

[48] *See id.* § 9.

[49] *Id.* § 10.

[50] *Id.* § 1.

[51] *Id.* § 10.

> The Signatories emphasize that the extraction and utilization of space resources, including any recovery from the surface or subsurface of the Moon, Mars, comets, or asteroids, should be executed in a manner that complies with the Outer Space Treaty and in support of safe and sustainable space activities. The Signatories *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.[52]

This is controversial as, some scholars argue that the United States is trying to become the global regulator of commercial space activity, as opposed to following the global spirit of the Outer Space Treaty.[53] An article published in the journal *Science* by two Canadian space experts argues a US-centric and capitalist approach is likely to create rampant exploitation of space resources at the expense of science.[54] This could see the United States leveraging signatories' political commitments, alongside lucrative financial contracts, to reinforce its own political agenda with regards to the Outer Space Treaty.[55] Others argue that this American attempt to sculpt the interpretation of international space law through the Artemis Accords is another reason why existing treaties, such as the Moon Agreement and Outer Space Treaty, should be amended to have specific stipulations and procedures surrounding mining rights.[56]

Advocates for the Artemis Accords, however, recognize its utility in using a bottom-up approach to build customary international law regarding asteroid resource utilization instead of waiting for an

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[52] *Id.* § 11(6) (emphasis added).

[53] Bob McDonald, *Canada Just Signed a New Moon Pact — is it a Good Idea?*, CANADIAN BROADCASTING CORP. (Oct. 16, 2020), https://www.cbc.ca/radio/quirks/canada-just-signed-a-new-moon-pact-is-it-a-good-idea-1.5763940.

[54] Aaron Boley & Michael Byers, *U.S. Policy puts the Safe Development of Space at Risk*, 370 SCIENCE 174, 174-75 (Oct. 9, 2020).

[55] Christopher Newman, *Artemis Accords: Why Many Countries are Refusing to Sign Moon Exploration Agreement*, THE CONVERSATION (Oct. 19, 2020), https://theconversation.com/artemis-accords-why-many-countries-are-refusing-to-sign-moon-exploration-agreement-148134.

[56] Boley & Byers, *supra* note 54, at 174-75.

international consensus.[57] This may even be coming to fruition, with some nations who are or were signatories or Parties to the Moon Agreement now subscribing to the Artemis Accords, it shows that the Moon Agreement and Artemis Accords can either coexist together or, otherwise, the Moon Agreement does not reflect customary international law.[58]

Additionally, Section 11(7) proposes the use of "safety zones" which are referred to as the area wherein notification and coordination of space activities will be implemented to avoid harmful interference.[59] Some worry these "safety zones" would also operate similar to the ownership of property, and provide the respective nation with exclusive uses to a specific extraterrestrial area for a supposed temporary period of time.[60] Some experts view such safety zones in contravention of the ban against claiming exclusive use and extraterrestrial sovereignty as laid out in Article II of the Outer Space Treaty.[61] Others argue safety zones are not intended to keep other actors out, but would exist to protect ongoing space activities by avoiding harmful interference and ensure other actors behave with due regard.[62]

IV. REACHING FOR THE STARS: NATIONAL STATUTES FOR MINING RESOURCES IN SPACE

Currently four nations – the United States, Luxembourg, the UAE, and Japan – have passed national legislation that grants their respective citizens a legal basis to engage in asteroid mining operations and associated rights to any resources that citizens mine in space. Other nations – namely Russia, Israel, and China – are slowly developing policies on the space mining issue.[63] However, as

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[57] See Walker A. Smith, Using the Artemis Accords to Build Customary International Law, 86 J. AIR L. & COM. 661, 690 (2021).

[58] *See id.* at 684; *see also* Stephan-Michael Wedenig & Jack Wright Nelson, *The Moon Agreement: Hanging by a Thread?*, MCGILL INST. AIR & SPACE L. (2023).

[59] Artemis Accords, *supra* note 46, § 11(7).

[60] *See* Rossana Deplano, *The Artemis Accords: Evolution or Revolution in International Space Law?*, 70 INT'L & COMPAR. L. Q. 799, 807 (2021).

[61] Outer Space Treaty, *supra* note 21, art II; Lucas Mallowan et al., *Reinventing Treaty Compliant "Safety Zones" in the Context of Space Sustainability*, 8 J. SPACE SAFETY ENG'G 155, 160 (2021).

[62] Mallowan, *supra* note 61.

[63] Senjuti Mallick & Rajeswari Pillai Rajagopalan, *If Space is 'The Province of Mankind,' Who Owns its Resources?*, OBSERVER RSCH. FOUND. (Jan. 24, 2019).

these policies are currently not in the form of a statute, this analysis will be restricted to ratified national legislation for space mining.

In particular, it is important to assess how well each piece of national legislation aligns with the provisions in Article VI of the Outer Space Treaty. Article VI provides that "…The activities of non-governmental entities in outer space, including the moon and other celestial bodies, shall require *authorization and continuing supervision by the appropriate State Party* to the Treaty."[64]

In essence, Article VI is an important component of the Outer Space Treaty that each Member State takes responsibility for the actions of their citizens in space, and does so via direct authorization and continuing supervision of any space activities.

Each law's substance is discussed in the paragraphs below. A major point of contention that is worthwhile to note prior to discussing the laws, is that each provides the right to its citizens to own space resources that they may extract or collect. However, none of them seem to make any explicit reference to the Outer Space Treaty or the non-appropriation principle. This potential grinding of ideologies is further discussed in Section V, *infra*.

A. The American SPACE Act Amendments of 2015

In 2015, the United States enacted the Commercial Space Launch Competitiveness Act (SPACE Act).[65] The portion of the Space Act most relevant to this article is codified in 51 U.S.C. §§ 51301-51303. Most notably, § 51303 gives Americans who successfully extract natural resources from outer space the property rights over those resources by stating that "[a] United States citizen engaged in commercial recovery of an asteroid resource … shall be entitled to … possess, own, transport, use, and sell the asteroid resource … in accordance with applicable law, including the international obligations of the United States."[66]

At the time of enactment, the SPACE Act of 2015 was the first national codification of asteroid mining rights worldwide. The Act was controversial due to its incentivization for asteroid mining within the American commercial sector regardless of a possible

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[64] Outer Space Treaty, *supra* note 21, art VI (emphasis added).

[65] U.S. Commercial Space Launch Competitiveness Act of 2015, H.R.2262, 114th Cong. (2015) [hereinafter SPACE Act].

[66] *Id.* § 51303.

violation of the Outer Space Treaty.[67] The Act attempts to fit into international law by clarifying any private exploitation could not result in the national appropriation of the celestial body; thus claiming accordance with Article II of the Outer Space Treaty.[68] Notably, the other three national laws vaguely outline a regulatory regime for the authorization of their respective nations' private actors; this is something absent from the United States SPACE Act. Instead, the SPACE Act demands the President to submit a report to Congress suggesting the federal agency to be in charge of such licensure.[69] Considering the technology to carry out asteroid mining was not available at the time of enactment, the Act's likely primary concern was to create the right to collect and own resources in order to incentivize commercial investments and further technological innovations.[70]

B. The Luxembourg Space Resources Act of 2017

Luxembourg has a well-established space industry which has played a significant role in the development of worldwide satellite communication systems.[71] Growing from this history, Luxembourg has launched an ambitious plan to extract resources from celestial bodies, such as asteroids.[72] Through this plan, Luxembourg hopes to position itself as Europe's center for space mining.[73]

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[67] Gbenga Oduntan, *Who Owns Space? US Asteroid-mining Act is Dangerous and Potentially Illegal*, THE CONVERSATION (Nov. 25, 2015), https://theconversation.com/who-owns-space-us-asteroid-mining-act-is-dangerous-and-potentially-illegal-51073; Jakhu & Nyampong, *supra* note 24, at 100.

[68] *See* Fabio Tronchetti & Hao Liu, *The White House Executive Order on the Recovery and Use of Space Resources*, 57 SPACE POLICY 101448, at 2; Space Act, Pub. L. 114-90, Title IV § 403.

[69] 51 U.S.C. § 51302(b).

[70] Tronchetti & Liu, *supra* note 68; Jakhu & Nyampong, *supra* note 24, at 100; von der Dunk, *supra* note 34, at 11.

[71] Société Européenne des Satellites (SES), *SES in Luxembourg is a World-leading Satellite Operator*, Luxembourg Space Agency (Sept. 4, 2019), https://www.science.lu/fr/video-transmission-and-data-networks/ses-luxembourg-world-leading-satellite-operator.

[72] Cecilia Jamasmie, *Luxembourg Shoots for the Stars, Invests $28 Million in Planetary Resources*, MINING.COM (Nov. 3, 2016), https://www.mining.com/luxembourg-shoots-for-the-stars-invests-28-million-in-planetary-resources/.

[73] Cecilia Jamasmie, *Luxembourg Joins Race to Conquer Space Mining*, MINING.COM (Feb. 3, 2016).

Through passing the Law of 2017 on the Exploration and Use of Space Resources (Luxembourg Space Resources Act), Luxembourg became the first European Union nation to pass a space mining law.[74] The Act hoped to boost exploration and commercial utilization of critical and strategic minerals from near-Earth objects.[75] The Luxembourg Space Resources Act lays out a clear framework for the authorization of space mining activities, including the filing of an application by the company which outlines the activities to be carried out on the mining mission,[76] authorization by the ministers in charge of the economy and space activities,[77] the "constant supervision" of space activities by Luxembourgish authorities,[78] and the personal and non-assignable nature of any authorization to conduct space mining operations.[79] Most importantly, Article 1 of the Space Resources Act states that "[s]pace resources are capable of being owned."[80]

The Space Resources Act is further bolstered by the recent Law of 15 December 2020 on Space Activities[81] (Luxembourg Space Activities Act) that imposes fines and sanctions on individuals that do not follow the aforementioned approval process, monitoring requirements, or do not conduct themselves within the bounds of their approved permissible activities.[82] Depending on which articles of the Luxembourg Space Activities Act are breached, punishments can include up to a €1.25 million penalty, imprisonment of up to five years, or even a €1 million per day fine for not obeying a discontinuance order.[83]

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[74] *Loi du 20 juillet 2017 sur l'exploration et l'utilisation des ressources de l'espace*, Journal Officiel du Grand Luxembourg, July 20, 2017 (entered into force J uly 20, 2017), https://data.legilux.public.lu/ file/eli-etat-leg-loi-2017-07-20-a674-jo-fr-pdf.pdf [hereinafter Space Resources Act].

[75] *Id.*

[76] *Id.* at art, 12.

[77] *Id.* at art. 2.

[78] *Id.* at art. 15.

[79] *Id.* at art. 5.

[80] *Id.* at art. 1.

[81] *Loi du 15 décembre 2020 portant sur les activités spatiales et modifiant : 1° la loi modifiée du 9 juillet 1937 sur l'impôt sur les assurances dite « Versicherungssteuergesetz »*, Journal Officiel du Grand-Duché de Luxembourg, Dec. 15, 2020 (entered into force Dec. 28, 20 20), https://space-agency.public.lu/en/agency/legal-framework/Lawspaceactivities.html [hereinafter Space Activities Act].

[82] *Id.* at art. 14.

[83] *Id.* at art. 14.

The Luxembourg Space Activities Act goes further than any other national legislation thus far by describing what kind of information is needed in the application for authorization. Article 7 specifies that authorization is subject to proof that the technical, financial, and governance outlooks are "comprehensive and proportionate to the nature, scale and complexity of the risks inherent to the business model."[84] Luxembourg likely enacted such detailed processes as it seeks to fully clarify its national regulatory scheme.[85]

In contrast to the American legislation, Luxembourg adds regulatory provisions to its space mining legislation to align with the obligations of Article VI of the Outer Space Treaty by overseeing the authorization of space mining operations, supervising activities on a constant basis, and punishing those circumventing these regulatory processes. Although owning space resources outright could nonetheless still be in contravention of Article I and Article II of the Outer Space Treaty, Luxembourg's space mining legislation could be used as a great starting point for other nations to replicate and expand upon within their own pieces of national legislation.

C. The United Arab Emirates Federal Law on the Regulation of the Space Sector of 2019

In 2019, the United Arab Emirates (UAE) enacted Federal Law No. 12 of 2019 on the Regulation of the Space Sector (UAE Federal Space Law).[86] The goal of the UAE Federal Space Law is to create a regulatory framework that allows the nation to achieve the objectives it set forth in its National Space Policy, including the exploration, exploitation, and use of "space resources."[87] Space resources are defined under Article 1 as "[a]ny non-living resources present in outer space, including minerals and water." Under Article 4, the UAE Federal Space Law explicitly states that "This Law

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[84] *Id.* at art. 7.

[85] Tronchetti & Liu, *supra* note 68, at 3.

[86] 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 Federal Space Law].

[87] National Space Policy of the United Arab Emirates (Sept. 2016), https://space.gov.ae/Documents/PublicationPDFFiles/UAE_National_Space_Policy_English.pdf [hereinafter UAE National Space Policy).

regulates… space resources exploration or extraction activities" whether that is for "scientific, commercial or other purposes."[88] Article 14.1 prohibits any space activities from taking place without obtaining a Permit from The United Arab Emirates Space Agency. Article 18 goes further by specifically noting that "the conditions and controls relating to Permits for the exploration, exploitation and use of Space Resources … shall be determined by a decision issued by the Council of Ministers of whomever it delegates" and that this decision will encompass the "ownership, purchase, sale, trade, transportation, and storage" of any space resources.[89]

The UAE statute is less regulatorily specific than the Luxembourg statute, but more specific than the American statute. Article 14.4 provides a blanket statement regarding the application for authorization by simply stating "[t]he Agency shall ensure" the application meets certain terms and conditions.[90] However, the "terms and conditions" it refers to are not elaborated upon. Similarly, the law outlines that an operator of a permit is culpable to administrative penalties or sanctions, but does not define what such penalties or sanctions might entail.[91]

Unlike the United States and Luxembourg laws, the UAE law does not expressly state that space resources are capable of being owned. But it does imply ownership by adding that "ownership, purchase, sale, trade, transportation, and storage" can be part of the terms and conditions related to the authorization granted by the Council of Ministers or its delegated grantor.[92] Thus, this law will likely face the same non-appropriation challenges as the other national laws.

D. The Japanese Space Resources Act of 2021

On 23 June 2021, the Japanese Diet passed the Act on Promotion of Business Activities Related to the Exploration and Development of Space Resources, Act No. 83 of 2021 (Japanese Space

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[88] UAE Federal Space Law, *supra* note 86, art. 4(i)-(j).
[89] *Id.* at art. 18.1.
[90] *Id.* at art. 14.4.
[91] *Id.* at art. 14.5.
[92] *Id.* at art. 18.

Resources Act) which came into force on 23 December 2021.[93] The act creates a framework for Japanese nationals to conduct business activities for the exploration and development of space resources, including the ability to have ownership over those resources.[94]

The authorization for a permit under the Japanese Space Resources Act is in combination with a permit under the Japanese Space Activity Act of 2016, which regulates the permitting of artificial satellites.[95] Under the Japanese Space Activity Act, a permit can be obtained from the Japanese Prime Minister to launch satellite from Japan after the applicant obtains the requisite certificate for a rocket design and radio equipment.[96] Additionally, the applicant must have insurance for any potential damage.[97] These are similar to most countries' national legislation related to private satellite launches and third-party compensation.[98]

To receive a permit under the Japanese Space Resources Act, the application requires the fulfillment of the aforementioned permitting requirements under the Japanese Space Activity Act, in addition to the submission of a business activity plan. This plan must include the purpose, term, location, methods of mineral extraction for the space mining activity, and any other matters that a future Cabinet ordinance will specify.[99] In order for the Japanese government to grant the permit, the applicant must have adequate ability to fulfill the business activity plan and the business activity plan must conform to Japan's Basic Space Law principles. This includes not producing any likely impediment to public safety or the implementation of conventions related to the development and use of

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[93] 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]; Library of Congress, *Japan: Space Resources Act Enacted*. 2021, www.loc.gov/item/global-legal-monitor/2021-09-15/japan-space-resources-act-enacted/ [hereinafter Japan Space Resources Act].

[94] Hiroko Yotsumoto et al., *the Space Law Review: Japan*, THE LAW REVIEWS (Dec. 9, 2021), https://thelawreviews.co.uk/title/the-space-law-review/japan#:~:text=On%2015%20June%202021%2C%20the,and%20to%20acquire%20ownership%20of

[95] Japan Space Resources Act, *supra* note 93; Currently, both Acts are only available in Japanese so research regarding them was done through outside sources.

[96] Japan Space Resources Act, *supra* note 93.

[97] *Id.*

[98] *Id.*

[99] *Id.*; Yotsumoto, *supra* note 94.

space.[100] Additionally, one unique specification of the Japanese Space Resources Act is that, upon granting the permit, the Prime Minister must issue a public announcement proclaiming the name of the permit grantee and their business activity plan. Again, due to the law's express declaration that anyone who mines or otherwise collects space resources acquires ownership of those resources, this law is likely to face the same non-appropriation challenges as the others.

V. TRENDS AND ANALYSIS: TOP-DOWN OR BOTTOM-UP?

The four aforementioned national laws affecting potential asteroid mining efforts are quite similar with respect to their overall goal of bolstering economic interest in the prospect of asteroid mining. Their main differences arise out of the regulatory and permitting guidelines provided. The Luxembourg law is arguably the most comprehensive law of the four and is the only one to go so far as setting tangible sanctions for those who violate the law. The Japanese law is the only one to expressly state that the permit's grantee must be publicly declared. However, the omission of public declaration by the other national laws likely will not prove to be an issue since all four countries are parties to the Artemis Accords and the Outer Space Treaty. The Artemis Accords reaffirm the commitment of informing the United Nations, the public, and the scientific community regarding an entities' space resource extraction activities in accordance with the Outer Space Treaty.[101]

Additionally, the United States, Japan, and UAE laws are less comprehensive administratively than Luxembourg, however, the wording of these three laws imply forthcoming rules by whichever entity these States delegate such authority. First, the American law states that the President shall designate the authorization and oversight of space resource extraction to a federal agency.[102] Second, the Japanese law states that any further requirements regarding application materials will be released by a future ordinance.[103] Last, the Emirati law states the "conditions, regulations and

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[100] Yosumoto, *supra* note 94.

[101] Artemis Accords, *supra* note 46, § 10(3); Outer Space Treaty, *supra* note 21, art. XI.

[102] SPACE Act, *supra* note 65, § 51302.

[103] Yotsumoto, *supra* note 94.

procedures related to the Authorization. . . shall be determined by a Decision issued by the Council of Ministers or whomever it delegates."[104] These countries likely did not include these specifics in their national laws because they want to outwardly induce commercial investment and spur the technological feasibility of asteroid mining while their respective regulatory systems determine the internal specifics.

The most notable and significant similarity between the four national laws is their recognition of private actors' rights to own the space resources that they extract or collect. Again, all four nations are also signatories to the Artemis Accords. The Artemis Accords, however, do not explicitly specify any ownership of extracted space resources, instead it stops at the claim that resources may simply be extracted without violating the Outer Space Treaty. The Accords expressly state, "[t]he Signatories 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." However, considering the loud stance of the United States, the recognition of ownership rights by the national legislation may be bolstered by the recognition that resources can be extracted at all by the increasing number of signatories to the United States-led Artemis Accords. This textualist interpretation is supported by scholarly claims that the omission of a mention to private actors from Article II is indication that individual or private extraction and ownership of resources from celestial bodies is permissible.[105]

Contrarily, other experts claim that any national legislation recognizing property rights of mined asteroid resources and granting permits to extract such resources are void from the outset.[106] This view stems from the notion that private extraction is prohibited by the Outer Space Treaty because a private entity claiming ownership implies a country licensed that entity to claim such ownership.[107] Von der Dunk explains this view by stating, "[s]ince a celestial body cannot be subjected to any single state's territorial

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[104] UAE Federal Space Law, *supra* note 86, art. 14.2

[105] Tronchetti & Lui, *supra* note 68, at 2; Crombie, *supra* note 23, at 10.

[106] *See* CHENG, *supra* note 34.

[107] *Id.*; von der Dunk, *supra* note 34, at 3.

jurisdiction, no single state's domestic laws. . . can apply on any celestial body."[108] Schmidt and Svec argue that the perspective that private companies can achieve ownership of space resources is contrary to the ordinary meaning and purpose of the "benefit and interest of all countries" phrasing found throughout the Outer Space Treaty.[109] The underlying assumption that stems from the creation of national legislation regulating asteroid mining is that these companies, who would be only able to act under their State of registry, are likely being empowered to pursue their interests at the expense of others – as opposed to having the view that they are "members of the international community, as actors paying due attention to general interests such as peace, security, and development, and as actors actively creating harmony in international relations as well as in outer space."[110]

Nonetheless, the textualist interpretation seems to be gaining traction as more countries sign the Artemis Accords and create national legislation. In less than three years of existence at the time of writing this paper, the Artemis Accords now has 27 total signatories,[111] which is nine more than the Moon Agreement.[112] It should be noted that the Artemis Accords are not a United Nations sanctioned international agreement like the Moon Agreement. The recent 2022 addition of France to the Artemis Accords carries particular weight due to the nation's influence in the European Union and broader international community – it is also the fourth country to have signed both the Moon Agreement and the Artemis Accords.

Romania and France both signed the Moon Agreement, but did not ratify it, while Australia and Mexico have both ratified it. All four have now signed the Artemis Accords. This is significant because, although the Artemis Accords and Moon Agreement are not expressly contradictory, two core principles of the Moon Agreement are that the Moon's resources are the "common heritage of humankind" and that the parties are committed to "establish an international regime" to govern the extraction of resources on the Moon –

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[108] *See* von der Dunk, *supra* note 34, at 3.

[109] *See* Schmidt & Svec, *supra* note 6, at 123.

[110] *Id.*

[111] The Artemis Accords, https://www.nasa.gov/specials/artemis-accords/index.html (last visited July 15, 2023).

[112] *See* Status of International Space Agreements, *supra note* 22.

both of which are absent from the Artemis Accords.[113] Regardless, since no international regime was ever established to govern space resource extraction as specified in Article 11 of the Moon Agreement, none of the four countries who signed both the Moon Agreement and the Artemis Accords will likely face criticism when it comes to their perspectives on asteroid resources. It is unclear whether the Artemis Accords and Moon Agreement can coexist,[114] however the signing of France, Australia, Mexico, and Romania show that the economic opportunities in space that the Artemis Accords encourage through its "bottom-up" approach is drawing countries who once were ready to undertake negotiations for a "top-down" approach.

A "bottom-up" approach means that countries develop their own national legislation or bilateral agreements to tackle space mining issues as opposed to a "top-down" approach where an international treaty sets a regime.[115] A hope behind the "bottom-up" approach is that any individual actions may eventually develop into customary international law.[116] A "bottom-up" approach is undoubtedly faster and more convenient than negotiating an internationally-recognized treaty, but the short-term benefits for individual countries may not outweigh the long-term dangers on the international stage if countries start developing parallel, yet opposing, national legislations on space mining.[117] Such simultaneous, incongruous regimes could lead to inhibited market growth in the sector and conflict both on Earth and in space.[118] Tronchetti notes that although countries have the absolute right to make bilateral and multilateral agreements, they should do so with mindfulness of their international obligations and understanding of the legal ramifications of their actions.[119] Some view the four current national legislations as a failure to this cosmopolitan mindfulness because they all omit any recognition of Article 1 of the Outer Space Treaty that the exploration and use of space shall be carried out for the

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[113] Moon Agreement, *supra* note 21, art. 11.
[114] *See* Smith, *supra* note 57, at 674.
[115] von der Dunk, *supra* note 34, at 11.
[116] *Id*.
[117] Tronchetti & Liu, *supra* note 68, at 5.
[118] Crombie, *supra* note 23, at 16; *See* Tronchetti & Liu, *supra* note 68, at 5.
[119] *See* Tronchetti & Liu, *supra* note 68, at 5.

"province of all [hu]mankind."[120] However, the national laws likely omitted reference to Article 1 as a political precaution, as the debate over benefit-sharing of asteroid resources looms even larger than the debate over ownership of asteroid resources.

A consensus on property rights over asteroid resources will be difficult to meet internationally without a concurrent agreement on how to divvy those rights for the "province of all [hu]mankind." This has been another pressing debate regarding space resources with some claiming space should be a global commons owned by all and thus shared by all, regardless of the origins of investment into the mining operations. The global commons view adopts the concept of space as a "common heritage for [hu]mankind" (the CHM Principle), which was introduced in the United Nations Convention on the Laws of the Sea (UNCLOS) and carried into the Moon Agreement. Notably, the CHM Principle was a major reason many countries neglected the Moon Agreement.[121]

The CHM Principle is not thoroughly defined, but benefits derived from the international seabed area are to be distributed evenly.[122] UNCLOS outlines two main characteristics of the CHM Principle as it applies to the extraction of resources from the international seabed. First, the CHM Principle applies to the entirety of the international seabed area and its resources (the Area),[123] which are defined as "all solid, liquid or gaseous mineral resources in situ in the Area at or beneath the seabed."[124] Secondly, the CHM Principle is understood as having a universalist intention, designed to support the ultimate objective to achieve a more egalitarian society – an objective that is a shared responsibility on all Member States and organizations.[125] Yu and Ji-Lu state that "Safeguarding the common heritage of [hu]mankind is the common responsibility of the international community."[126] This means that both landlocked

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[120] *See* Schmidt & Svec, *supra* note 6, at 123.

[121] Carl Q. Christol, *The 1979 Moon Agreement: Where Is It Today*, 27 J. SPACE L. 1, 31 (1999).

[122] Crombie, *supra* note 23, at 15; John S. Goehring, *Why Isn't Outer Space a Global Commons*, 11 J. NAT'L SEC. L. & POL'Y 573, 580 (2021).

[123] United Nations Convention on The Law of the Sea, art. 1(1) & 136, Dec. 10, 1982, 1833 U.N.T.S. 397 [hereinafter UNCLOS].

[124] *Id.* at art.133(a).

[125] *Id.* at art.139.

[126] Jia Yu & Wu Ji-Lu, *The Outer Continental Shelf of Coastal-States and the Common-Heritage of Mankind*, 42 OCEAN DEV. & INT'L L. 317, 326 (2011).

and coastal States have a shared responsibility to protect the seabed Area from unlawful mining infringements that do not duly adhere to the mining regiment outlined by the International Seabed Authority (ISA). Parallels could be drawn that the Outer Space Treaty places a similar level of responsibility amongst signatories to adhere to the CHM Principle as it could be interpreted to pertain to any mining activities on asteroids. Using the CHM Principle as a guideline, nations that have developed sophisticated spacefaring capabilities should strive to adhere to and emulate the objectives of the CHM Principle, as their actions have the potential to impact the shared resources of currently non-spacefaring nations.

The United States, thus far, has been the only country to outright decline the global commons characterization of space through executive action, but has not defined what that means or how else to characterize space.[127] Traditionally, the term "global commons" has two conceptual understandings: (1) an enabling geopolitical understanding and (2) a restricting economic understanding.[128] The enabling concept is that if an area is a global commons jurisdictionally, countries are able to freely traverse that area as it is free of geopolitical limitations.[129] The restrictive concept is that of shared ownership of the area and its resources, and thus indicates limitations on any uses economically.[130] Goehring offers a simple example of these different uses of "global commons" by referencing countries' freedom to roam the high seas as an enabling global commons and the international seabed's CHM Principle as an example of the constraining global commons.[131] Although the United States has not officially specified which concept of global commons it is rejecting, it is likely referring to the economic standpoint.[132] Even still, this type of vague blanket statement only creates more confusion and uncertainty around how asteroid resource activities should be

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[127] Exec. Order No. 13914, 85 Fed. Reg. 20381 (April 10, 2020); *see* Tronchetti & Liu, *supra* note 68, at 6.

[128] Goehring, *supra* note 122, at 574.

[129] *Id.* at 574-75.

[130] *Id.* at 577.

[131] *See id.* at 579.

[132] *See id.* at 582-83.

conducted since no other alternative characterization has been put forward.[133]

An ideal top-down approach would include a new international agreement to regulate and disincentivize a monopolistic beginning to the asteroid mining sector. Many scholars have already suggested how an agreement could work such as: a lottery for the resources, application of terrestrial mining laws, or a moratorium on resource extraction altogether until a different approach than "first in time, first in right" was adopted.[134] Likely, however, such an agreement would need to focus on more than the physical resources of water and metals.

Currently, if following the legislation of one of the four aforementioned countries that states resources are able to be extracted without regulation, the first in time, first in right concept rings true. The companies with the most capital can claim the rights to the first few prospected asteroids that they reach. Likely these will be the most valuable asteroids within accessible limitations. As this value to accessibility gap broadens, mining operations will have an increasing initial investment, thus preventing other actors from entering the market.[135]

The data from prospecting asteroids could play a key role in creating an equitable agreement without hampering investors. Not only is this data valuable for the global space mining community, but it will produce information for scientific investigation as well.[136] Creating a regulatory body around the data from prospecting asteroids allows for a better estimate of how many asteroids are likely viable or worthwhile – knowledge which, in itself, can assist in mining regulation.

In seeking and considering a new international agreement, new perspectives to discuss can include the need to create principles in a regulatory scheme that may endow equitable concepts, but are more modern, adaptive, definitive, and unique than the CHM Principle as seen in UNCLOS. Such a scheme should be more

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[133] Tronchetti & Liu, *supra* note 68, at 6; *See also* Hertzfeld et al., *How Simple Terms Mislead Us; The Pitfalls of Thinking about Outer Space as a Commons*, presented at IAC 2015 (No. IAC-15 - E7.5.2 x 29369), https://swfound.org/media/205390/how-simple-terms-mislead-us-hertzfeld-johnson-weeden-iac-2015.pdf.

[134] *See* Steffen, *supra* note 23, at 6.

[135] *Id.* at 5.

[136] *Id.* at 7.

accommodating to recognize the geopolitical realities of today. It should be more adaptive to the increasing technological capabilities of private companies. It should be more definitive in what the purposes and outcomes are expected to be, including definitions on use, celestial bodies, and appropriation. It should be unique in that it should not be called the CHM Principle or allude to it, as the negative connotation behind that UNCLOS principle will likely deter nations from the outset.

In the hopes of resurging discussions surrounding international frameworks, the Hague International Space Resources Working Group (Hague Working Group) formulated a set of talking points pertinent to space resource governance. The Building Blocks for the Development of an International Framework on Space Resource Activities (Building Blocks) is a draft guideline outlining principles that stakeholders ought to consider for an international framework for space resource utilization.[137] The Building Blocks are not binding, but are influential by guiding potential negotiations for a legal framework as well as providing insight into how international custom may form without an international framework. Hopefully, further clarification and consensus-building on how the international space treaties interact with national laws and new technological developments for the space sector may be assisted with dialogue formed using the Building Blocks.

Additionally, the united, global effort to achieve the United Nations Sustainable Development Goals (SDGs) creates a possible route for the coexistence of a capitalistic asteroid mining industry that also aligns with the goals of the Outer Space Treaty by allowing for a portion of profits to be used for the "benefit and interest of all countries." SDGs were agreed upon by United Nations Member States as a method to solve some of the most significant challenges that humanity currently faces. However, as Schmidt and Svec note, SDGs consistently suffer from a lack of funding and resources.[138] Through the creation of a percentage-based funding mechanism, that portions some profits received through asteroid mining, then

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[137] BUILDING BLOCKS FOR THE DEVELOPMENT OF AN INTERNATIONAL FRAMEWORK FOR THE GOVERNANCE OF SPACE RESOURCE ACTIVITIES, https://www.universiteitleiden.nl/binaries/content/assets/rechtsgeleerdheid/instituut-voor-publiekrecht/lucht—en-ruimterecht/space-resources/bb-thissrwg—cover.pdf. [hereinafter BUILDING BLOCKS].

[138] Schmidt and Svec, *supra* note 6, at 124.

the majority of profits for asteroid mining companies can be realized, while also adhering to the core aspects of the Outer Space Treaty. Without a globally agreed upon framework, Bohacek *et al.* theorized that those engaged in space mining could pre-emptively contribute a portion of their realized profits towards existing, internationally agreed goals, such as SDGs or the Paris Agreement, as a form of investment protection to avoid possible legal action and ensure they are in compliance with Art. 1 of the Outer Space Treaty.[139] Percentages or base amounts could also be further set in national space mining legislation, if a nation sees it as necessary.

This approach would allow for national governments and private companies to decide the legislative scheme that works best for their own space actors, while adhering to globally agreed to principles within the Outer Space Treaty and stabilizing many of the legal uncertainties that have plagued space mining investments. Ultimately, the goal of this approach would be to maximize the autonomy of nations to decide their space policy while also creating a geopolitical environment where a peaceful space environment can be fully realized.

VI. CONCLUSION

Asteroid mining is no longer a vision from science fiction novels and companies' failed ventures. With rapid technological advancements, the proposition of mining asteroids is becoming more of a reality every day. Many spacefaring countries are recognizing the attainability of extraterrestrial resources and are clinging to these resources' potential. Along with the ability to cost-effectively access and use these resources, however, returns the questions that have haunted space explorers, advocates, and lawyers for decades. Geopolitical conflicts are inevitable if these legal questions are not resolved, and the seemingly opposing views of global space treaties are reconciled with national asteroid mining legislation.

Although the American-led Artemis Accords have been attracting a growing number of signatories, two major spacefaring nations, Russia and China, are unlikely to sign. Russia and China have shown interest in forming their own path into cosmic expansion and resource mining. With the likely surge in national

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[139] Bohacek, *supra* note 19, at 128.

legislation and regional agreements, the possibility of differing views on regulatory schemes for asteroids will increase. Such conflicting regimes in the international community heightens the likelihood of conflicts terrestrially and in space

Stepping back to look at the other aspects of space mining, such as the prospecting data and supply-chain logistics involved, could provide areas of agreement and compromise for an international agreement. Furthermore, pre-emptively sharing portions of asteroid mining proceeds to align with internationally agreed upon goals, like SDGs, may allow for private space actors to ignite further investment while shielding themselves from international legal action. A trilateral approach that includes the input of private space actors, national legislators, and the international community could result in a successful implementation of uniform or nearly uniform asteroid mining frameworks.