

A RE-EXAMINATION OF FUNDAMENTAL PRINCIPLES OF INTERNATIONAL SPACE LAW AT THE DAWN OF SPACE MINING

Fengna Xu, Jinyuan Su** & Miqdad Mehdi***+*

ABSTRACT

When the Outer Space Treaty and Moon Agreement were concluded, there existed no urgency to regulate space resources extraction activities. Four decades thereafter, technological development makes the exploitation and use of space resources not only possible, but likely a reality in the near future. At present, both governments and ambitious private actors are engaged in the development of technologies for space mining activities. The United States and Luxembourg have enacted domestic legislation to protect property rights over the resources to be extracted. Consequently, given that the context in which the Outer Space Treaty operates has become starkly different from the one in which it was conceived, there is an urgent need for a new international regime to regulate these activities. Indeed, the international community is trying to create an appropriate legal framework, in fora such as the Legal Subcommittee of United Nations Committee on the Peaceful Uses of Outer Space and the Hague Space Resources Governance Working Group. But before instigating such a regime, it is important to examine the contents of the Outer Space Treaty, the *Magna Carta* of international outer space law, especially the four fundamental principles most relevant to space mining, including the freedom of exploration and use, non-appropriation, common benefit and interests and environmental protection. This Article analyzes these fundamental

* PhD candidate, The Silk Road Institute of International Law, School of Law, Xi'an Jiaotong University, fengna.xu@foxmail.com.

** Professor specializing in space law, School of Law, Xi'an Jiaotong University, jinyuan.su@hotmail.com.

*** PhD candidate, The Silk Road Institute of International Law, School of Law, Xi'an Jiaotong University, miqdadmehdi93@gmail.com.

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principles of international space law, bearing in mind today's new circumstances where the mining of space resources is becoming feasible, so as to shed some light on their application in the context of space mining. It is submitted that the international community should cooperate to establish a legal framework on space resources activities.

I. INTRODUCTION

At the dawn of the space age, many expected that outer space would be used only for peaceful purposes and in the interest of all humankind. After several years of deadlock in the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), the urgent need for a space treaty arose partly due to the great strides humanity was making towards landing on the Moon in the mid-1960s.¹ Recognizing the need to establish a regime in outer space before national interests developed and froze positions on the matter, the Union of Soviet Socialist Republics (Soviet Union) and the United States (US) tended to agree on proposals about the initial principles of space legislation.² Eventually, the Outer Space Treaty (OST)³ was concluded with both nations making important concessions. The OST was largely based on the 1963 Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space (1963 Declaration),⁴ but also introduced some new provisions. Significantly, the OST only precludes States from appropriating territorial portions of outer space. It never mentions

¹ Comm. On the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on Its Fifth Session, 44th mtg., U.N. Doc. A/AC.105/PV.44, at 20 (Oct. 25, 1966); Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. On Its Fifth Session, 72nd mtg., U.N. Doc. A/AC.105/C.2/SR.72, at 3 (Oct. 19, 1966) (The US delegation noted that "[i]t was important to establish a universally accepted regime of law before the first landing was made on the moon.").

² U.N. Doc. A/AC.105/PV.44, *supra* note 1, at 20. See also Rep. of the First Comm. on Its Sixteenth Session, 1214th mtg., U.N. Doc. A/C.1/SR.1214, at 268 (Dec. 11, 1961). The delegate from the Soviet Union noted that "the debate on the question of the peaceful uses of outer space had shown that all States were anxious to see the establishment of international co-operation, on a basis of equality, in that new and important field of human activity [space]."

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].

⁴ G.A. Res. 1962 (XVIII) (Dec. 13, 1963).

the exploitation and use of space resources, although the COPUOS was required to study questions related to the utilization of outer space and celestial bodies.⁵ Consequently, the OST left many non-space powers unsatisfied as negotiations mostly emphasized demilitarization and peaceful uses.⁶

As newly independent developing States pushed for the establishment of a “New International Economic Order” during the late 1960s and early 1970s, they also sought to assure their access to the benefits derived from space exploration and exploitation.⁷ Consequently, questions related to the utilization of the resources of the Moon continued to be discussed for several years.⁸ But little progress was made by the Legal Subcommittee (LSC) of COPUOS as, among other things, some States held it was premature to enact international legal principles on the matter,⁹ and consensus could not be reached on whether a new treaty should govern just the Moon or other celestial bodies as well.¹⁰ Astonishingly, the Moon Agreement (MA)¹¹ was completed after secret discussion within fifteen days.¹² But the MA has only been ratified by eighteen

⁵ This idea was first proposed by France. Rep. of the First Comm. on Its Twenty-First Session, 1492nd mtg., U.N. Doc. A/C.1/SR.1492, at 430 (Dec. 17, 1966) (“[W]hile the principles established by the [Outer Space Treaty] would no doubt be easy to apply in the case of the exploration of space, their application would be more difficult when State activities involved exploitation.”).

⁶ BIN CHENG, *STUDIES IN INTERNATIONAL SPACE LAW* 358 (1997).

⁷ Nirav S., *Comprehensive Essay on New International Economic Order (NIEO)*, PRESERVE ARTICLES, <http://www.preservearticles.com/essay/comprehensive-essay-on-new-international-economic-order-nieo/20115> (last visited May 2, 2020).

⁸ See Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on Its Eighth Session, Annex I, U.N. Doc. A/AC.105/58, at 4-7 (1969).

⁹ See e.g., Comm. On the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on Its Eleventh Session, 187th mtg., A/AC.105/C.2/SR.187, at 3 (May 2, 1972). The Japanese delegation “still had some doubts, however, as to the usefulness of trying to prepare a new treaty in addition to the 1967 Treaty.”

¹⁰ See e.g., Comm. On the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on Its Eleventh Session, 188th mtg., U.N. Doc. A/AC.105/C.2/SR.188, at 21 (May 3, 1972). The Austrian delegation noted that “there were differences of opinion as to whether [the treaty] should apply only to the moon, or to other celestial bodies as well.”

¹¹ Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 18, 1979, 1363 U.N.T.S. 3 (1979) [hereinafter Moon Agreement].

¹² BIN CHENG, *supra* note 6, at 361-362. After several futile attempts to address resource utilization on the Moon, an informal working group was established in June 1979 to focus on the matter. After four secret meetings between June 26 and July 3, 1979, whose proceedings are not published, a draft treaty relating to the Moon was adopted by consensus without a vote.

countries.¹³ After that, the international community failed to make any progress in developing binding space law at the international level. For a time this caused no great concern, as it would be nearly three decades before a State attempted space resources activities.

Over the five decades since the adoption of the OST and four decades since the negotiation of the MA, the global political and commercial environment has changed dramatically. Today's world is no longer dominated by two superpowers and tends to be multipolar. Technological innovation has increased the possibility of the exploitation and use of space resources and greatly reduced the cost of getting into space. At present, the extraction and use of space resources is not technically feasible, but is expected to happen in the near future. It is no longer national prestige, but scientific and economic opportunities that drive missions to space. Many believe that space mining could support commercial application, stimulate technological innovation, produce economic return and give important contribution to create and redistribute wealth in the world. Consequently, not only governments but also ambitious private actors are engaged in the development of technologies for space mining activities. For example, several private business entities have publicly indicated that they are making plans to extract resources from the Moon and other celestial bodies, including, for example, Caterpillar, Inc.,¹⁴ Moon Express, Inc.,¹⁵ (Moon Express) and Blue Origin, Inc.¹⁶ To support American commercial efforts in space, the US adopted the Commercial Space Launch Competitiveness Act (CSLCA), which seeks to facilitate the commercial exploration for and commercial recovery of space resources by US citizens.¹⁷

¹³ State parties are Armenia, Australia, Austria, Belgium, Chile, Kazakhstan, Kuwait, Lebanon, Mexico, Morocco, the Netherlands, Pakistan, Peru, Philippines, Romania, Saudi Arabia, Turkey, Uruguay and Venezuela. See Comm. on the Peaceful Uses of Outer Space, *Status of International Agreements Relating to Activities in Outer Space as at 1 Jan. 2019*, U.N. Doc. A/AC.105/C.2/2019/CRP.3 (2019).

¹⁴ Jennifer Leman, *Construction Company Caterpillar Wants to Mine the Moon*, POPULAR MECHANICS. (Oct. 30, 2019), <https://www.popularmechanics.com/space/moon-mars/a29587959/caterpillar-space-mining/>.

¹⁵ Mike Wall, *50 Years After Apollo 11, A New Moon Rush Is Coming*, SPACE.COM (July 22, 2019), <https://www.space.com/moon-exploration-plans-nasa-india-china-and-more.html>.

¹⁶ Jayshree Pandya, *The Race to Mine Space*, FORBES (May 13, 2019), <https://www.forbes.com/sites/cognitiveworld/2019/05/13/the-race-to-mine-space/#49e7ef3c1a70>.

¹⁷ See 51 U.S.C. §§ 51301-03 (2018).

Luxembourg followed suit two years later and enacted its own national space law granting property rights to private space resource extractors.¹⁸ As the US and other States seek to expand extraterrestrial private property rights, it is apparent that the exploitation and use of space resources requires clearer international governance.¹⁹

However, as mentioned above, there was no urgency to regulate space resources activities when the OST and MA were concluded. In particular, there was insufficient scientific information available regarding space resources and the possibility of their economic use. Consequently, the two treaties do not regulate the exploitation and use of space resources. Nevertheless, the OST, as the cornerstone of international space law, established important principles directly related to space mining, including the freedom of exploration and use, non-appropriation, common benefit and interests and environmental protection.²⁰ These principles could provide guidance for space mining, but their precise applications to this activity are not at all clear. The MA further developed these principles, but, as we have seen, it was not accepted by the major space-faring countries. For the beneficial use of space resources, a specific legal regime for the exploitation of resources should be elaborated. In the development of such a regime, the four principles enumerated above need to be clarified, as they should provide the foundation for the management of resource extraction and utilization.

In fact, the international community is trying to create an appropriate legal framework. The LSC of COPUOS meets every year to discuss legal questions related to the exploration and use of outer

¹⁸ Loi 674 du 20 juillet 2017 sur l'exploration et l'utilisation des ressources de l'espace [Law 674 of July 20, 2017 on the Exploration and Use of Space Resources], JOURNAL OFFICIEL DU GRAND-DUCHE DE LUX., July 28, 2017, <http://legilux.public.lu/eli/etat/leg/loi/2017/07/20/a674/jo>. See also Philip de Man, *Luxembourg's Law on Space Resources Rests on a Contentious Relationship With International Framework*, THE SPACE REV. (Oct. 23, 2017), <http://www.thespacereview.com/article/3355/1>. The UAE has also released some details of its new space law which suggest that they are also considering ways to administer resource extraction and utilization legislation. Melissa Maday, *UAE Space Law Details Announced to Facilitate Space Sector Development*, SPACEWATCH.GLOBAL (Feb. 25, 2020), <https://spacewatch.global/2020/02/uae-space-law-details-announced-to-facilitate-space-sector-development/>.

¹⁹ Eytan Tepper, *Structuring the Discourse on the Exploitation of Space Resources: Between Economic and Legal Commons*, 49 SPACE POL'Y 101290, 2 (2019).

²⁰ Outer Space Treaty, *supra* note 3, arts. I, II and IX.

space. In 2016, it agreed on a new item for discussion, entitled “General exchange of views on potential legal models for activities in exploration, exploitation and utilization of space resources,” which became an agenda item in the sessions of 2017-2019.²¹ The representatives of member States debated on the issue, including the application of these principles. In the 2019 session, Belgium and Greece submitted a working paper proposing the establishment of a working group for the development of an international regime on the utilization and exploitation of space resources.²² Although it was not successful due to the opposition of some delegations, the proposal was not completely ruled out.

Efforts are also being undertaken outside the COPUOS. The Hague Space Resources Governance Working Group (HSRGWG), for instance, gathered interested members from government, industry, universities, civil society and research centers in 2014 to discuss and propose solutions to the governance of space resources.²³ On September 13, 2017, it released Draft Building Blocks for the Development of An International Framework on Space Resource Activities, which were developed to create an enabling environment for space resources activities.²⁴ After minor revisions, it adopted a final version of the Building Blocks (Hague Building Blocks) on November 12, 2019.²⁵ The HSRGWG members included “stakeholders of space resource activities and represent[ed] consortium partners, industry, States, international organisations [sic], academia and

²¹ Comm. On the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on Its Fifty-Fifth Session, U.N. Doc. A/AC.105/1113, at 250 (2016).

²² Comm. On the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. Rep. on Its Fifty-Eight Session, U.N. Doc. A/AC.105/C.2/2019/CRP.22 (Apr. 8, 2019) (working paper by Belgium and Greece); Comm. On the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on Its Fifty-Eight Session, U.N. Doc. A/AC.105/C.2/L.311 (Mar. 11, 2019) (working paper by Belgium and Greece).

²³ Comm. On the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on Its 55th Session, U.N. Doc. A/AC.105/C.2/2016/CRP.17 (Apr. 5, 2016).

²⁴ DRAFT BUILDING BLOCKS FOR THE DEVELOPMENT OF AN INTERNATIONAL FRAMEWORK ON SPACE RESOURCE ACTIVITIES (2017), <https://www.universiteitleiden.nl/binaries/content/assets/rechtsgeleerdheid/instituut-voor-publiekrecht/lucht—en-ruimterecht/space-resources/draft-building-blocks.pdf>.

²⁵ BUILDING BLOCKS FOR THE DEVELOPMENT OF AN INTERNATIONAL FRAMEWORK ON SPACE RESOURCE ACTIVITIES (2019), https://www.universiteitleiden.nl/binaries/content/assets/rechtsgeleerdheid/instituut-voor-publiekrecht/lucht—en-ruimterecht/space-resources/hisrgwg_building-blocks-for-space-resource-activities.pdf [hereinafter BUILDING BLOCKS].

NGOs.”²⁶ The Hague Building Blocks represent their consensus perspective on the fundamental principles set forth in the OST, namely, the freedom of exploration and use, non-appropriation, common benefit and interests and environmental protection

This Article analyzes these fundamental principles of international space law under today’s new circumstances where the exploitation and use of space resources is becoming a reality, so as to shed some light on their application in the context of space mining. Parts II-V address the principles of freedom of exploration and use, non-appropriation, common benefit and interests and environmental protection respectively. Each part begins with the interpretation of the principle in the OST and the MA and proceeds to elaborate on and evaluate the relevant debates in the LSC and the Hague Building Blocks of HSRGWG. Part VI concludes and calls for international cooperation to establish a legal framework to manage space resources activities.

II. FREEDOM OF EXPLORATION AND USE

Space mining is considered to be promising. It has provoked interest by States as well as private actors in recent years. For example, the US National Aeronautics and Space Administration (NASA) launched the OSIRIS-REx spacecraft in 2016 to explore the asteroid Bennu before collecting a sample to return to Earth, with the intent to improve our understanding of the resources in near-Earth space.²⁷ Similarly, the United Arab Emirates “has launched a multipronged effort” to establish a space mining industry, including an investment of more than \$5 billion and continuous launch of satellites.²⁸ Luxembourg is also taking part in the race to mine space resources by setting up a \$227 million fund to entice space mining companies to open offices in the country and make it the

²⁶ *The Hague International Space Resources Working Group*, UNIV. OF LEIDEN, <https://www.universiteitleiden.nl/en/law/institute-of-public-law/institute-of-air-space-law/the-hague-space-resources-governance-working-group> (last visited Apr. 17, 2020).

²⁷ *NASA Mission Reveals Asteroid Has Big Surprises*, NASA, <https://www.nasa.gov/press-release/nasa-mission-reveals-asteroid-has-big-surprises> (last visited Apr. 17, 2020).

²⁸ Thomas Heath, *Space-mining May Be Only A Decade Away. Really*, THE WASH. POST, June 2, 2017, https://www.washingtonpost.com/business/space-mining-may-be-only-a-decade-away-really/2017/04/28/df33b31a-29ee-11e7-a616-d7c8a68c1a66_story.html?utm_term=.e00b010f3a37.

hub of space mining innovation.²⁹ Additionally, Moon Express, the first company to receive US government approval to fly a mission beyond Earth orbit and to the Moon, is planning to set up the first lunar research outpost and prospect for water and useful minerals.³⁰ Moon Express also signed a Memorandum of Understanding (MOU) with the Canadian Space Agency (CSA) to explore the possibilities of using its orbiter and lander for missions to the Moon.³¹ Clearly, the exploitation and use of space resources is going to take place. However, whether the activity is sanctioned by the OST is ambiguous at best.

A. Freedom of Outer Space

Under Article I of the OST, outer space shall “be free for exploration and use by all States.”³² Such freedom shall be non-discriminatory, equal and in conformity with international law.³³ Moreover, all areas of celestial bodies shall be freely accessible and “there shall be freedom of scientific investigation.”³⁴ These aspects constitute the freedom of exploration and use principle in the OST. Like the freedom of high seas, such freedom in outer space stems from its status of *terra communis*. Unlike *terra nullius*, which refers to a territory not belonging to any particular country,³⁵ *terra communis* or *res communis* denotes a common thing or area that cannot be owned or appropriated, such as light, air and the sea.³⁶ Accordingly, outer space is open to all States, but cannot be appropriated by any of them. The MA developed more specific rules than the OST. Pursuant to the MA, States may collect and remove from the Moon samples of its mineral and other substances for scientific investigation and use these resources in quantities appropriate to support

²⁹ Lily Hay Newman, *Luxembourg Bets Big on Space Mining for Some Reason*, SLATE (June 7, 2016), <https://slate.com/technology/2016/06/luxembourg-invests-in-space-mining-research.html>.

³⁰ *Three Maiden Expeditions*, MOON EXPRESS, <http://moonexpress.com/> (last visited May 2, 2020).

³¹ *Supporting Canada’s Lunar Initiatives*, MOON EXPRESS, <http://moonexpress.ca/> (last visited Apr. 21, 2020).

³² Outer Space Treaty, *supra* note 3, art. I.

³³ *Id.*

³⁴ *Id.*

³⁵ *Terra Nullius*, BLACK’S LAW DICTIONARY (9th ed. 2009).

³⁶ *Res Communes*, BLACK’S LAW DICTIONARY (9th ed. 2009).

their missions.³⁷ These provisions not only reaffirm the freedom of exploration and use principle, but also expressly refer to the use of space resources for the first time. Unfortunately, the MA was rejected by major spacefaring countries because it recognized the Moon and its natural resources as “the common heritage of [hu]mankind” (CHM).³⁸ The concept of CHM means that outer space belongs to all humanity and should be protected and managed for its benefit.³⁹

The freedom of exploration and use principle, which grants all States the right of access, exploration and scientific investigation, is similar to John Rawls’ equality of opportunity or liberty principle.⁴⁰ Rawls uses a thought experiment widely known as the “veil of ignorance” where public policy is based on the hypothetical condition that people do not know the social positions or the particular comprehensive doctrines of the persons they represent.⁴¹ As a result, a fair agreement must eliminate the bargaining advantages resulting from cumulative social and historical tendencies.⁴² And people similarly motivated and endowed should have the same prospects of success.⁴³ Basically, the OST grants each State an equal right to the most extensive scheme of equal basic liberties compatible with a similar scheme of liberties for others. Accordingly, outer space is open for access and all States have an equal chance to access space for exploration and use, regardless of their degree of economic or scientific development. But it’s worth noting that the OST restricts total freedom to scientific investigation. It does not refer to commercial exploitation and use of space resources. Indeed, some argue that the freedom to engage in scientific exploration of outer space does not justify large-scale exploitation of extraterrestrial resources for commercial purpose.⁴⁴ That is why the national laws of

³⁷ Moon Agreement, *supra* note 11, art 6.

³⁸ See Dennison A. Butler, *Who Owns the Moon, Mars, and Other Celestial Bodies: Lunar Jurisprudence in Corpus Juris Spatialis*, 82 J. OF AIR L. & COM. 505, 508-09 (2017).

³⁹ *Common Heritage of Mankind*, BLACK’S LAW DICTIONARY (9th ed. 2009).

⁴⁰ JOHN RAWLS, JUSTICE AS FAIRNESS: A RESTATEMENT ¶ 13.1 (2001).

⁴¹ *Id.* ¶ 6.2.

⁴² *Id.*

⁴³ *Id.*

⁴⁴ Jinyuan Su, *Legality of Unilateral Exploitation of Space Resources under International Law*, 66 INT’L COMP. LAW Q. 991, 1006 (2017).

the US and Luxembourg caused widespread controversy in the international community.

Scientific research and commercial mineral exploitation have different purposes: the former aims for scientific knowledge while the latter is focused on profit. Moreover, there exists a marked difference in quantity of resource collection. The six Apollo missions brought back 382 kilograms (842 pounds) of lunar material for research and teaching projects,⁴⁵ some of which NASA exchanged with the Soviet Union for some of the approximately 300 grams of lunar material brought back by three Soviet Luna missions.⁴⁶ Although these sample collections were never protested by other countries, it does not mean that commercial space mining was also accepted by the international community, as the numbers of samples collected from the Moon are significantly smaller than the normal scale of mineral exploitation. As the *Whaling in the Antarctic* case demonstrates, large-scale extraction of resources is likely beyond the reasonable need of scientific research.⁴⁷ However, the OST does not give a clear answer as to whether the exploitation and use of space resources for commercial purpose is in conformity with this principle. According to Article 31 of the Vienna Convention on the Law of Treaties (VCLT),⁴⁸ we must review the object and purpose of a Treaty during the course of interpretation. From its preamble, we could observe that the purpose of the OST is to promote rather than restrict the free exploration and use of outer space, especially given that the common interest of all humankind is implicated.⁴⁹ Accordingly, as long as space mining for commercial purpose could promote the free exploration and use of outer space, it may be lawful under the freedom of exploration and use principle.

⁴⁵ *Lunar Rocks and Soils from Apollo Missions*, NASA, <https://curator.jsc.nasa.gov/lunar/> (last visited Apr. 18, 2020).

⁴⁶ Berin Szoka and James Dunstan, *Space Law: Is Asteroid Mining Legal?* WIRED (May 1, 2012), <https://www.wired.com/2012/05/opinion-asteroid-mining/>.

⁴⁷ *Whaling in Antarctica (Austl. v. Japan)*, Judgment, 2014 I.C.J. Rep. 226, ¶ 94 (Mar. 31) (“In particular, a State party may not, in order to fund the research for which a special permit has been granted, use lethal sampling on a greater scale than is otherwise reasonable in relation to achieving the programme’s stated objectives.”); Su, *supra* note 44, at 1005-06.

⁴⁸ Vienna Convention on the Law of Treaties art. 31(1), May 23, 1969, 1155 U.N.T.S. 331 [hereinafter Vienna Convention].

⁴⁹ Outer Space Treaty, *supra* note 3, Preamble.

B. Commercial Incentives

To answer whether the exploitation and use of space resources for commercial purpose conforms to this principle, the terms “exploration,” “use” and “exploitation” should first be clearly defined. In the context of outer space, “exploration” refers to all activities that have as their primary goal the gaining of knowledge, without immediate practical application;⁵⁰ “use” denotes those activities that could be transformed into actionable interests, be they of economic, military, civil or other nature.⁵¹ In comparison, “exploitation” means the act of taking advantage of something,⁵² regardless of its purpose. Surely, in practice, the three notions are difficult to distinguish from each other, as the finality of activities is not always clear from the start.⁵³ Moreover, taking into account statements made by French delegate, it is clear the drafters of the OST did not preclude the concept of the exploitation of space resources from the broad definition of the concept of “use.”⁵⁴ The delegation referred to practical uses of space like meteorological research and telecommunications, but reserved discussion of utilization of minerals on the Moon as it was “hard” at that time to conceive.⁵⁵ Additionally, the evolution of these terms in the *travaux préparatoires* of the OST, including the United Nations General Assembly Resolution 1348,⁵⁶

⁵⁰ PHILIP DE MAN, EXCLUSIVE USE IN AN INCLUSIVE ENVIRONMENT, THE MEANING OF THE NON-APPROPRIATION PRINCIPLE FOR SPACE RESOURCE EXPLOITATION 79 (2016).

⁵¹ *Id.* at 79, 80.

⁵² *Exploitation*, BLACK’S LAW DICTIONARY (9th ed. 2009).

⁵³ See DE MAN, *supra* note 50, at 78-82.

⁵⁴ According to the French delegation:

It was quite clear that the treaty was to apply both to celestial bodies and to outer space, but what type of activity was it to regulate? The text referred to exploration and “use.” Did the latter term imply use for exploration purposes, such as the launching of satellites or did it mean us in the sense of exploitation, which would involve far more complex issues?

Comm. On the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on Its Fifth Session, 63rd mtg., U.N. Doc A/AC.105/C.2/SR.63, at 8 (July 20, 1966). See also Comm. On the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on Its Fifth Session, 69th mtg., U.N. Doc A/AC.105/C.2/SR.69, at 5-6 (July 27, 1966) (Indicating that the French delegation had no “theoretical preference as to whether the treaty should be limited to scientific exploration or should also deal with use.”).

⁵⁵ U.N. Doc A/AC.105/C.2/SR.63, *supra* note 54, at 8.

⁵⁶ The Resolution, entitled “Question of the Peaceful Use of Outer Space,” addresses the desire “to promote energetically the fullest exploration and exploitation of outer space for the benefit of [hu]mankind.” G.A. Res. 1348 (XIII), at Preamble (Dec. 13, 1958).

United Nations General Assembly Resolution 1721⁵⁷ and the 1963 Declaration,⁵⁸ confirmed to some extent the synonymity between the concept of use and exploitation. Hence, the exploitation of space resources is encompassed by the freedom of exploration and use principle.

Commercial incentives are essential to develop space mining ventures because of the high cost and risk involved. In 2009, NASA reported that the total cost of the Apollo program “arrived at a figure of [US]\$170 billion in 2005 dollars (or around [US]\$200 billion in today’s money).”⁵⁹ This figure does not calculate the associated risk of no return on investments, death, pollution and other investment-limiting factors. Out of financial pressure, governments are increasingly turning to private companies to spearhead space resource utilization efforts and providing confidence for investors by way of regulations and laws in order to generate revenues and open new markets. According to Hayek’s theory of free-market,⁶⁰ commercial incentives could promote investment in the exploration of space resources and enable the development of the most efficient use of such resource. With the prospect of obtaining some sort of property rights, the private sector would likely make every effort to invest and develop technology for profit. Free markets would increase the means of production by placing it directly in the hands of laborers, which makes it possible for private sectors to acquire space resources legitimately. Such a spontaneous order—which is not designed by anyone but evolves slowly as the result of human actions, would do a remarkable job of coordinating people’s actions in outer space. For instance, Moon Express, by using robotic explorers, claims it will collapse the cost of lunar access and deliver

⁵⁷ The Resolution, entitled “International Co-operation in the Peaceful Uses of Outer Space,” indicates a belief that “the exploration and use of outer space should be only for the betterment of [hu]mankind.” G.A. Res 1721 (XVI), at Preamble (Dec. 20, 1961).

⁵⁸ The 1963 Declaration opens with the statement that delegates are “inspired by the great prospects opening up before [hu]mankind as a result of man’s entry into outer space.” G.A. Res. 1962 (XVIII), at Preamble (Dec. 13, 1963).

⁵⁹ Sebastian Anthony, *The Apollo 11 Moon Landing, 45 Years On: Looking Back at Mankind’s Giant Leap*, EXTREMETECH (July 21, 2014), <https://www.extremetech.com/extreme/186600-apollo-11-moon-landing-45-years-looking-back-at-mankinds-giant-leap>.

⁶⁰ For a succinct explanation of F.A. Hayek’s theory as considered in the context of space, see Lawrence A. Cooper, *Space Exploration Through A New Application of Space Property Rights*, 19 SPACE POL’Y 115-16 (2003).

breakthrough opportunities for scientific and commercial exploration.⁶¹ As a result, space mining for commercial purpose would promote rather than limit the exploration and use of outer space and be to the benefit and in the interests of all countries. Thus, in this regard, space mining driven by commercial incentives is in line with the purpose of the OST.

However, the hand of the market is blind to issues of distributional justice.⁶² *Pareto optimum* and perfect markets have never existed and may not be theoretically possible.⁶³ Without government interference, the *laissez-faire* market does indeed generate extreme distributions of wealth. Extrapolating this concept to space resources, due to huge economic and technological disadvantages, developing countries may be left far behind by spacefaring countries. Free markets may do nothing to help developing countries escape from their current predicaments; they may even make their situation worse. For example, the introduction of space resources to the global market may hurt the gross domestic product of countries that have industries mining these resources terrestrially. Gradually, these developing countries may never be able to participate in space mining and enjoy its attendant benefits. Consequently, the freedom of exploration and use principle should be restricted by the terms of the OST and general international law, including the treaty's

⁶¹ *Scalable Robotic Spacecraft*, MOON EXPRESS, <http://moonexpress.com/> (last visited Apr. 18, 2020).

⁶² *Free Market Pros and Cons - Should We Privilege Allocative Efficiency and Accept the Resulting Inequality?* NETIVIST, <https://netivist.org/debate/free-market-pros-and-cons> (last visited Apr. 23, 2020). A free market may nevertheless sometimes result in unsatisfactory outcomes too. It is considered by many economists as one of the major causes of income inequality and economic disparity. For instance, monopolistic and cartelistic behavior of companies can disrupt allocative and productive efficiency, as well as generate a welfare loss.

⁶³ Supriya Guru, *Economic Efficiency and Pareto Optimality: Marginal Condition and Critical Evaluation*, YOUR ARTICLE LIBRARY, <http://www.yourarticlelibrary.com/economics/economic-efficiency-and-pareto-optimality-marginal-condition-and-critical-evaluation/37570> (last visited Apr. 23, 2020). *Pareto optimum* (often called economic efficiency) is a position from which it is impossible to make anyone better off without making someone worse off by any reallocation of resources or distribution of outputs. However, the conditions under which a perfect competitive market system achieves *Pareto-optimality* are quite restrictive, including: (1) the second order conditions are satisfied; (2) the externalities in production and consumption are absent; (3) prevailing distribution of income is optimal from the social point of view; and (4) available resources are fully employed. It may also be noted that in present-day free enterprise capitalist economies perfect competition is an exception rather than the rule.

common benefit and interests principle and its environmental protection principle.

In the debates within the LSC, States expressed views on potential legal models for space resources activities. These statements may be qualified as State practice “that contributes to the formation, or expression, of rules of customary international law,”⁶⁴ as it is now generally accepted that verbal conduct (whether written or oral) of a State may count as practice.⁶⁵ For example, delegates often referred to “exploration,” “exploitation,” “use” and “extraction” interchangeably when talking about space mining. And they did not make a distinction between scientific and commercial exploration, but it could be inferred that they primarily focused on the latter, as the term “commercial” or “private entities” was repeatedly used. For space resources activities, most delegates expressed that the extraction of space resources is included in the scope of Art. I of the OST,⁶⁶ although the opposite view exists.⁶⁷ Besides, some argued that resources extraction needs to adhere to this principle, ensuring that free access to all areas of the celestial body would be maintained.⁶⁸ Meanwhile, some held that the freedom of exploration and use principle should be restricted by other principles in the OST and international law⁶⁹ and in a manner that respects the freedoms of others.⁷⁰ Hence, it can be observed that the mainstream view of the international community is that the exploitation and use of space resources for commercial purpose conforms to this principle, subject to some limitations.

The Hague Building Blocks also support the freedom of exploration and use principle and envisages some mechanisms to

⁶⁴ Int'l Law Comm'n, Rep. on the Work of its Sixty-Eighth Session, U.N. Doc. A/71/10, at 76 (2016).

⁶⁵ *Id.* at 77.

⁶⁶ See Comm. on the Peaceful Uses of Outer Space, Legal Subcomm., Questions and Observations by Belgium on the Establishment of National Legal Frameworks for the Exploitation of Space Resources, U.N. Doc. A/AC.105/C.2/2018/CRP.8, at 2 (2018); Comm. on the Peaceful Uses of Outer Space, Draft Rep. of the Legal Subcomm. on Information on the Activities of International Non-Governmental Organizations, U.N. Doc. A/AC.105/C.2/L.304/Add.3, ¶ 27 (2018) [hereinafter 2018 Information Report]; Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm on Its Fifty-Sixth Session, U.N. Doc. A/AC.105/1122, ¶¶ 232, 246 (2017) [hereinafter Fifty-Sixth Legal Subcomm.].

⁶⁷ Fifty-Sixth Legal Subcomm., *supra* note 66, ¶ 247.

⁶⁸ 2018 Information Report, *supra* note 66, at ¶ 31.

⁶⁹ *Id.* ¶ 41.

⁷⁰ Fifty-Sixth Legal Subcomm., *supra* note 66, ¶ 243.

promote commercial incentives. Principle goals include: promoting and securing “the orderly and safe utilization of space resources,” promoting “the sustainable, rational, efficient and economic use of space resources,” providing “legal certainty and predictability for operators” and taking “into particular account the contributions of pioneer operators.”⁷¹ These principles perhaps reflect the fact that the members of the HSRGWG are primarily from spacefaring and emerging space powers and include representatives of commercial entities like ispace Inc. and Asteroid Mining Corporation.⁷²

C. The Rule of Capture

Another important problem in the freedom of exploitation and use of space resources is that some actors may simply use first possession as a justification for ownership of space resources. Indeed, space resources, as *res communis*, can be appropriated to some extent on the basis of the freedom of exploration and use principle. But the rule of capture,⁷³ which illustrates the role of first possession, still needs to be carefully studied. In fact, this rule drove early and rapid development of the oil industry of the US in the 19th century, although a frenetic race among surface owners followed and led to an extraordinary waste of oil and gas. Today, the rule of capture is still in force, with some functional substitutes incorporated to effectively control its side effects.⁷⁴ Given that so far there is no

⁷¹ BUILDING BLOCKS, *supra* note 25, ¶ 4.

⁷² There are 22 confirmed members, including members from the following countries: Brazil, Australia, Indonesia, South Africa, the Netherlands, Italy, the United Kingdom, the United States, Switzerland, India, France, Mexico, China, Luxembourg. See *Members*, UNIV. OF LEIDEN, <https://www.universiteitleiden.nl/binaries/content/assets/rechtsgeleerdheid/instituut-voor-publiekrecht/lucht—en-ruimterecht/space-resources/members-website-1-3.pdf> (last visited Apr. 18, 2020).

⁷³ The rule of capture means that the owner of a tract of land acquires title to the oil and gas which he produces from wells drilled thereon, though it may be proved that part of such oil or gas migrated from adjoining lands. For a fuller explanation see Bruce M. Kramer & Owen L. Anderson, *The Rule of Capture - An Oil and Gas Perspective*, 35 ENVTL. L. 900 (2005).

⁷⁴ See Terence Daintith, *The Rule of Capture: the Least Worst Property Rule for Oil and Gas*, in AILEEN MCHARG, *PROPERTY AND THE LAW IN ENERGY AND NATURAL RESOURCES* 140-158 (2010). Functional substitutes include: binding work or work expenditure programs at the exploration stage as well as creating obligations to relinquish substantial amounts of acreage at fixed intervals and on entering the production phase, continue exploration obligations even on production acreage. See *generally* TERENCE

agreement regarding property rights in space resources, they are essentially in a “state of nature.” Allocation by the capture rule is simple and requires very little government involvement to deter another person or entity (called a “junior”) from displacing the rightful first comer (called a “senior”).⁷⁵ And it would maximize overall efficiency of the exploitation and use of space resources by developing more rapid and more diverse space exploration vehicles.⁷⁶

However, considering the defects of the capture rule,⁷⁷ we should not vest an absolute monopoly in the senior and deprive a whole neighborhood or community of its rights. The international community should equitably distribute rights therein so as to prevent waste and abstract claims, learning from the experience of water rights and mineral rights in the expansion of the western US.⁷⁸ The senior who has mined substances and removed them from a celestial body would be awarded priority rights, but not a monopoly on that land’s limited resources. The junior, who begins appropriating resources from the same land, could also receive rights and prevent the senior from enlarging his share to the junior’s detriment. Alternatively, a dual system may be another good choice. For instance, the International Telecommunication Union (ITU) employs the rule of “first-come, first-served,” supplemented by a nominal allocation of an orbital slot to each ITU member.⁷⁹ Similarly, due to the vastness of outer space and the uncertainty of resources,

DAINTITH, DISCRETION IN THE ADMINISTRATION OF OFFSHORE OIL AND GAS: A COMPARATIVE STUDY (2006).

⁷⁵ Robert P Merges & Glenn Harlan Reynolds, *Space Resources, Common Property, and the Collective Action Problem*, 6 N.Y.U. ENVTL. L. J. 119 (1997). Aside from a method of recording claims and some threat or sanction to deter stronger second-comers from displacing rightful first possessors, very little in the way of governmental authority is needed.

⁷⁶ *Id.* at 120. The rule of capture will encourage a race ever deeper into space. Such inefficient races to claim and develop space resources will come with a significant spillover benefit: the development of more rapid and more diverse space exploration vehicles.

⁷⁷ “The two major problems associated with a rule of capture ownership regime [are] overdrilling and the dissipation of the reservoir’s natural energy.” Kramer & Anderson, *supra* note 73, at 902 (internal citations omitted).

⁷⁸ Ross Meyers, *The Doctrine of Appropriation and Asteroid Mining: Incentivizing the Private Exploration and Development of Outer Space*, 17 OR. REV. INT’L L. 190, 198-200 (2015).

⁷⁹ See Mark Griffin, Space Servs. Dep’t, Intl Telecomm. Union, Orbit/Spectrum Allocation Procedures 10-13 (Sept. 28-30, 2010), https://www.itu.int/en/ITU-R/space/workshopBangkok2010/03a-Orbit_Spectrum%20Allocation%20Procedures_MG.pdf.

it may be more necessary and advisable to establish reserve zones on the Moon and Mars than asteroids passing by the Earth for those countries with limited capabilities for space mining.

In the debates within the LSC, some delegates expressed that resource extraction on the Moon and other celestial bodies based on “first come, first served” basis was not compatible with the principles of equality of access to space.⁸⁰ Conversely, the Hague Building Blocks enable the attribution of priority rights for a maximum period of time.⁸¹ Based on the analyses above, giving States equal liberty to explore and use outer space does not negate the “first come, first served” rule, as such freedom is implemented in terms of their abilities in practice. Recognizing priority rights of spacefaring countries to search and/or recover space resources may stimulate them to invest and develop mining industry. Nevertheless, overprotecting the “senior” by awarding priority rights could run the risk of disorder, waste, inequality and even monopoly. At present, space resources are accessible to only a very limited number of States and to a handful of enterprises within those States. Consequently, considering the interests of developing countries, priority rights should not be absolute but subject to some arrangements. For example, such rights would necessarily be limited in terms of the size of the area and the duration to be exploited or by reserve zones. After all, others’ freedom should be respected too. Otherwise, the free exploration and use of outer space might be hindered.

In sum, the exploitation of space resources for commercial purpose is subsumed by the freedom of exploration and use principle and is therefore lawful under the OST. Commercial incentive and the capture rule could give stimulus for mining in outer space, while their defects must be tackled.

III. NON-APPROPRIATION

Anticipating a race for space resources, some States took the lead by enacting legislation to grant and recognize property rights over mined resources. For example, the 2015 CSLCA states that US citizens engaged in commercial recovery of an asteroid resource or

⁸⁰ Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm on Its Fifty-Fifth Session, U.N. Doc. A/AC.105/1113, ¶ 83 (2016) [hereinafter *Fifty-Fifth Legal Subcomm.*].

⁸¹ BUILDING BLOCKS, *supra* note 25, ¶ 7.

a space resource are entitled 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.”⁸² Similarly, Luxembourg developed a legal framework in 2017, which not only guarantees miner’s rights to the resources they extract, but also provides for the authorization and the issuance of licenses by States.⁸³ However, due to the lack of an international regime, concerns have been raised about whether these domestic laws conflict with international law, especially the non-appropriation principle.

Article II of the OST embodies the non-appropriation principle, which proscribes the national appropriation of outer space “by claim of sovereignty, by means of use or occupation, or by other means.”⁸⁴ From Article VI of the OST, it can be inferred that “national appropriation” covers both appropriation by States and by private entities.⁸⁵ Although this principle precludes the possibility of the appropriation of outer space and celestial bodies, whether it extends to natural resources therein is uncertain. The OST never makes a distinction between space and celestial bodies on the one hand and resources extracted from them on the other. Put differently, it is unclear whether the term “outer space” includes both outer space broadly considered and its natural resources. In contrast, the MA clearly states that the Moon and its resources are the CHM and prohibits national appropriation of the resources of the Moon. There is no proprietary right over natural resources in place, which is without prejudice to the establishment of an international regime referred to in Article 11(5) of the Agreement.⁸⁶ Due to this provision, the MA has garnered limited support and will not prevent the majority of spacefaring countries from carrying out space mining.⁸⁷

⁸² 51 U.S.C. § 51303 (2018).

⁸³ Jeff Foust, *Luxembourg Adopts Space Resources Law*, SPACENEWS (July 17, 2017), <https://spaceneews.com/luxembourg-adopts-space-resources-law/>.

⁸⁴ Outer Space Treaty, *supra* note 3, art II.

⁸⁵ *Id.* at art VI. Among other things, Article VI indicates that States “shall bear international responsibility for national activities in outer space . . . whether such activities are carried on by governmental agencies or by non-governmental entities . . .” *Id.* (emphasis added).

⁸⁶ Moon Agreement, *supra* note 11, art 11.

⁸⁷ *See* Butler, *supra* note 38, at 508-09.

Given these tensions, the legal status of resources on celestial bodies has raised much controversy over the years. While some hold the prohibition in Article II applies both to outer space and its natural resources,⁸⁸ others argue that the non-appropriation principle refers only to celestial bodies but not to the resources.⁸⁹ The latter view is supported by the US and Luxembourg, whose national law stipulates that private entities only have rights to resources and not to the body from which they are extracted. Under this interpretation, space resource extraction does not violate non-appropriation principle. Similarly, for the HSRGWG, the concept of exploitation in this manner conforms to its purpose, namely to “enable, support and co-ordinate the use of space resources [in a manner] acceptable for spacefaring nations and other interested States.”⁹⁰

In comparison, delegates in the LSC differ on this question. Some argued that the unilateral national legislation to protect private property rights in resources extracted from the Moon or any other celestial body may amount to either a claim of sovereignty or a national appropriation of those bodies.⁹¹ Conversely, some held that such legislation did not constitute a violation of the OST without an authorization granted to an entity for space mining as its application would necessarily be reviewed in accordance with the international treaty obligations of that State.⁹² Besides, some delegates expressed that the principle of non-appropriation only applies to resources that are “in place,”⁹³ while others expressed that whether the resources are to be used in situ or transported to Earth would not make any difference to the determination of the lawfulness of that space resource activity.⁹⁴ What’s more, national laws

⁸⁸ 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 L. 429, 440 (1980).

⁸⁹ *Id.* at 441.

⁹⁰ *The Hague International Space Resources Governance Working Group*, UNIV. OF LEIDEN, <https://www.universiteitleiden.nl/en/law/institute-of-public-law/institute-of-air-space-law/the-hague-space-resources-governance-working-group> (last visited Apr. 18, 2020).

⁹¹ Fifty-Fifth Legal Subcomm., *supra* note 80, ¶ 74; Fifty-Sixth Legal Subcomm., *supra* note 66, ¶¶ 241, 247.

⁹² Fifty-Fifth Legal Subcomm., *supra* note 80, ¶ 75; 2018 Information Report, *supra* note 66, ¶¶ 31, 47.

⁹³ Fifty-Sixth Legal Subcomm., *supra* note 66, ¶ 248.

⁹⁴ 2018 Information Report, *supra* note 66, ¶ 49.

on space resource exploitation and utilization were questioned,⁹⁵ and the view was expressed by multiple delegates that an international framework is required to provide legal certainty on commercial activities in outer space.⁹⁶ Thus, the essential question is still whether exploitation of space resources amounts to appropriation prohibited by the OST.

A. Distinction Between Exploitation and Appropriation

The OST was concluded during the Cold War and should be read as anti-imperial.⁹⁷ By excluding sovereignty in outer space under Article II, the OST encourages States to choose a peaceful and cooperative strategy rather than engage in intense and heavy extraterritorial land grab. As legal theorist Carl Schmitt demonstrated, the history of international law could be traced through land appropriation.⁹⁸ Indeed, the term “appropriation” is primarily concerned with the expansion of State territory. But the legal status of natural resources is not necessarily the same as the surface of land. There are three different types of property rights over natural resources of the subsoil in Earth: i) the regime of *accessio*; ii) the national property model; and iii) the model of absolute property of the State.⁹⁹ Consequently, the land in outer space not under national or private dominion doesn’t mean that exploitation of natural

⁹⁵ *Id.* ¶ 37.

⁹⁶ *Id.* ¶¶ 34, 40 and 48. See also Fifty-Sixth Legal Subcomm., *supra* note 66, ¶¶ 228, 234 and 250.

⁹⁷ P. J. Blount and Christian J. Robison, *One Small Step: The Impact of the U. S. Commercial Space Launch Competitiveness Act of 2015 on the Exploitation of Resources in Outer Space*, 18 N.C. J. L. & TECH. 160, 164 (2016).

⁹⁸ *Id.* at 169.

⁹⁹ Jose Juan Gonzalez, *The Scope and Limitations of the Principle of National Property of Hydrocarbons in Mexico*, in AILEEN MCHARG ET.AL., PROPERTY AND THE LAW IN ENERGY AND NATURAL RESOURCES, 210-12 (2010). Under the regime of *accessio*, the natural resources of the subsoil belong to the land owner. The national property model distinguishes between property in land and property of other natural resources whose nature is different from the soil, such as hydrocarbons. It means property of resources in the subsoil is vested in the State. In contrast, the model of absolute property of the State recognizes the absolute property of the State over natural resources. These different types of property rights over natural resources of the subsoil demonstrate that the legal status of natural resources is not necessarily the same as the surface of land. In this respect, although outer space is not subject to national appropriation, it does not necessarily mean natural resources therein cannot be subject to appropriation.

resources in the subsoil is unlawful under the non-appropriation principle.

When the OST was adopted, the issue of exploitation and use of natural resources did not emerge, thus it was not addressed *expressis verbis*. But explicit prohibition does not amount to lawfulness. As Brooks posited, the question about the rights of States in using the resources of celestial bodies may still be open.¹⁰⁰ The recent advancements of science and technology and the increasing interest in space resources makes it urgent to develop a clear international legal regime to handle these activities. In the search for such a regime, existing international mechanisms such as those regulating international fisheries or seabed mining might be instructive.¹⁰¹

Outer space is identified as a global commons, like the high seas, the atmosphere and Antarctica.¹⁰² Many examples confirm that the exploitation and use of resources to some extent can occur in global commons. The protection of property rights over resources that private actors may recover from an area beyond national jurisdiction or of global interest, as shown by international regulations governing mining from the deep seabed, does not necessarily amount to a sovereignty claim over the territorial area.¹⁰³ Mineral resources in the deep seabed, which is recognized as CHM, could become the property of miners based on their labor or effort rather than sovereignty.¹⁰⁴ And the operators are obliged to respect international law and get licensed by the International Seabed Authority.¹⁰⁵

Nevertheless, concerns have been raised that apart from sovereignty, under the OST, “use or occupation” or “other means” may

¹⁰⁰ See Christol, *supra* note 88, at 442.

¹⁰¹ Fifty-Fifth Legal Subcomm., *supra* note 80, ¶ 81.

¹⁰² U.N. SYSTEM TASK TEAM ON THE POST-2015 UN DEVELOPMENT AGENDA 5 (2013), https://www.un.org/en/development/desa/policy/untaskteam_undf/thinkpieces/24_thinkpiece_global_governance.pdf.

¹⁰³ See generally Tepper, *supra* note 19, at 6-7.

¹⁰⁴ United Nations Convention on the Law of the Sea art. 137(2), Dec. 10, 1982, 1833 U.N.T.S. 397 [hereinafter UNCLOS] (“All rights in the resources of the Area are vested in [hu]mankind as a whole, on whose behalf the Authority shall act. These resources are not subject to alienation. *The minerals recovered from the Area, however, may only be alienated in accordance with this Part and the rules, regulations and procedures of the Authority.*”) (emphasis added).

¹⁰⁵ *Id.* at arts. 138, 151(2).

also be equivalent to appropriation. In this respect, whether exploitation and use of space resources amounts to appropriation would largely depend on the manner in which it is to be implemented. The OST demonstrates the possibility of occupation or inhabitation in Article XII by recognizing that “all stations, installations, equipment and space vehicles on the Moon and other celestial bodies,”¹⁰⁶ are something different from appropriation. It is also true when it comes to geostationary slots and frequencies in the outer space. These resources in this inclusive area are administrated and allocated by the ITU and can be exclusively used and not interfered with by other users. States using frequency bands for radio services temporarily are given rights based on the ITU Constitution rather than their ownership over these resources. One of the conditions is that States have the obligation to ensure equitable access to those orbits and frequencies.¹⁰⁷ In this way, a balance could be struck between maintaining the open access, non-appropriable and collectively beneficial nature of space while also ensuring that private property rights can attach to space resources.

What’s more, the exploitation of space resources is not equated with appropriation to some extent. The reasons are multiple. First of all, as referred to above, the exploitation of space resources is permitted by the freedom of exploration and use principle encapsulated in Article I of the OST. Considering the consistency with Article II, a reasonable explanation may be that acts of exploitation of space resources are lawful and not included in the scope of non-appropriation principle. Second, the MA also differentiates the concept of exploitation from appropriation. On the one hand, it refers to exploitation of the natural resources of the Moon and other celestial bodies in the preamble and the need for an international regime in Article 11 (5); on the other hand, in Article 11 (2) and (3),¹⁰⁸ it repeats the non-appropriation principle, much like Article II of the OST. The structure in the MA demonstrates that the exploitation of the natural resources of the Moon does not constitute a means of appropriation. Third, some have argued that exploitation of space resources always accompanying actual use determines the

¹⁰⁶ Outer Space Treaty, *supra* note 3, art. XII.

¹⁰⁷ Constitution of the International Telecommunication Union [ITU] art. 44(3), <https://www.itu.int/council/pd/constitution.html> [hereinafter ITU Constitution].

¹⁰⁸ Moon Agreement, *supra* note 11, art. 11.

lawfulness of the exclusion of others from use of these resources. In contrast, the justification of appropriation of an area is derived from authority rather than effort. In this respect, claims over space resources are different from claims over areas.¹⁰⁹ Nevertheless, it cannot be argued that traditional property rights over space resources are lawful under the OST.

It is noted that rules relevant in other global commons cannot be automatically applied to outer space, as they are distinct in many ways. For example, the approach that each ITU member is entitled to an orbital position should not be introduced into the legal regime regulating space mining.¹¹⁰ In addition to the great difficulty of physically allocating space resources fairly, regulation tends to cause inefficiency and potential waste. Although the MA has provided a valuable framework to govern the exploitation of space resources, due to its poor ratification, an international regime for such exploitation should be formulated independent of the MA. Otherwise, the legal uncertainty will shrink the investment pool and impede the process of exploration and use of outer space by humankind. In this context, the national legislation of the US and Luxembourg as well as the Hague Building Blocks are of great importance and can greatly enhance discussions in the international community. The following section will focus on these subsequent practices, which introduce a new version of the concept of appropriation in international space law as a starting point for a workable regime of resources exploitation.

B. Subsequent Practice

As the context of space mining evolves, some provisions of the OST are more likely to be re-interpreted or even informally modified to fulfil its object and purpose, or maintain its foundation in the

¹⁰⁹ DE MAN, *supra* note 50, at 207-08, 410-11.

¹¹⁰ For a review of major principles regarding the ITU regulation of orbit usage, see ITU Radio Regulatory Framework for Space Services, online at: https://www.itu.int/en/ITU-R/space/snl/Documents/ITU-Space_reg.pdf. Space mineral resources are different from geosynchronous orbit in many ways. For instance, as space is quite large and many asteroids are movable, there are great difficulties in physical allocation of mineral resources therein. More importantly, space mineral resources are exhaustible while orbital positions are not. For this reason, space mining may seek its own distinct legislation.

agreement of the parties.¹¹¹ For example, the US and Luxembourg, by transforming their interpretation of Article II, the non-appropriation principle, into national law, may lead the future development of international space law in their desired direction. According to Article 31(3)(b) of VCLT,¹¹² these domestic laws can be subsequent practice in the application of Article II, which is helpful to establish agreement among the parties regarding its interpretation. Besides, given that space resource activities depend on the level of technological and economic power of the State, they can be conducted by only a limited number of States Parties of the OST. It is these States that are most active in pursuing a particular interpretation through domestic legislation. For this reason, these State practices can be considered to be representative and should be given more weight as an interpretative tool of the OST. However, we should be careful in examining whether the limited State conduct is accepted by those parties not engaged in this particular practice, albeit tacitly.¹¹³ In this respect, the practice of US and Luxembourg is one of several possible interpretations, but the consensus of the international community on this issue has not been reached.¹¹⁴

Actually, the Hague Building Blocks also uphold the non-appropriation principle by indicating that the rights to space resources and products derived therefrom should be lawfully acquired and mutually recognized between States.¹¹⁵ Moreover, it permits the establishment of safety zones.¹¹⁶ The mutual recognition of resources rights is similar to a “reciprocating States regime,” a practice among States on international seabed mining. Before the United Nations Convention of the Law of the Sea (UNCLOS)¹¹⁷ entered into force, some western States wanted to protect their domestic companies which had invested much in preparation for seabed mining. The reciprocating states regime requires that each State adopt similar national legislation on deep seabed mining and

¹¹¹ Int'l Law Comm'n Rep. on the Work of the Sixtieth Session, Annex A, U.N. Doc. A/63/10, ¶ 14 (2008).

¹¹² Vienna Convention, *supra* note 48, art. 31(3)(b).

¹¹³ Philip De Man, *State Practice, Domestic Legislation and the Interpretation of Fundamental Principles of International Space Law*, 42 SPACE POLY 98 (2017).

¹¹⁴ *Id.* at 92, 97.

¹¹⁵ BUILDING BLOCKS, *supra* note 25, ¶ 8.

¹¹⁶ *Id.* ¶ 11.

¹¹⁷ UNCLOS, *supra* note 104.

commit to coordinate and not interfere with each other's activities.¹¹⁸ But this regime only served as a transition and was later replaced by the 1994 Implementation Agreement of Part XI of the UNCLOS.¹¹⁹ Hence, given the status quo of technological and industrial development at the dawn of space mining, the practice of mutual recognition of space resources rights could also play a similar role before an international framework is reached. In fact, Luxembourg is concluding cooperative agreements with like-minded States such as Poland, the United Arab Emirates, Portugal and Japan, comparable to those concluded under a reciprocating states regime.¹²⁰

On the other hand, the practice of mutual recognition of space resources rights may also be established by the agreement of all States, although the fundamental principles of the OST—the freedom of exploration and use, common benefit and interests—warrant a particularly rigorous assessment of the conditions for subsequent practice as an interpretative tool. Nevertheless, such practice may primarily reflect or protect the interests of technologically advanced countries, as the majority of developing countries do not have meaningful space capabilities. Consequently, it is important to exchange views continually on new and upcoming issues on space mining like in the LSC to take the developing countries' concerns into account.¹²¹ Additionally, with the numerous challenges and questions posed by the utilization of space resources, the determination of the legality of such activities cannot be resolved through unilateral action but requires an inclusive multilateral process.¹²² An international framework that clearly defines and provides guidance on commercial activities in outer space is indispensable in avoiding gaps and ensuring the consistency of national legislation.

Regarding the issue of safety zones, although the access to these zones is restricted only to a limited period of time, it

¹¹⁸ FABIO TRONCHETTI, *THE EXPLOITATION OF NATURAL RESOURCES OF THE MOON AND OTHER CELESTIAL BODIES A PROPOSAL FOR A LEGAL REGIME* 111-12 (2009).

¹¹⁹ Agreement relating to the implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982, July 28, 1994, 1836 U.N.T.S. 3.

¹²⁰ Luxembourg Ministry of the Economy, *Luxembourg and the Republic of Poland Agree to Cooperate on Space Activities* (Oct. 12, 2018), https://space-agency.public.lu/en/news-media/news/2018/Lux_Poland.html.

¹²¹ De Man, *supra* note 113, at 101-02.

¹²² Fifty-Sixth Legal Subcomm., *supra* note 66, ¶ 237.

nevertheless does not amount to appropriation because of the lack of claims to that area. For example, under the ITU system, during a limited and predetermined period of time, the operator is allowed to use a certain orbital slot located in a non-appropriable area exclusively, without ownership rights granted over it.¹²³ Similarly, the safety zone is also permitted in the exclusive economic zones created by UNCLOS to ensure the safety both of navigation and of offshore oil and gas facilities.¹²⁴ Additionally, during the Cold War, both the US and the Soviet Union established keep out zones and safety zones in outer space. Such jurisdiction would not involve a claim of ownership rights but in the interest of national security to repel other human-made objects coming close to their space system.¹²⁵ Hence, a safety zone is necessary to assure safety and avoid any harmful interference with others' space resources activities. In particular, considering that space resources are scarce with limited quantity, accessibility and affordability, an inevitable economic rivalry is likely to occur in the exploitation and use of these resources. Consequently, a safety zone should be established to protect a mining activity or a habitat on an asteroid or other celestial body from intrusion by a competitor. Otherwise, it wouldn't be guaranteed for the business certainty and investor confidence as well as continued safety of operations.¹²⁶ However, when a safety zone is established and how an appropriate limited period of time is authorized need to be clearly addressed. Without proper regulation, there is a high risk that the safety zone is equivalent to *de facto* appropriation. Imagine a safe area for space mining established in a manner that excludes others from entering a particular location for a significant period of time. How would this be different from appropriating the celestial body?

To summarize, the exploitation of space resources is not unlawful under the non-appropriation principle. It is simply a matter left for the future development of international law. In the search for such a regime, it would be useful to look at existing legal

¹²³ ITU Constitution, *supra* note 107, art. 44(5).

¹²⁴ UNCLOS, *supra* note 104, art. 60.

¹²⁵ Colleen Driscoll Sullivan, *Defining and Strengthening the Common Nature of the Outer Space*, 64-65 (Apr. 19, 1993) (unpublished Ph.D. thesis, Temple University (on file with author)).

¹²⁶ See Cody Knipfler, *Revisiting 'Non-Interference' Zones in Outer Space*, THE SPACE REV. (Jan. 29, 2018), <https://www.thespacereview.com/article/3418/1>.

framework regulating the exploration and use of resources in other global commons and relevant contents in the national legislation of the US and Luxembourg and the Hague Building Blocks.

IV. COMMON BENEFIT AND INTERESTS

Article I of the OST provides that the exploration and use of outer space shall be: carried out for the benefits and in the interests of all countries, regardless of their degree of economic or scientific development; and the province of all humankind.¹²⁷ It reflects the common benefit and interests principle, which means that the interests of spacefaring countries and non-spacefaring countries, developed countries and developing countries should be taken into account. Under this provision, the obligation of countries to share benefits is legally binding. As the word “shall” indicates, it cannot be relegated to the preamble of the OST and has the full strength of a duly formulated international contractual norm.¹²⁸ However, States hold opposing positions on what constitutes “the interests of all countries” and how to share benefits which might rely largely on their good faith. The MA further adds the interests of future generations and requires that benefits equitably derived from space resources be shared on the basis of CHM.¹²⁹ But the CHM of the Moon and its natural resources was one of the biggest barriers for the MA to be ratified by most major developed States.¹³⁰

A. Maximum Benefits

Basically, the exploitation and use of space resources would bring a wide-range of benefit and interests to all countries. For instance, it is argued that these activities are incentives: to develop new technologies for furthering deep space missions; promoting terrestrial development activities;¹³¹ expanding the use of outer space; and impelling future generations to reach beyond the relatively close resources of our solar system for “their share.”¹³² So it is of great significance to encourage activities of space mining to

¹²⁷ Outer Space Treaty, *supra* note 3, art. I.

¹²⁸ Su, *supra* note 44, at 1003.

¹²⁹ Moon Agreement, *supra* note 11, arts. 4, 11.

¹³⁰ Butler, *supra* note 38, at 508-09 (2017).

¹³¹ Fifty-Sixth Legal Subcomm., *supra* note 66, ¶ 238.

¹³² Cooper, *supra* note 60, at 114.

maximize welfare for humankind. Spacefaring countries who have invested much on such activities are certainly entitled to profit from the work of their own labor. Developing countries, despite their limited capabilities for space exploration, could also benefit from such activities.

However, the common benefit and interests of all countries are not equivalent to the common benefit and interests of every country. As Bentham proposed, the highest principle of morality requires “the greatest happiness for the greatest number,” namely a focus on the sum whole of happiness.¹³³ It’s conceivable that, with different levels of economic or scientific development among States, the benefits and interests they gain from space mining will also vary. Inequalities are inevitable, as it is often difficult to satisfy each and every State. But some inequalities could be tolerable if they are to the greatest benefit of the least advantaged. Based on Rawls’ difference principle, such inequalities should be arranged so that they are both (a) reasonably expected by every State’s advantage and (b) attached to positions and offices open to all.¹³⁴ The difference principle provides a “social minimum,” including basic liberties such as freedom of thought, choice, wealth, self-respect and so on. In many ways, it is about fair procedure to kick in unequal distribution of talents instead of outcomes distributed at exactly the same levels to all States. In Article I of the OST, every State is endowed with a minimum set of “primary goods” like freedom of access, exploration and scientific investigation. Accordingly, they have self-respect to pursue their good as an equally worthy member of societies. Such arrangement expresses the commitment of spacefaring countries to share their fate and could help maximize resources of developing countries to explore and use the outer space. In this respect, inequalities in practice should be allowed, as they

¹³³ BENJAMIN K. SOVACOOLO & MICHAEL H. DWORIN, GLOBAL ENERGY JUSTICE, PROBLEMS, PRINCIPLES, AND PRACTICES 93 (2014).

¹³⁴ *Id.* at 157-159. The difference principle justifies social and economic inequalities only if they are to the greatest benefit of the least advantaged. It ensures that society is endowed with a minimum set of “primary goods” or “goods every rational man is presumed to want,” including basic liberties such as freedom of thought, freedom of movement and freedom of choice, powers and prerogatives of offices and positions of responsibility, income and wealth, and self-respect and confidence. It provides a “social minimum” and kicks in to correct for unequal distribution of talent by rewarding only attributes that benefit society as a whole.

would benefit the least advantaged and help avoid an even greater inequality.

Nevertheless, under current space law, developing countries hardly benefit from space mining. Rawls' difference principle cannot avoid a greater inequality. Actually, the gap among spacefaring and developing countries is widening instead. As a pragmatic compromise, Rawls only designs a procedure to divide slices of cake, but pays less attention to the size of each slice of cake, as for Rawls, the goal is to design a procedure that encourages fairness and impartiality. But basic liberties are far from enough to reach socioeconomic equality. For this reason, this principle is widely criticized.

Sen and Nussbaum developed Rawls' theory and referred to notions of "functioning" and "capabilities" which refer to the substantial freedoms people ought to have to enjoy the various things they may value doing.¹³⁵ It is implied that every State ought to have access to a "social minimum" energy or technology so that its citizens can enjoy a modern, healthy lifestyle. In furthering distribution, developing countries need to be assured that they will not be excluded from the vast potential that space resources offer. In short, Sen and Nussbaum argue that outcomes matter. As Nussbaum puts it, "the capabilities approach is fully universal: the capabilities in question are held to be important for each and every citizen, in each and every nation, and each person is to be treated as an end." In this way, they would benefit from the exploitation and use of space resources.¹³⁶ Thus, an international legal framework governing space mining to maximize welfare is essential, not necessarily in the narrow utilitarian way argued by Bentham, but also in the ability to enable peoples to realize functions and capabilities.

This view is also supported by some delegates in the LSC and HSRGWG. In the LSC, views were expressed that the benefits of the exploration and use of outer space will be enjoyed by all humanity, and all countries will stand to benefit from the progress made in space resource utilization.¹³⁷ Similarly, the Hague Building Blocks reiterate the common benefit and interests principles.¹³⁸

¹³⁵ *Id.* at 159-61.

¹³⁶ *Id.* at 160.

¹³⁷ Fifty-Fifth Legal Subcomm., *supra* note 80, ¶ 79; Fifty-Sixth Legal Subcomm., *supra* note 66, ¶¶ 230, 232, 238 and 242; 2018 Information Report, *supra* note 66, ¶¶ 31, 42 and 45.

¹³⁸ BUILDING BLOCKS, *supra* note 25, ¶¶ 1, 4 and 9.

They refer to several relevant principles, such as considering the needs of developing countries and the contributions of pioneer operators.¹³⁹

B. International Cooperation

Similar to other global commons, outer space faces a collective action problem. Because of the competing views and interests among different countries, substantial disagreement exists with regard to benefit sharing. This issue has become more tangible and pressing especially given that space mining will become a reality soon. Specifically, spacefaring countries are seemingly reluctant to sacrifice their “hard earned” benefits to those who do not have the capacity to invest or gain them on their own, while developing countries are pressing for equitable distribution of benefits. To make these benefits truly accrue to all countries and avoid the tragedy of the anti-commons, the concept of a “community of shared future for humankind” (CSFM) provides a potential solution. It was first proposed by China,¹⁴⁰ and has been written into several resolutions adopted by the UN.¹⁴¹ Unlike CHM, CSFM requires States to cooperate to jointly tackle current security and developmental challenges and properly handle State-to-State relations. On the one hand, CSFM highlights the idea of common interest and harmonious coexistence for universal prosperity in the outer space. By international cooperation, States would conduct space resources activities with due regard to the corresponding interests of other States and the international community. Developing countries could be enabled to bridge the still widening gap of technology and knowledge, which is beneficiary for their future development and

¹³⁹ *Id.* ¶ 4.

¹⁴⁰ The term of CSFM first appeared in a White Paper of the State Council of China in September 2011, entitled “China’s Peaceful Development,” where it was translated as “the Community of common density.” President Jinping Xi then put forward and expounded on the vision of CSFM on a number of international occasions. See Fengna Xu & Jinyuan Su, *Shaping ‘A Community of Shared Future for Mankind’: New Elements of General Assembly Resolution 72/250 on Further Practical Measures for the PAROS*, 44-45 *SPACE POL’Y* 57, 59 (2018).

¹⁴¹ The concept of CSFM has been written into several resolutions adopted by the UN, including: G.A. Res. 74/6, at 2 (Oct. 31, 2018); G.A. Res. 37/23 (Mar. 19, 2018); G.A. Res. 72/250 (Dec. 24, 2017); S.C. Res. 2344 (Mar. 17, 2017).

considerably contributes to worldwide stability and peace.¹⁴² On the other hand, as a community of shared interests, CSFM advocates win-win cooperation instead of confrontation and exclusiveness. Given that the space mining industry, with high cost and risk, has posed developmental challenges to humankind, all States need to jointly tackle it. International cooperation provides a feasible way to strike a balance among different players. For developing countries, their interests would be guaranteed by directly participating in the exploitation and use of space resources, as they would be recognized as partners in formulating decisions and not merely recipients of benefits.¹⁴³

It is clear that international cooperation, as an important principle in both general international law as well as the *lex specialis* of space law, does not incur mandatory monetary benefit-sharing. In the discussion within COPUOS and the LSC on a relevant item, developing countries were willing to allay the concerns of developed countries and struck a compromise to resolve the issue.¹⁴⁴ And in the 1996 Declaration on International Cooperation, States are allowed to determine freely “all aspects of their participation in international cooperation on an equitable and mutually acceptable basis.”¹⁴⁵ The fate of Part XI of the UNCLOS also demonstrates this. After hard negotiations among developed and developing countries, the 1994 Implementation Agreement¹⁴⁶ was adopted. It accepted a

¹⁴² STEPHAN HOBE, COLOGNE COMMENTARY ON SPACE LAW, VOL. I: OUTER SPACE TREATY ¶ 72 (2009).

¹⁴³ Xu & Su, *supra* note 140, at 59, 60.

¹⁴⁴ See Marietta Benkii & Kai-Uwe Schrogl, *History and Impact of the 1996 UN Declaration on ‘Space Benefits’*, 13 SPACE POLY 139-42 (1997).

¹⁴⁵ G.A. Res. 51/122, ¶ 2 (Dec. 13, 1996).

¹⁴⁶ Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea, Nov. 16, 1994, 1386 U.N.T.S. 3. In the 1980s, some marine powers like the US, the UK, Germany and France refused to join UNCLOS due to their skepticism of Part XI. There are many requirements of equalitarianism in Part XI, such as compulsory economic assistance or compensation to developing States whose economies are seriously affected by deep seabed mining activities (UNCLOS, Article 151, 6 (10)), unconditional transfer of technology (UNCLOS, Annex III, Article 5(3), (6)), high annual fee from the date of entry into force of the contract (UNCLOS, Annex III, Article 13(3)). But after hard negotiations between them and developing countries, the 1994 Implementation Agreement of Part XI of the UNCLOS was adopted with notable changes to reflect commercial interests. For instance, economic assistance fund should not exceed payments received from contractors and voluntary contributions (1994 Implementation Agreement of Part XI of the UNCLOS, Annex, Section 7); the transfer of technology should be based on fair and reasonable commercial terms and conditions on

free-market approach to some extent. For this reason, for spacefaring countries, with a considerable amount of money and effort going into space mining, compulsory monetary benefit-sharing would generate disincentives for them to invest in space mining. And requirements that benefit or technology be shared with others regardless of their level of involvement in the endeavor would also place substantial burdens on private space development, especially in its early stage.¹⁴⁷ Hence, international cooperation must be considered to be subject to some extent to commercial incentives, which are vital for investment in the exploitation and use of space resources as mentioned above. As argued by Olson, in a large group, rational and self-interested individuals will not voluntarily act in their common or group interest, unless there is coercion or some separate incentive.¹⁴⁸ Besides, developing countries should also make what contribution they can to an activity of common interest to all.¹⁴⁹ A lesson drawn from the failure of the MA is that concepts like CHM focusing on rights and benefits while neglecting obligations and burdens are unacceptable for spacefaring countries. Developing countries should indicate a readiness to cooperate through positive action rather than as free-riders, as voluntary cooperation implies win-win cooperation.

As a result, the international community needs to carefully balance the interests of developed and developing countries which are reconcilable and not mutually exclusive. Fortunately, there are various options we could use to expand access to energy and technology, such as joint ventures like pro-poor public private partnerships (5Ps).¹⁵⁰ According to this new pro-poor partnership model, developing countries are recognized not only as consumers receiving benefits but also as partners in business ventures. In this way, each party could benefit a lot from this model. Besides, assistance

the open market, or through joint-venture arrangements (Section 5); and the annual fee is reduced and paid from the date of commencement of commercial production (Section 8). As a result, the UNCLOS was joined and ratified by most countries in the world.

¹⁴⁷ Thomas R. Irwin, *Space Rocks: A Proposal to Govern the Development of Outer Space and Its Resources*, 76 OHIO ST. L. J. 217, 232 (2015).

¹⁴⁸ MANCUR OLSON, LOGIC OF COLLECTIVE ACTION, PUBLIC GOODS AND THE THEORY OF GROUPS 2 (2002).

¹⁴⁹ Comm. On the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on Its Fifth Session, U.N. Doc. A/AC.105/C.2/SR.71, at 23 (1966).

¹⁵⁰ Akanksha Chaurey et al., *New Partnerships and Business Models for Facilitating Energy Access*, 47 ENERGY POL'Y 48, 50 (2012).

programs could help avoid inequality and protect the interests of developing countries. In fact, it is quite practical to compensate those countries who are adversely affected to achieve the “ultimate good” for society. According to the principle of rational benevolence refined by Henry Sidgwick, the good of any State is of no more importance, from the point of view of the Universe, than the good of any other.¹⁵¹

What’s more, procedural justice also matters because it tends to promote better outcomes in terms of the traditional welfare economics approach.¹⁵² Unlike distributive justice, procedural justice is oriented towards process rather than outcome. It is recognized as an important determinant of perceived fairness¹⁵³ by providing meaningful involvement and access to the decision-making process. Specifically, procedural justice deals with recognition (who is recognized), participation (who gets to participate) and power (how power is distributed in decision-making forums).¹⁵⁴ Outer space, as a global commons, should be collectively managed by all States or all humankind. The exploitation and use of space resources is no exception. To establish relevant regimes of benefits sharing, the UN should play a key role due to its legitimacy and inclusivity. At the same time, stakeholders, including private sectors, governments of spacefaring and developing countries and experts, should be encouraged to participate in it. As in the LSC, the majority of delegations have actively participated in the discussion on potential legal models for activities in exploration, exploitation and use of space resources. Nevertheless, decisions should not be made on a “one State, one vote” basis, as demonstrated by the failure of Part XI of the UNCLOS. Those countries contributing much to the exploitation and use of space resources should be given an impact proportionate to their interest and the involvement. But it is still rewarding for developing countries to be included in the decision-making forums to raise possible concerns. Additionally, other measures may also be useful, such as better information disclosure and

¹⁵¹ SOVACOO & DWORKIN, *supra* note 133, at 94.

¹⁵² See Paul Dolan et al., *It Ain't What You Do, It's the Way that You Do It: Characteristics of Procedural Justice and Their Importance in Social Decision-Making*, 64 J. ECON. BEHAVIOR & ORG. 159 (2007).

¹⁵³ See Robert J. Bies et al., *Procedural Fairness and Profit Seeking: The Perceived Legitimacy of Market Exploitation*, 6 J. BEHAVIORAL DECISION-MAKING 253 (1993).

¹⁵⁴ SOVACOO & DWORKIN, *supra* note 133, at 137, 138.

auditing to promote transparency of decisions, effective remedies mechanism and so on.

In the debates within the LSC, many delegations held that solid cooperation is beneficial to maximize space resources for the common prosperity, security and the long-term sustainability of outer space activities.¹⁵⁵ And international space cooperation should be based on the concepts of equality, mutual benefit and inclusive development.¹⁵⁶ In particular, developing countries must be involved for their rights and benefits to be considered.¹⁵⁷ Hence, it is important to strengthen technical assistance and sharing.¹⁵⁸ Regarding procedural justice, delegates stressed the important role of the UN in strengthening and developing cooperation and collaboration among countries,¹⁵⁹ since taking a multilateral approach to space resources within COPUOS and its LSC is the only way to ensure that the concerns of all States.¹⁶⁰ Obviously, these views are basically consistent with our above analyses. In contrast, the Hague Building Blocks address some measures and requirements of benefits sharing, including: promoting the participation in space activities by all countries, in particular developing countries; no compulsory monetary benefit-sharing; and encouraging operators to provide for benefit-sharing.¹⁶¹ But these provisions only cover distributive justice; not procedural justice. Given its membership, there is no broad participation in the HSRGWG, which makes it impossible to fully reflect the demands of the international community. As Belgium argued, without any actual mandate received from States and of a formal mechanism ensuring their representation, the HSRGWG does not provide a “forum for negotiations on an international framework.”¹⁶² Besides, the neutrality of the Working Group

¹⁵⁵ Rep. of the Comm. on the Peaceful Uses of Outer Space on Its Sixtieth Session, U.N. Doc. A/72/20, ¶ 58 (2017) [hereinafter the COPUOS 2017 Report].

¹⁵⁶ Fifty-Fifth Legal Subcomm., *supra* note 80, ¶ 244; Fifty-Sixth Legal Subcomm., *supra* note 66, ¶ 264.

¹⁵⁷ COPUOS 2017 Report, *supra* note 155, ¶ 229.

¹⁵⁸ *Id.* ¶ 311. See also Fifty-Fifth Legal Subcomm., *supra* note 80, ¶ 65.

¹⁵⁹ COPUOS 2017 Report, *supra* note 155, ¶ 58.

¹⁶⁰ Fifty-Sixth Legal Subcomm., *supra* note 66, ¶ 225; 2018 Information Report, *supra* note 69, ¶ 28.

¹⁶¹ BUILDING BLOCKS, *supra* note 25, ¶ 13.

¹⁶² Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm., Questions and Observations by Belgium on the Establishment of National Legal Frameworks for the Exploitation of Space Resources, U.N. Doc. A/AC.105/C.2/2018/CRP.8, ¶ 3 (2018).

can be questioned, as it is primarily financed by the Dutch Ministries of Foreign and Economic Affairs, the Secure World Foundation, Deep Space Industries, ispace, the University of Luxembourg, Nishimura & Asahi and the Ten to the Ninth Plus Foundation¹⁶³

Thus, the exploitation and use of space resources for commercial purpose conforms to common benefit and interests principle. International cooperation is conducive to balancing the interests of developed and developing countries and contributes to a CSFM of outer space. In addition to distributive justice, procedural justice could also promote equitable benefits sharing.

V. ENVIRONMENTAL PROTECTION

When the OST was concluded, it emphasized the peaceful use of outer space; environmental protection was not a priority or concern. But this issue is becoming particularly important at the dawn of space mining. Article IX of the OST has laid the basis for environmental protection in outer space. It requires that States pursue studies and conduct exploration of outer space so as to avoid their harmful contamination and also adverse changes in the environment of the Earth.¹⁶⁴ In addition, according to Article VI, States are obliged to consider environmental aspects for the authorization and supervision of national activities in outer space¹⁶⁵ and adopt appropriate measures when necessary. This is the environmental protection principle. However, the provisions contained in this principle are rather vague and broad. The MA also addresses this principle in Article 7, using the terms “preventing the disruption of the existing balance of its environment,” and “avoiding harmfully affecting the environment of the Earth through the introduction of extraterrestrial matter or otherwise.”¹⁶⁶ It also creates an obligation of notification of States to the maximum extent feasible, concerning the measures adopted by them and all placements of radioactive materials. What’s more, it refers to areas as international scientific preserves which should be reported and protected by special

¹⁶³ Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm., The Hague Space Resources Governance Working Group, Information Provided by the Netherlands, U.N. Doc. A/AC.105/C.2/2018/CRP.18, at 4 (2018).

¹⁶⁴ Outer Space Treaty, *supra* note 3, art. IX.

¹⁶⁵ *Id.* at art. VI.

¹⁶⁶ Moon Agreement, *supra* note 11, art. 7.

arrangements.¹⁶⁷ But major spacefaring nations who have not ratified the MA may argue that they do not have to comply with these obligations. As a result, current space law cannot protect the environment of outer space and the Earth adequately.

Space resources activities are *per se* ultra-hazardous activities, which may be harmful to both the outer space and the Earth environment. Forward contamination arising from Earth affects the environment of outer space. This type of contamination may include: all forms of debris found in outer space of nonhazardous nature; hazardous waste which is chemically or physically dangerous; radioactive waste which is the residue of nuclear-powered space objects;¹⁶⁸ and biological material from Earth to a planetary body with space probes or human space missions. On the other hand, backward contamination arising in space adversely affects the surface or atmosphere of Earth. In particular, returning spacecraft may also spread pollution or bring back waste, such as radioactive debris and extraterrestrial material. For this reason, we should carry out these activities with a high standard of care and due diligence, in spite of uncertainties about specific contamination at present.

According to Article III of the OST, general international environmental law is applicable to protect the environment of outer space as well as the Earth. For example, the 1972 Stockholm Declaration and the 1992 Rio Declaration affirm that, "States have . . . the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction."¹⁶⁹ In addition to *post hoc* action, Principle 15 of the Rio Declaration also requires States to take "the precautionary approach . . . according to their capabilities. Where there are threats of serious or irreversible damage. . . [and] the lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent

¹⁶⁷ *Id.*

¹⁶⁸ Major Bernard K. Schafer, *Solid, Hazardous, and Radioactive Wastes in Outer Space: Present Controls and Suggested and Changes*, 19 CAL. W. INT'L L. J. 2, 3 (1988).

¹⁶⁹ U.N. Conf. on Environment and Development, *Rio Declaration on Environment and Development*, Principle 2, U.N. Doc. A/CONF.151/26 (Vol. 1) (Aug. 12, 1992) [hereinafter *Rio Declaration*]; U.N. Conference on Environment and Development, *Declaration of the United Nations Conference on the Human Environment*, Principle 21, U.N. Doc. A/CONF.48/14/Rev.1 (June 16, 1972).

environmental degradation.¹⁷⁰ Actually, the duty of prevention and due diligence has been recognized by the International Court of Justice (ICJ) in the *Gabcikovo-Nagymaros Project*¹⁷¹ case.

Regarding forward contamination, the fragility of the space environment itself, and our general lack of understanding of that environment are behind the reasoning of the precautionary principle. After all, it is always easier to avoid contamination than deal with it after it emerges. As for backward contamination, we should also take prudent precautions to protect the Earth environment. For instance, the Committee on Space Research (COSPAR) promulgated a Planetary Protection Policy as an international standard on procedures to avoid organic constituent and biological contamination in space exploration.¹⁷² There are five categories for target body/mission type combinations. Category V pertains to all Earth-return missions. For the subcategory defined as “Restricted Earth Return,” destructive impact upon return is absolutely prohibited. Post-mission, there is a need for strict containment and timely analyses of any unsterilized sample collected and returned to Earth. If any sign of the existence of a non-terrestrial replicating organism is found, the returned sample must be treated by an effective sterilization procedure.¹⁷³ Similarly, NASA had a Lunar Quarantine Program during the Apollo program for the astronauts when they came back from their lunar missions to maintain its planetary protection policy.¹⁷⁴ Both the European Space Agency (ESA) as well as

¹⁷⁰ Rio Declaration, *supra* note 169, at Principle 15. Similarly, several international environmental law conventions, such as the Vienna Convention for the Protection of the Ozone Layer of 1985 and the Convention on the Protection and Use of Transboundary Watercourses and International Lakes of 1992 repeat this principle. See EIRIK BJORGE & CAMERON MILES, LANDMARK CASES IN PUBLIC INTERNATIONAL LAW 438 (2017).

¹⁷¹ Case Concerning the Gabčíkovo-Nagymaros Project (Hung. v. Slov.), Judgment, 1997 I.C.J. Rep. 7, ¶ 97 (Sept. 25). In the Gabčíkovo -Nagymaros proceedings, Hungary connected prevention to precaution in its arguments by urging that “[t]he previously existing obligation not to cause substantive damage to the territory of another State had . . . evolved into an *erga omnes* obligation of prevention of damage pursuant to the ‘precautionary principle.’” *Id.*

¹⁷² COSPAR PLANETARY PROTECTION POLICY (2005), <http://w.astro.berkeley.edu/~kalas/ethics/documents/environment/COSPAR%20Planetary%20Protection%20Policy.pdf>.

¹⁷³ *Id.* at 2.

¹⁷⁴ *Interplanetary Contamination and Extraterrestrial Life*, SPACE SAFETY MAG., <http://www.spacesafetymagazine.com/space-exploration/extraterrestrial-life/> (last visited Apr. 19, 2020).

the Japanese Aerospace Exploration Agency (JAXA) are also cooperating with NASA to implement and develop planetary protection policy.¹⁷⁵

Recently, there has been a growing tendency not only towards tackling the problem of environmental preservation and protection in outer space, but also towards trying to avoid their harmful contamination to the maximum possible extent.¹⁷⁶ Space sustainability has become an important concern at modern times, and is a priority agenda in the Scientific and Technical Subcommittee (STSC) of COPUOS. In 2010, the STSC established the Working Group on the Long-Term Sustainability of Outer Space Activities (LTS) to propose measures that could enhance sustainability and produce voluntary guidelines to reduce risks to long-term sustainability.¹⁷⁷ After continuous discussion, STSC has made tangible progress and reached consensus on the text of twenty-one guidelines. Although these guidelines are safety-oriented, they could help protect the environment of outer space to some extent by: supervising national space activities; sharing information on space objects and orbital events; and managing space debris in the long term.¹⁷⁸ Additionally, these guidelines are also meaningful because they raise a broad awareness among COPUOS members of the need to address space sustainability concerns by international cooperation. Similarly, in the debates within LSC, some delegates also expressed that there is a need to care for the outer space environment in the same way as the Earth for the benefit of future generations.¹⁷⁹ And some delegates held that studying the conditions under which both public and private operators could conduct resource utilization activities

¹⁷⁵ Office of Planetary Protection, NASA, <https://planetaryprotection.nasa.gov/intpolicy/> (last visited Apr. 19, 2020).

¹⁷⁶ HOBE, *supra* note 142, ¶ 36.

¹⁷⁷ *Long-term Sustainability of Outer Space Activities*, U.N. OFF. FOR OUTER SPACE AFF., <http://www.unoosa.org/oosa/en/ourwork/topics/long-term-sustainability-of-outer-space-activities.html> (last visited May 17, 2019).

¹⁷⁸ Rep. of the Comm. On the Peaceful Uses of Outer Space, U.N. Doc. A/73/20, at 207, 208 (2018); Comm. on the Peaceful Uses of Outer Space, Rep. of the Sci. and Technical Subcomm. on Its Fifty-Fifth Session, U.N. Doc. A/AC.105/1167 (2018); Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on Its Fifty-Ninth Session, U.N. Doc. A/71/20 (2016).;

¹⁷⁹ COPUOS 2017 Report, *supra* note 155, ¶ 34; Fifty-Fifth Legal Subcomm., *supra* note 80, ¶ 33; Fifty-Sixth Legal Subcomm., *supra* note 66, ¶¶ 51, 232.

and reaching a multilateral consensus to prevent multiple new potential risks to both the terrestrial and space environments,¹⁸⁰ would ultimately contribute to the preservation of a safe, secure and sustainable space environment.¹⁸¹

The Hague Building Blocks also mark a significant step forward in addressing the very complex topic of space sustainability. In paragraph 4, the Building Blocks refer to “contributing to sustainable development” and “promoting the use of sustainable technology.”¹⁸² In paragraph 10, they address a variety of harmful impacts resulting from space resources activities, including but not limited to harmful contamination of outer space and adverse changes in the environment of the Earth. Specifically, the paragraph also adds “[r]isks to the safety of persons, the environment or property,” “[d]amage to persons, the environment or property,” “[h]armful interference with other on-going space activities,” “[c]hanges to designated and internationally endorsed outer space natural or cultural heritage sites,” as well as “[a]dverse changes to designated and internationally endorsed sites of scientific interest.”¹⁸³ Hence, HSRGWG keeps pace with COPUOS to enhance the long-term sustainability of outer space activities by improving the safety of space operations and the protection of the space environment. For example, avoiding harmful interference could mitigate risks posed by congestion and ensure the freedom of all States to explore and use outer space. Regarding the space environment, it is also progressive by protecting the areas in the last two categories due to their important value.¹⁸⁴ Additionally, the provisions in paragraphs 11 and 12 address corresponding measures in the whole process of space mining to avoid harmful impacts. In paragraph 11, the Hague Building Blocks require that space mining activities be reviewed prior to a decision to proceed with a space resource activity, develop technical standards and assess conformity to avoid harmful impacts.¹⁸⁵ These precautionary measures are rewarding for space mining activities to be carried out in a safer manner. For

¹⁸⁰ 2018 Information Report, *supra* note 66 at ¶ 30.

¹⁸¹ COPUOS 2017 Report, *supra* note 155, ¶ 45.

¹⁸² BUILDING BLOCKS, *supra* note 25, ¶ 4.

¹⁸³ *Id.* ¶ 10.

¹⁸⁴ Mark Williamson, *A Pragmatic Approach to the “Harmful Contamination” Concept in Art. IX of the Outer Space Treaty*, 53 PROC. INT’L INST. SPACE L. 666, 668 (2010).

¹⁸⁵ BUILDING BLOCKS, *supra* note 25, ¶ 11.

example, standardization could facilitate routine interactions and decrease operational risk by increasing predictability, which is an effective method to promote coordination among many operators.¹⁸⁶ In contrast, section 12 provides *post hoc* solutions. It requires States to monitor these activities, conduct response measures and adaptive management if a harmful impact occurs.¹⁸⁷

However, these regulations are not enough to avoid harmful contamination of the environment of outer space and the Earth. The stress on “safety,” “technical standards” and the scope of harmful impacts demonstrate that the Hague Building Blocks are more concerned with protecting activities rather than protecting the environment. This conclusion is consistent with our previous analysis that the HSRGWG is in favor of the industrial development. But HSRGWG should not be blamed for this. After all, considering the increasing use of outer space, all States are concerned about the ability to continue operating in a safe environment.¹⁸⁸ That is why the international community at present are focusing mainly on the safety and security of space activities for long-term sustainability. In contrast, the more forward-looking topics of protection and preservation of the space environment are not fully discussed, as space mining has not yet become a reality.

Last but not least, in regulating the negative effects of space mining on the environment, a balance needs to be made between protection and preservation on the one hand and exploration and development on the other. Compared with passive preservation or non-activity, active preservation is more in line with the purpose of the OST. As a result, the growth of this nascent industry should not be impeded by over-regulation.¹⁸⁹ Further, the sustainability of space activities might be enhanced through the formulation of best practices, standards and rules applicable to space operators, which are not burdensome or unnecessary.

¹⁸⁶ Blount & Robison, *supra* note 97, at 160.

¹⁸⁷ BUILDING BLOCKS, *supra* note 25, ¶ 12.

¹⁸⁸ Comm. on the Peaceful Uses of Outer Space, Rep. of the Sci. & Technical Comm., Long-term Sustainability of Outer Space Activities, Preliminary Reflections, U.N. Doc. A/AC.105/C.1/2010/CRP.3, at 5 (2010).

¹⁸⁹ S.M. Mousavi Sameh, *Suborbital Flights: Environmental Concerns and Regulatory Initiatives*, 81 J. AIR L. & COM. 65, 90 (2016).

VI. CONCLUSION

As the resource supplies of the Earth continue to dwindle, outer space is the only place where we can find fresh supplies of energy and raw materials. And technological development makes the exploitation and use of space resources possible and likely to become a reality in the near future. Besides, more and more emerging space actors as well as private entities are developing capabilities to involve them to a much greater extent than hitherto in space resources activities. But, as mentioned above, the OST was concluded during the Cold War, it cannot effectively protect and promote these activities. Given that the context in which the OST operates has become different from the one in which it was conceived, there is an urgent need for a new international regime to regulate these activities. But before expounding such a regime, we need to examine the contents of the OST, the *Magna Carta* of international outer space law, especially the four fundamental principles most relevant to space mining. Elaborating them could help us find out the legality of exploitation and use of space resources, as these principles reflect the object and purpose of the OST, though generous and ambiguous. Additionally, considering the debates within the LSC from 2017 to 2019 and the Hague Building Blocks, it is significant to analyze and review these principles so as to correctly understand and apply them.

It is concluded that the exploitation and use of space resources conforms to the principles of freedom of exploration and use, common benefit and interests and is hence permitted. However, without further regulation, it is likely to lead to a *laissez-faire* approach to space mining in an open access commons. A number of issues can be anticipated, such as over-consumption, disorder, intra-generational inequality and even monopoly. Besides, as the legality of space resources activities is unclear under the non-appropriation principle, some spacefaring countries are interpreting their international obligations to serve their own interests best. For example, the US and Luxembourg adopted their national laws to protect investors' rights and enhance their confidence. Such a unilateral approach has challenged the spirit and wording of the OST to some

extent.¹⁹⁰ What's more, although environmental protection is a technical issue to a large extent, a relevant regime is also needed. States are obliged to consider environmental protection and preservation when they carry out space resources activities with a view towards long-term sustainability. As a result, a legal framework is called for to include three essential points: universal benefit rather than monopoly; guarantees of legal certainty; and rationality and sustainability.¹⁹¹

To search for such a regime, international cooperation and dialogue pave the way to balance interests among different countries. For example, through active participation by the majority of delegations in the LSC during 2017-2019, a growing awareness of the need for internationally agreed rules and multilateral approach has been raised. And, despite its failure, a working group was proposed by Belgium and Greece in the LSC 2019 session to address the development of an international regime for space mining activities. More than that, the twenty-one agreed guidelines in the STSC also opened new avenues for negotiation of some difficult issues.¹⁹² Thus, we are moving in the direction of multilateralism rather than unilateralism regarding the regulation of exploration and use of outer space, and space mining is no exception.

However, given that COPUOS operates in a manner that requires for a program of work to be adopted by consensus, it is difficult to negotiate such an international regime among States in a short period of time. For this reason, establishing a working group in COPUOS with a clear mandate might be a viable option to achieve concrete results. Besides, relevant customary practice is of a comparatively short duration and historical experience does not necessarily transfer into the unique environment of outer space. Consequently, the working group could consider developing soft international space law to clarify, interpret and develop these principles above. On one hand, it could refer to subsequent practice like national legislation of the US and Luxembourg as well as the Hague

¹⁹⁰ Fabio Tronchetti, *Multilateralism vs Unilateralism, the Road Ahead in the Exploration and Utilization of Outer Space Resources*, Presentation at China Space Conference (Apr. 2019).

¹⁹¹ Fifty-Sixth Legal Subcomm., *supra* note 66, at ¶272.

¹⁹² Peter Martinez, *Development of An International Compendium of Guidelines for the Long-Term Sustainability of Outer Space Activities*, 43 SPACE POL'Y 13, 17 (2018).

Building Blocks to enable, support and coordinate the exploitation and use of space resources. On the other hand, taking into account the needs and interests of developing countries, this group could encourage them to participate in a continued high-level exchange of views on space mining to raise possible concerns. Only in this way, is the space age deemed to be an opportunity of development for all countries, rather than for a limited group of States. Accordingly, the vision of a CSFM of outer space is likely to be fulfilled.