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Space Mining and International Law

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ABSTRACT

The increasing interest in space mining, fueled by technological progress and the presence of high-value resources on celestial bodies, has outpaced the development of a complete international legal framework. This paper discusses the current state of international space law with regard to space mining, with special focus on the Outer Space Treaty (OST) of 1967, the Moon Agreement of 1979 , and national space law of states like the United States and Luxembourg. The paper discusses the legal uncertainty of resource exploitation, property rights, and non-appropriation principles, and the tensions between unilateral measures taken by states and the need for a harmonized international regime. The paper promotes the implementation of a soft law, inspired by the practice of terrestrial mining and international cooperation paradigms, to ensure fair and sustainable regulation of space resources. The paper acknowledges the need for international cooperation to prevent conflicts and ensure peaceful uses of resources in outer space.Small countries like Luxembourg are actively pushing space mining law, attracting corporations with legal and financial incentives. Nauru's role in deep seabed mining under UNCLOS has analogues, raising questions about equity and distribution of benefits. Domestic legislation, like the U.S. Commercial Space Launch Competitiveness Act and Luxembourg's 2017 law , allow private companies to own extracted resources, which would be contrary to existing international norms.

I. INTRODUCTION

The prospect for mining celestial bodies like the Moon, asteroids, and other near-Earth objects has gone from science fiction to potential commercial reality. Private industry like Planetary Resources and Deep Space Industries and government-sponsored programs like NASA's Artemis Program[2] mark the beginning of a new age of extraterrestrial resource extraction. But the legal framework that will govern such endeavors is still patchwork, predicated as it is on Cold War-era treaties not necessarily specifically directed to 21st-century commercial space mining. This paper examines the interface of international space law and national law, and the difficulties of applying the current treaties to the extraction of resources and towards a unitary international system. Discuss space mining and its importance in the context of the global

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[2] ARTEMIS PROGRAM

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resource deficit on Earth and space exploration in the next few years. Discuss the global law of space mining, the gaps, and the solutions. The present global space law, mainly the Outer Space Treaty, does not have a clear definition of space mining, and a new system for ensuring equitable and sustainable extraction of resources is required.

II. THE GLOBAL LEGAL REGIME OF SPACE MINING

A. The 1967 Outer Space Treaty

The most significant provisions of relevance to space mining are:

Article II provides that outer space, the Moon, and other celestial bodies are not to be appropriated by a State through sovereignty, use, occupation, or any other means. Article IX: States shall pursue activities with due regard for the interests of other states and shall not cause damage. The OST[3] does not ban or allow extraction of resources itself, and this results in conflicting interpretations. The United States and Luxembourg, for example, believe that mining of resources is not appropriation of celestial bodies and have compared the case to fishing in the high seas. Russia and China, on the other hand, believe that they can contravene the non-appropriation principle.It lays out introductory guidelines for space operations and has been ratified by further than 110 countries, including all of the major space faring nations. Important clauses pertaining to space mining include Composition I All countries are free to explore and use external space, including the Moon and other Elysian bodies, without demarcation No nation may appropriate external space, including the Moon and other Elysian bodies, by claiming sovereignty, using or unwrapping them, or by any other means.Different interpretations have resulted from the OST's silence on resource extraction. Using comparisons to fishing in international waters or harvesting resources from the high seas, proponents of space mining, including the United States and Luxembourg, contend that resource extraction does not amount to appropriation of celestial bodies. They argue that resources become private property as soon as they are extracted, which is in line with Article VI's recognition of non-governmental activities. Critics, such as Russia and some developing countries, contend that resource extraction could undermine the non-appropriation principle and violate Article II by creating de facto control over resource-rich areas.The problem is made more difficult by the OST's emphasis on initiatives that benefit "all mankind" (Article I). According to researchers like Radi (2024), commercial mining may put the interests of powerful corporations and wealthy countries ahead of those of developing nations due to its profit-driven nature. These issues are made worse by the absence of procedures to guarantee

[3] OST - OPEN SPACE TREATY

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fair benefit-sharing.

B. The 1979 Moon Agreement

The Agreement on the Activities of States on the Moon and Other Celestial Bodies (Moon Agreement)[4] also clarifies the OST, and more specifically includes extraction of resources. Article 11 proclaims the Moon and its resources to be the "common heritage of mankind" and suggests an international regime for the regulation of the exploitation of the resources. To date, however, the Moon Agreement has been ratified by only 17 states as of April 2024[5], and none of them are significant space faring states, so it is de facto non-binding in practice.

C. Other Pertinent Frameworks

UN Convention on the Law of the Sea (UNCLOS): Establishes a template for the regulation of resources in the area beyond national jurisdiction, i.e., the deep seabed, through the International Seabed Authority (ISA)[6].

Artemis Accords: A 48-signatory (as of November 2024) multilateral agreement started by the United States, which feels that resource harvesting is not necessarily in violation of Article II of the OST. The Accords encourage the use of safety zones and shared use of resources but are not binding, e.g., a treaty.As of November 2024, 48 nations have ratified the Artemis Accords, a non-binding multilateral agreement that was started by the US in 2020. By stating that resource extraction is allowed under the OST because it does not amount to national appropriation, the Accords seek to set standards for lunar exploration and resource use. In accordance with Article IX, safety zones surrounding mining operations can stop detrimental interference.

Cooperative resource activities require transparency and data sharing. The Accords are criticized for being U.S.-centric and lacking the legal force of a treaty, even though they encourage useful cooperation. The Accords are seen by non-signatories like China and Russia as an attempt to unilaterally influence space governance, which could exacerbate geopolitical tensions.

Hague International Space Resources Governance Working Group: The 2019 "Building Blocks"[7] issued more advanced guidelines for resource activities, including transparency, cooperation, and respect for international law.

[4] MOON AGREEMENT
[5] 17/04/2024
[6] INTERNATIONAL SEABED AUTHORITY
[7] BUILDING BLOCKES 2019

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III. DOMESTIC LEGISLATION AND INTERNATIONAL LAW

A. United States

According to the U.S. Commercial Space Launch Competitiveness Act[8] (2015), US citizens can possess, own, transport, use, or sell space resources obtained in accordance with international obligations. However, critics of this legislation claim that the Act is in possible contravention of the OST because it implies property rights over resource extraction without an international consensus. The U.S. argues that the CSLCA complies with the OST, as resource extraction does not involve appropriating celestial bodies themselves. However, scholars like Stubs (2020) contend that granting property rights over extracted resources could set a precedent for de facto appropriation, particularly if mining operations exclude other actors from resource-rich areas. The CSLCA's lack of environmental or benefit-sharing provisions further raises concerns about compliance with Articles I and IX of the OST.

B. Luxembourg

Luxembourg's aggressive initiatives include attracting companies like Planetary Resources and Deep Space Industries[9], thus placing the country in a strong position to become the space-mining experimentation hub. However, its compatibility with international space law has evoked debates. Luxembourg is positioned as a global leader in space mining regulation thanks to its 2017 Law on the Exploration and Use of Space Resources. The law gives businesses that are registered in Luxembourg the authority to possess and sell space resources that have been extracted. Creates a licensing system that demands adherence to environmental regulations and international law. Provides monetary rewards and legal assistance to entice space mining firms. A flourishing space industry ecosystem has been created by Luxembourg's laws, which have attracted businesses like space and Planetary Resources. However, detractors contend that because the law implies property rights without international agreement, its unilateral approach runs the risk of weakening the OST's non-appropriation principle. Although Luxembourg's support for the Artemis Accords and active participation in the Hague Working Group point to an attempt to bring domestic law into line with new standards, tensions.

C. Other States

Japan and United Arab Emirates are the two other countries that have enacted the above laws, while China and Russia are continuing their state-led efforts towards space mining by

[8] COMMERCIAL SPACE LAUNCH COMPETITIVENESS ACT 2015
[9] PLANETARY RESOURCES AND DEEP SAPACE INDUSTRIES

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instituting the International Lunar Research Station[10]. These domestic proliferation's emphasize a rather disjointed international picture in the area of international legislation as they expose further conflicts in claims and disputes.

1. Japan

Subject to government approval, commercial organizations are allowed to extract and own space resources under Japan's 2021 Space Resources Act. The law stresses adherence to international commitments and is consistent with Japan's involvement in the Artemis Accords. Japan's technological ability to mine space is demonstrated by the Hayabusa2 mission, which successfully returned asteroid samples in 2020.

2. The United Arab Emirates

Commercial resource extraction is permitted by the UAE's 2021 Federal Law on Space Resources, which also creates a licensing framework. The UAE is positioned as a new player in space mining thanks to its aspirations, which are best represented by its Hope Mars Mission and plans for lunar exploration. The UAE's legislation, like other domestic laws, raises concerns about OST compliance, especially with regard to equitable benefit-sharing.

3. Russia and China

Although they have not passed any laws specifically pertaining to space mining, China and Russia nevertheless use state-led programs to extract resources. Russia's lunar program focuses on helium-3 extraction, while China's International Lunar Research Station, which is scheduled for the 2030s, includes goals for resource utilization. Both nations condemn unilateral domestic laws as OST violations and support a multilateral approach to space governance. Their unwillingness to sign the Artemis Accords highlights the geopolitical differences in the laws governing space mining.

IV. SPACE MINING'S LEGAL DIFFICULTIES

Non-Appropriation and Property Rights

The question of whether extracted resources can be owned without asserting sovereignty over celestial bodies is brought up by the OST's ban on national appropriation. Resources can be appropriated once they are extracted, according to analogies to terrestrial commons like fishing in international waters, but there is uncertainty because there is no clear international law.

[10] INTERNATIONAL LUNAR RESEARCH STATION

Safety Zones and Priority Rights

Although it might be in opposition to the OST's freedom of access principle, the idea of priority rights—granting exclusive access to a mining area—could avoid disputes between operators. Similarly, if the Artemis Accords'[11] safety zones bar other parties from accessing valuable mining locations, they may result in de facto appropriation.

Ethical and Environmental Aspects

Degradation of celestial bodies and resource depletion are two environmental hazards associated with space mining. In order to guarantee sustainable practices, academics support environmental impact assessments by using terrestrial models such as the Antarctic Treaty System[12]. Making sure developing countries have fair access to space resources is one ethical concern.

Settlement of Conflicts

Conflicts are more likely when there is no specific dispute resolution procedure for space mining. According to some academics, international arbitration could provide an impartial forum for settling conflicts while utilizing the New York Convention's enforceability[13].

V. SUGGESTED SPACE MINING GOVERNANCE FRAMEWORK

This paper builds on current models and principles to propose a soft law framework to address the legal gaps:

Principles of Soft Law

Transparency: To prevent disputes and preserve proprietary characterization data, states and businesses should exchange location information for mining operations.

Cooperation: Negotiations for a non-binding code of conduct should be facilitated by an international forum, such as the UN Committee on the Peaceful Uses of Outer Space (COPUOS).

Sustainability: Using the Antarctic Treaty System and ISA regulations as a guide, environmental impact assessments ought to be required.

Equity: Measures like revenue sharing or technology transfer should be included to guarantee that developing countries profit from space resources.

[11] ARTEMIS ACCORDS
[12] ANTARTIC TREATY SYSTEM
[13] NEW YORK CONVENTION'S ENFORCEABILITY

International Space Resources Authority

Based on the ISA, this organization could manage licensing, keep an eye on adherence, and settle conflicts. To guarantee inclusivity, it would function under UN authority. Zones of Priority and Safety: Temporary, non-exclusive priority rights could strike a balance between business interests and the OST's values, preventing monopolization while maintaining security. **Dispute Resolution:** To resolve disputes and ensure enforceability through current international mechanisms, an international arbitration panel with expertise in space law could be involved. Steps in Implementation Organize a COPUOS working group to develop soft law principles, taking into account suggestions from states, business, and civil society.

VI. International space law interpretations and discussions

Interpretations of the OST: According to some academics, resource extraction is allowed under the "freedom of use"[14] clause of Article I, provided that no territorial claims are made. Others argue that resource extraction might violate Article II by amounting to appropriation. Comparable to fishing in foreign waters: It is possible to extract resources without claiming the land.

The 2020 Artemis Accords:

The Accords, which were signed by 48 nations as of November 2024, maintain that resource extraction is not always considered national appropriation.

To avoid interference, "safety zones" should be established around mining sites; however, their legality under the OST is up for debate.

Deep seabed mining is governed by the UN Convention on the Law of the Sea (UNCLOS), which declares resources to be part of humanity's common heritage.

Important Points:

Different interpretations result from the OST's ambiguity. Although they are not widely accepted, the Artemis Accords make an effort to define mining rights. Though they don't directly apply to space, analogies offer insights.

VII. Difficulties in law, technology, and ethics

Non-Appropriation and Property Rights

Fundamental concerns regarding property rights in space mining are brought up by the OST's Article II ban on national appropriation. Is it possible to possess resources that have been

[14] FREEDOM OF USE

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extracted without asserting control over celestial bodies? Advocates make comparisons to terrestrial commons, like fishing in international waters, where resources are turned into private property after they are harvested. Large-scale mining operations, especially those that call for permanent infrastructure, are criticized for potentially violating the OST by de facto[15] appropriation. The problem is made more complex by the idea of "in situ resource utilization" (ISRU), which refers to the use of resources such as lunar water for building or fuel. Although ISRU is essential for sustainable space exploration, its commercial uses might put private interests ahead of the "benefit of all mankind[16]" tenet of the OST. There is disagreement among academics, such as Byrd (2022[17]), regarding the need to differentiate between commercial and scientific ISRU in order to comply with international law.

Safety Zones and Priority Rights

Some suggest giving priority rights to organizations that start operations in a certain area first in order to avoid disputes between mining operators. This problem is intended to be addressed by the Artemis Accords' idea of safety zones, which are regions surrounding mining sites to avoid detrimental interference. Safety zones, however, might bar other actors from resource-rich locations, which would be similar to territorial claims and might be against Article II. Although implementation is still controversial, the Hague Building Blocks propose temporary priority rights that are subject to international oversight.

Technical Difficulties

Since space mining technologies are still being developed, there are both practical and legal obstacles to overcome:

Resource Prospecting: Sophisticated robotic systems, like NASA's VIPER rover or ESA's PROSPECT mission, are necessary for the precise identification of resource deposits. Methods of Extraction: Methods such as magnetic separation for asteroid metals or thermal extraction for lunar water have not been tested on a large scale.

Transportation: Economical launch and logistics systems are necessary for the return of resources to Earth or for their processing in space.

The necessity for legal frameworks that encourage innovation while guaranteeing adherence to international law is highlighted by these technological obstacles.

[15] DE FACTO
[16] BENEFIT OF ALL MANKIND
[17] BYRD 2022

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Fair and Moral Access

According to the "benefit of all mankind" principle of the OST, all countries should have access to space resources, regardless of their level of technological capability. However, wealthy countries and corporations control the majority of space mining, which raises moral questions about discriminatory practices. Developing nations may be excluded because they lack the means to take part, which would maintain global inequality. This problem is intended to be addressed by the Moon Agreement's "common heritage[18]" principle, but its limited adoption makes it useless. Mechanisms like revenue distribution or technology transfer. Ethical considerations also include preserving celestial bodies[19] for future generations and respecting their cultural significance, as some indigenous groups view the Moon as sacred

Resolution of Conflicts

Conflicts are more likely when there is no specific dispute resolution procedure for space mining. Competing claims to resource-rich sites are one example of a potential dispute harm to the environment brought on by mining activities. Violations of priority rights or safety zones. The Haguorking Group's proposal for international arbitration may offer an impartial forum for settling conflicts. Arbitration is a feasible alternative since the New York Convention guarantees the enforceability of arbitral awards. As an alternative, complicated mining disputes might be heard by a specialized space court akin to the International Tribunal for the Law of the Sea.

VIII. CONCLUSION

With resources for space exploration, sustainable development, and economic expansion, space mining has the potential to revolutionize human civilization. However, commercial resource extraction cannot be adequately governed by the current international legal framework, which is anchored by the OST and dispersed by domestic laws. Conflicts and exclusionary practices are risked by legal ambiguities pertaining to property rights, environmental protection, and equitable access. Prospecting and extraction are examples of technical difficulties that highlight the necessity of coordinated governance.A practical and comprehensive solution is provided by the suggested multi-tiered framework, which combines soft law principles, an International Space Resources Authority, priority rights, safety zones, and arbitration. The framework strikes a balance between commercial innovation and the OST's tenets of peaceful use, non-appropriation, and benefit-sharing by referencing terrestrial

[18] COMMON HERITAGE
[19] CELESTIAL BODIES

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models such as UNCLOS and the Antarctic Treaty System. In order to establish consensus and test governance mechanisms, implementation calls for ongoing international cooperation, starting with COPUOS negotiations and pilot agreements.The international community must take decisive action to guarantee that space mining benefits all of humanity as we approach the dawn of a new era in space exploration. In addition to being required by law, a strong and just legal system is also morally required to protect space as a common frontier for coming generations.

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