frontiers | Frontiers in Space Technologies

TYPE Perspective
PUBLISHED 03 February 2025
DOI 10.3389/frspt.2024.1499486

OPEN ACCESS

EDITED BY
M. Reza Emami,
University of Toronto, Canada

REVIEWED BY
T. John Tharakan,
Indian Space Research Organisation, India

*CORRESPONDENCE
Joseph N. Pelton,
joepelton@verizon.net
Nishith Mishra,
nishith.mishra@mail.mcgill.ca
Martina Elia Vitoloni,
martina.eliavitoloni@mail.mcgill.ca

RECEIVED 20 September 2024
ACCEPTED 19 November 2024
PUBLISHED 03 February 2025

CITATION
Pelton JN, Mishra N and Elia Vitoloni M (2025) Mining the ocean floor vs mining the Moon: what can we learn from our past experiences? *Front. Space Technol.* 5:1499486. doi: 10.3389/frspt.2024.1499486

Mining the ocean floor vs mining the Moon: what can we learn from our past experiences?

Joseph N. Pelton[1]*, Nishith Mishra[2]* and Martina Elia Vitoloni[2]*

[1]International Space University, ACES Worldwide, Arlington, VA, United States, [2]Faculty of Law, Institute of Air and Space Law, McGill University, Montreal, QC, Canada

This perspective piece examines the parallels and distinctions between ocean floor mining and potential lunar extraction, emphasizing the necessity of protecting the Moon as a global common. It traces the historical evolution of global commons governance, highlighting key international treaties that have shaped the management of shared resources. The analysis delves into the practical implementation challenges of maintaining equitable access and environmental sustainability in both terrestrial and extraterrestrial contexts. Through a case study of the Pacific Ocean seabed mining initiative by Nauru Ocean Resources Inc., the paper illustrates the complexities and controversies surrounding resource exploitation in recognized global commons. It underscores the inadequacies of current legal frameworks, such as the Moon Agreement and the Law of the Sea, in addressing emerging technological and geopolitical dynamics. The discussion extends to the unique challenges posed by celestial bodies like the Moon and asteroids, advocating for tailored regulatory mechanisms that consider their distinct environmental and regenerative capacities. Last, this perspective piece argues that without just and equitable regulatory decisions in ocean mining, similar oversights are likely in lunar endeavours, thereby jeopardizing the sustainable and fair utilization of outer space resources.

KEYWORDS

ocean floor mining, potential lunar extraction, legal and regulatory, parallels and differences, sustaianable development, need for protecting the Moon as a global common

1 Introduction and historical background

The concept of fairness, justice, and ethical conduct has been a central tenet of human society for millennia. With the launch of Sputnik 1 in 1957 the Space Age began, prompting the emergence of questions concerning what is fair, just, ethical, and more importantly, equitable in outer space activities. An increasing number of countries and private entities are developing the capabilities to use and explore outer space freely and with a view towards utilizing its resources. This means that the existent disparities and differences in opportunity to use resources on Earth will likely carry over to space exploration and applications.

1.1 Earliest recorded notion of "commons"

The 1814–1815 Vienna Congress is most notable for having created an agreement on the peaceful governance of nations in Europe and the foundation of the sanctity of the nation-state.

Yet, it also provided for the management of the Rhine to ensure peaceful access to the river as it flowed through a number of European countries. Hugo Grotius had articulated the principle of freedom of the seas and conceptualized the sea as an international resource open to all countries to navigate for commerce and other purposes. However, it was not until the Vienna Congress that an international treaty established a mechanism for the management of disputes and issues related to a "commons" (regulation of Rhine river) shared by countries and deemed essential for the benefit of everyone. This resulted in the formation of a Commission for the regulation of the Rhine, tasked with establishing standards and providing oversight of pollution in the river, creating the first regulatory process for international-regional governance over one common resource (Schiff, 2017).

In the century that followed, new international treaties and agreements have facilitated broader access and environmental protections to Antarctica, the Ocean, and the seabed. In addition, bilateral and multilateral agreements have provided for regulations and governance systems to govern rivers, canals, and the Earth's atmosphere. A significant result of these processes has been the development of the concept of a 'Global Commons' (hereinafter "global commons"), meaning areas beyond the exclusive jurisdiction of countries, and where no country holds sovereign authority: although, every country is expected to take responsibility for these areas. Countries have recognized that international cooperation and freedom of access is essential for the governance of these areas, and these are deemed beneficial for the international community as a whole. However, even this is changing rapidly.

1.2 The recognition of global commons

Although there is no universal agreement on an official list of global commons, the U.N. Task Force, established in 2010 and comprising representatives from approximately sixty U.N. entities and international organizations. This Task Force unambiguously maintained that:

> "Global commons have been traditionally defined as those parts of the planet that fall outside national jurisdictions and to which all nations have access. International law identifies four global commons, namely the High Seas, the Atmosphere, the Antarctica and the Outer Space.", has stated: "International law identifies four global commons, namely the High Seas, the Atmosphere, Antarctica, and Outer Space." (UN System Task Team on the Post, 2015 UN Development Agenda, 2013)

This U.N. Task Force had sought to develop and maintain a clearer categorization of areas which are recognized as global commons. Based on the need to preserve common resources of humankind, this endeavor has been driven, on the one hand, by the necessity to achieve sustainability (especially guided by the Sustainable Development Goals (SDGs), and, on the other hand by climate change concerns.

Moreover, the 2018 Report of the Secretary-General of UN was issued in the context of identifying "Gaps in international environmental law and environment-related instruments: towards a global pact for the environment," reiterates:

> "93. Gaps also persist in the enforcement of rights and obligations regarding the global commons and shared natural resources, such as the high seas, Antarctica and outer space." (Report of SG, 2018)

The purpose of this perspective piece is to examine a specific international legal and regulatory issue pertaining to the global commons, specifically concerning the proposals to mine the ocean floor in the Pacific Ocean. This analysis will examine the implications of these developments for the longer-term issue of potential surface mining of the Moon in the future. Questions arise though as to "who will decide what is to be done and also who will provide the oversight and environmental controls associated with such mining efforts on the Ocean's floors as well as on the Moon?".

2 The implementation of the global commons concept in practice

The concept of global commons is ideal in theory. In a perfectly harmonious world where all countries possess similar capabilities to support, implement, and enforce equitable and universally approved treaty provisions, the resources of the global commons could be extracted and used in an equitable, sustainable as well as environmentally sensitive manner. However, the reality is that disparities in capabilities and interests often lead human beings from making use of these resources towards exploiting these resources. This phenomenon has sometimes also been known as the "tragedy of the commons." The concept of the "Free Seas" as presented by Hugo Grotius, over the last few centuries, has been described by critics as a shift towards a policy of "first come, first served." Resources of the high seas have increasingly been overconsumed, and industrial applications have not only polluted the oceans but also caused an increase in their temperatures. The pollution of the sea, resulting from oil spills and plastics, and the rise in temperatures have been increasingly recognized, although corrective actions have seldom been taken.

At present, in addition to legal constraints, novel technologies, including remote sensing satellites, automatic identification systems (AIS), radar, and monitoring devices, among others, facilitate the safeguarding of global commons and ensure that their utilization is conducted in a responsible manner, thereby enabling countries to benefit from globally shared and environmentally protected areas. Nevertheless, a certain degree of vigilance over these global commons is still necessary, and quite urgent (Pelton, 2021). The idealistic notions and theories behind the concept of global commons cannot succeed without the implementation of legal mechanisms to ensure the responsible use of shared resources and equitable access to them. It can be assumed that the international community accepts the political concept of outer space as a global commons, though it has not yet been recognized as a legal principle universally. Having said that, implementation of principles to regulate such global commons is likely to face potent challenges due to current geopolitics and mainly due to the current perspective or position held by some advanced countries, including the US. In the absence of protective frameworks and processes, the long-term sustainable use of global commons'

resources is unlikely to be achieved, and even has the potential to disturb Earth's delicate balance.

3 Special issues of how to protect resources of the Moon and celestial bodies within the theme of long-term sustainability

The Moon Agreement, which was designed to regulate the activities of human beings on the Moon, and potentially provide a scope for the utilization of its resources, has become a notable anomaly within the domain of space law. Not only has it not been ratified by a significant number of countries, but it has also been denounced by one advanced space-faring country. Article 11 of the Moon Agreement delineates the intention to conclude an agreement at a future date with the objective of establishing a regulatory framework for the utilization of resources of the Moon, which, however, has never materialized into concrete legal principles. As a result, the absence of any clearly defined regulations governing the use of the Moon and its resources represents a significant risk for the long-term sustainability of space activities.

The primary difference between global commons such as the oceans, Antarctica, and the domain of outer space, especially the Moon, is that Earth's biosphere fosters regenerative and sustainable systems. By implementing suitable measures to safeguard the environment from detrimental factors such as pollution and overfishing, economic exploitation and overuse, etc., these resources can be sustained over an extended period of time. In contrast, the Moon does not support organic systems or regeneration of its resources. As example, if frozen water and volatiles are extracted, there is no rainfall or other regenerative systems to replenish the extracted resources. Similarly, if electrolysis is employed to generate hydrogen for fuel and oxygen for breathing, these resources will not be naturally replenished. Nevertheless, there are some exceptions as, for example, lunar regolith materials can be reprocessed and reused.

The concept of global commons, and its potential implementation principles, as understood in Earth's context is thus not easily transferred to implementation of legal principles for use of resources on the Moon, particularly with regard to water, volatiles, regoliths, and even to their [legal principles'] application to or other celestial bodies. If analysis is extended to encompass asteroids and other resources within the solar system, a markedly different picture is likely to emerge. A significant number of asteroids in the outer reaches of the solar system contain substantial quantities of water. Here lies one of the critical gaps in space law: the need to differentiate between the importance and nature of various celestial bodies, and to propose regulations accordingly. This gap may also be closely linked to another shortcoming of space law and policy: the lack of an established boundary between airspace and outer space. Each celestial body possesses distinctive characteristics, and some of which are potentially hazardous.

This lack of consensus hinders the ability to determine whether these resources are strategic or disposable and whether they pose a potential risk to humanity. Furthermore, there are currently no established criteria for determining which resources are useful and should be preserved in order to ensure the sustainability of space activities. With regard to the Moon, a number of arguments can be made in favor of its designation as a protected resource, and its regulation as a global common. In contrast, no analogous argument exists with respect to asteroids, comets, centaurs, and trojan space objects. The solar system is a vast and complex entity, comprising a multitude of celestial bodies and matter, both within and beyond Earth's orbit – and, it may not be wise to assume that all celestial bodies outside of Earth are identical and require same type of considerations and protections. It is thus imperative that the legal community, the international space policy community, and the scientific community collaborate in the coming years to develop a framework that ensures the orderly and sustainable use of outer space.

4 Mining of the Pacific Ocean seabed

One of the current issues in the realm of global commons is the question of how to regulate seabed mining. Under the Law of the Sea, seabed resources are designated as the "Common Heritage of [Hu] mankind." This concept, often confused with that of the global commons, entails the sharing of resources and benefits (Schrijver, 1997). The Moon Agreement, unsuccessfully, attempted to designate the Moon as a Common Heritage. In contrast, the Law of the Sea (United Nations Convention on the Law of Seas) has a longer history of conferring this (common heritage) status upon the seabed and its resources. In a manner of speaking, the resources of the high seas and the seabed have been protected and regulated to prevent their overconsumption and exploitation. However, these resources are now facing a threat of significant disruption. The law of the seas provided rules for the utilization of seabed resources, and had called for the creation of the International Seabed Authority ("ISA"). Enterprise, an organ of ISA, has been empowered to carry out mining activities in the seabed. Nevertheless, 2 decades later, the ISA has yet to issue clear guidance or rules for seabed mining.

Recently, the Government of Nauru along with the Metal Company, submitted a formal application in June 2021 to ISA to undertake a massive endeavor to mine the Pacific Ocean seabed. The formal notice expressed the intent to commence seabed mining within a 2-year period. This effort is to be undertaken by the Nauru Ocean Resources Inc. ('NORI') a subsidiary of The Metals Co. (Reid, 2021). This initiative consists of mining resources (i.e., poly-metallic nodes containing nickel, manganese, copper, and cobalt) via a sort of ship-based strip-mining process that involves harvesting ships equipped with suctioning tubes. The objective, with some irony, is to suck up key metals off the seabed to supply the materials for batteries needed for electric vehicles – to reduce the impact of vehicle emissions on the Earth's atmosphere. Notwithstanding the absence of a regulatory oversight plan issued by the ISA, the Metal Company has initiated feasibility trials to ascertain the viability of project. However, an investigation by the New York Times revealed that informal exchanges with the ISA on this topic had been occurring for 15 years, potentially illustrating that despite the absence of a concrete regulatory framework, there is a persistent intent of countries and companies to pursue this type of activity.

In late August 2022, the ISA granted approval for the commencement of a "trial mining"' operation. The authorization of this project by the ISA has provoked widespread controversy. The reports concerning this trial authorization indicated:

> "...increasing number of states and observers from civil society raising concerns about the safety and necessity of deep-sea mining. Some member states, including Palau, Fiji and Samoa, have even called for a moratorium on deep-sea mining until more is understood about the marine environment .....Other concerns hinge upon an environmental impact statement (EIS) that NORI had to submit in order for mining to begin." (Elizabeth Claire Alberts, 2022)

Many critics have highlighted that this test authorization came from the ISA Legal and Technical Committee, without appropriate consultation with the ISA Council. The environmental effects of the mining, including the impact on photo-plankton and other sea life, as well as the potential for pollution, have been a significant area of concern.

It is evident from this that the international community's response to this mining operation will potentially serve as a precedent or indication of how the mining of space resources may be conducted in the future. The efficacy of regulatory oversight, the character of environmental impact statements, and the independent scientific monitoring of potential adverse effects could provide valuable guidance regarding the future of mining operations on the Moon. Additionally, it will be beneficial to observe, track and consider the degree to which the UN General Assembly views the seabed mining test.

One of the most intriguing aspects of this debate is the question of derived economic value from mining operations on the seabed floor. This topic has consistently been a point of contention in discussions surrounding the concept of global commons. Does this provide a potential solution to the question of how to approach the mining of "Common Heritage of Humankind" areas by private companies? Does the involvement of a single or multiple countries in the partnership affect the outcome? It is conceivable that several countries with specific interests, such as Palau, Fiji, and Samoa with special standing, may initiate legal proceedings before the International Court of Justice to decide upon these issues. It is of the utmost importance now to reach clear decisions on a number of issues pertaining to environmental protection, the rights of countries to undertake mining activities on the seabed floor, and the degree to which there might be an economic sharing of benefits. This is not only relevant to the case of seabed mining, but also to the future development of legal and regulatory frameworks for the use of resources on the Moon.

5 Conclusion

There are numerous intriguing inquiries pertaining to the recognition of the Moon as a global commons, and the impact (regulatory, policy, legal, and environmental) that seabed mining operations may have on humanity's future exploration and use of the Moon. Thus, the legal and regulatory decisions that will be made in the near future with regard to seabed mining will likely inform the subsequent actions and decisions that will be undertaken with regard to the Moon in the years ahead. If appropriate, just and equitable decisions are not made now with regard to the ocean floor and seabed mining, in the context of these being protected as a global common (or even, as a Common Heritage of humankind), it seems unlikely that the mining of the lunar surface, in future years, is likely to be effectively protected under the global commons concept. Much remains to be done.

Data availability statement

The contributions presented in the study are included in the perspective piece, further inquiries can be directed to the corresponding authors.

Author contributions

JP: Writing–original draft, Writing–review and editing. NM: Writing–original draft, Writing–review and editing. EM: Writing–original draft, Writing–review and editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this perspective piece.

Conflict of interest

Author JP founded ACES worldwide.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

Publisher's note

References

Elizabeth Claire Alberts (2022). "Regulator approves first deep-sea mining tests, surprising observers," in *Mongabay Oceans series*. Available at: https://news.mongabay.com/2022/09/regulator-approves-first-deep-sea-mining-test-surprising-observers/.

Haakonssen, K. (2004). *Natural law and enlightenment classics*. Indianapolis: Liberty Fund Inc. Available at: https://scholar.harvard.edu/files/armitage/files/free_sea_ebook.pdf.

Pelton, J. (2021). *Space systems and sustainability*, 10. Switzerland: Springer Press, 167–180.

Reid, H. (2021). Pacific island of Nauru sets two-year deadline for U.N. deep-sea mining rules. Available at: https://www.reuters.com/business/environment/pacific-island-nauru-sets-two-year-deadline-deep-sea-mining-rules-2021-06-29/.

Schiff, J. S. (2017). *The evolution of Rhine river governance: historical lessons for modern transboundary water management*, 279–294. doi:10.1007/s12685-017-0192-3

Schrijver, N. (1997). *Sovereignty over natural resources: balancing rights and duties*. Cambridge: Cambridge University Press, 219–220.

United Nations (1979). Agreement governing the activities of states on the Moon and other celestial bodies, 1363 UNTS 3, (entered into force 11 July 1984) [Moon Agreement].

United Nations General Assembly (2018). "Report of the Secretary General - gaps in international environmental law and environment-related instruments: towards a global pact for the environment", UN Doc. A/73/419.

UN System Task Team on the Post 2015 UN Development Agenda (2013). Global governance and governance of the global commons in the global partnership for development beyond 2015. Available at: https://www.un.org/en/development/desa/policy/untaskteam_undf/thinkpieces/24_thinkpiece_global_governance.pdf?ref=tftc.io.