



## Space resource activities and the evolution of international space law

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### ABSTRACT

We are experiencing a period of renewed interest in human activities in outer space and, in particular, the return of humans to the Moon. Multiple lunar missions, including the NASA led Artemis project and the China and Russia International Lunar Research Station propose a sustained human presence on the Moon which will require in-situ resource extraction and usage. This article explores the likely impact of statements and actions by states on the future evolution of international space law in relation to space resource activities, highlighting the urgent need for greater clarity in the law regarding space resource activities. It will examine the relevant international law, domestic legislation, multilateral agreements, and recent international discussions concerning space resource activities. It concludes that the current international space law regime lacks clear laws regarding space resource activities and emphasises the importance of space law evolving in order to progress with industry and exploration.

### 1. Introduction

Recent years have witnessed an increasing interest in human activities in outer space, including crewed missions to the Moon and beyond. In 2019, China and Russia both launched uncrewed lunar missions as a step towards crewed missions [1] and, in 2021, announced plans to establish a permanently inhabited base on the Moon, formally inviting other states and international organisations to become involved in the International Lunar Research Station (ILRS) [2]. The ILRS will focus on projects such as utilising in-situ resources, extracting minerals and water, manufacturing various products, and identifying the effects of low gravity on human biology [3]. The project is similar to the Artemis program of the National Aeronautics and Space Administration (NASA) announced in 2020 [4], which includes the Gateway, Human Landing System, Orion crew capsule, Space Launch System, Commercial Lunar Payload Services, Extravehicular Activity and Human Surface Mobility program, and an inhabited lunar base [5]. The Artemis 1 uncrewed mission was successfully undertaken in November–December 2022 to test the operation of the Space Launch System and the Orion capsule. The Artemis program is a multilateral project between national space agencies but is extensively reliant upon engagement with commercial partners [6]. Despite their common aims, there is a noticeable lack of coordination between the ILRS and Artemis missions, raising the

question of how to ensure peaceful cohabitation, the operation of multiple competing and complementary activities and the effective regulation of such activities on the Moon and other celestial bodies [7]. In particular, these missions will rely upon the extraction and use of local materials, generating a focus on the legal framework applicable to activities related to space resources.

The commitment and investment of multiple space agencies and private space companies in missions to expand human space activities to the Moon and beyond reflect a major shift away from the focus on activities in low Earth orbit of the past few decades. To date, the most successful collaborative human space activity is the International Space Station (ISS), which operates pursuant to the International Space Station Intergovernmental Agreement supported by four Memoranda of Understanding between NASA, the European Space Agency, the Canadian Space Agency, Roscosmos and the Japanese Space Agency [8]. The success of this endeavour demonstrates that cooperation between competing states is possible in the space domain and even suggests that such complex projects can only succeed on the basis of multi-partner cooperation. The complex set of operating agreements also indicates that clear rules of cooperation are required to proactively address potential conflicts and uncertainties regarding access to, and activities undertaken on, the ISS. However, such agreements of course, only bind the parties to those agreements, and not states generally. Although there are ongoing uncertainties regarding how long the United States (US) and

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### Abbreviations

ILRS	International Lunar Research Station
ISS	International Space Station
NASA	National Aeronautics and Space Administration
UNCOPUOS	United Nations Committee on the Peaceful Uses of Outer Space

Russia will continue to support the ISS, it is clear that their efforts are now directed to missions to the Moon.

A sustained presence on the Moon will be reliant upon quite different resources from the life support systems required by crewed space stations in low Earth orbit. The average mission time from Earth to the ISS is 6 hours, whereas the flight time to the Moon is approximately 3 days, assuming that a suitable launch vehicle is fuelled and ready to launch. Hence, with respect to matters such as food, fuel and water supplies, the crew will need to be less immediately reliant on resupply missions from Earth. Further, if the Moon is to be used as a launching point for further exploration of the solar system, such as a forward mission to Mars, Moon resources could be utilised to provide both fuel and water, generating a need for resource extraction expertise and capability.

Therefore, the dominant purpose of space resource extraction activities is to produce consumables for space missions and space settlements [9]. Such consumables include rocket propellants, reactants for energy production, life support gases and materials for manufacturing spare parts or planetary surface infrastructure [9]. The key resources currently focused on are volatiles, such as hydrogen, helium, and water oxygen [10]. More broadly, minerals and other indigenous resources may also be the focus of resource extraction. By utilising resources in space, the mass launched from Earth for missions could be significantly reduced, which would result in significant monetary savings [10]. Notably, extracting resources in space to be returned to Earth is not financially viable at present [11].

The current international legal framework for space activities does not specifically address space resource activities. The foundational space law treaty that governs space activities, namely the *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies* ('Outer Space Treaty'), pursuant to Article VI, applies to all space activities, regardless of whether they are conducted by a government space agency or a private actor [12]. The *Outer Space Treaty* does not explicitly permit or prohibit space resource activities, although such activities would clearly fall within the scope of 'exploration and use' permitted by Article I. The *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies* ('Moon Agreement') explicitly addresses these activities but is only binding on its 18 State Parties and is not reflective of customary international law [13]. Given the uncertainty regarding the regulation of space resource activities in existing international space law, states have forged a path ahead by enacting domestic legislation regarding space resources and by entering into bilateral agreements with other states that address space resources, such as the Artemis Accords [14].

This article explores the likely impact of actions by states on the future evolution of international space law in relation to space resource activities and highlights the urgent need for greater clarity in the law. It will examine the relevant international law, domestic legislation, multilateral agreements, and recent international discussions concerning space resource activities. It will conclude that the current international space law regime is absent of clear laws regarding space resource activities and emphasise the importance of space law evolving in order to progress with industry and exploration.

## 2. International space law framework

The primary and most significant treaty in the international space law framework is the *Outer Space Treaty*. This treaty is supplemented by the *Rescue and Return Agreement* [15], the *Liability Convention* [16], the *Registration Convention* [17] and, for its 18 State Parties, the *Moon Agreement* [13]. These subsequent treaties all build upon obligations in the *Outer Space Treaty*, which has 112 ratifications and 23 signatories as at November 2022 [18], including all major spacefaring states. This treaty includes fundamental principles governing space activities, including the principle of non-appropriation in Article II which is generally accepted to be reflective of customary international law. The *Outer Space Treaty* was negotiated and entered into force during the height of the Cold War, in the context of the threat of the use and placement of nuclear weapons in outer space. The origins of the *Outer Space Treaty* account for its focus on ensuring transparency, cooperation and equal access to outer space. While the principles this treaty contains provide a strong foundation for space resource activities, detailed rules governing the specifics of such activities are lacking.

Space resource activities are a 'use' of outer space, which is permitted by Article I of the *Outer Space Treaty*. Article I explicitly permits state parties to use 'outer space, including the Moon and other celestial bodies' [12], which would encompass space resource activities such as in-situ resource utilisation. Whilst this explicitly encompasses 'use' in space of resources such as fuel, oxygen or water, it most likely also includes resource extraction for use on Earth (once this becomes viable). It is envisaged that the use of resources extracted in space may have consequent benefits for the Earth's environment, both in terms of reducing the amount of energy needed to send additional resources to space for use in situ (given they can be extracted and used in space) and also for possible uses on Earth [19]. Article I also states that such exploration and use 'shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development' [12]. How such principles may be fulfilled remain unclear and a potential source of tension, although there are some examples of practices which may be interpreted as giving them effect, for example, by the sharing of samples returned from the Moon.

The greatest challenge for space resource activities is the principle of non-appropriation in Article II of the *Outer Space Treaty*, which provides that '[o]uter space, including the Moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means' [12]. This prohibition applies to both governmental space resource activities and commercial ones. The non-appropriation principle is also reiterated in Article 11(2) of the *Moon Agreement* [13]. It is debated whether a distinction can be drawn between the appropriation of a celestial body as a whole, and the appropriation of resources that have been extracted from it [20–22]. If such a distinction can be drawn, which is by no means settled at law, the principle of non-appropriation would prohibit only the appropriation of a celestial body as a whole. This interpretation of the principle of non-appropriation would have a significant impact on the commercial viability of space resource activities.

Article III of the *Outer Space Treaty* requires state parties to 'carry on activities in the exploration and use of outer space, including the Moon and other celestial bodies, in accordance with international law' [12]. Hence, there is no legal vacuum, and states cannot simply undertake resource extraction activities without regard to international law. Certainly, it is imperative that in undertaking such activities states (and their respective civil and commercial entities) act within the letter and the spirit of the *Outer Space Treaty*. In particular, it has been argued that this approach is crucial to avoid a situation such as the 'tragedy of the commons' in relation to resource extraction activities, which would occur when individuals (or states) choose to act in their own interest with respect to a shared common pool of resources, leading to the premature depletion, destruction or environmental degradation of that resource [23].

The two key principles in regard to resource extraction activities are those of authorisation and continuing supervision. These are found in Article VI of the *Outer Space Treaty* [12], which states that:

States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the Moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the Moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty.

Therefore, states are required to give official permission or approval to, and monitor, in some cyclical pattern, the activities of non-governmental entities in outer space in order to ensure that these entities are complying with the *Outer Space Treaty* [24]. In relation to resource extraction activities, commercial actors would require a state's official permission to undertake such activities. Furthermore, the state must then continuously monitor these activities. However, the obligations imposed by a state on these commercial actors would likely not be burdensome [24].

Article IX of the *Outer Space Treaty* requires states to give 'due regard to the corresponding interests' of other states [12]. In the context of space resource activities, this would require consideration during mission planning of how the proposed activities may affect the space activities of other states. Article IX also requires state parties to engage in consultations prior to undertaking any space activities that might create 'harmful interference' with those of other states. While there is very little practice of states undertaking consultations, even in the context of debris-causing activities, the obligation to avoid harmful interference and engage in consultations may provide a good foundation for the development of laws specific to space resource activities where there may be competition over the same resources and extraction activities taking place in close proximity.

The 18 state parties to the *Moon Agreement* must fulfill additional obligations specifically related to space resource activities. Article 11(1) of the *Moon Agreement* states that 'the moon and its natural resources are the common heritage of [hu]mankind' [13]. Significantly, Article 11(3) of this treaty provides that:

Neither the surface nor the subsurface of the moon, nor any part thereof or natural resources in place, shall become property of any State, international intergovernmental organization, national organization or non-governmental entity or of any natural person [13].

Article 11(5) provides that state parties 'undertake to establish an international regime, including appropriate procedures, to govern the exploitation of the natural resources of the moon as such exploitation is about to become feasible' [13]. According to Article 11(7), the main purposes of this international regime include 'the orderly and safe development of the natural resources of the moon, the rational management of those resources, [and] the expansion of opportunities in those resources' [13]. Furthermore, another main purpose is:

an equitable sharing by all State Parties in the benefits derived from those resources, whereby the interests and needs of the developing countries, as well as the efforts of those countries which have contributed either directly or indirectly to the exploration of the moon, shall be given special consideration [13].

It is clear that the *Moon Agreement* is not reflective of customary international law and applies only to its state parties [25]. This view has been expressed most recently by the US in the context of the Artemis Accords [14]. In 2020, the US 'Executive Order on Encouraging International Support for the Recovery and Use of Space Resources' clearly stated that [26]:

[T]he United States does not consider the Moon Agreement to be an effective or necessary instrument to guide nation states regarding the promotion of commercial participation in the long-term exploration, scientific discovery, and use of the Moon, Mars, or other celestial bodies. Accordingly, the Secretary of State shall object to any attempt by any other state or international organization to treat the Moon Agreement as reflecting or otherwise expressing customary international law.

Whilst the accompanying White House statement affirms the position that this Executive Order addresses 'US policy regarding the recovery and use of resources in outer space' it reaffirms the position that the US will object to 'any attempt to treat the 1979 Moon Agreement as expressing customary international law' [27]. The US continues to articulate its view that the 'utilisation of space-based resources – including commercial utilisation – is consistent with the four main United Nations space treaties' [28]. Noting that the *Outer Space Treaty* does not provide a 'comprehensive international regime for space resource utilisation activities' the US position is that the Artemis Accords 'form a starting point for the US Government's future work on space resources' [28].

For states such as Australia that are party to the *Moon Agreement* and also the Artemis Accords, this may result in a need to reconcile the extent to which Australia can be involved in Artemis missions that include space resource activities, in the absence of any international regime governing the exploitation of space resources. Australia has, in a statement in June 2021 to the Legal Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS), expressed that its position is 'that the Artemis Accords are consistent with Australia's international legal obligations' [29]. The statement goes on to confirm that Australia supports the 'further development of norms that could guide the orderly and safe development, as well as rational management of the Moon's natural resources' [29]. Principles such as Section 11 of the Artemis Accords, which deal with the deconfliction of space activities, will bring greater understanding to the meaning of Article IX of the *Outer Space Treaty* concepts such as 'due regard' and 'harmful interference' through the implementation of these principles in practice.

Given the absence of clear laws or guidelines regarding space resource activities in existing international space law, some states have acted to fill this gap by passing domestic legislation, which seeks to provide some clarity, domestically at least, regarding these activities.

### 3. Domestic legislation

As space resource activities have become increasingly more feasible because of technological advances over the past decade, several countries, namely the US (2015) [30], Luxembourg (2017) [31], the United Arab Emirates (UAE, 2019) [32] and Japan (2021) [33], have enacted domestic legislation permitting and regulating space mining activities. Although the US law was initially met with criticism [34,35], this view has changed as more states have enacted similar domestic legislation and discussions at international fora have begun to include the explicit consideration of space resource activities [36]. Because each of the domestic laws governing these activities is expressed to be consistent with that state's obligations under the *Outer Space Treaty*, this is significant state practice for the interpretation of existing space law and may foreshadow the development of international space law specifically governing such activities.

The *Commercial Space Launch Competitiveness Act* was the first domestic law to authorise the exploitation of space resources by private actors. Title IV of the Act, which is entitled 'Space Resource Exploration and Utilisation', contains the key provisions. Section 51302 refers to [30]:

the right of United States citizens to engage in commercial exploration for and commercial recovery of space resources free from

harmful interference, in accordance with the international obligations of the United States and subject to authorization and continuing supervision by the Federal Government.

Section 51303 provides that [30]:

A United States citizen engaged in commercial recovery of an asteroid resource or a space resource under this chapter shall be entitled to any asteroid resource or space resource obtained, including to possess, own, transport, use, and sell the asteroid resource or space resource obtained in accordance with applicable law, including the international obligations of the United States.

It is significant that this law is explicitly expressed to apply to space resources ‘obtained in accordance with applicable law, including the international obligations of the United States’ [30]. This makes the law subject to obligations under the *Outer Space Treaty*, including the principle of non-appropriation. As noted above, the US has a longstanding view that the utilisation of space-based resources, including commercial utilisation, is consistent with international space law and its obligations under the *Outer Space Treaty* [28]. However, this has not been tested in an international forum and considerable debate remains about the interpretation of the principle of non-appropriation and its application to space resource activities.

Luxembourg adopted an approach similar to that of the US in its domestic law. The *Law on the Exploration and Utilisation of Space Resources* explicitly states in Article I that ‘[s]pace resources are capable of being owned’ [31]. The *Federal Law on the Regulation of the Space Sector* (UAE) addresses space resource utilisation, among other issues such as the regulation of facility construction on other planets and the issuance of space activity permits [32]. The Japanese domestic law, the *Space Resources Act*, permits [37]:

Japanese private entities to explore, extract and use various space resources such as water, minerals and other natural resources existing in outer space, including on the Moon and other celestial bodies. Most significantly, the Act allows persons who conduct these activities of exploration and development of space resources to acquire ownership of the space resources that they mine or extract by their activities conducted in accordance with the plan they submitted when obtaining permission.

Greater clarity is needed regarding the application of the principle of non-appropriation to space resource activities. The absence of such clarity creates uncertainty around the legal right to engage commercial space resource utilisation activities [38], which may stifle innovation and dissuade private actors from investing in and undertaking such activities.

#### 4. Multilateral agreements

On 15 May 2020, NASA released the Artemis Accords, which articulate a:

shared vision for principles, grounded in the Outer Space Treaty of 1967, to create a safe and transparent environment which facilitates exploration, science, and commercial activities for all of humanity to enjoy [14].

With 21 signatories as at 9 November 2022, the number of state space agencies that have signed the Accords exceeds the number of state parties to the *Moon Agreement*. The signatories to the Accords are Australia, Bahrain, Brazil, Canada, Columbia, France, Israel, Italy, Japan, the Republic of Korea, Luxembourg, Mexico, New Zealand, Poland, Romania, Saudi Arabia, Singapore, Ukraine, the UAE, the United Kingdom and the US [39]. Thus, the space agencies of all four states with domestic laws permitting space resource activities are signatories to the Accords. Russia initially indicated that it was open to participating in the Artemis program [40] but has since declared that the

Gateway project is too ‘US-centric’ [41]. In contrast, China is excluded from involvement in the Artemis program under the *Wolf Amendment*, which prohibits NASA from collaborating with any Chinese entity that uses government funding without specific Congressional permission [42]. Russia and China are instead pursuing the development of the ILRS.

The principles of the Artemis Accords either consist of existing norms that are broadly repetitive of provisions of the *Outer Space Treaty* or extend well beyond these provisions and attempt to establish new norms of behaviour. These significantly new principles are contained in Sections 5, 9, 10, 11 and 12 of the Artemis Accords. For example, recognising that the development and use of interoperable standards and equipment will enhance the capabilities of a diverse multinational project team, Section 5 prescribes the development and use of ‘interoperable and common exploration infrastructure and standards, including but not limited to fuel storage and delivery systems, landing structures, communications systems, and power systems’ [14]. Section 9 asserts that the signatories intend to preserve outer space heritage and to use their experience under the Accords to contribute to multilateral efforts to further develop international practices and rules that are applicable to the preservation of this heritage [14]. Furthermore, Section 12 states that the signatories are committed to planning for the mitigation of orbital debris and to limiting, to the extent feasible, the generation of new long-lived harmful debris by taking appropriate measures [14]. Examples of such measures include the selection of safe flight profiles, operational configurations and post-mission disposal of space structures [14].

In particular, the principles related to the extraction and utilisation of space resources and the concept of safety zones to ensure the deconfliction of activities extend beyond current international consensus. Section 10(4) of the Accords states [14]:

The Signatories intend to use their experience under the Accords to contribute to multilateral efforts to further develop international practices and rules applicable to the extraction and utilization of space resources, including through ongoing efforts at the COPUOS.

A main way in which the Accords seek to facilitate space resource activities is through the introduction of safety zones, which are expressed as a mechanism consistent with the obligations of due regard that can be used to mitigate against harmful interference [5]. NASA has subsequently acknowledged the importance of promoting these activities in a responsible way [5].

In addition to seeking to drive the evolution of international space law through the Accords, NASA has also initiated space activities to generate new state practice relating to the commercial extraction and sale of space resources. In 2020, NASA entered into contracts with four private companies, Lunar Outpost, ispace Japan, ispace Europe and Masten Space Systems [43], for small amounts of lunar regolith [44]. These proof-of-concept missions will facilitate tests—by both NASA and commercial actors—of technology and work through practical issues and challenges that will arise in the context of the extraction of space resources [28]. The individual collections of lunar regolith will weigh between 50 gm and 500 gm [44], and NASA will pay only a nominal amount in instalments for the extracted and returned lunar regolith [44]. The significance of these contracts lies in the ability of the companies to practise the extraction of resources from the lunar surface and may be the first step in the creation of business and legal norms for developing a market of buyers and sellers of extracted space resources [44]. The procurement arrangements require the successful companies to undertake the performance of their contracts in ‘full compliance with the Registration Convention, Article II, and other provisions of the Outer Space Treaty, as well as in accordance with NASA’s other relevant international obligations’ [43]. Ultimately, the purpose of the project is to test commercial technical capabilities and the appropriate legal mechanisms for the transfer and extraction of materials on the Moon. This will not be the first time that there has been a transfer of ownership over

space resources. NASA has previously given away lunar samples, and lunar samples collected by the Soviet Union have been sold on the private market [28].

In 2021, Lunar Outpost was the first company to be issued a payment under the contract, for 10% of its contract price, which amounted to 10 cents [45]. Both ispace and ispace Europe also received an interim payment under the contract on 22 September 2022 for meeting the interim milestones [46]. Furthermore, ispace has received a license to conduct business activity on the Moon from the Japanese government effective as of 4 November 2022 [47]. The licence was granted under the *Space Resources Act*, which came into force on 23 December 2021 [33]. Article 2(1) of this Act defines ‘space resources’ to be water, minerals and other natural resources that exist in outer space, including the Moon and other celestial bodies [33]. In this regard, ispace will utilise the license to transfer ownership of the lunar regolith to NASA [47]. Further, ispace is planning to launch the HAKUTO-R lander to the Moon on board the SpaceX Falcon 9. The launch was originally scheduled to occur on 28 November 2022 but, at the time of writing, has been postponed to an unknown date [48].

According to Article 3(1) of the *Space Resources Act*, applicants for a licence must provide a business activity plan, which must include the purpose of the proposed exploration and exploitation activity of space resources; the term, location, method and other details of the activity; and other matters specified by the Cabinet ordinance [33]. Pursuant to Article 5 of the *Space Resources Act*, a person who obtains a license will own the space resources that they exploit in accordance with the approved business activity plan [33]. According to Article 3(2) of this Act, a license must not be granted to the applicant unless the Prime Minister determines that the business activity plan complies with the basic principles of the *Basic Space Act*, that the business activity plan is unlikely to cause any adverse effect on the accurate and smooth implementation of the conventions on developing and using outer space and on ensuring public safety, and that the applicant has sufficient capacity to execute the business activity plan [33]. When a license is granted to an applicant, their name, their business activity plan and other matters specified by the Cabinet Office Order must be publicly announced according to Article 4 of the *Space Resources Act* [33].

## 5. International discussions

In 2016, the Legal Subcommittee of the UNCOPUOS included an item entitled ‘General exchange of views on potential legal models for activities in exploration, exploitation, and utilisation of space resources’ in its agenda. No progress was initially made, owing to a divergence in views about space resource activities between delegations, but in 2021, the Legal Subcommittee of UNCOPUOS established a Working Group under the agenda item ‘General exchange of views on potential legal models for activities in the exploration, exploitation and utilisation of space resources’ (renamed in 2022 as the Working Group on Legal Aspects of Space Resource Activities). This Working Group has developed a five-year working plan, to conclude in 2027 with a report of its activities and a set of initial recommended principles for space resource activities for consideration by UNCOPUOS and possible adoption by the United Nations General Assembly as a dedicated resolution or other suitable action [49]. This Working Group has considered many independent initiatives to provide working models for resource extraction and use, which are discussed in this section.

### 5.1. Building Blocks

In 2019, the Hague International Space Resources Governance Working Group, founded in 2016 by Professor Tanja Masson-Zwaan of the International Institute of Air and Space Law at the University of Leiden, released its *Building Blocks for the Development of an International Framework on Space Resource Activities* (‘Building Blocks’) [50]. The *Building Blocks* provide suggested guidelines and recommended

practices for lunar mining and are intended to become the basis of future negotiations for an international legal framework for space resource activities, including the commercial use of space resources. The *Building Blocks* do not form part of international space law in and of themselves but provide a useful perspective for how specific laws governing these activities may develop in the future.

The authors of the *Building Blocks* interpret Article I of the *Outer Space Treaty* to permit space resource activities as a ‘use’ of outer space and suggest that such activities could be undertaken on the basis of priority rights for specific locations for specific periods of time. Section 4 of the *Building Blocks* makes a series of recommendations about how the *Outer Space Treaty* could be implemented in an international lunar mining framework [51]. The *Building Blocks* authors propose that any international framework for space resource activities should:

- remain within the scope of existing international space law (Section 4.1);
- authorise and be responsible for authorised lunar activities (Section 4.2(a));
- promote predictable and compatible domestic regulation of lunar mining by commercial companies (Section 4.2(b));
- promote safety (Section 4.2(e));
- develop lunar mining technology (Section 4.2(g));
- support science (Section 4.2(j));
- be used for peaceful purposes (Section 4.3(a));
- be for the benefit of humankind (Section 4.3(b)); and
- pay due regard to, and engage in, international consultation as required by Article IX of the *Outer Space Treaty* (Section 4.3(c)).

In the *Building Blocks*, it is accepted that entities have the right to use and trade in extracted space resources. Section 8.1 recommends [51]:

The international framework should ensure that resource rights over raw mineral and volatile materials extracted from space resources, as well as products derived therefrom, can lawfully be acquired through domestic legislation, bilateral agreements and/or multilateral agreements.

Section 8 goes on to suggest that states should coordinate their use of celestial bodies in accordance with obligations under Article IX of the *Outer Space Treaty*. Section 10 addresses proactive measures for avoiding and mitigating any potentially harmful effects that emerge from space resource activities and aims for long-term sustainability of space resources [51]. Section 11 addresses the inherent risks of these activities and describes safety zones or other area-based safety measures around an area that is specified for a space resource activity [51]. Section 13 recommends that states and international organisations undertaking these activities should provide benefit sharing through promoting participation by all countries, especially developing nations, in such activities [51].

Luxembourg and the Netherlands submitted the *Building Blocks* to the Legal Subcommittee of UNCOPUOS on 3 February 2020 [52]. The *Building Blocks* can be considered an effort to promote the development of rules for regulating space resource activities through joint action between states within UNCOPUOS. In 2020, the Canadian Outer Space Institute issued an open letter to UNCOPUOS expressing concern about the national and bilateral approaches to these activities and urging the commencement of negotiations for a multilateral agreement on space resource utilisation [53]. These and other statements on behalf of national delegations led to the establishment of the aforementioned Working Group.

### 5.2. Best practices for Sustainable Lunar Activities

In March 2020, the Moon Village Association released for consultation its *Best Practices for Sustainable Lunar Activities*, intended to assist in the facilitation of peaceful settlement on the Moon through the

establishment of best practices for the long-term sustainability of lunar and cislunar activity [54]. Principle 9 states that all space actors should endeavour to [54]:

Establish a publicly available international land use registry (the ‘Land Use Registry’) for registering existing and prospective lunar activities. Each registration should include information regarding (i) the location of the activities, (ii) the nature of the activities, and (iii) the duration of the activities. Ideally, the United Nations would serve as the registrar charged with maintaining the Land Use Registry.

Principle 10 suggests that all space actors should endeavour to ‘register any existing or planned lunar activities and recognize the right of registered lunar activities to be free from harmful interference’ [54]. A revised edition of the *Best Practices* was published on 19 October 2020, following that consultation period [55].

The proposal for a registry builds upon the work of the *Building Blocks* which propose a registry of priority rights with respect to the search for and recovery of space resources. The Moon Village Association proposal goes further, extending registration to all ‘land use’ for lunar activities. Each of these registry proposals is designed to deconflict activities, promoting safety zones and the avoidance of harmful interference. Notably, this registration applies to all users, not just states.

In 2021, the Moon Village Association proposed and hosted the Global Expert Group on Sustainable Lunar Activities, a neutral forum for multi-stakeholder discussion on lunar exploration. The Global Expert Group consists of members and observers who are stakeholders in lunar activities, including representatives from space agencies/governments, international organisations, industry, academia and civil society [56].

As the drafters of these principles note, they contribute to ‘incremental evolution of governance’ but lack an enforcement mechanism [57]. As with other registries, they serve to provide notice to other potential users, but will not prevent rivalries developing over scarce or precious resources. In further developing frameworks based on these principles, it will be necessary to consider the shape and constitution of any oversight authority. Although the Principles suggest that the UN should serve as the Registrar, it is noted that there are existing models and precedents that could be drawn upon from other areas, such as the law of the sea, the International Seabed Authority, the Antarctic Treaty and the International Telecommunications Union [58]. In particular, considerations should also address how registration systems might allocate rights in accordance with Article I of the *Outer Space Treaty*, ‘for the benefit and in the interests of all countries’ [12]. Does this mean that registries should be required to operate on an equitable resource sharing basis or simply according to first come-first served? Bohacek et al. argue that there may be an opportunity to use the common benefit requirement to ‘gain global legitimacy and acceptance of commercial activities’ [59] and hence protect their investment. This could be achieved not through the simple division of resources, but by contributing access to relevant space resources such as access to satellites to address disasters and climate change, to manage space debris or to provide communication. Identification of relevant services could be managed under the UN Sustainable Development Goals as reflected in the Space 2030 Agenda, and would provide the resources developer with a Social Licence to Operate [59]. This proactive approach provides a practical response to the uncertainty of the application of Article I of the *Outer Space Treaty*.

### 5.3. Working Group on Space Resource Activities

In 2021, UNCOPUOS noted the dangers of the unilateral regulation of space resource activities and the advantages of international regulation for ensuring compliance with obligations under the *Outer Space Treaty* [60]. Further, in 2021, the UNCOPUOS Legal Subcommittee established the Working Group on Space Resource Activities under the agenda item on the general exchange of views on potential legal models for activities in the exploration, exploitation and utilisation of space resources [61]. During debates about the creation of the Working Group,

the US observed that the use of space resources is critical to the long-term viability of space activities and stated:

The four core space treaties provide a basic legal framework within which States can ensure that their interests will be protected for the initial technology demonstration missions that are required before widespread space resource utilisation activities can occur [28].

The Russian Federation supported the creation of the Working Group, noting that any ‘activity that is related to the exploration, exploitation and utilisation of space resources must be based on a clear legal framework which is widely recognized on a global level’ [62]. The Group of 77 and China argued that it is urgent to consider domestic laws ‘allowing for the exploitation of celestial bodies for economic purposes’ in light of international space law ‘in order to avoid contradictions or gaps within the legal framework in this area and in order to provide a clear understanding of the legal obligations of States in space exploration’ [63]. Luxembourg noted:

The Artemis Accords, in combination with initiatives like the Hague International Space Resources Governance Working Group and the group of experts of the Moon Village Association, will lead to valuable knowledge sharing and better technical understanding of key issues, which will in turn advance progress and discussion at the United Nations [64].

Submissions made to the Working Group on Space Resource Activities as at the date of writing have come from a range of states, non-government organisations and other interested parties. The Space Generation Advisory Council submitted a report, the *Effective and Adaptive Governance for a Lunar Ecosystem (‘E.A.G.L.E.’) Lunar Governance Report*, on 27 May 2021 [65]. The report argued that any lunar governance regime should be ‘based on four components: fairness, effectiveness, adaptiveness and sustainability’ [65] and advocated for the development of ‘a Lunar Governance Charter as a shared narrative that could frame the global debate on lunar governance within pragmatic but also idealistic terms’ [65]. On the same date, the Moon Village Association submitted its report on the Global Expert Group on Sustainable Lunar Activities [66]. The report noted that the:

current lack of coordination mechanisms for lunar activities presents challenges to future missions and could lead to unintentional harmful interference, especially in light of the increased global interest in specific areas like the lunar south pole [66].

All submissions made to the Working Group noted the importance of, and need for, international regulation of space resource activities. As noted above, the Workplan of this group extends to 2027. During this time, it is likely that more states will enact domestic laws and plan more missions dedicated to resource extraction. It is notable that such missions, being robotic, may readily predate any return of humans to the Moon, and hence, the timeframe is tighter than it may appear in the broader context of the Artemis missions.

## 6. Conclusion

Recent developments in domestic legislation and bilateral agreements have indicated a desire from states for freedom to engage in space resource extraction and utilisation for commercial gain. The current international space law regime contains gaps in relation to space resource activities and needs to evolve in order to keep pace with industry. Any international legal framework for such activities will need to ensure that an appropriate balance is struck between commercial interests, the security of the space domain and the preservation of space for all of humanity.

At this stage, it appears that international coordination for space resource utilisation is unlikely to take the form of a binding treaty [67]. Rather, multilateral coordination may take the form of agreements in the style of the Artemis Accords, whereby states are able to develop

practice that supports their interpretation of the principles of the *Outer Space Treaty*. Furthermore, the differences between the categories of resources in space and the consequent differences in the manner of how these resources are to be utilised means that a single regime is unlikely to be applicable to all types of space resources [67].

The US, Luxembourg, the UAE and Japan have all enacted domestic legislation permitting and regulating resource extraction activities in outer space. For example, ispace will utilise a license granted by the Japanese government in order to transfer the ownership of lunar regolith to NASA. Initiatives such as NASA's lunar regolith contracts will lead to the technical capabilities and the legal mechanisms for resource extraction activities in outer space being tested. Ultimately, greater certainty regarding the legal framework for resource extraction activities is required. This is particularly pressing, given that competition for in-situ resources and desirable locations on the Moon may spark disputes between commercial operators and states alike.

Although it is by no means certain that these various domestic space resource laws and multilateral agreements will result in the creation of new rules of customary international law, given the high threshold for crystallisation of customary international law, they will continue to evolve and impact the evolution of international space law [68]. In the absence of clear, binding laws, these developments create the possibility of conflict. That conflict may be over suitable sites and scarce resources. However, it may also reflect social and civil discontent between states over resource sharing. It is therefore important that further international consensus building efforts relating to space resource activities seizes the opportunity to make space a model for sustainability, accountability and security [19]. Such principles should address how such resources may be extracted, used and developed in accordance with the aspirations of the *Outer Space Treaty*, including the potential for benefit sharing and for profit activities [69]. In this way, space resource extraction and use has the potential to promote the space resources sector as an opportunity not only for profit, but for the greater benefit of humanity [59].

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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