Managing the Resource Revolution: Space Law in the New Space Age

Book Section

10. Managing the Resource Revolution: Space Law in the New Space Age

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10.1 Introduction

The rise of human space activity has seen a number of risks and challenges develop from current technology and engineering capabilities. The emergence of human made, orbital debris and the risks posed by state and extremist group violence are all indicative of the new frontiers of risk that are opening up due to a significant expansion in private and state-based space capabilities. One area of risk yet to manifest itself, but one which is clearly in the contemplation of both policy makers and strategists comes from an area yet to see any space activity; that of the mining and exploitation of celestial bodies, such as the Moon and Near-Earth Objects (NEOs). Unlike other areas of human space activity, the risks at this stage are purely speculative, given that the necessary technological infrastructure does not yet exist to even begin exploratory mining ventures.

The chapter will investigate this new frontier of risk and explore how the mere prospect of asteroid mining threatens to unbalance the current legal and political cooperation that regulates space activity. In many respects, this chapter will be diametrically opposed to other inquiries into the viability of space mining. Traditional treatises on space mining tend to brim with optimism on the untold riches of space that are just waiting to be claimed once the technology is ready. This discussion, however, will seek to emphasise the prosaic, terrestrial difficulties that any new

space mining enterprise faces. The lack of legal certainty over property mined in outer space means that investors are hesitant to invest large sums of capital where there is no guarantee that minerals would be freely tradeable. This lack of investment inhibits research and development activity and makes the prospect of space mining ever more distant. Without a certain and internationally legitimate legal framework, investment in space mining is likely to stagnate and attempts to unilaterally legislate have already caused international tension and pose a serious risk to the stability of space governance.

The discussion will start by exploring why space mining poses such a challenge to current space law and policy. It will identify the potential riches and outline the numerous commercial actors that are actively engaged in exploring asteroid. There will then be an assessment of the technical issues that have emerged and need to be addressed before any significant commercially viable enterprises can be established. Following on from this, the aforementioned legal and policy regime will be critically examined. At present, it is the legal and regulatory, not the technical, difficulties regarding the distribution and ownership of the mined resources that present the clearest danger to stable and sustainable space activity. Any discussion of future space mining ventures overlooks these issues at its peril.

By focusing on the legal and policy debates, the chapter will forsake speculation as to the infrastructure and engineering solutions that have yet to be truly conceptualized, let alone developed into working systems. Indeed, it is something of a paradox, that the biggest risk posed by this future space activity is to cooperation and governance arrangements in the present day. The fracturing of this consensus, over disputes as to how to allocate and manage resources, could

place at risk the creation of the very infrastructure that would be needed to facilitate asteroid mining. This chapter will ultimately evaluate both the causes for pessimism and optimism in this area and attempt to outline the way in which the legal risks can be mitigated and projecting policy solutions to foster a resource utilization regime accepted by all stakeholders.

10.2 Space mining in context

The economic case for investing in asteroid mining at first sight appears to be a compelling one. It would appear that there are substantial amounts of precious and valuable metals in asteroids scattered throughout the solar system. It has been suggested that Amun, a fairly small NEO with a mass of approximately 30 billion tons, contains approximately $8,000 billion in iron and nickel, $6,000 billion in cobalt and $8,000 billion in platinum group metals. Similar estimates have projected that the asteroid belt also contains about four billion tons of uranium (Lewis, 1997). Whilst the Moon and other planets may have even more lucrative resources, asteroids, and in particular NEOs, have the added lure of being "the most easily reachable bodies within the entire solar system." There are estimated to be 20,000 NEOs larger than 100m diameter, all capable of being mined in the near future, given sufficient investment (Di Martino et al, 2009 at p. 195)

As well as their relative convenience and abundance of minerals, another aspect of asteroids and NEOs that makes them attractive propositions for mining ventures is the potential to utilize water which is present on such bodies (Lewis, 2015). Water is a valuable commodity in space; it can be used for drinking, bathing and cleaning but it can also be used to make air and rocket fuel. As it

costs $20,000 to put a typical 500ml bottle of water into orbit it would be vastly more efficient and cost effective to use a space-based source of water rather than rely on a supply from Earth (Shepard, 2015). Asteroid mining for water ice is technologically feasible and would be achievable using established technology (Lewis, 1999).

The production of fuel in space would be of interest to a number of stakeholders in the space sector. First, the mining industry itself would more quickly be able to become self-sustaining by employing such in-situ resource utilization. Additionally, on-orbit servicing is, much like the space mining sector, a developing and embryonic industry which would greatly benefit from a comparatively cheap source of fuel (Henry, 2017). Finally, established space companies such as the United Launch Alliance (ULA) have indicated that they would be willing to pay $3,000 for a kilogram of propellent delivered to Low Earth Orbit (David, 2016). This projection fits well with the assessment made by Lewis, that delivery to Earth orbit for less than $10,000 per kilogram would be competitive with Earth launched material (Lewis, 1999 at p. 113). In the future, it is not difficult to envisage the creation of a series of space-based ‘filling stations’ processing locally sourced water and facilitating travel into the solar system.

10.2.2 Nascent Space Mining Industry

Even discounting the lucrative mineral deposits, the exploitation of asteroids and NEOs as part of a wider infrastructure to support deep space exploration becomes a very attractive proposition. In respect of convenience and accessibility, the Moon is also attracting the attention of commercial enterprises. Moon Express and iSpace are both companies that have invested in

research and development of technology capable of exploiting lunar resources. Those advocating for the exploitation of the Moon have tended to focus on the presence of helium-3, an extremely rare isotope on Earth that has potential to be a fuel source for fusion reactors (Bilder, 2009-10). The utility of helium-3 mining is, however, contingent upon that technology becoming viable for widespread usage and at present this prospect is somewhat remote (Newman, 2015 at p.31). There are, however, other materials, such as rare earth metals and water ice that make the Moon of interest to developers. This is especially the case if the resources were in support of a manufacturing or servicing industry in low earth orbit, supporting lunar bases and/or a developing cis-lunar economy (David, 2015). At present, such discussions may seem somewhat far-fetched, yet the proposals for a Moon village from ESA and commercial 'space hotels' from Bigelow Aerospace illustrate that such ideas could soon emerge as serious propositions.

Given the apparent abundance of minerals and the ability to use in-situ materials to obtain these resources, it was inevitable that companies would emerge and try to exploit these opportunities. Two companies, Planetary Resources and Deep Space Industries, announced their intentions to commence commercial asteroid mining within the near future in April 2012 and January 2013, respectively. Their proposals utilize current technology and their business plans, while ambitious, do lay out a convincing method of creating a profitable enterprise (Foust 2012). So convincing were their proposals that they have successfully garnered support from the government of Luxembourg. In both the United States and Luxembourg this support has also been backed by legislation. The United States has Title IV of the US Commercial Space Launch Competitiveness Act[1] and Luxembourg, the Law on the Exploration and Use of Space

[1] Available at https://www.congress.gov/114/plaws/publ90/PLAW-114publ90.pdf

Resources.[2] Both the American and Luxembourg laws are drafted so as to be able to cover space mining of any and all celestial bodies, the focus is on resources not the 'territory' they are found on or in and as such could apply to the Moon or Asteroids alike.

10.2.2 Introducing the Legal Dimension of Space Mining

There are significant legal and policy issues that need to be addressed if (to paraphrase one headline) space mining is to take a giant leap from science fiction to science fact (Cookson, 2017). The promulgation of national legislation creating a process for the authorization of space mining has prompted discussion at the international level, particularly the Legal Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), where it has been discussed at both the 2016 and 2017 sessions and is on the agenda for the 2018 session as well. It has also been the focus of The Hague Space Resources Governance Working Group, a multinational, interdisciplinary group comprised of experts and other stakeholders. The Hague Working Group has at the conclusion of Phase One of their work released a set of 'Draft Building Blocks for the Development of an International Framework on Space Resource Activities'. This seeks to initiate discussion about creating an international consensus for the governance of space resource activities.

Despite the promulgation of these national laws and discussions on an international level, there are significant legal obstacles preventing the establishment of a broad consensus at the present time. These will be considered in some detail later on. The discussion will, at first instance turn

[2] Available at http://data.legilux.public.lu/file/eli-etat-leg-loi-2017-07-20-a674-jo-fr-pdf.pdf

to consider the technical and engineering aspects of space mining. The technology is developing as the industry is developing, with investment and R&D looking to overcome the formidable challenges facing those who seek to create the necessary infrastructure. Consideration of the technical difficulties will help place the legal and policy solutions in context, and assist in the broader aim of creating a robust and enduring governance framework.

10.3 The technical aspect of Space Mining

It is axiomatic to say that the space mining industry is still in the early phases of its development. It has yet to engage in rudimentary operational testing, much less conduct mining activity. The developmental nature of the hardware means that the final picture of how space mining will be technically accomplished is still unclear. Additionally, understanding of the actual makeup of celestial bodies is limited. Sample return missions have been conducted, with the USA, the Soviet Union and Japan having all returned samples from celestial bodies to Earth, primarily the moon but also asteroids and comets (Willis, 2016). This means that there exists some experience with extracting material from celestial bodies and returning them to Earth, however it is a weak foundation upon which to establish a regulatory regime.

10.3.1 The Composition of Celestial Bodies

One of the major issues facing the space mining industry is the lack of scientific knowledge of the makeup of asteroids and comets. This was partially demonstrated by the *Rosetta* mission which required multiple forms of landing methods because the mission planners really had no

idea what they would find (see for example the recent Rosetta mission). Furthermore the actual make up of asteroids and comets could pose an obstacle to commercial mining operations. The current knowledge base is limited for a foundation upon which to base commercial operational planning. The accuracy of astronomical observations needs to improve in order to be useful for commercial operations, the current standard of accuracy is poor, which doesn't matter for scientific endeavors but would be a big problem for commercial operations who will not want to waste time or money on exploration of non-commercially viable objects (Elvis, 2013) Current "optical-near-infrared spectra can only tell us the mineral content of the asteroid's surface" though for most, if not all asteroids, surface content should be representative of the whole object (Elvis, 2013 at p. 91). Spectrometric observations are not reliable to a commercial standard, for example, M-class asteroids were thought to be primarily Iron (Fe) and Nickel (Ni) but it turns out that they have much more silicate content than was thought (Granvick, 2013 at p. 151).

This shortfall in scientific knowledge has consequences for any potential legal categorization of celestial bodies too. Asteroids are defined by their composition not their size and the current state of understating of their composition makes it unwise to use the existing knowledge bases for the establishment of a legal categorization system. Additionally astronomical terms themselves are vague and "any small sized body orbiting the Sun could be defined an asteroid." (Di Martino et al, 2009 at p. 72) The difference between asteroids and comets is not only somewhat vague but transitory, as over time comets have their volatiles 'baked off' and come to resemble asteroid like objects (Di Martino et al, 2009 at p.73). While it is true that there are thousands of Near Earth Objects (NEOs) larger than 100m diameter and vast numbers of even smaller NEOs however it may prove to be a challenge to find commercially viable asteroids as it is necessary to

find materials that are commercially viable to mine. Indeed, it could be that "finding suitable asteroids to mine could well be the bottleneck to developing asteroid resources." (Elvis, 2013).

In summary, and as previously identified, there is still a substantial amount of research and development to undertake on the hardware and yet further scientific discovery as to the nature of celestial bodies before space mining can move beyond this nascent phase of planning and into actual space activity. These technical difficulties may well be overcome, given sufficient investment and attention. Having considered these areas, the discussion will move on to consider in more depth the legal and policy problems regarding ownership and regulation of mining. In order to fully appreciate the depth of these difficulties and the risk posed to wider cooperation in space, it is necessary to understand the origins of the laws governing space activity. Consideration of the foundations of the existing legal framework with special regards to property ownership in space will illustrate the conceptual and attitudinal shift required in order to create a meaningful set of property rights for the fruits of space mining.

10.4 The existing legal framework for outer space activity

At first sight, it may seem somewhat hyperbolic to talk about the legality of property ownership as being a significant barrier to the establishment of an economically viable space mining industry. Yet, one of the underpinning precepts of international space law was that outer space and celestial bodies should not be subject to claims of ownership or sovereignty. This provision arose due to the conflict of the cold war, the backdrop against which space law was formed (Blount, 2012). Yet despite the changing geopolitical situation, the resulting treaty, known

colloquially as the Outer Space Treaty 1967 remains the cornerstone of the international space law regime. There are additional treaties, such as the Moon Agreement[3], which also has relevance for the topic of space mining, UN General Assembly resolutions, customary international law and so-called 'soft law' instruments which expand upon and develop the principles outlined in the Outer Space Treaty. Yet it is the 1967 Treaty which remains the focal point and has been described as the 'constitution' of outer space (Gangle, 2009 at p.52) It enjoys virtually universal recognition having been ratified by 104 states and signed by a further 25 including all the space capable states. Many of the provisions of the Outer Space Treaty may well be considered to be customary international law, most specifically Articles I-IV and VI. An argument can be made for the rest of the provisions of the treaty having also achieved that status, given its broad acceptance (Larsen, 2014 at p.289)

10.4.1 The Outer Space Treaty and Space Mining

Regarding space mining, the key provisions of the Outer Space Treaty are Articles I-III and VI. Articles I and II are often read together and are certainly complimentary (Lyall & Larsen, 2009, at p. 180). Art I is a statement of the basic principle of the freedom of exploration, access and use of outer space for all countries. Art II of the Outer Space Treaty codifies the non-appropriation principle that was established in UN General Assembly resolution 1721.[4] It establishes that "outer space, including the Moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means".

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[3]Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (adopted 18 December 1979, entered into force 11 July 1984) 1363 UNTS 3 (Moon Agreement/MA)
[4]UNGA Res 1721 (20 December 1961) UN Doc A/RES/1721 (XVI), A1(b)

This was one of the earliest and most widely agreed principles of space law (Freeland and Jakhu, 2009). Articles I and II work in conjunction and are what make space *res communis* (a thing belonging to the entire community) rather than *res nullius* (belonging to no one). Article III of the Outer Space Treaty establishes that there is the rule of law in outer space and declares that space activities shall be carried out in accordance with international law "including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international cooperation and understanding".

If the first five articles of the 1967 treaty can be said to establish broad behavioral norms, Articles VI, VII and VIII of the Outer Space Treaty lays down the contours of state responsibility. Article VII establishes state liability for damage caused by space objects and Art VIII provides that on-going jurisdiction and control of space vehicles and personnel remains with the state on whose registry the craft is carried. Most crucially for space mining, Article VI articulates the key principle that states are responsible for the actions of their nationals in outer space.

Under Art VI, Governments are required to authorize and continually supervise their own national space activities. This is usually achieved by the enactment of primary national space legislation such as the UK's Outer Space Act 1986 or Australia's Space Activities Act 1998. It is through Article VI of the Outer Space Treaty that the non-appropriation principle found in Article II of the Outer Space Treaty can be said to apply to corporations and natural persons (referred to in the treaty as non-governmental entities) as well as states themselves (Tronchetti, 2015).

10.4.2 The Moon Treaty in context

There are several other main space treaties however beyond the Outer Space Treaty that which is most relevant for this discussion is the Moon Agreement. The Moon Agreement is generally regarded as being a 'failed treaty' (von der Dunk, 2012) due to its low uptake of 17 ratifications and 4 signatures.[5] It has, nonetheless, achieved the requisite number of ratifications under the UN rules, it is a valid, active treaty and indeed it is still gaining new parties; Venezuela became a party to the treaty as recently as November 2016.[6] For the most part the Moon Agreement replicates the Outer Space Treaty, however regarding the topic of space mining it is Art 11 that is most relevant. Art 11 largely expands upon the provisions of Art II of the Outer Space Treaty. However, Art 11, (1) declares that "the Moon and its natural resources are the common heritage of mankind", this is the infamous 'common heritage of mankind' principle that can also be found as a distinct concept in the Law of the Sea Convention (UNCLOS)[7]. Accompanying this, is the provision in Art 11(5) of the Moon Agreement for the establishment of an international regime to "govern the exploitation of the natural resources of the Moon…" and the provision in Art 11(7)(d) for "an equitable sharing by all States Parties in the benefits derived from those resources…". This common heritage principle has attracted significant criticism in respect of both uncertainty of its scope (Jakhu, 2005) and the different interpretations that could be placed on the management of resources by individual states (Tronchetti, 2015).

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[5]http://www.unoosa.org/documents/pdf/spacelaw/treatystatus/AC105_C2_2017_CRP07E.pdf
[6]UNOOSA, 'Accession by Venezuela (Bolivarian Republic of) to the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies' (3 November 2016) UN Doc C.N.829.2016.TREATIES-XXIV.2 (Depositary Notification)
[7]http://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf, Art 136

The basic legal framework governing space activities has remained largely unaltered from the cold war era. The Outer Space Treaty sought to preserve peace in space, as was its primary purpose. Issues such as space mining were, however not within the sensible contemplation of the drafters of the treaty, preoccupied as they were with the race to the Moon. Nonetheless, the principles which found their expression in the 1967 treaty have become normative values, accepted by all members of the spacefaring community. This, however, causes significant problems for space mining in three key respects. First, Art I and II of the Outer Space Treaty have placed a significant question mark over whether space resources can ever be 'owned'. Second, Art VI means that states are responsible for ensuring all of their national space activity is compliant with the treaty and authorizing space mining in a way which is compliant with Art II is extremely problematic. Finally, the inclusion of Art 11 is undoubtedly the reason why the Moon Treaty has not received broader acceptance and remains largely ignored by spacefaring nations. Yet Art 11 of the 1979 Treaty was, perhaps, the best chance of establishing an international consensus on the way in which space resources could be administered and managed. Having outlined these basic principles of space law, the discussion will now directly address the legality of space mining.

10.5 The legality of space mining

This question of whether space mining is permitted under the existing treaty regime has gained significant traction as more companies, looking for investment, seek a more certain legal framework upon which to base their plans. As stated, Art II prohibits states from owning territory on the Moon or any of the planets or celestial bodies, this is a broad prohibition on

appropriation which applies to their nationals and bodies corporate via Article VI of the Treaty. It is not clear whether this prohibition extends to natural resources contained on or in these celestial bodies and the Treaty is silent on this aspect. On a strict reading of the terms of the treaty, it has been argued that Art II does indeed prohibit such exploitation and that natural resources cannot, legally speaking, be separated from the celestial body in which they are found (Tronchetti, 2015 at p. 790). There is now, however, an emerging body of opinion taking the view that resources and celestial bodies can be legally distinct, specifically after the resource has been extracted. An analogy would be fish in the high seas: no one can appropriate the high seas but fishermen who extract the fish from the seas can appropriate those fish and lawfully trade them as commodities (Dula and Zhang, 2015).

10.5.1 Domestic space resource legislation

This is the view taken by the United States since the enactment of the US Space Resource Exploration and Utilization Act of 2015[8], and Luxembourg in their respective space mining law. Indeed, the Luxembourg legislation refers specifically to this in the explanatory document published alongside their draft space mining law.[9] Furthermore, there is state practice that supports this argument in that several governments (US, USSR, and Japan) have conducted scientific sample return missions to various bodies in the solar system and all claim ownership of their respective samples. Indeed, the Russian Federation has even sold portions of the Soviet lunar samples at auction in 1993 without objection from the international community (Pop, 2013). Whether this constitutes sufficient state practice and *opinio juris* to create a customary

[8]US Commercial Space Launch Competitiveness Act, Public Law 114-90, 114th Congress, 25 November 2015, 51 U.S.C., Title IV

rule is certainly a question worthy of consideration (Listner, 2014).

Somewhat unhelpfully, the term 'celestial bodies' is used frequently throughout space law instruments, yet there is no definition of the term provided by the Outer Space Treaty or any of the other space treaties. This is odd for both a UN treaty of a general nature like the Outer Space Treaty (Hobe, 2009 at p. 29). Some have argued that this could potentially affect which naturally occurring 'space objects' are subject to the terms of the Outer Space Treaty, and specifically which fall under the prohibition on national appropriation laid out in Article II of the Outer Space Treaty (Pop, 2009). If a naturally occurring space object is not a celestial body then it may not fall under that prohibition. If asteroids, or even certain asteroids, are for example, not celestial bodies, at least in the legal sense as meant by the treaties, then they would be free for appropriation. This would of course depend on what the definition of a celestial body is.

10.5.2 Defining 'Celestial Body'

In his book, '*Who owns the Moon',* Virgiliu Pop has argued that there are four approaches to defining celestial bodies; the 'spatialist approach' which would categorize naturally occurring objects based on their size; the 'control approach' which would categorize an object based on the ability of humans to move it; the 'functionalist approach' would differentiate between objects treated as celestial bodies and those simply being used as moveable orebodies; the 'space object' approach arises out of the discussion of the possibility of converting asteroids into spaceships, and would allow for converted asteroids to be registered as 'space objects.' (Pop, 2009 at pp. 51-57). Pop's four approaches can essentially be reduced to two approaches which provide three

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[9]Luxembourg Ministry of the Economy (2016) 'Draft Law on the Exploration and Use of Space Resources'

options for legal classification; either asteroids and comets are categorized by their size or by their ability to be moved by artificial means. A third option is to state that all are celestial bodies and neither their size nor our ability to move them makes any difference to their legal status. This approach is the one that most closely accords with the interpretive rules laid out in Article 31(1) of the Vienna Convention on the Law of Treaties and has been endorsed by a number of academics and international bodies.[10]

There is a further complication with regards to those few states who are parties to the Moon Agreement. There is a strong argument to be made that the contentious Art 11 of the Moon Agreement places a moratorium on mining operations until the 'international regime' is established to govern those activities. This argument is strengthened by the fact that states are not meant to undermine the object and purpose of a treaty they are a party or signatory to, which the unilateral authorization of space mining prior to the establishment of the required international regime would do (Jakhu et al, 2013). Obviously, this has little impact upon those states who are not parties to the Moon Agreement but it is a further complication of the legality of space mining that is worth considering and is potentially a source of diverging space law regimes for those states who are and are not party to the Moon Agreement.

International space law is, inherently a permissive and voluntary system, meaning states retain freedom of action unless specifically prohibited. Furthermore, Art I of the Outer Space Treaty

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Available at: http://www.gouvernement.lu/6481974/Draft-law-space_press.pdf (Accessed 12 March 2017)

[10]The Space Generation Advisory Council's (SGAC) Space Law and Policy Project Group took this view in their space mining position paper, and is a view which was endorsed by Mark Sundahl in Sundahl, M. 'Don't muddy the message to space mining companies' Space News available at: http://spacenews.com/op-ed-dont-muddy-the-message-to-space-mining-companies/ (accessed November 2017)

provides a very broad freedom of use of space. There is no definition of use given, therefore, in accordance with the rules of treaty interpretation laid out in the aforementioned Vienna Convention on the Law of Treaties it is the 'plain ordinary meaning' of the term 'use' that should be used in interpreting Article I of the Outer Space Treaty. The *Oxford English Dictionary* defines use as to "take, hold or deploy as a means of achieving something or take or consume (an amount) from a limited supply" which would therefore mean that space mining can be included within the freedom of use laid out in Article I of the Outer Space Treaty. This is of course tempered by the prohibition on national appropriation in Article II of the Outer Space Treaty, and indeed the rest of the provisions of the treaty and any other provision of international law that would be relevant but does not prohibit space mining, though it will have implications for how it is regulated, authorized and conducted.

10.6 A risk to the international order: 21st Century fracturing of the consensus?

As previously discussed States have an obligation under Article VI of the Outer Space Treaty to 'authorise and supervise' the activities of their nationals in outer space. To this end most States with active private space sectors have national legislation providing for a process of 'authorization and supervision'. The United States and Luxembourg both felt that their existing legislation was inadequate for the task of 'authorising and supervising' space mining activities and therefore chose to introduce national space mining laws in response to the development of a space mining industry in their jurisdictions.

In November of 2015 the United States passed the Commercial Space Launch Competitiveness

Act[11], Title IV of which dealt with Space Resource Exploration and Utilization. It defined an 'asteroid resource' as "a space resource found on or within a single asteroid"[12] and a space resource as "an abiotic resource in situ in outer space"[13] which "includes water and minerals."[14] It also stipulates that a US citizen is 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 the applicable law, including the international obligations of the United States".[15] Luxembourg followed suit in 2017 with a law of its own, that while more detailed than that of the United States, largely mirrors the law, with a few notable exceptions. Luxembourg will only grant authorization to legal persons incorporated in Luxembourg (and only to the two specific types of corporation stipulated in the law, roughly analogous to the limited liability corporations found in the US and UK) and there are criminal penalties stipulated for noncompliance.[16] There are other states expected to follow with space mining laws of their own in the next few years.

The Outer Space Treaty is now fifty years old; the governance regime that it established has served space well. Space has become a vital part of Earth's infrastructure and economy, which has been made possible by the order and stability provided by the space law regime which rests upon foundation provided by the Outer Space Treaty (see Johnson-Freeze, 2017). However, space mining has the potential to undermine the stability of the space law regime. There are three main potential friction points which will be discussed below. The first potential conflict is over

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[11]US Commercial Space Launch Competitiveness Act, Public Law 114-90, 114th Congress, 25 November 2015, 51 U.S.C.
[12]§51301(1)
[13]§51301(2)(A)
[14]§51301(2)(B)

the legality of space mining itself, which has been already touched upon, with a second potential area of conflict being over the actual resources being mined and the third over the distribution of the profits from space mining. These three issues have the potential to destabilize or delegitimize the space law regime without which the economic value of space would considerably diminish.

10.6.1 Risks from an uncertain legal framework

The first potential area for conflict or crisis in space law is over the legality of space mining itself. The 2016 Legal Subcommittee of COPUOS saw several delegations, most notably that of the Russian Federation, strongly object to and criticise the United States' Space Resource Exploration and Utilization Act of 2015, focusing on the perceived unilateral nature of the US space law (UNCOPUOS, 2016) This has not deterred the US or Luxembourg from enacting the space mining laws.

There are essentially three arguments against the legality of space mining and the US and Luxembourg position in particular. The first is, as has already been mentioned, that Article II of the Outer Space Treaty creates a total prohibition on property rights in space and this includes commercial space mining operations. This involves a strict interpretation of the definition of appropriation. Those who articulate this viewpoint also generally see resources as being inseparable from the celestial body they are found in and as appropriation of celestial bodies is prohibited in whole or in part then so is the appropriation of their resources (Larsen, 2014). The second is that these national laws are an act of sovereignty and are therefore incompatible with the space law regime. The third is that space mining can only be legal under an international

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[15] §51303

regime.

A more widely held view, articulated by several States at the 2015 session of the Legal Subcommittee of the UN Committee on the Peaceful Uses of Outer Space is that the US space mining law constitutes an act of national appropriation which is incompatible with the outer space treaty, Article II in particular. Authorizing mining operations and/or granting title over extracted resources is an act of national appropriation which is in violation of Article II. In order for a government to have the authority to regulate an activity, they need to have jurisdiction over the area the activity is being conducted. By claiming jurisdiction over the celestial body, the state violates Article II of the 1967 Treaty. The government in this case is granting title to the extracted resource and is thus claiming ownership by virtue of authorizing the transfer of ownership (Tronchetti, 2015a).

This approach suggests that space mining can only be compliant with international space law if it is sanctioned by an international regime. If space belongs to the international community, it is part of the global commons and therefore no individual state has the right to authorise its nationals to conduct mining within it. Only the international community working together, preferably through the United Nations can there be legal consensus on space mining. This holds even more true for those states who are party to the Moon Agreement, who look towards Article 11 of that treaty (see UNCOPUOS, 2016).

The counterargument to these viewpoints is that the US and Luxembourg positions are a

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[16]http://data.legilux.public.lu/file/eli-etat-leg-loi-2017-07-20-a674-jo-fr-pdf.pdf

legitimate interpretation of the Outer Space Treaty and it is within the rights of a State Party to unilaterally interpret their obligations under a treaty. It is within the purview of states to authorize and supervise space mining through the means of national legislation. Both the US and Luxembourg make no claim to territorial sovereignty or control over any celestial body either in whole or in part, or indeed to the resources in situ. They are regulating the activities of their nationals as they are required to do by Article VI of the Outer Space Treaty. Furthermore, they reject the requirement for an international regime as neither are party to the Moon Agreement and therefore are not bound by it (UNCOPUOS, 2016) This approach was endorsed by the International Institute of Space Law as being a valid interpretation of international law not long after the promulgation of the US space mining law.

10.6.2 The Risk of a Resource Stampede

The risk of these diverging opinions is of the emergence of two distinct power blocs emerge. The first, which regards space mining as legal and legitimate and feel they need to circumvent the UN system in order to effectively manage the resources that emerge from space mining. The other power bloc would regard either space mining or the national legal regimes underpinning it as incompatible with international law and as such, the fruits of the mining as being illegitimate. The development of this schism has the potential to undermine the generally collaborative space law framework. Given the nature of space it undoubtedly needs an internationally recognized and respected framework in order to be continue and the ripples would be felt in all areas of space activity (see for example governance of the radio spectrum.) A breakdown in the established space law regime could prove seriously detrimental to the value of the space environment for all actors.

A further risk to peace, and a potential source of conflict, is over resources themselves. It is becoming clear, even from limited scientific data, that there is an abundance of resources in the solar system. Where those resources are located and how easy they are to access is not as clear. The initial target for space mining operations will be the Near-Earth Asteroids (NEOs) as their location makes then relatively easy to access. As stated above, there is still a lot that is not known about the distribution of resources among NEOs. If easy to access resource rich asteroids turn out to be a rarity, then that could cause problems (Shepard, 2015). The limitations of asteroid mining in this respect are particularly important when considering the discussing the concerns of developing nations, particularly regarding equitable access. If it does turn out that the number of commercial viable asteroids and other NEOs are limited, then their concerns could further lead to fractures in the space governance framework and also have wider diplomatic ramifications.

Articles I and II of the Outer Space Treaty make space a *res communis*, part of the global commons. Furthermore, the preamble of the Outer Space treaty declares that activities should be carried out for the "benefit of all peoples" which is reaffirmed in Article I. Traditionally, large scale space activity has excluded the 'global south' and it is argued that there needs to be some kind of benefit sharing arrangement in the event of space mining. The fear is of a repeat of colonialism in space, in which the Western or developed states reap the rewards and either there is little left by the time the lesser developed states get into space or what is left is harder to access (Oduntan, 2005).

10.6.3 Potential disputes over profit sharing

It was these fears regarding the potential of both deep-sea mining and space mining that drove the development of the 'common heritage of mankind' principle found in the UNCLOS and the Moon Agreement (Christol, 1981). There are still calls for equitable sharing of space benefits although they do not have the same intensity as they did during the era of the 'New International Economic Order'. Glimpses of this conflict are already being seen, however if substantial and lucrative mining operations begin it could further fuel resentment and tension. There have already been suggestions of this in other areas of space governance such as the Bogotá Declaration[17], in which equatorial states declared ownership over the geostationary orbit which is located above the equator and thus their countries. They felt that the developed world was unfairly reaping the benefits of the geostationary orbit and wanted 'a slice of the pie'. These are concerns which continue to manifest themselves if access to space is seen as the preserve of the established space powers (Zullo, 2001-2002).

Given the cost and complexity of accessing space it seems unlikely that actual armed conflict will happen in space any time in the near future, at least beyond Low Earth Orbit (LEO). It is not unimaginable given the vast potential wealth available that this might occur in the future should perceived inequality of access continue. There is precedent from history, with organizations like the East India Companies having considerable naval capacity to protect their wealth and even today, the terrestrial mining industry employs private military contractors to protect their investments in the more dangerous areas of the developing world. However, conflict over resources is much more likely to take the form of legal and diplomatic conflict than the armed

variety. This will all have a cost and has the potential to undermine the legitimacy and effectiveness of the overall space law regime, especially if the existing system is unable to satisfactorily resolve disputes.

The US and Luxembourg space mining laws only apply to their respective nationals. This is not necessarily a problem if the space mining industry is restricted to a handful of actors (and at the moment the embryonic industry is dominated almost to the point of exclusivity by American based companies) but combined with the lack of a dispute resolution system in space law more generally could be a potential source of conflict were two companies from two different states to try and mine the same asteroid. There is the provision in Article IX of the Outer Space Treaty against 'harmful interference' with another State's space activities but neither what constitutes 'harmful interference' nor who is responsible for preventing it have ever been clarified

Additionally, there are also concerns about the effect that space mining of metals would have on the terrestrial markets as many developing states rely on mining as an important source of income. Neither of the two main asteroid mining contenders are discussing either mining metals or bringing them to Earth in the near future (Cookson, 2017). It also doesn't at present (or any time in the near future) make economic sense to return material to Earth (Ryan and Kutschera, 2013). That does not stop it from being a source of concern or opposition, and is thus something that needs to be discussed (UNCOPUOS, 2016).

Clearly, however, as identified above, the main risk to the Earth from space mining comes from

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[17]http://www.spacelaw.olemiss.edu/library/space/International_Agreements/declarations/1976_bogota_declaration.p

an inherently damaging fracturing of the international consensus governing space activity. From this, there is the danger of diplomatic tension and possibly to armed conflict over the resources and the method by which any profits are shared. There is little doubt that this is a real risk with grave consequences. It is not, however, the inevitable consequence of space mining activity. The discussion will now seek to outline potential legal and policy solutions which could mitigate some or all of this risk. A new solution to space property rights could not only keep the peace both on earth and in space but also provide the certainty to unlock investment and see the emergence of a viable, lucrative space mining industry.

10.7 Mitigating the Risk from Space Mining: A New Solution to Property rights?

There is a recognition, both by the space mining industry, but also by the states that they are operating, or proposing to operate in, that space mining requires international legitimacy in order to work. There are a number reasons for this, not least of which is that space activities do not occur in a political vacuum and are not inseparable from their broader international relations. Commercial entities need an international market place for their resources in order for their industry to be economically viable. This requires that their property rights over the extracted resources have international legitimacy, especially as the so-called ‘new space revolution’ is making the satellite market increasingly international. Indeed, mining companies rank security of property rights as their highest priority when investing in mining ventures and states (see Dula and Zhang, 2015). Furthermore, international dialogue and cooperation over space resources is needed to avert the potential conflicts that were discussed above.

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10.7.1 Space resources and international bodies

Despite the dangers posed by a fracturing international consensus, there is some evidence of a will to cooperate on an international level. The ongoing discussions during the sessions of the COPUOS, the Legal Subcommittee in particular shows that the subject is getting precisely the level of scrutiny needed. This is particularly important as COPUOS has been the source of all five of the existing space law treaties and is seen as the body as having the most legitimacy with regards to the international governance of peaceful activities in outer space. Additionally, there is The Hague Space Resources Governance Working Group[18], a group of legal, policy and scientific experts, industry representatives and other stakeholders who have been discussing a set of Building Blocks for the Development of an International Framework on Space Resource Activities.[19] First is the fact that the space mining industry is in its infancy and any proposed governance framework either at the national or international level needs to keep this in mind. At this stage, it needs to focus on general principles rather than technical details, especially about the actual mining process itself. This will be facilitated by the use of the principle of 'adaptive governance' (under building block 4.2a) whereby regimes and structures need to be adaptable so as to be able to deal with developments without having to revise or abandon the overall governance framework.

From these discussions, it would appear that coordination and discussion should be prioritized over excessive harmonization. There may come a time when harmonization, perhaps via a binding legal instrument like a new treaty, is necessary but given the state of the technology and

[18]http://law.leiden.edu/organisation/publiclaw/iiasl/working-group/the-hague-space-resources-governance-working-group.html

infrastructure, it is premature to discuss such things at this stage. It needs to be established as a normative value that it is within the sovereign right of a state to produce national legislation for the 'authorization and supervision' of space mining activities conducted by its nationals without being in violation of Article II of the Outer Space Treaty. Once this is accepted, it is also clear that states need the right to devise their own methods for doing so, especially there is little expertise on either the activity or the regulation of the activity yet. It is suggested that it is sensible for the international community to consider coordination of both activities and national legislation. Coordination of activities is the most pressing concern as there is the prospect that multiple operators from multiple states could be interested in the same celestial body and for the early operators to go after the 'low hanging fruit'. It is not only in the interest of States to avoid conflict and interference with the operations of other companies and states, it is actually a requirement of the Article IX of the Outer Space Treaty (and indirectly through Article III). As for legislative cooperation, the space industry itself is largely and increasingly international is focus and that is also the trend within the space mining industry. Both Planetary Resources and Deep Space Industries while having headquarters in the United States also have subsidiaries in Luxembourg, and similarly iSpace, while based in Japan, also has a subsidiary in Luxembourg.

10.7.2 Space resources dispute resolution

Fundamentally, there is a need for dispute resolution mechanisms. It may be premature to discuss a formal dispute resolution system beyond those that already exist for disputes of an international nature. It would, however, be prudent to discuss arrangements before a dispute arises, and some form of 'soft law' agreement between states or even just industry guidelines could be of

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[19]The Hague Working Groupe Draft Building Blocks on Space Resource Activities 2017 -

enormous benefit to all concerned. In concert with this, it is also worth taking some time to consider the provisions of Article 11 of the Moon Agreement which could provide the legal certainty and security that the space mining industry is desiring. The international regime called for in Art 11(5) is not an unreasonable idea. There are no specifications as to the nature of this international regime. There may be a common expectation that the international regime would duplicate the International Seabed Authority but there is no detail in the Moon Agreement which would require it. Non-binding, voluntary mechanisms could play an important role in shaping normative solutions based on incentivized participation. Such incentives will be invaluable in overcoming political reticence to commit to the Moon Agreement.

Art 11(7) calls for "an equitable sharing by all States Parties in the benefits derived from those resources..." It is important to note several things about this provision. First, it calls for an equitable sharing, not an equal sharing. While equity and equality are often related they do mean different things (Christol, 1981). Equity is more concerned with fairness and there is certainly an argument to be made that those who actually undertake the effort and risk to extract resources should be the primary (if not sole) beneficiary of that effort and risk. The wording of Art 11(7) is also significant stating that equitable distribution "shall be given special consideration", this does not require a redistribution of the benefits of resource extraction to all states on Earth. Any advocacy of resource sharing and the creation of expensive, multinational bodies to administer such sharing (outside of the control of sovereign states) would appear to be politically naïve. It is unlikely that, in its present form, any aspect of Art 11 of the Moon Agreement would be palatable to major space actors.

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http://media.leidenuniv.nl/legacy/draft-building-blocks.pdf

Yet even in this respect there are precedents which give cause for some optimism. The aforementioned UNCLOS, dealing with mining of the sea bed is illustrative of potential avenues of consensus and cooperation. UNCLOS was negotiated around the same time as the Moon Agreement and also contains the Common Heritage of Mankind principle (as stated above). Crucially, it too was regarded as being a 'failed treaty' as Western states largely avoided it not desiring to have to give up their technology to lesser developed states. It was, however amended in 1994, following protracted negotiations and now a majority of states have signed up to UNCLOS with the noticeable exception of the United States of America (Adolph, 2006). Admittedly, it is unlikely that the Moon Agreement could be revived in its current form. The agreement is particularly toxic politically particularly in the United States and that discussions of attempting to revitalize the Moon Agreement remain moribund. Despite this, it is contended that the DNA of the Moon Agreement, particularly Article 11 does require consideration for the reasons listed above. A version of Article 11, forming the basis of on-going negotiations could provide an internationally legitimate regime.

10.8 Conclusion

As stated at the outset, this chapter has examined the prosaic and administrative risks to space mining. The discussion on the technical environment has illustrated that there are still too many imponderables, in terms of infrastructure and industrial practices, to effectively draw up any meaningful governance framework. The incomplete scientific picture in respect of the actual abundance of resources on asteroids and NEOs compounds this lack of certainty. Where the drafters of the Treaty in 1967 based their deliberations on the practices of the state parties at the

time, such contemporary activity is not available for those looking to legislate on space mining at the moment. Given the incomplete picture, augmented only with supposition and educated guesswork, the temptation is to recommend law makers adopt a cautious wait-and-see approach rather than enshrining a system which may not reflect the reality of space mining operations.

The picture for cooperation is not without cause for optimism. The space law community both within COPUOS and in other, informal groupings has responded with alacrity. Whilst there has been some posturing, there still exists a dialogue over ways in which resource ownership question and Art II can be addressed. The very fact that discussions are on-going is a source of optimism. A wholescale renegotiation of the 1967 Treaty appears unlikely in the current geopolitical environment. The Moon Agreement of 1979, at first sight appears to be an unlikely saviour, but there is much within that is already accepted as normative. The evolution of UNCLOS suggests that even the most moribund of international agreements can be revived if there is sufficient political will. Nonetheless, only the most optimistic of advocates of the Moon Agreement would overlook the difficulties in garnering widespread support for a treaty that is widely regarded as having failed due to the uncertainties of the CHM principle.

A collaborative approach, at this stage, appears to have limited chances of success. States such as the USA and Luxembourg have already shown a willingness to fill the legal and policy void around space resources with bespoke national provisions designed to embolden investors and energize companies into developing space mining as a serious endevour. These domestic laws eschew the difficulties of the appropriation aspect of Art II of the Outer Space Treaty by focusing on the licensing and supervisory duties incumbent under Art VI and by seeing mining

as an element of usage permitted under Art I. The genie of national legislation is out of the bottle and the risk is that there will be a fracturing along the fault lines of Art II. Such a schism could significantly undermine the peaceful and largely cooperative nature of space governance that has existed since the signing of the Outer Space Treaty. Independent mining and the perception of a colonialist approach to space mining could further exacerbate diplomatic tensions.

Space mining may be the start of the divergence of space law. This could see a move from a uniform framework under international law to a more fragmented situation where national law is the primary instrument and this process may already be underway. The future of the international framework may depend on whether other states decide to enact legislation that provides for national property rights or whether an enduring consensus can be found along the lines suggested. It is a legitimate position to question whether the international approach to space governance is the right way for space governance to go, given the changing geopolitical environment. The risk in the Outer Space Treaty regime collapsing is that with it will go stability and an acceptance in free and unfettered access to space. A new, internationally recognised space property rights framework, agreed by all stakeholders must surely be the aim of on-going discussions. Even if that framework is predicated on broadly accepted national laws, the risk of doing nothing far outweighs the risk of being inactive. The creation of such a framework would facilitate exploration, encourage investment and pave the way for the creation of an infrastructure that could see humanity emerge as a truly interstellar species.

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