



Space Resources and the Politics of International Regime Formation

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ABSTRACT

Space resources such as minerals or lunar ice deposits are of growing economic and political interest in the context of the emerging space economy and the intensifying geopolitical tensions of a new “space race”. Scholars and stakeholders increasingly engage with the question of how to regulate the future exploration and exploitation of space resources under international law. A potential option that has drawn broad attention in the debate is a multilateral regime that would regulate space resources as the common heritage of humanity and aim for the fair and equitable sharing of benefits that derive from their exploration and exploitation. Whereas a considerable body of literature addresses the legal and institutional characteristics of such a hypothetical regime, questions of regime *formation* have so far been neglected. This paper probes the feasibility and the prospects of developing a multilateral and common heritage-centric regime for space resources by a) drawing on theoretical insights from the scholarly debate on the politics of international regime formation and b) extracting insights and lessons from two historical cases of regime formation (under the Antarctic Treaty System and the Law of the Sea Convention) addressing similar challenges of regulating transnational commons in Areas Beyond National Jurisdiction. The analysis indicates extraordinarily adverse background conditions that make the successful formation of a multilateral and common heritage-centric regime for space resources highly implausible despite its *prima facie* normative appeal. The political prospects for devising fair, equitable and effective solutions to the problem of space resources are accordingly limited and likely to remain so.

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INTRODUCTION

Space resources, such as lunar ice deposits or mineral deposits in near-Earth asteroids, are of significant contemporary interest to states and to the emerging private space industry. Space resources have a complex legal status, as they are situated in an Area Beyond National Jurisdiction and are subject to ambiguous collective rights: Article 1 of the 1967 Outer Space Treaty provides that exploration and use of outer space “shall be the province of all mankind”; and Article 11 of the 1979 Moon Agreement stipulates that “[t]he moon and its natural resources are the common heritage of mankind”.

The precise nature of these collective rights is subject to broad scholarly debate (e.g., Joyner 1986; Pop 2009; Hague Working Group 2019; Cross 2021; Garcia 2021) and their interpretation has vexed space lawyers for decades. The debate is recently gaining in urgency due to intensifying political debates, and controversies, over the status of outer space as a global commons (Deplano 2021; European Union 2023). With spacefaring nations increasingly vying for influence in space, and with the emergence of a vast, private space industry, the question of how to understand, define and implement collective rights in space resources, such as precious metals and ice deposits, is no longer of mere theoretical interest (see Pekkanen 2019). Inside the UN Committee on the Peaceful Uses of Outer Space (COPUOS), states are exploring potential modalities for novel multilateral legal arrangements on space resources. Outside the UN, the US is pressing for a regulatory model in tune with commercial resource operations backed by exclusionary property rights (see Deplano 2021), as the political and economic stakes of the new space race increase, the “permissibility of commercial space mining has become a central aspect of US space policy” (Boley and Byers 2020: 174). In parallel, the Council of the European Union recently recognized space as “a global commons”, emphasizing “the right to a free, fair and peaceful use of and access to space for the benefit of all peoples” (European Union 2023).

The exploration and exploitation of space resources poses problems of international cooperation that, in other contexts, have typically been addressed through binding, multilateral agreements between states. Notwithstanding the institutional innovations and changes in the structure of global governance over the past few decades (e.g., Abbott et al. 2016; Roger and Dauvergne 2016; Abbott and Faude 2021), conventional multilateralism is unique in its potential to deliver (limited) solutions for problems of international collective action where the technological- and economic capacities of states diverge and crucial norms of global justice are at stake. This conventional approach is the core

of international regimes for similar cases of transnational commons in Areas Beyond National Jurisdiction, notably for Antarctica, the ocean floor and its subsoil in the high seas, or the global seeds commons (Butkevičienė and Rabitz 2022). Similarly, the new 2023 agreement on biodiversity beyond national jurisdiction, adopted under the Law of the Sea Convention, sets out to ensure the long-term conservation and sustainable use of high-seas biodiversity, drawing on the common heritage of humanity as a guiding principle (see Mendenhall et al. 2023). The parameters of a multilateral regime for space resources have long been an object of interest among space lawyers (e.g. Bilder 2009; Pop 2009; Doshi 2016; Heise 2018; Hague Working Group 2019). Yet as space resources are rapidly transforming from an abstract theoretical problem into a contentious political one, the perspectives and feasibility of regime formation are becoming a crucial issue, albeit one which has been virtually ignored in the literature so far.

This text addresses the politics of international regime formation for the regulation of space resource access and utilization, through a legally-binding and multilateral agreement that gives due regard to the ambiguous collective rights set out in contemporary space law, particularly the Outer Space Treaty. I probe the political perspectives and feasibility of negotiating and adopting such an agreement by parsing the broader literature on international regime formation for its theoretical implications for the case of space resources; and by deriving insights and “lessons learned” from two successful instances of international regime formation for similar problems of transnational resource governance. My theoretical and empirical analysis indicates marginal prospects for devising conventional multilateral solutions for the problem of space resources and associated issues of global justice and collective rights. Contemporary attempts to pursue such solutions, including under COPUOS, are accordingly misguided. The scope for devising fair and equitable solutions for the problem of space resource governance, including through alternative institutional models, is thus severely limited. While there may be a strong normative case for the multilateral implementation of collective rights as a matter of public international law, including under the common heritage principle, the political barriers are likely to be insurmountable. There is thus little room for optimism regarding the capacity of the international community to devise and operate governance solutions for space resources that are simultaneously fair, equitable and effective.

Section 2 elaborates on the politics and rationale of a multilateral agreement for space resource governance. Section 3 draws on the wider literature on international regime formation and applies conceptual insights on situation structure, leadership and linkages to the case

of space resources. Section 4 addresses two successful cases of regime formation for the management of natural resources in a transnational context, under the UN Law of the Sea Convention and the Antarctic Treaty System respectively. Here, I illustrate how situation structure, leadership and issue linkages have been largely conducive to successful regime formation; and elaborate inductive insights, or “lessons learned”. Section 5 concludes on the notion that the politics of space resources are unlikely to be amenable to default multilateral solutions. Alternative institutional models, such as governance through goals or the orchestration of private actors and institutions, have greater degrees of political feasibility than conventional multilateralism. However, their potential for delivering fair- and effective global solutions is bound to be considerably smaller. Accordingly, there is a need to acknowledge limitations and to temper expectations in the contemporary debate on space resource governance.

TOWARDS A MULTILATERAL AGREEMENT ON SPACE RESOURCES?

Space resources have been defined as “extractable and/or recoverable abiotic resource[s] *in situ* in outer space” (Hague Working Group 2019, para 2.1). They include various mineral resources of significant economic value, notably Rare Earth Elements and Platinum-group metals. Their extraction from terrestrial sources is expensive, technically challenging and comes with a significant social- and environmental footprint. Yet the demand for these and other technology metals is bound to increase manifold in the context of global decarbonization due to their comparatively greater prevalence in clean energy- and transportation technologies when compared to incumbent, fossil-based ones (Hayes and McCullough 2018). There are indications that they could be present in near-Earth asteroids in significantly greater densities than is the case on Earth, which would improve the economics of their extraction. As they are used in minimal volumes compared to bulk materials such as iron or aggregate, a limited amount of transit operations to and from extraterrestrial mining sites could suffice to cover total global demand practically indefinitely. Beyond earthbound purposes, space resources are indispensable for the future exploration, or even colonization, of the solar system. Lunar ice deposits could provide water, air and hydrogen fuel for space travelers, reducing the material load and thus the energy costs of escaping the Earth’s gravitation. Regolith, on the moon and other celestial bodies, could serve as a raw material for large-scale construction projects via advanced 3D printing technology. Extraterrestrial Helium-3 deposits

have been proposed as a virtually unlimited energy source in hypothetical nuclear fusion (Bilder 2009).

The economic and political interest in space resources has increased dramatically in the past two decades. One reason is the emergence of a private space industry, mainly as result of sharp cost decreases of space operations that reduced the entry barriers for commercial actors. Today, a welter of small- and medium enterprises, and several large multinationals such as SpaceX or Blue Origins, are pursuing diverse commercial interests in space, including by partnering with national space organizations (see Mazzucato and Robinson 2018). Currently, space resources are but a minor element within the broader commercial engagement with outer space. A first generation of startup companies exploring the possibility of asteroid mining ended in failure over the past years, highlighting the considerable technological- and economic barriers to the commercial exploitation of space resources. At the same time, the explosive growth of the new space economy, and the criticality of space resources for various space-to-space and space-to-Earth applications, implies that, over the long run, the game is on for commercial exploration and exploitation (Shammas and Holen 2019).

Asides from commercial interests, access to space resources has acquired a geopolitical dimension. From its beginnings during the 1950s, the space age was shaped by the superpower confrontation of the Cold War, albeit with robust forms of East-West cooperation rapidly emerging (Byers 2019; Garcia 2021). The global politics of the 1990s created a brief period of easing tensions in the politics of outer space. However, a new “space race” has commenced in the decades since, as China, the USA and their respective partners each pursue supremacy in outer space (Pekkanen 2019). The USA intends to construct a space station in lunar orbit during the coming decade. China is pursuing the construction of an International Lunar Research Station, in the Moon’s orbit or on its surface, in the same time period. Inside the UN COPUOS, the chief multilateral forum for outer space governance, a working group was established in 2021 to consider the need for, and modalities of, a potential international framework for space resource activities, where questions of access, ownership and control are now of paramount political importance (COPUOS 2021; 2023). Outside the UN, the USA has been multilateralizing its own, appropriation-centric approach through the so-called Artemis Accords, a legally non-binding instrument with presently 24 participants that diverges from existing international space law in important respects, creating legal ambiguities and potential inconsistencies (see Deplano 2021).

The precise meaning and implications of key legal provisions, notably of the 1967 Outer Space Treaty, have

become central elements of the contentious contemporary politics of outer space. The Outer Space Treaty is the central legal framework dealing with a wide range of space-related activities. The treaty stipulates that “[t]he exploration and use of outer space [...] shall be carried out for the benefit and in the interests of all countries [...] and shall be the common province of all mankind”; and that “[o]uter space [...] is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means” (Articles 1 and 2). The 1979 Moon Agreement more explicitly declares the moon, other celestial bodies of the solar system (other than Earth) which are not covered by specialized legal instruments, as well as all of their natural resources, as the common heritage of humanity (Articles 1 and 11). The normative force of the Moon Agreement remains limited due to its low number of parties that, moreover, do not include any spacefaring nations. The Outer Space Treaty, however, is the keystone of international space law and its provisions on space resources have been the subject of intense legal discussion for decades (e.g., Joyner 1986; Khatwani 2019; Cross 2021).

While the Outer Space Treaty may not necessarily require the regulation of space resources based on (emerging or existing) legal principles such as common heritage of humanity or fair- and equitable benefit-sharing, it is compatible with regulatory approaches that use these or related principles for giving effect to collective rights of humanity or international society (Butkevičienė and Rabitz 2022). Legal scholars have shown avid interest in the modalities of a legal regime for space resources that would incorporate notions of common heritage and benefit-sharing (see Bilder 2009; Pop 2009; Doshi 2016; Heise 2018). Beyond the intricacies of treaty interpretation, there is thus a legal, political and perhaps ethical case to consider a broadly common heritage-based regime as an appropriate potential solution to the distributional conflicts, such as between spacefaring- and non-spacefaring nations, that are presently emerging in the international politics of space resources. This is against the background of an intensifying international legal debate on the role of fair- and equitable benefit-sharing in addressing a wide range of contemporary social- and environmental challenges (see Morgera 2016). As the rising commercial- and political interest in space resources entails a distinct tendency towards an enclosure of the space commons, it is an opportune moment to consider as an alternative an international solution that gives effect to the collective rights that are implicitly and explicitly enshrined in international space law.

The argument below assumes that any international regime for the effective implementation of collective rights in the various benefits associated with different

types of space resources would need to possess two key characteristics. First, it would need to be *multilateral*, having among its state parties as many spacefaring- and non-spacefaring nations as feasible. Broad participation of the former would be required to ensure that the exploration and extraction of space resources is conditional on operator compliance with the obligation to share the diverse associated benefits in accordance with international rules; and broad participation of the latter is necessary to ensure the effective distribution of material and immaterial benefits in accordance with criteria of global justice.

Second, a space resources regime would require a high degree of *legalization*, in the sense of defining rights and obligations with high degrees of specificity and normative force, with additional international support mechanisms to facilitate implementation (Abbott et al. 2000). As the strong degree of distributive conflict, as well as the challenges of monitoring the compliance of space-based activities with international rules, create incentives to shirk or defect from international obligations, deep institutionalization is required to overcome the associated collective action problem. From the outset, this conceptualizes space resources as a “hard” problem for international regime formation, as broad participation and deep institutionalization need to be combined despite the partial incompatibilities and trade-offs that can exist between them (e.g., Farias and Roger 2022).

A space resources regime conceptualized along those lines amounts to a conventional type of multilateralism that has been developed for various other problems of natural resource governance in transboundary contexts, including for Antarctica, deep-sea minerals, seed commons, marine biodiversity beyond national jurisdiction (Joyner 1986; Blay 1992; Jaeckel et al. 2017; Kim 2017; Butkevičienė and Rabitz 2022; Mendenhall et al. 2023). In the academic literature, conventional multilateralism has come under increasing scrutiny, as scholars point to its increasing irrelevance vis-à-vis transnational- and soft intergovernmental governance (Abbott and Snidal 2010; Abbott et al. 2016; Roger and Dauvergne 2016; Abbott and Faude 2021) and its occasional design for failure (Dimitrov 2020). However, a core assumption behind this text is that conventional multilateralism is the best hypothetical solution among a range of imperfect governance options for grappling with problems of natural resource management in transboundary contexts where distributional conflicts and global equity challenges arise. While I briefly return to alternative governance models in the conclusions of this text, conventional multilateralism would, in principle, offer the best prospects for the effective regulation of space resources in a manner that gives effect to collective rights embodied in notions of common heritage or common province (Garcia 2021).

DETERMINANTS OF INTERNATIONAL REGIME FORMATION

The literature on the conditions for successful regime formation spans half a century. International regimes are here broadly understood as functional rules regulating state conduct in a given issue area, with binding multilateral agreements being one particular type of regime. With notable exceptions (e.g. [Young 1991](#)), the literature on international regime formation tends towards a rationalist outlook: regimes allow states to overcome collective action problems and thus reap cooperative gains; yet their formation is commonly subject to collective action problems itself. In other words: the fact that an international regime would likely create benefits for its participants does not necessarily mean that such a regime will be adopted in the first place (see [Dimitrov et al. 2007](#)). While there is no general theory of international regime formation, there are several broader strands that deal with different causal mechanisms that either facilitate or hamper successful negotiation and adoption. Below, I discuss three such mechanisms before turning to their theoretical implications for the case of space resources.

SITUATION STRUCTURE

The first and possibly foremost factor that shapes the prospects and perspectives of international regime formation is the formal nature of the cooperation problem, often referred to as “situation structure” ([Mitchell and Keilbach 2001](#)). The situation structure derives from the distribution of expected utilities over interdependent decision alternatives and can be represented through various game-theoretical models. Situation structures that resemble a prisoner’s dilemma, for instance, are inherently biased towards non-cooperative equilibrium outcomes. In other contexts, situation structures might approximate a battle-of-the-sexes model, where the challenge is for states to coordinate on one among several cooperative outcomes that all create benefits for all participants, albeit to different degrees. Generally, the former type of situations, where cooperative outcomes are beneficial for some actors yet disadvantageous for others, are much less amenable to successful regime formation than the latter type, where all actors derive *some* benefit under *any* cooperative outcome and the political challenge merely consists in finding agreement on who is to benefit by how much ([Underdal 2002](#)).

The situation structure for space resources is decidedly malignant in this regard. For the most part, space resources amount to rivalrous goods. Any public- or private operators that initially exploit or recover rivalrous space resources will, by necessity, incur losses under any multilateral

regime that redistributes assets away from them in order to satisfy criteria of global equity and common heritage. The zero-sum logic behind rivalrous space resources implies that successful multilateral regime formation requires additional elements to compensate operators for such losses (see below); and, possibly, for enforcing compliance due to the strong incentives for operators to shirk their obligations ([Mitchell and Keilbach 2001](#)). These conditions do not apply for *all* aspects of space resources, however: The exploration of space resources via scientific means generates non-rivalrous goods that are not subject to the zero-sum logic and cooperation challenges that apply to the exploitation or recovery of space resources as rivalrous goods. Indeed, the sharing of data that results from the freedom of scientific research in outer space has a strong and unambiguous normative foundation in the Outer Space Treaty (see Articles 1 and 11), as is the case for similar regimes such as on marine scientific research in international waters under the Law of the Sea Convention (see section 4 below). Here as there, commercial interests in data protection may interfere with public interests in open data-sharing.

LEADERSHIP

There is little doubt about the centrality of leadership for regime formation as well as for international politics more broadly ([Young 1991](#)). Yet the concept itself is surprisingly difficult to pin down: while leadership implies a measure of strength, influence or power, it cannot be reduced to simple dominance because, in one way or another, it is geared towards ends that align with collective interests rather than exclusively benefitting the leader itself ([Skodvin and Andresen 2006](#)). The notion of leadership thus entails two distinct elements: policy objectives of a leading actor which have a high degree of ambition in regards to common interests or collectively agreed-upon goals; and a strong capacity for a leader to *achieve* these objectives ([Oberthür and Rabitz 2014](#)). There is broad conceptual variation in the literature on the different types of leadership that allow state actors to achieve policy objectives that jibe with shared interests and international goals. One obvious way is for leaders to leverage various power resources, typically of an economic type, in order to compel or motivate other states to fall in line ([Ikenberry 1996: 389–391](#)). Similarly, leaders may choose to take unilateral domestic action in order to entice international partners to follow suit. Finally, and perhaps most ambiguously, leadership can proceed through diplomatic finesse, bargaining skill, as well as deep technical- and legal finesse ([Schulz et al. 2017](#)).

These three types of leadership will matter to different degrees in different contexts and methodological challenges of operationalization and measurement can be

considerable. At its core, however, leadership is frequently indispensable for the successful formation of international regimes. In fact, leadership provides an important conceptual lens for understanding the formation of the Artemis Accords as a US-led effort at, presumably, widening the scope for the commercial exploration and use of space resources while limiting the ability for others to share in the resulting benefits as the “province of all mankind” (Outer Space Treaty, Article 1). What is less clear is which, if any, state actor possesses both the capacity for, and an interest in, assuming international leadership towards a multilateral regime regulating space resources as the common heritage of humanity. Within the COPUOS Working Group on Legal Aspects of Space Resource Activities, the most salient and high-level contemporary process towards a potential multilateral agreement for space resources, spacefaring nations have generally expressed a preference for a hands-off approach that would not interfere with the ability of private- and public operators to appropriate and retain benefits resulting from relevant activities. Russia, with its historically-strong national space program and thus some hypothetical material capacities to leverage for the facilitation of international collective action, has expressed a willingness to at least consider a benefit-sharing model for space resources (COPUOS 2023), although broader historical- and contemporary questions of international diplomacy render a Russian leadership scenario implausible. China, as a space power that is second only to perhaps the US, has generally expressed its support for the COPUOS process, emphasizing the Outer Space Treaty as the central point of reference. Just as in other international forums, China has shown some degree of willingness under COPUOS to assume a leading role in the context of the informal G77/China coalition, emphasizing the Outer Space Treaty’s provisions on the benefits and interests of all countries and the common province of all humanity (COPUOS 2021). Considering the rising stakes that China itself holds in the exploration and use of space resources, especially in the context of the Chinese lunar program, a more-than-symbolic commitment towards the interests of non-spacefaring nations, over the long term, is doubtful.

LINKAGES

Issue linkages are crucial elements in international regime formation as well as in international negotiations more broadly. The debate on the nature and functions of issue linkages in world politics goes back decades (e.g. Haas 1980; Muzaka 2011). At its core, the linkage of disparate issues allows bargaining blockades to be overcome by allowing the conditional trade of mutual concessions. Linkage is a crucial feature that allows cooperative outcomes

even where zero-sum conflicts are present: actors make concessions on some issues in the understanding that they will be (over-)compensated by the concessions that others make on disparate, linked issues. As states typically differ in the way they weighting losses and gains across issues, for instance with minimal losses for some actors leading to considerable gains for others, linking of issues enables cooperative outcomes with net-benefits for all participants even where single issues are characterized by a zero-sum structure (see Poast 2012).

This means that, even to the extent that the situation structure of space resources is malign, and even in the absence of states that could credibly assume a leadership role towards a multilateral agreement on space resources as common heritage, ambitious cooperative outcomes would, in principle, be possible as part of some grand, political bargain between actors and coalitions with disparate interests. The crucial question, however, is whether the overall agenda of outer space politics is, over the short- and medium term, conducive towards such a bargain. To be sure, this agenda has gained considerable breadth in recent years. Within COPUOS, contemporary discussions include issues as distinct as space debris mitigation, space traffic management, space weather or the use of nuclear power sources in space, besides from the issue of space resources itself. Whether, or how, these contemporary and possible future issues could come together in a larger package deal that would deliver a multilateral solution to the challenges posed by space resources, in particular their zero-sum elements, cannot easily be predicted. Yet as we know from other contexts, any successful linkage strategy would need to “[broaden] interest group lobbying and bureaucratic jurisdiction” (Davis 2004: 154) in the domestic politics of spacefaring nations to enable aggregate state interests that, at the international level, are conducive towards multilateral cooperation. As space operations are likely to remain limited to public- and private organizations from a narrow set of technologically-advanced nation states for the foreseeable future, it is unclear which of the contemporary issues on the outer space agenda could lead to sufficient buy-in from their domestic bureaucracies and interest groups for offsetting parallel economic losses from the redistribution of space resources and derived benefits.

In other words: the scope for a mutual give-and-take between spacefaring- and non-spacefaring nations, where a deal on space resources would be tied into a larger package, appears marginal at present. A precondition for the emergence of suitable linkage strategies would be a considerable widening of the political agenda: A negotiation system comprising space-related agenda items (such as those currently being addressed under COPUOS) together with “Earth-bound” items could unlock linkage strategies

where governments would trade concessions for mutual benefit. This means that outer space would have to be cast as an element of a wider problem field, similar to how the global environment came to be part of a larger thematic area in the international negotiations on sustainable development up to and beyond the 1992 Rio Earth summit. Due to the multitude of contingencies involved in the social construction of political issue areas, the feasibility of future linkage strategies to facilitate regime formation for space resources remains highly speculative.

SUCCESSFUL REGIME FORMATION UNDER THE ATS AND THE LOSC

The Antarctic Treaty System (ATS) and the Law of the Sea Convention (LOSC) are frequent points of reference in the debate on the modalities of a multilateral regime for space resources (e.g. Pop 2009; Khatwani 2019; Butkevičienė and Rabitz 2022). Yet they also potentially hold valuable insights for questions of regime formation for space resources. This is because they deal with a similar political problem: the negotiation of binding, international rules for resources in Areas Beyond National Jurisdiction where collective rights and distributional conflicts are in play. The following two subsections present a condensed narrative of successful regime formation processes under, respectively, the ATS and the LOSC, highlighting the facilitating role of situation structures, leadership and issue linkages as well as elaborating potential insights and “lessons learned” for the case of space resources.

THE ANTARCTIC TREATY SYSTEM

The ATS comprises the 1959 Antarctic Treaty and three so-called related agreements on environmental protection, the conservation of seals and the conservation of marine living resources. It is a governance system covering the area south of the 60th parallel south and thus territories that are under state sovereignty, territories where sovereignty claims are disputed or not acknowledged, as well as territories not subject to sovereignty claims of any sort whatsoever. Members of the Antarctic Treaty Council, most of which continue to assert claims to different Antarctic territories, have historically opposed any explicit consideration of Antarctica as common heritage (Keyuan 1991). However, the ATS comprises various implicit elements of the common heritage concept, notably through the provision that “it is in the interest of all mankind that Antarctica shall continue forever to be used exclusively for peaceful purposes and shall not become the scene or object of international discord” in the preambular text of the Antarctic Treaty itself.

These collective interests are also at the core of all related agreements in the ATS, also figuring prominently in the attempts, from the 1970s onwards, to negotiate an international regime on Antarctic mineral resources, the existence of which in abundant quantities has been hypothesized, albeit never proven, for decades. One observer states that this uncertainty was, in fact, a driving factor motivating governments to develop an international regime *before* any potential discoveries of commercially-significant deposits would make negotiations “immeasurably more difficult” (Watts 1987: 166). In 1981, the Antarctic Treaty Consultative Meeting adopted a formal recommendation to conclude a regime for mineral exploration and exploitation which would provide for sufficient protection of the Antarctic environment and that would not prejudice the collective interests of humanity in Antarctica (ATCM 1981: 20).

In 1989, 19 states signed the resulting Convention on the Regulation of Antarctic Mineral Resource Activities (CRAMRA), providing a detailed rule framework for authorization and inspection of extractive operations, as well as on matters of environmental protection and operator liability. In the meantime, however, the political winds had turned, as Australia, France and others came to oppose the ratification of CRAMRA on grounds of the expected adverse environmental impacts of Antarctic mineral resource activities. With more-and-more signatory states distancing themselves, CRAMRA never cleared the ratification threshold required for its legal entry-into-force. While policy preferences shifted from stringent regulation of Antarctic mineral resource activities to comprehensive prohibition, parties to the ATS rapidly negotiated a new legal instrument, the Madrid Protocol on Environmental Protection to the Antarctic Treaty, which was adopted in 1991 and entered into force in 1998 (Blay 1992). The Madrid Protocol forgoes regulatory complexity, simply determining that “[a]ny activity relating to mineral resources, other than scientific research, shall be prohibited” (Article 7) and thus prioritizing environmental conservation and stewardship over any uncertain and speculative future economic benefits from mineral extraction.

In terms of the three factors associated with the success or failure of international regime formation discussed in section 3, first, the situation structure for the governance of Antarctic mineral resources was relatively conducive towards reaching negotiated outcomes. This is because the ultimate stakes were shrouded in uncertainty and remain so until the present day, as the extent to which Antarctica possesses mineral resources, and the extent to which their extraction might be technically and economically feasible, are unknown. Such uncertainties over the international distribution of gains have been identified as factor

conducive to successful regime formation (Young 1991). Second, the successful conclusion of the Madrid Protocol shows clear markings of successful political leadership by, primarily, the government of Australia, which had already been instrumental in the previous negotiations on CRAMRA (Blay 1992). Third, the successful formation of a moratorium on any non-scientific, mineral-related activities in Antarctica constitutes but one element of the 1991 Madrid Protocol, together with other items such as other environmental protection obligations, requirements for environmental impact assessments and provisions for coordinated responses to environmental emergencies. This implies the presence of issue linkages in the negotiation system that, just as situation structure and leadership, have likely facilitated successful regime formation.

Beyond the specification of these conceptual elements, the regime formation process for Antarctic minerals also offers three distinct lessons for the possible creation of a multilateral and common heritage-centric agreement on space resources in the future. First, giving effect to collective rights requires careful balancing between the economic benefits of resource extraction and the protection of the space environment, for instance from debris generated during asteroid mining operations. This opens the door to potential value conflicts that can be difficult to reconcile. Second, the relative ease with which parties concluded the CRAMRA negotiations, at least by the standards of international diplomacy, indicates that the absence of tangible commercial interests may facilitate international policy-making by blunting the edge of the underpinning zero-sum politics. (Watts 1987). A multilateral agreement on space resources is bound to be considerably easier while overall commercial stakes still remain limited. Third, the abandonment of CRAMRA highlights the vulnerability of regime formation processes to political contingencies. A space resource regime is bound to be difficult to construct yet the political process might be easy to derail due to rapid and largely unforeseeable shifts in the policy preferences of key actors.

THE LAW OF THE SEA CONVENTION

The 1982 LOSC, including its Part XI which creates distinct rules for the international seabed and its mineral resources as the common heritage of humanity, resulted from more than half a century of negotiations on the law of the sea, an extraordinary length of time even by the standards of international diplomacy (Treves 2015). The LOSC is a comprehensive framework that deals with a vast range of marine activities. Its Part XI had begun to acquire specific significance since the emergence of the modern concept of the common heritage of humanity in the international legal debate of the late 1960s. Under part XI, the seabed,

ocean floor and subsoil of international waters, as well as all “solid, liquid or gaseous” minerals therein, are the common heritage of humanity (LOSC, Articles 1(1), 133(a) and 136). They are not subject to claims of sovereignty or appropriation; and an International Seabed Authority (ISA) is created to “provide for the equitable sharing of financial and other economic benefits” that derive from resource exploitation and similar activities (Articles 137(1) and 140(2)).

The provisions of part XI were generally met with opposition from developed countries that were anxious to guard the blue gold that, during the 1970s and 1980s, was widely expected to be almost within reach of commercial exploitation, against the redistributive politics of the Global South which, for most of this period, had been pursuing greater global equity under a proposed New International Economic Order. The US and several other industrialized states initially chose not to become parties to the LOSC precisely due to the provisions of part XI. Getting these crucial states to join the LOSC required legal trickery, in the form of a 1994 Implementation Agreement that, in principle, amended key provisions of part XI, making them sufficiently amenable to industrialized states to secure their ratification (Churchill 2015).

Part XI of the LOSC provided a general framework that, in the decades since 1982, has gradually been operationalized through technical discussions and intergovernmental negotiations in ISA. The rules developed under ISA to implement the provisions of part XI are collectively referred to as the “mining code” and, as of March 2023, cover the exploration, but not the exploitation, of polymetallic nodules, seafloor massive sulfides, as well as ferromanganese crusts. In the development of the mining code, ISA tends to prioritize commercial resource usage over the protection of the deep-sea common heritage (see Jaekel et al. 2017) and pervasive industry influence in its internal governance has been a matter of controversy for many years. At the time of writing and in reminiscence to the fate of CRAMRA discussed above, while ISA is coming close to finalizing its exploitation regulations which would allow for commercial and large-scale deep-sea mining operations to commence for the first time in history, France and several others have begun to vocally advocate for a moratorium instead.

In contrast to the ATS, the formation of the deep-sea mining regime confronted a considerably more malign situation structure, as governments during the 1980s widely considered mining operations to be imminent, accordingly being anxious to share in the potential windfall gains (Sprenberg 2019). The zero-sum conflict in the regulation of deep-sea minerals meant that full participation of industrialized countries could only be reached by softening

up international rules through the 1994 Implementation Agreement. While the situation structure was thus inconducive to successful regime formation, Skodvin and Andresen (2006: 23–25) have identified “entrepreneurial” leadership as crucial for overcoming the deadlocked international negotiations on LOSC part XI from the late 1970s onwards. Finally, the extraordinarily broad scope of the LOSC negotiations enabled extensive use of issue linkages in order for parties to trade concessions for mutual benefit, conditioned by the ubiquitous awareness of the strong interlinkages between environmental- and other marine policy issues (Caminos and Molitor 1985).

The case of LOSC part XI is thus consistent with the theoretical expectation that leadership and issue linkages facilitate the successful formation of international regimes. In addition, the case offers several lessons of its own for the formation of a potential space resource regime. First, as with the LOSC, a regime for space resources will likely place priority on resource extraction rather than environmental protection, due to the diffuse and uncertain nature of environmental harm in outer space. The case of the LOSC and ISA suggests that this might require an arduous and long process of regime formation. The outcomes of that process, secondly, are subject to unpredictable political contingencies, as the recent discussions on a deep-sea mining moratorium show, also echoing the experience under the ATS. Third, there is a curious disconnect between the common-heritage aspirations of the LOSC and the development of operational rules under ISA that appear to center primarily on the interests of commercial operators and only secondarily on the collective rights of humanity as such (see Kim 2017). This seeming bias towards appropriation over benefit-sharing takes place in the shadow of the common heritage provisions of the LOSC that are substantially more precise than the ambiguous specifications of the Outer Space Treaty, where common heritage is merely one among several possible interpretation of treaty language on the common province of humanity as well as the benefits and interests of all countries.

CONCLUSIONS

In the context of rising political- and commercial interest in the exploration and exploitation of space resources, some serious thought is required for devising international solutions that broadly satisfy criteria of global equity between spacefaring- and non-spacefaring societies. One of the various options that figure prominently in the wider debate is an international regime that would regulate exploration and exploitation of space resources as the common heritage of humanity, an ambiguous

concept that revolves around non-appropriation, non-admissibility of sovereign claims, environmental stewardship as well as fair and equitable benefit-sharing (Joyner 1986). There are strong normative grounds for a common heritage-approach to space resources and the Outer Space Treaty, as the central international governance framework, is generally compatible with this approach although it does not explicitly mandate it (Butkevičienė and Rabitz 2022).

Regardless of its normative attractiveness, the analysis above suggests that the successful formation of a hypothetical, multilateral regime for the regulation of space resources as the common heritage of humanity has a considerable plausibility deficit. Reviewing key themes in the wider literature on regime formation, I have shown that space resources possess a situation structure that creates substantial problems of international collective action; that there is unlikely to be adequate leadership towards a multilateral regime; and that there are no obvious linkage strategies for solving the space resource conundrum through some sort of grand bargain between spacefaring- and non-spacefaring nations. The examination of historical precedents from instances of successful regime formation on resource governance challenges with similar characteristics suggests that a multilateral regime for space resources might take considerable time to negotiate; that contemporary growth in commercial stakes increasingly places cooperative solutions in jeopardy; and that unpredictable political contingencies might suddenly and irrevocably disrupt any and all efforts at devising a balanced international solution. In addition, the unclear implications of space resource exploration and exploitation for the outer space environment make it difficult to assess how a multilateral regime should calibrate the balance between commercial operations and environmental stewardship.

Theoretical analysis and historical precedent strongly suggest that a multilateral regime for the regulation of space resources as the common heritage of humanity is implausible. This may be regrettable for some and cause for relief for others. Yet for the wider problem of how to devise political arrangements that would secure some degree of global fairness and equity in the emerging space economy, it raises the question which other means might be available, beyond conventional multilateralism. To say this first: while a multilateral regime is implausible, any other means for achieving fairness and equity in the exploration and exploitation of space resources are likely to have lower degrees of effectiveness, irrespective of their greater political feasibility.

One alternative to conventional, treaty-based multilateralism is governance through goals. Unlike rule-

making, which prescribes, encourages, enables, restricts or prohibits certain types of behavior, goal-setting operates through diffuse steering effects and can gradually shift problem perceptions and facilitate the mobilization of political resources (Young 2017). An international goal to work towards fairness and equity in the utilization of space resources could be a catalyst for the later development of a robust implementation regime while also providing a normative backstop against the gradual shift towards a commercial extraction regime, including in contemporary interpretations of the non-appropriation provision of the Outer Space Treaty's Article 2. When the global distribution of technological, economic and other capacities remains unfavorable towards multilateral, commons-centered solutions, norm entrepreneurship is indispensable for triggering transformational policy change (Finnemore and Sikkink 1998). For space resources, such norm entrepreneurship would entail synergies with fair- and equitable benefit-sharing as a norm that has been emerging in a variety of international contexts over the past three decades (Morgera 2016).

Another pathway towards global fairness and equity in the utilization of space resources is in the orchestration of private actors from the space industry. Orchestration is a mode of governance whereby international organizations shape the behavior of private actors and institutions through non-binding, voluntary measures such as regulatory standards or codes of conduct (Abbott and Snidal 2010). In practice, this would entail an international bureaucracy such as the UN Office for Outer Space Affairs to provide guidance, recommendations and best practices for the commercial space industry to voluntarily engage in the global sharing of material and immaterial benefits associated with the utilization of space resources. The spotty track record of private governance arrangements on issues such as eco-labels, corporate net-zero targets or Environmental, Social and Governance standards implies a need to be realistic about what orchestration of private actors and institutions can accomplish (see Moog et al. 2015; Hale et al. 2022).

To conclude, conventional multilateralism is theoretically the best among a range of imperfect solutions for the management of natural resources in a transnational context. In principle, conventional multilateralism can deliver outcomes that are fairer and more effective than is the case for alternative governance solutions, both of the transnational and the soft intergovernmental type. Its major downside, however, is in the considerable political challenges that bedevil the formation of binding, multilateral regimes. The Madrid Protocol to the Antarctic Treaty, LOSC part XI and the recent agreement on biodiversity beyond national jurisdiction

are thus rare instances of success. That is to say nothing of their specific content, though: While the LOSC with its deep-sea mining regime is a milestone in the history of multilateralism, the desirability of deep-sea mining is a question of an entirely different nature (Kim 2017). The same applies for space resources: There is precedent for conceptualizing space resource management along the lines of an extractivist model flanked by a strong benefit-sharing component (Butkevičienė and Rabitz 2022). However, a prohibition of non-scientific space resource activities, analogous to the Madrid Protocol, may well be desirable to protect both the space environment and the terrestrial environment from diverse physical- and socio-political risks. In addition to the various issues raised here, there is thus also a need for stakeholders, and global society more broadly, to find common ground regarding the endgame of outer space governance.

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The author has no competing interests to declare.

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