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# Benefit-Sharing as Investment Protection for Space Resource Utilization

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## ABSTRACT

*Despite the adoption of several national space mining legislations, Space Resource Utilization (SRU) suffers from international legal ambiguity that increases investment risks. We consider the vagueness of the benefit-sharing requirements from space activities under the Outer Space Treaty Article I to be the main legal gap regarding SRU. To increase private investments into the SRU sector, we offer a way to address the legal uncertainty. We argue that: (1) there is a low likelihood of an emergence of a new international space-mining regime that would fix this uncertainty, and (2) the relatively low knowledge regarding the required processes, technologies, and final benefits of SRU prevent us from designing an effective, functional, and flexible way of sharing the benefits without significantly constraining private investments. As a fix we provide an investor-oriented approach that (1) shifts the responsibility for defining and proposing the benefit-sharing mechanism to private actors soliciting authorization for space mining; (2) considers the contributions of space-mining actors to the existing globally agreed goals, such as the Sustainable Development Goals or the Paris Agreement, as a form of ensuring the use of outer space benefits all countries in accordance with the OST Article I.*

**Keywords:** space resources, International Space Law, space policy, social license to operate, investment risks

## INTRODUCTION

**S**PACE RESOURCE UTILIZATION (SRU) HAS been of growing interest from commercial, scientific, policy, and legal perspectives. As investments into SRU continue to flow into the research and development of new technologies and missions, the sector continues to rely mainly on public investments, grants, and contracts. Unlike the global terrestrial mining sector that is expected to reach 1846 billion USD in 2021<sup>1</sup> and other low Earth orbit activities amounting to billions of dollars, the investor appetite for space mining is nowhere close to this. This is mainly because its profitability is yet to be demonstrated not only because of technological immaturity but also due to legal and regulatory uncertainty. These factors can be considered as investment risks, preventing bigger private investments and full unlocking of the immense economic potential of outer space. This article focuses on investments risks for private actors associated with legal uncertainty surrounding the Outer Space Treaty in regard to SRU and discusses ways of addressing it.

So far, the risk of legal uncertainty has been mitigated to some extent only by a handful of national legislatures clarifying the domestic legality of space mining, namely in the United States, Luxembourg, the United Arab Emirates, and Japan. However, these national laws remain controversial on the international level due to their lack of clarity over its compliance with the OST, namely OST's Article I benefit-sharing clause.<sup>2,3</sup>

We believe that this persisting legal ambiguity should be addressed sooner rather than later, to attract more investments and avoid any associated long-term risks. In this sense, we argue that any attempt to address these investment risks needs to be context-based and reflect the unique technological and international characteristics of the SRU sector. First, we argue that the absence of an international consensus or willingness

to provide a top-down global legal solution to the legal uncertainty of SRU and thus the associated investment risks require us to find novel, more practical, and investor-oriented policy solutions.

Second, we argue that the early technological progress of space-mining technology and our relatively low geological knowledge of celestial bodies inhibit us from a full understanding of the space resources' utility, costs of their utilization, and mainly the benefits they can offer. This, thus, impacts our ability to understand and decide about the best ways of sharing those benefits.

We first provide a quick overview of the SRU legal gap in the existing international regime and the resulting investment risks associated with this legal uncertainty. Second, we describe (1) the international context of SRU legal discussions and the improbability of an emergence of a new international agreement to address the legal uncertainty, and (2) the knowledge gap that prevents us from evaluating the benefits of space resources. Finally, we offer an investor-oriented approach to benefit-sharing for SRU that enables commercial actors to lower investment risks, and ensures compliance with the OST's benefit-sharing principles.

## LEGAL GAP AND ASSOCIATED INVESTMENT RISKS

The SRU concerns activities outside of national jurisdiction, and it thus requires its own special legal status. There are different legal concepts for treating resource utilization beyond national jurisdiction, including *res communis* (inexhaustible resources accessible by all), *res nullius* (exhaustible and appropriable resources by utilizing actors), or *common heritage of mankind* (deep seabed resources governed by a special international regime).<sup>3,4</sup> The Moon Agreement defines space resources as the "common heritage of mankind," requiring an establishment of an international regime. However, only 18 states are parties to the Moon Agreement and thus it can hardly be considered as a widely accepted international legal regime. We are, thus, left with the Outer Space Treaty as the main source of international space law.

The OST does not include the "common heritage of mankind" principle or any other classification of space resources. However, OST Article I and Article II are applicable to the question of SRU. The Article II of the OST articulated the *non-appropriation principle*, stating 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."<sup>5</sup> Being adopted in other areas of international law governing deep seabed or high seas, where resources are utilized, we cannot consider it as pro-

hibiting SRU.<sup>3,6</sup> An example of such utilization without appropriation is the use of orbital slots. What the Article II arguably prevents, however, is an adoption of generally applicable norms and rules by a single actor over such areas.<sup>7</sup>

Obligations for all space activities, including SRU, originate from the so-called *common benefits clause*, articulated in the Article I of the OST as: "the exploration and use of outer space shall be carried out for the benefit and in the interest of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind."<sup>5</sup> So although the Outer Space Treaty does not outrightly prohibit the utilization of space resources, and it prohibits a complete appropriation of Celestial bodies, it does, however, set the benefit-sharing precondition for all activities, including mining.

This is all we are left with in regard to the legal status of space resources and their use. The precise meaning of the OST's Article I benefit-sharing clause for SRU remains a topic of interpretations, and even by rejection. However, considering Article I as purely inspirational whereas other articles of the OST are to be legally binding has been criticized by many legal scholars<sup>8,9</sup> as well as the United Nations Committee on the Peaceful Uses of Outer Space.<sup>10,11</sup> Particularly contested is the question of what the obligations to share the benefits of outer space activities are.<sup>2</sup>

Without any international agreement that would additionally specify the legal status of space resources and their use, actors will have to ensure their actions are not viewed as violating this vague but binding obligation of the OST. In this regard, the applicability of the *common benefits clause*, enshrined in Article I of the OST, to SRU remains in our view the most unclear issue in the existing international space law regime; it is, thus, a source of legal uncertainty and, consequently, of investment risk.

The existing absence of a clear international legal regime for space mining prevents further investments.<sup>12</sup> The stability of the regulatory and political environment is critical for the attractiveness of any investments. The significant amount of investments required for space mining warrants minimization of the risks. To address the main risks for space-mining operations, the investors will seek (1) broadly recognized property rights to space resources, (2) clear conditions under which natural resources may be explored and exploited, and (3) legal protection and enforceability of rights.<sup>3</sup> As stated earlier, the main legal uncertainty this article is concerned with is the benefit-sharing principle.

The negative consequences of ill-compliance with the benefit-sharing principle can be legal as well as practical. If space-mining activities of some actors lead to legal disputes

over the rights to the mined resources or are simply viewed as illegal, this can also affect all miners' terrestrial activities and business relations. More seriously, disagreement over such basic pillars of the legal use of space resources can undermine the entire shared international legal framework.

The resulting negative consequences would be much more practical than just legal. An uncontrolled race for the control of resourceful areas and the emergence of rival parallel mining operations without adequate rules, protocols, and safety measures can dramatically increase costs, disrupt space operations, and threaten their continuation. For example, a competition over the control and use of the few water-rich permanently shadowed regions of the Moon's South Pole can leave all actors unable to carry out operations there.

Mining operations themselves or associated descents and ascents can eject large amounts of fine-grained lunar dust into the microgravity environment, damaging even a distant mining infrastructure,<sup>13</sup> or cover solar panels or reflection mirrors used for water extraction.<sup>14</sup> Clear rules and principles must be accepted and observed by all actors to be functional.

### UNLIKELYHOOD OF NEW INTERNATIONAL REGIME FOR SRU

If we consider the benefit-sharing as desirable, we must ask whether and how it would be feasible. However, there is no international taxing and redistributive authority that could simply provide global benefit-sharing mechanisms. A frequently given example of an international authority involved in benefit-sharing of resources utilization for the benefit of mankind is the International Seabed Authority (ISA). Established in 1994 with the goal of managing and distributing benefits of deep-sea mining, the ISA has not yet defined whether the benefits will be shared by direct payments, funded projects, or even how to determine each actor's share of generated benefits.<sup>15</sup> Besides not really showing itself as a functional example, it is also governed by the United Nations Convention on the Law of the Sea, which unlike the OST explicitly designs the deep seabed as the common heritage of mankind.<sup>16</sup>

There are no clear guidelines on how this legal question ought to be addressed. At the United Nations level, the proposal put forward by Greece and Belgium in 2019 to establish a dedicated *ad hoc* working group for discussing and studying the legal challenges of SRU was not supported.<sup>17</sup> A better outlined proposal to establish such a 5-year working group on space resources was adopted by the United Nations Committee on the Peaceful Use of Outer Space (COPUOS) at its 60th session in 2021.<sup>18</sup>

Previously, Luxembourg and the Netherlands submitted the Building Blocks for the Development of an International Framework on Space Resource Activities (BB) as a white paper for consideration at the 2020 session of the Legal Subcommittee meetings.<sup>19</sup> The BB are a result of a multi-stakeholder dialogue within the Hague International Space Resources Governance Working Group (HWG). Concerning the question of the benefit-sharing, the BB only call for an actor to give "due regard" to the interests of all countries and humankind, not calling for any mandatory or concrete fulfillment of the OST Article I.

Further, the BB recognize the benefit-sharing principle only in terms of symbolic promotion of participation in space resource activities, especially among developing countries, through education, information sharing, joint ventures, or technology exchange. And although the BB also propose the sharing of benefits into an international fund, they simultaneously explicitly reject any mandatory monetary contributions from mined resources.

The HWG's approach builds on problematic assumptions. First, by limiting the shared benefits to the area of promoting participation in SRU, it gives a message that all countries, including developing countries, need to participate in the utilization of space resources. This not only limits the sharing of the benefits to those who can participate in such a sophisticated high-tech activity as SRU; most importantly, such an approach is unrealistic since it makes no sense for all 195 countries in the world to be mining in space.

Developing nations face a lack of resources to address the most basic needs of their populations; participating in space resource activities certainly does not rank high among those needs. Shared information, joint ventures, technology exchange, and education on SRU would provide zero benefits to developing societies without the capacity to make use of it. Further, in the globalized economy of the 21st century, there are very few things every single national economy is capable of doing or should logically do due to the logical division of labor, supply chains, and effective diversification of economies, industries based on national capabilities, resources, history, and development.

Rather than being based on ensuring all countries and humankind benefit from SRU, as mandates the OST Article I, the HWG's view is based on sharing benefits only with those advanced and capable countries, who can afford to mine. Unless the international community agrees to the creation of a new legal regime, the BB building blocks are short in offering any solution to the legal uncertainty over the benefit-sharing principle.

In the face of the unwillingness to establish a working group to only discuss the legal questions over SRU at the

United Nations level, the United States and 10 other countries signed the Artemis Accords (AAs) as a new legal regime for activities at the Moon, including resource utilization, for countries planning to participate in the United States Artemis lunar program. The AAs have provided essential rules and principles for lunar operation, including the establishment of safety zones.

However, it has drawn criticism for circumventing the UN processes, weakening the international space law, sanctioning the first-come-first-served principle, and not addressing the existing legal uncertainty for SRU that exists within the OST regime.<sup>20</sup> It has also highlighted the limits of the AA in their essential impossibility of including all countries and serving as a globally accepted and thus functional legal framework for lunar operations. Moreover, the criticism of Russia and the geopolitically homogeneous list of AAs signatories show that space resources are not immune to geopolitical realities, which is quite the opposite. In such an environment, an international consensus on the new international regime of SRU is simply not feasible.

## KNOWLEDGE GAP IN UNDERSTANDING SRU BENEFITS

There are no clearly defined and understood value chains for any area of SRU. The SRU value chain can be divided into different phases from prospecting resources, establishing operations, mining, transporting and refining the resources, to manufacturing goods, beneficiating materials, and supplying them to users.<sup>21</sup> However, technology in each of these steps is still in development and lacks sufficient ground truth for its fast advancement.

The research and development of different chemical methods for the separation of desired minerals from regolith cannot be just simply tested on a Celestial body due to the costs. The research and development rely fully on the use of regolith simulants and simulated conditions. Because regolith simulants can usually only simulate properties of some minerals or of one particular characteristic of the real regolith, the experiments can never offer a sufficiently accurate picture.

Further, even the very first step in the SRU process, the prospecting of a Celestial body for locating resourceful areas for mining, remains in early development. Prospecting continues to be dependent mainly on remote sensing by either ground sensors and on a few occasions by orbiting probes around the Moon, Mars, or even asteroids. *In situ* prospecting by analysis of the actual samples remains scant and only limited to very few complex missions but it is also restricted by the use of limited tools for such analysis aboard the space vehicle.

Prospecting by sample return that allows a real thorough analysis at terrestrial laboratories has been so far carried out only on a few occasions with samples from the Moon (Apollo, Luna and Chang'e programs), whereas there is an ongoing NASA-ESA sample return mission on Mars, and on sample-return missions to three asteroids (completed visits to 25143 Itokawa and 162173 Ryugu, and ongoing sample return from 101955 Bennu).

The geological knowledge, thus, mainly covers only the surface composition of regolith, which does not serve well for estimating the sub-surface content due to its weathering over millions of years under the influence of solar radiation, meteorite impacts, and other cosmic events.<sup>22</sup> This limitation in the so-called ground-truth limits our understanding of where to mine but mainly complicates the development of adequate techniques and methods based on the actual composition of regolith.

This includes not only extraction methods but also the purification, storage, and beneficiation of the materials as key steps toward making the resources ready for use. Asteroid mining also faces many distinct technical challenges. Asteroids' low porosity and microgravity environment can complicate any collection of regolith. Dangerous ejecta can be caused by an interaction with the body,<sup>23</sup> small impacts,<sup>24</sup> or its fast spin,<sup>25</sup> whereas the complex microgravity can complicate close proximity operations. Simply said, we just do not have enough data and capabilities yet.

To give a more concrete example, we look more closely at one of the most advanced SRU areas: the mining of water ice on the Moon for its separation into liquid oxygen and liquid hydrogen and their use as rocket fuel. Water ice has been detected by various means in the permanently shadowed craters and regions on the Moon's south pole. Proposed concepts include the heating of the frozen regolith for evaporating water for collection at the bottom of permanently shadowed craters that can be fueled by the solar energy from the regions of high illumination at the craters' edge peaks.

However, the water content estimates range widely from 2.9 to 55.6% and 30% water content by LCROSS and Chandrayaan-1 remote probes, respectively.<sup>26,27</sup> The exact characteristics of the form of water ice and its purity are also hard to estimate only from remote sensing. This further complicates the choice of the most suitable water extraction methods from complete atmospheric or hot rod heating<sup>28</sup> to drilling and its subsequent furnace heating.<sup>29</sup>

Even other methods of extraction of oxygen for fuel not only from water but also from metal oxides in the Moon's regolith remain only at Technology Readiness Level (TRL) around 3–4.<sup>30</sup> Further, there are critical steps that require



either electrolysis of the water to separate oxygen and hydrogen, purification of the substances, as well as their liquefaction and cryogenic storage. The equipment for these operations also remains at TRL 3–4.\*

In the case of near-Earth objects, the technology for their utilization continues to be even more unclear as distant rendezvous and proximity operations of these low-gravity bodies continue to be challenging; however, the extremely low porosity of loosely assembled near-Earth objects can present a challenge to their extraction, possibly leading to either their full capture, partial disintegration, or other impacts in the bodies.<sup>31</sup> However, asteroids are potentially extremely valuable from their economic, scientific, and security perspectives, with each of these benefits requiring their own policy and legal perspectives.<sup>32</sup>

The benefits that SRU provides in different areas, from economic, scientific, humanitarian, or security terms will be defined by the specifics of the necessary technology, supply chains, costs, and final utility of the resource. Resources for rocket fuel are beneficial in a different way than minerals for additive manufacturing and will likely have different markets and values. Similarly, they should have different benefit-sharing models, just as we apply to different resources on the Earth.

Deciding on the ideal benefit-sharing model will, thus, require detailed knowledge of these details. Knowledge of the scope and type of SRU benefits is critical to the discussion over what benefits can be acquired from specific SRU operations. They will be very different and so should be the legal requirement for sharing benefits of the utilization of those resources.

Overall, the limited prospecting capabilities prevent us not only from understanding where to carry out what operations but also mainly from understanding what exact methods, processes, and techniques will be required. Further, the limited testing opportunities, caused by reliance on regolith simulants and unavailability of *in situ* testing, are an obstacle to the development of required technologies within the different steps of SRU.

Without these critical steps, it seems difficult to correctly assess the actual SRU costs and mainly its resulting benefits. Putting in place a static benefit-sharing mechanism, a fixed tax rate, international redistributive systems, or any pre-defined formats of monetary retribution for space mining activities, without the knowledge of what the benefits can bring, seems like a blind approach.

\*Such estimates have been presented in the past for example by Europe's prime provider of cryogenic rocket fuel AirLiquide.

## INVESTOR-ORIENTED BENEFIT-SHARING

Legal gaps do not necessarily need to be fixed only by new legal regimes. This is especially true both for global issues, where consensus on international regulation is hard to come along, and for quickly evolving technology areas, where governments stay always far behind the private sector in its regulation. Addressing the limitations described earlier, we outline a desirable and feasible legal fix for investment protection. This approach rejects a top-down static and homogeneous approach of fixed centralized benefit-sharing mechanisms and rules, which would require a new international authority and institutions.

Instead, the fix to the benefit-sharing legal gap is based on the earlier mentioned challenges for SRU—the lack of complete knowledge of the SRU processes and benefits, which does not allow for an effective definition of benefit-sharing mechanisms, and the unlikelihood of an international redistributive regime SRU. Concretely, the approach utilizes private actors' own motivation to protect their investments from legal uncertainty and additional costs by disruptions, and it partially shifts the responsibility to define and propose benefit-sharing mechanisms from international or national authorities to the private actors themselves.

There is no need for additional international or national definitions of what constitutes the benefits and interests of all countries or how precisely any SRU project must contribute to it. There are already various globally adopted goals that the international community has consensually approved, and thus the private actors could define their contribution to those in any way they find the most effective and continue to update it with progress in their technology and changes to the globally adopted needs of all countries. Therefore, national authorities authorizing the proposed SRU operations and the compliance with the benefit-sharing mechanisms with the OST would only have to ensure the contributions are proportional and clearly defined in national legislation.

## PROTECTING INVESTMENTS WITH SOCIAL LICENSE TO OPERATE

The OST's principle that the use of space must be done for the benefit and in interests of all countries should not be disregarded, because it is difficult to comply with. Instead, it should be seen by private actors as an opportunity to gain global legitimacy and acceptance of commercial activities, and thus protection of their investments. For space-mining companies, the legal gap becomes a source of investment risk that is in their interest to fix.

Similarly, terrestrial mining companies are already faced with investment risks from legal uncertainty, especially in

areas with weak government control and inadequate regulatory frameworks. To protect their investments in such situations against potential disruptions, sabotage, and additional costs, companies have been relying on Social License to Operate (SLO).<sup>33</sup> The SLO is a risk-reducing tool to avoid costly conflicts with communities affected by mining operations, based on an ongoing process of acceptance and approval between the communities and investors.<sup>34</sup>

In other words, terrestrial mining companies develop relationships with the communities affected by their mining operations to understand their needs to be able to compensate any occurring costs imposed on the communities by mining in their residential areas. This is done as a prevention to avoid a creation of any grievances that could result in additional costs of their industrial operations by protests, attacks, sabotage, or other disruptions. An affected community can be local,<sup>33</sup> with direct impact, wider,<sup>35</sup> with broad social impact, or multinational,<sup>36</sup> with indirect cross-border impact. The application of SLO to space mining as a means of investor protection has been explored in the past, for example by Svec *et al.*<sup>3</sup>

The SLO is considered to be based on an ongoing acceptance and approval of the benefit-sharing of mining operations by the affected communities. Given the fast-changing technology progress, evolving understanding of the utility of space resources, and growing knowledge of how it can be beneficial, an ongoing evaluation of how these benefits can be the best shared is a more suitable format than a fixed monetary contribution of the final revenue. Terrestrial mining companies, in this sense, invest in public infrastructure development projects; they provide local employment and develop partnerships with local businesses and work with the community and different social groups in the affected communities.

Likewise, SLO for space mining would have to constantly reflect on the ways they contribute to the community according to their own technological progress to gain approval. This is similar to other commercial sectors where companies develop corporate social responsibility to give back to the society.

For space mining, the most effective way of benefit-sharing would be contributions through space capabilities that are essential for addressing many global challenges both in space (*i.e.*, space debris, planetary defense, space weather) and on the Earth (*i.e.*, addressing climate change, increasing access to space capabilities and technology, education and science, crisis management and disaster relief, telecommunication).

As the affected community in question of exploiting space resources, we consider the international community as a whole. This is because of the language of the OSTs that declares space as the province of mankind in which all activities,

including SRU, must be carried out in the interest and benefit of all countries. Resultingly, the international community is the only community with the capability to not only legitimately challenge but also accept resource utilization in space according to the OST.

Private actors would need to ensure acceptance by the global community based on their ever-changing needs and requirements. There are plenty of global as well as local needs, whose addressing can be acknowledged as in the benefit and interest of the international community. These needs and challenges, however, cannot be completely left for the private actors to decide on since it is the nation-states that remain to be the ones authorizing and carrying legal liability for actions in space. Ill-compliance of national legislation with international law does not justify international wrongful acts.<sup>37</sup> Therefore, creating a national law addressing SRU compliant with the Outer Space Treaty is the only way to make international space law in this area work.

## DEFINING GLOBAL BENEFIT-SHARING

We approach this discussion with the assumption that the development of the SRU sector is in the interest of society and thus also national governments. Therefore, burdening space mining projects that are already risky and provide only a long-term investment return with complicated taxation that would be subject to new emerging regulations and changes is undesirable. Instead, governments tend to issue tax exemptions to attract foreign direct investment and tax credits to incentivize private actors to participate in economic activity that is considered beneficial for society.

They should consider the same thing for space mining. Providing a stable legal regime, in our case a legal regime that fixes the benefit-sharing legal gap, is also an incentivizing move.

However, there is no way to ensure all 195 countries are directly benefiting from every particular SRU operation that can take decades. First, every nation has different needs and interests, which eliminates the possibility of customizing the contribution to every single of them. Second, these interests change quickly with progress or sociopolitical changes. The question also remains whether such benefit-sharing can be done according to the principle of an equally distributed share of benefits or with a goal of redistributing from the wealthy to poor countries, for example in the form of per capita income by each country.

A fixed static system would be ineffective, not provide any real benefits, and rather prove to discourage than incentivize investors into space mining. Further, the evolving understanding of SRU processes, possibilities, and its actual execution does not make a fixed and static format of

benefit-sharing for decades-long projects logical. To provide share benefits without assessing the contemporary needs and interests of every individual country, we can turn to already globally agreed shared goals and agendas that can be understood as global interests and benefits.

These include, for example the Sustainable Development Goals, Space Agenda 2030, Guidelines for the Long-term Sustainability of Outer Space Activities, or the Paris Agreement. Benefit-sharing would, thus, be defined by contributions to achieving these globally defined goals.

To clarify the process, national authorities can outline the specific areas of globally agreed goals to which private actors applying for space-mining authorization must contribute by their own preferred mechanism. This can even take the form of Nationally Determined Contributions (NDCs) that remain the main voluntarily defined format of nation-state compliance with the Paris Agreement. States can even set up concrete joint ventures in which a space-mining company provides certain capabilities to develop a complete service or package that provides globally established benefits. In the space domain, this could include areas such as space debris removal, space weather, or near-Earth object monitoring.

A concrete example of such a globally beneficial joint venture is the emergency.lu initiative between the Luxembourg government and the SES satellite company, in which the space company uses its existing satellite communication capabilities to re-establish critical communication in disaster-hit areas within hours anywhere in the world free of charge.<sup>38</sup> Such benefit-sharing would be somewhat costly but since it would be defined by the private actor it could be based on an already existing capability and be much less pricey compared with any set and imposed distributive mechanism.

Further, it is important to mention that SLO is mostly an ongoing relationship rather than a set structure. Private space actors need create trust within the international community by their actions so when it comes to presenting their contributions to global interests and benefits to procure a social license to mine in space, their proposals appear credible. Some New Space actors, such as SpaceX, continuously portray their space activities within the larger perspective of the civilization fate of humankind, aiming at saving humanity's future by spreading its presence to other celestial bodies, increasing the accessibility and affordability of space, and providing internet access to those left out.

However, what specifically qualifies as an activity toward global benefits and interests will have to be defined not only by them, but also come out of interactions and processes between all stakeholders that private actors, national governments, and the international community must participate in.

Given the length of the space-mining operations, such an approach would enable national governments to develop long-term projects and address long-term global challenges by specifying areas to which commercial mining entities must contribute. Further, the UN COPUOS can serve as an ideal platform not only for discussing the needed global contributions in these areas but also for commercial entities to demonstrate to the international community compliance with the benefit-sharing principles of the OST in specific space-related areas.

This approach will require active participation of both sides, the private actors and governments. A clear legal framework that addresses the legal gap and provides protection of investments into space mining is an advantage that national governments can create. Just as the Luxembourg space-mining law had a significant impact on attracting large amounts of private investments into the country in the space sector, lowering investment risks by better compliance with international law while offering a significant degree of flexibility are key incentives to attract more investments into space mining.

On the other side, private actors will have to invest into demonstrating their credible benefit-sharing solutions by building a strong relationship with the international community. In exchange, they can enjoy a significant degree of flexibility and thus effectivity in defining their contributions and ensure effectivity and rentability of their investments, unlike those with questionable compliance with the OST's Article I or subject to a fixed tax or a static redistributive mechanism.

## CONCLUSION

With the growing plethora of global challenges in a dire need of addressing, it is unlikely that private companies will get a completely free reign over their activities in space, especially over the exploitation of space resources. However, compliance with the OST benefit-sharing principle does not have to be a heavy burden that leads to sharing of very little of the actual benefits and discourages investors. Instead, it can be a powerful tool for lowering investment risks not only by fixing the existing legal uncertainty and strengthening international space law, but also by nurturing a wider societal acceptance of space mining and commercial space activities as responsible endeavors and not billionaires' pet projects and joy rides.

Since the SRU remains a nascent commercial and technological activity that possesses not only great potential but also many unknowns, we cannot let our lack of understanding constrain it. The utilization of space resources for fuel,

additive manufacturing, or life support systems is yet to be proven and full value chains are established. Once these processes are defined, each use of resources will enable different capabilities, which can themselves be used to solve issues of global interest. Each area of space resource use will be embedded by different technologies and actors with different activities. Each actor and each activity will thus possess their own unique potential to provide benefits for all humankind and comply with the OST.

Defining the ways to satisfy the common benefits clause ought not to be left fully on national governments without complete knowledge of the ever-changing technological and knowledge capabilities. Neither can be the compliance with international law be completely left in the hands of private actors, for whose actions the licensing national government remains responsible. However, we can turn to the defined areas of internationally agreed global goals, such as Sustainable Development Goals (SDGs) or the Paris Agreement, and leave it to the private commercial SRU operators to propose the most effective way they can contribute to them.

This way we will avoid restricting the visionary drive of New Space entrepreneurship and allow it to unlock the immense potential of outer space to benefit all humanity in a greater way.

## AUTHOR DISCLOSURE STATEMENT

Simon Pete Worden, a co-author of this article, is a member of the journal's editorial board.

## FUNDING INFORMATION

No funding was received.

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