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Broadening Benefit as a Pathway to the Widely Accepted Development of Extra-terrestrial Resources

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Abstract

Although considerable attention has been focused on the non-appropriation (Article 2) and exploration and use clauses (Article 3) of the Outer Space Treaty (OST) and the common heritage language of the Moon Agreement (Article 11.1) when discussing space mining, there are indications that the OST's benefit clause (Article 1) may emerge as a key to achieving broad international support for commercial mining operations beyond Earth. The multilateral utility of the benefit concept is evident in frequent references to it in such contexts as UNCOPUOS, GEO, the Hague Space Resources Governance Working Group, and numerous international space conferences. Because states will ultimately evaluate "benefit" in terms of its impact on their citizens and their wellbeing and not on the history of its use in legal proceedings, the study of the concept's potential to create a receptive and permissive environment for commercial resource development off Earth is inherently political and economic. Fortunately, there is a rich array of terrestrial experience that can help provide insight into how mining interests have been reconciled with those of the communities in which they have operated. There are also insights to be drawn from unsuccessful examples. This paper will seek to highlight best practices from the terrestrial experience that can illuminate the challenge of broadening the benefit base for space mining. Additionally, it will offer an initial assessment of the applicability of the terrestrial experience to the special context of extracting resources from sources in space. The paper will also draw on recent work of the Secure World Foundation to improve the understanding of value creation through space activity, since the ability to add and communicate value that can have broadly favorable impact increases the range of potential benefits that could flow from the development of space resources.
Keywords: space resources, benefit, benefit-sharing, commercial space, extractive industries

Acronyms/Abbreviations
Access and Benefit Sharing (ABS)
Convention on Biological Diversity (CBD)
Committee on the Peaceful Uses of Outer Space (COPUOS)
Corporate Social Responsibility (CSR)
Nagoya Protocol [to the Convention on Biological Diversity] (NP)
Outer Space Treaty (OST)
Precision, navigation and timing (PNT)
Reducing Emissions from Deforestation and Forest Degradation (REDD+)
United Nations General Assembly (UNGA)

1. Introduction

As private sector space companies around the world push forward on the financing and implementation of business cases focused on surveying, accessing, extracting, and utilizing space resources ("space mining") and as governments consider the proper regulatory and legal frameworks to enable this activity in a manner consistent with international law governing space activity, the topic of benefit arising from space resources development, and the sharing of those benefits globally, has emerged as a central issue.

In discussions during the April 2017 United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) Legal Subcommittee agenda item on "General exchange of views on potential legal models for activities in exploration, exploitation and utilization of space resources," numerous delegations expressed views on, or questions about, the relationship of space resources development to the benefits of space exploration to humankind, to society, and/or to developing nations [1]. From the discussion it was clear that a diversity of perspective exists on the relationship between space resources and benefit and that there is need for further discussion on this issue. The importance of the linkage to benefit has long been recognized within the space resources development community; for example, a paper published in 2000 looking at lessons for space resources policy from international mineral economics and law finds that "economic rationale must be clearly defined, and must

show a strong potential for financial and social benefits" in order to find a supportive government policy environment for space resources development. [2]

The importance of the concepts of benefit, benefit-sharing, and the relationship to government frameworks is not unique to the nascent space resources industry. In fact, benefit has a long history as a core component of international space governance philosophy and has been key reaching agreement on frameworks for the successful growth in society's use of a variety of space-based systems. These concepts have also been addressed in several terrestrial extractive industries (including mining, forestry, and genetics/biopharmaceuticals) at both domestic and international levels. As international and national fora consider the relationship of benefit to space resources oversight, it useful to review prior experience and practice for guidance on the path forward. As most near-term, credible business plans in the space resources sector focus on applications in-space, rather than on delivering materials to Earth, terrestrial terms-of-trade issues associated with space resources have largely been excluded from the analysis in this paper.

2. Origins of 'benefit' as a concept in space governance

The idea that space activity could and should contribute to benefit for all humankind through substantial improvements to life on Earth is deeply rooted in the thinking of the international community. In the 1958, United Nations General Assembly (UNGA) Resolution that created the first ad hoc Committee on the Peaceful Uses of Outer Space (COPUOS), the concept appears twice in the preamble and once in the resolution itself:

> *"Desiring to promote energetically the fullest exploration and exploitation of outer space for the benefit of mankind,*
> *Conscious that recent developments in respect of outer space have added a new dimension to man's existence and opened new possibilities for the increase of his knowledge and the improvement of his life,…*
> *1. [The General Assembly] Establishes an ad hoc Committee on the Peaceful Uses of Outer Space … [and requests it to report on] …*
> *(b) The area of international co-operation and programmes in the peaceful uses of outer space which could appropriately be undertaken under United Nations auspices to the benefit of States irrespective of the state of their economic or scientific development, taking into account the following proposals, …" [3]*

Moving quickly from a general aspiration that space activity would benefit "mankind," the preamble adds an important clue to the nature of the benefit expected; new dimensions to human existence, increases in knowledge, and improvement in human life. In the pages that follow, we will draw frequently on these aspirations as we seek to outline a pathway of action that could lead to a consensus that the development of physical resources off-Earth can deliver benefits well beyond the borders of the States authorizing the missions and that it can bring improvements to the lives of a broad cross-section of the world's people.

The text of this early UNGA Resolution also presents some important challenges when it establishes a clear goal that the benefits of space should be available to countries "irrespective of the state of their economic or social development," and when it adds "States" to the community to participate in the benefits of space activity. As we know the interests of States and those that live within them are not always the same. In fact, within a year, in the resolution that established COPUOS as a permanent committee, the benefit language had already evolved to make States its object. Fortunately, the "betterment" of people was still an objective:

> *"Believing that the exploration and use of outer space should be only for the betterment of mankind and to the benefit of States irrespective of the stage of their economic or scientific development." [4]*

This language remained essentially the same by the time the General Assembly agreed in 1961 on the resolution "International Cooperation in the peaceful uses of outer space [5]. Nonetheless sections C and D of that resolution introduced important clues to the emerging understanding of benefit with very specific instructions to assist States where needed in their efforts to benefit from the rapidly developing meteorological and telecommunications applications of space technology. Although the idea of benefit would become more complex with time as capacity building and technology transfer were integrated into the definition of benefit, simple participation in the fruits of advancing space technology continues to be a core component of the concept.

By the mid-1960's, the concept of benefit had become intricately interwoven with cooperation. This can be seen with the General Assembly adopting unanimously its resolution, "International cooperation in the peaceful uses of outer space." That linkage may prove particularly useful in meeting the benefit objectives of that other mid-60's document, The Outer Space Treaty, since it opens a natural pathway for including partners at various stages of economic development.

The Outer Space Treaty carefully integrates exploration, use, benefit and cooperation into a coherent

statement of principles even managing to draw on the benefit to peoples language in the preamble:

> *"Believing that the exploration and use of outer space should be carried on for the benefit of all peoples irrespective of the degree of their economic or scientific development," [6]*

Just a few lines later, however, in Article I, we see a return to the benefit to States language:

> *"The exploration and use of outer space, including the Moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind." [7]*

Most importantly, the OST reflected a combination of practical thinking and idealistic anticipation that, incorporated into broadly accepted positive law, provides fertile ground for cultivating a culture of benefit in newly emerging space capabilities and activities. Amidst all the detailed discussion of nuanced meanings of specific articles of the OST, it is worth noting what inspired its parties:

> *"Inspired by the great prospects opening up before mankind as a result of man's entry into outer space,*
> *Recognizing the common interest of all mankind in the progress of the exploration and use of outer space for peaceful purposes," [8]*

By the late 1970's, the specific application of benefit to the exploitation of off-Earth resources had made its way into the annex of the Moon Agreement as an example of why States parties to that treaty had chosen to adopt it.

Two decades later, the UNGA would bring considerable precision to its understanding of the synergy of cooperation and benefit through its "Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit of All States, Taking into Particular Account on the Interests of All Countries." [9] In the annex to that resolution, paragraph 5 is particularly applicable to the commercial development of off-Earth mining activity:

> *"5. International cooperation, while taking into particular account the needs of developing countries, should aim, inter alia, at the following goals, considering their need for technical assistance and rational and efficient allocation of financial and technical resources:*
> *(a) Promoting the development of space science and technology and of its applications;*
> *(b) Fostering the development of relevant and appropriate capabilities in interested States;*
> *(c) Facilitating the exchange of expertise and technology on a mutually acceptable basis.*
> *space among States." [10]*

Each of the goals above has examples of successful application in terrestrial mining situations demonstrating that off-Earth implementation could also be a useful pathway to broadening the base of benefit received on Earth.

Acknowledging the importance of the 1997 Benefits Declaration, the third UN Conference on the Peaceful uses of Outer Space, UNISPACE III, met two years later under the theme, "Space Benefits for Humanity in the Twenty-first Century." Not only did the 157-page report of that Conference include 168 references to benefit in the context of space activity, it also specifically acknowledged space mining as an emerging commercial possibility "with challenges." [11]

In the 18 years since UNISPACE III, its report including the Vienna Declaration it adopted has set the agenda for the UN Committee on the Peaceful Uses of Outer Space, an agenda that has provided ample time to pursue benefit for an increasing number of countries. For much of that time, however, any discussion of the benefits that might arise from space mining was conducted in a speculative environment. Now as we approach the UN's fourth space policy conference, UNISPACE+50, scheduled for June 2018, what used to be seen as a "someday" possibility looks increasingly imminent. With space mining looking more and more likely, it is worthwhile to see what lessons can be learned from other cases of benefit in space and terrestrial extractive industries as we look to both develop a new commercial use of space and meet the deeply rooted objective of broad-based benefit.

3. Treatment of 'Benefit' in Multilateral Space Initiatives

Before examining how the concept of benefit can be applied to space resource development, it's helpful to understand how the provisions discussed in the previous section have already been applied to applications and resources derived from space technologies. The Outer Space Treaty both enshrines both the concept of non-appropriation (Article 2) and exploration and use (Article 3) in space and highlights the importance of benefits from space (Article 1). This decision not only "opened the way for individual states to explore and use outer space" but also lead to "a series of evolving negotiations and agreements between states limiting activities in outer space and imposing obligations on distributing the benefits derived from exploring and using outer space." [12] This section will look how the

concept of benefit has been instrumental in multilateral space initiatives related to remote sensing.

3.1 Remote Sensing

Remote sensing, "the observation of the Earth's land and water surfaces by means of reflected or emitted electromagnetic energy," represents a well-documented case of international negotiation and eventual broad support for governmental and commercial activities. Multilateral discussions about how remote sensing should be regulated started in the late 1960s and continued throughout the 1970s. [13] This excerpt from the 1978 report of the COPUOS Scientific and Technical Subcommittee encapsulates many of the prevailing views:

> *"Some delegations reiterated the view that the dissemination of data obtained by remote sensing must be subject to prior consent and should be made available freely to the sensed State as an expression of respect for its sovereignty and not be distributed to third parties without its consent. Other delegations were of the view that primary data ought to be available for open dissemination. Some delegations also expressed the view that analysed information was the work product, and the property, of the analyser and therefore could not be treated in the same manner as primary data. Still other delegations expressed the view that the remote sensing data with a certain special resolution should be circulated solely with the consent of the sensed State." [14]*

The Legal Subcommittee of COPUOS concurrently debated many of the same issues related agreeing on the best way forward for an international legal and regulatory framework for remote sensing without advancing a consensus position. It wasn't until 1986 that COPUOS was able to reach agreement on the Principles Relating to Remote Sensing of the Earth from Space, which were subsequently forwarded to the General Assembly and adopted unanimously. [15] This achievement was spurred by the continued advancement of remote sensing technology "including the dissemination of primary data, processed data, and analyzed information, particularly following the successful LANDSAT operations after 1972." [16] Though the concept of benefit was not the primary driver in negotiations, it was a major consideration that eventually helped lead to compromise among various positions. Christol describes the evolution of thought thus: "During the negotiations it became evident that the space-resource States were going to continue to engage in fact-gathering via satellite despite the protestations and excessive limits sought by the sensed countries. During this period, it was also evident that the sensed States, no *less than the* sensing countries, were deriving very substantial benefits from the product of sensing activities." [17]

The Principles themselves also highlight how a variety of national needs can be meet. The Principles include several provisions protecting less technologically developed states, particularly in their right to access any data related to their territory. Principle XII states:

> *"The sensed State shall have access to them on a non-discriminatory basis and on reasonable cost terms." [18]*

The output can be summarized thus: "the special needs of developing countries were formally affirmed in Principles II, IX, XII, and XIII. Further, sensing States committed themselves in Principles II and IV not to discriminate by reason of the economic, social, scientific, and technological developmental conditions of States." [19] Agreement would not have been reached if the various parties had not acknowledged the importance of derived benefit for all, rather than just those carrying out the remote sensing [20].

The Principles represented the first step in regulating remote sensing. States retain the ability to regulate companies within their borders as they wish and each does so differently. Still, it's important to note that ensured benefit was a frequent discussion point during the development of the Principles and continues to be part of the discussion following.

4. Treatment of Benefit-Sharing in Terrestrial Extractive Industries

Having looking at concepts for how benefit is elaborated and defined, it is instructive to also look at how mechanisms for sharing that benefit have been developed. Doing so both further elucidates various concepts for the how benefit might be identified and suggests structures and approaches for how access to benefit from industry activity and development can be achieved in a manner consistent with principles based in international law.

Discussion of benefit sharing as an issue in the governance of resources based industries is not unique to the space sector - and in fact has been a key topic in terrestrial extractive and natural resources industry sectors - including forestry, genetic (biological) resources, mining and hydropower. As a result "the concept of benefit sharing - meaning the division and distribution of monetary and non-monetary benefits in a way that has equitable outcomes and is procedurally fair, has seen growing adoption in the development and conservation discourse in recent years." [21] As much of this research deals with problems, challenges, and solutions which may be instructive to current

discussions within the space sector - including such things as types of benefit sharing regimes, treatment of common-pool or shared resources, and balancing of domestic and international law - it is useful to review it.

4.1 The Convention on Biological Diversity (CBD)

Perhaps one of most-well defined approaches to benefit sharing in international law can be found in the 1992 Convention on Biological Diversity (CBD), ratified by 196 countries (note: the U.S. has signed, but not ratified the CDB), and the subordinate Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefit Arising From Their Utilization, which entered into force in 2014. The CBD focuses on international governance approaches for sustainable development and biodiversity based on three pillars: "conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising from the use of genetic resources." [22] The philosophy of benefit sharing contained in the CBD has been reflected in other multilateral agreements related to natural resources use, including the International Treaty on Plant Genetic Resources for Food and Agriculture, and in discussions of the Parties to the UN Law of the Sea Convention and to the Antarctic Treaty. [23]

The Convention's treatment of benefit sharing related to genetic resources - which pertains to biopharmeceutical and biotechnology trade and research - represented a dramatic shift in the treatment of genetic resources in international law. [24] While a detailed discussion of the origins and objectives of the CBD are beyond the scope of this paper, "prior to the CBB there was no international mechanism to share the benefits arising from the development new products of patent [sic] with the provider of such resources…" [25] Prior to the CBD natural genetic resources were considered as common heritage resources and available to all for access and use. The Convention established that genetic resources were subject to national sovereignty, that nations had the obligation to "control access to and share in the benefits arising out of the utilization of it's genetic resources." [26] To further enhance this principle the CBD Parties began a long negotiation process to develop an international legal framework for benefit sharing, resulting in the Nagoya Protocol (NP). [27]

The negotiation history of the Nagoya Protocol reveals discussion of a number of issues and solutions that find parallels in current discussion of space resources utilization. An non-exhaustive of these includes:

- *Treatment of "raw" materials vs. "derivative" products thereof.*
- *Establishment of benefit-sharing agreements on case-by-case through bilateral negotiations between parties defined on a country of origin basis.*
- *Treatment of intellectual property rights.*
- *Balancing of developing countries and developed countries interests, and the establishment of an international implementation and capacity building fund - funded by Governments, and not through direct contribution by the private sector.*
- *Distinctions between commercial and non-commercial research use of genetic [28]*

A primary tool for benefit sharing under the CBD and the Nagoya Protocol - implemented through national legislation - is the Access and Benefit Sharing (ABS) Agreement. Under the protocol ABS agreements "between users and providers of genetic resources, that became a condition for obtaining access to the resource." [29] On a bilateral, case-by-case basis, ABS agreements regulate access to genetic resources and stipulate how the benefits resulting from that use are shared. States parties to the Protocol are obligated to establish a national ABS regime. Since the Nagoya Protocol only entered into force in October 2014, data on the effectiveness of its implementation is limited. A number of countries, including the European Union, India, Brazil and South Africa have undertaken steps to implement the Protocol through domestic legislation and policy - a 2016 analysis found that 39 countries have national ABS laws in force. [30, 31] The nature of the ABS regime is discussed further in a following section of this paper.

4.2 Approaches to Benefit Sharing

While several efforts have been made to develop a literature-based typology of benefit sharing mechanisms used in natural-resources based industries, no consensus exists. [32] However, it is possible to identify and review a few of the more common structural approaches. The following list is not an exhaustive list of benefit sharing approaches, but is rather an identification of some of the more common.

4.2.1 Access and Benefit Sharing (ABS) Under the CBD

Under the CBD and NP states party are obligated to manage access to and sharing of benefit from genetic resources through the primary

means of ABS agreements. ABS agreements are bilateral negotiated agreements between the State hosting a genetic resource and a State seeking to access or use that resource. Through the ABS process the parties involved negotiate "conditions of access, uses of the resource, and the sharing of benefits." [33] ABS agreements in general are "designed to address social injustices related to equitable access to, and sharing of benefits from, ecosystem services." [34]

An Annex to the Nagoya Protocol enumerates a number of specific benefit types that might be considered in the negotiation of ABS agreements, including both monetary and non-monetary benefits.

Monetary
1. Access fees/fee per sample collected or otherwise acquired; 2. Up-front payments; 3. Milestone payments; 4. Payment of royalties; 5. Licence fees in case of commercialization; 6. Special fees to be paid to trust funds supporting conservation and sustainable use of biodiversity; 7. Salaries and preferential terms where mutually agreed; 8. Research funding; 9. Joint ventures; 10. Joint ownership of relevant intellectual property rights.
Non-Monetary
1. Sharing of research and development results; 2. Collaboration, cooperation and contribution in scientific research and development programmes, particularly biotechnological research activities, where possible in the Party providing genetic resources; 3. Participation in product development; 4. Collaboration, cooperation and contribution in education and training; 5. Admittance to ex situ facilities of genetic resources and to databases; 6. Transfer to the provider of the genetic resources of knowledge and technology under fair and most favourable terms, including on concessional and preferential terms where agreed, in particular, knowledge and technology that make use of genetic resources, including biotechnology, or that are relevant to the conservation and sustainable utilization of biological diversity; 7. Strengthening capacities for technology transfer; 8. Institutional capacity-building; 9. Human and material resources to strengthen the capacities for the administration and enforcement of access regulations; 10. Training related to genetic resources with the full participation of countries providing genetic resources, and where possible, in such countries; 11. Access to scientific information relevant to conservation and sustainable use of biological diversity, including biological inventories and taxonomic studies; 12. Contributions to the local economy; 13. Research directed towards priority needs, such as health and food security, taking into account domestic uses of genetic resources in the Party providing genetic resources; 14. Institutional and professional relationships that can arise from an access and benefit-sharing agreement and subsequent collaborative activities; 15. Food and livelihood security benefits; 16. Social recognition; 17. Joint ownership of relevant intellectual property rights.

Table 1: Types of Benefits, As Identified in the Annex to the Nagoya Protocol

Although formalized through the Nagoya Protocol, the concept of ABS originated in the CBD, and experience in utilizing this arrangement predates the NP. A wide variety of industry sectors has experience in utilizing ABS agreements, including: "the pharmaceutical, biotechnology, seed, crop protection, horticulture, cosmetic and personal care, fragrance and flavor, botanicals, and food and beverage industries." [35] A review of ABS-implementation experience indicates that "the package of benefits typically includes a mix of monetary benefits like fees per sample, milestone payments, royalties on net sales, and licensing agreements, as well as non-monetary benefits like training, capacity-building, research exchanges, supply of equipment, technology transfer, and joint publications." [36] Experience also suggests that non-monetary forms of benefit are more common, and in the views of some more easily accessible. [37] Furthermore, many of the monetary-benefit sharing mechanisms identified in the NP are common costs or methods of doing business, rather than specially-applied instruments. It is also important to note that ABS agreements are based in territorial sovereignty over the resources being accessed and used; and are executed through domestic regulation, taxation and policy as well as private contract law - not through a multilateral system.

4.2.2 Collaborative Benefit Sharing / Collaborative Resource Management

Collaborative benefit sharing refers to a general set of benefit sharing mechanisms which are "designed to provide the means for local communities to share power with governmental actors" in decision making related to the use of local natural resources. [38] Collaborative benefit sharing approaches aim to be participatory, decentralized, and locally attuned. [39] Benefit sharing approaches of this type are common in the forestry, fisheries, wildlife and mining sectors, and may be described under many names including collaborative resource management; co-management, community-based natural resource management and community-based conservation. With their emphasis on local engagement and participation these approaches typically are heterogeneous in specific implication; and their effectiveness is highly dependent on relationships and institutions involved in each individual instance. [40]

4.2.3 Corporate Social Responsibility

At the corporate level benefit sharing may be achieved through, or tied to, broader corporate social responsibility (CSR) programs, through which private sector investments in the social and public development of a community or market affected by resource use is intended to offset any perceived or real negative impacts of that private sector investment. For example, in the mining industry the term "social license to operate" has become common as mining companies seek to establish affected-community acceptance of their operations through treatment of societal and environmental impacts and the distribution of benefits arising from industry operations. [41] CSR-based approaches to benefit sharing place most of the power into the private sector, and can thus result in unequitable implementation, however CSR is well-recognized within the corporate sector as an element of business strategy. [42] Benefit sharing approaches rooted in CSR are also not tied to state or local sovereignty over the extractable resources, as is the case is many other benefit-sharing models.

4.2.4 Fund and Revenue Sharing Based

Revenue sharing based models of benefit are common in the extractive industries, and function by seeking to ensure that "funds accumulated through fees, permits, and/or taxes from protected areas or tourism establishments are allocated to local communities." [43] Revenue-sharing based treatment of benefit may be executed through taxation rates - where the resulting benefit is generally applied through general public expenditures - or through specific compulsory funds - where the resulting benefit is applied to a more targeted problem. [44]

Benefit sharing mechanisms of this type can often be implemented through existing taxation mechanisms and are easily understood. However, their effectiveness can be impacted by bureaucratic inefficiency, and actual financial benefits to affected communities can be difficult to trace. Excessive taxation and compulsory funds may also place undue burden on the private sector, in particular in emerging industry sectors.

A related approach is known as "market-oriented" or "market-based" benefit sharing, which is "designed to address market-failures, where the value of benefits cannot be captured in monetary terms." [45] These approaches tend to be voluntary, rather than compulsory. Examples include the Payment of Environmental Services model common in the hydropower sector; or the Reducing Emissions from Deforestation and

Forest Degradation (REDD+) initiative. Market-oriented benefit sharing approaches aim to establish market and economic incentives for managing ecosystem impacts; and typically function through buyer/seller relationships at the local level. [46]

4.3 Summary and Implications

While this paper does not aim to offer a complete examination of the various benefit sharing mechanisms used throughout the extractive industries sector; the literature reviewed conducted does suggest a number of factors that should be considered when considering the implementation of a benefit-sharing regime, including:

- *Policy integration and articulation with broader development goals at the local and national level*
- *Participatory design and decision making processes*
- *Mechanisms to ensure or at least address objective and equity in implementation and execution - which might include attention to contracts and workforce integration in a multinational context.* [47]
- A management or governance approach that is adaptive and responsive to changes in technical, market and/or environmental factors.

However, it is also noteworthy that most of the benefit-sharing models in use in terrestrial extractive industries are based on both the condition of national and/or local sovereignty over the affected resources and on the presence of a community local to the affected resources. Neither of these conditions might apply in the case of space resources.

5. Conclusions

The preceding analysis suggests several principles or tenets that might inform the space community's efforts to contextualize the relationship between benefit, benefit-sharing, and the development of a space resources industry. The first of these is that there can be no benefit without development. Throughout the history of the space age the concept of benefit has been refined and implement in complement to advances in technology, and our understanding of it, there is no reason that this should be different for space resources.

In and of itself, this suggests the need for an adaptive approach to the development of governance approaches to space resources benefit. Policymakers and industry must ask themselves the question of whether a technology needs to benefit all from the onset of its deployment or rather if it needs to show a pathway and potential to benefit. If the later governance mechanisms need to include a capacity to adapt to changes in technology and how it might be applied to benefit. This is the model that has successfully been applied in the commercial remote sensing industry, and its relationship to activities that provide broad benefit - such as the International Charter on Space and Major Disasters. History shows that an effective concept of benefit in space governance initiatives is based on the identification of unifying and adaptable principles, not overly prescriptive definitions and frameworks.

Experience from both the treatment of benefit in multilateral space governance and in the elucidation of benefit sharing mechanisms across a range of terrestrial extractive industries suggests that most benefit sharing expectations and arrangement are defined, implemented, and executed through national and local policy and regulation - rooted in internationally agreed to principles. This suggests, in the context of space resources, a need to link the discussion of benefit to concurrent discussions of national authorization and supervision approaches to space resources. Experience from terrestrial extractive industries also suggests a wider range of non-monetary benefit sharing, than regimes based on monetary concepts of benefit.

Lastly, over the long-term a significant portion of the benefit from the development of space resources can be expected to be realized in the context of an off-Earth economy - and in enabling space-based services that provide benefit on Earth. This suggests a need to analyze ways to identify, describe, and share benefit in a solely space-based context, without the traditional concepts of sovereignty and locally-affected communities that are central to most of the terrestrial concepts of benefit.

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[Table 1] Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (ABS) to the Convention on Biological Diversity, Annex. Monetary and Non-monetary Benefits.
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