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A Comprehensive Approach to the Payment Mechanism for Deep Seabed Mining



Umwelt
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This IASS Policy Brief was written by Torsten Thiele (IASS), Hans-Peter Damian (UBA), and Pradeep Singh (IASS). The key messages of this publication are premised on a detailed study of the benefit sharing regime of the ISA and have been discussed at an international expert workshop hosted at the Institute for Advanced Sustainability Studies in Potsdam.

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Summary

The International Seabed Authority (ISA) is presently developing regulations (the “Mining Code”) to govern the exploration and exploitation of mineral resources of the international seabed (or “Area”). Whilst the financial mechanism is a critical component of this Mining Code, its development has been delegated to the Open-Ended Ad Hoc Working Group of the Council. These informal discussions have prioritized a model that gives preference to enabling mining over delivering fair compensation for the loss of resources. This policy brief argues that a fundamentally different and comprehensive approach is required and outlines some of its key components.

Drawing on concepts of sustainability, climate change, biodiversity, and circular economics, this approach emphasizes the importance of safeguarding the natural capital of the deep ocean. The social, cultural, and environmental impacts of seabed mining in the Area need to be fully reflected in economic assessments of proposed mining activities. This would enable any potential benefits to be adequately identified and – should the activities proceed – equitably shared. The payment mechanism is a means to ensure that all humankind, including future generations, enjoys the benefits of its shared stewardship of the Area. The mechanism must accordingly reflect the wider aspirations of the United Nations Convention on the Law of the Seas (UNCLOS).

■ **Message 1:** **Reflect the risks to the deep-sea environment**

The deep ocean is a complex environment that provides numerous ecosystem services. A holistic accounting system based on true cost and natural wealth is needed to capture impacts on ecosystem resilience and identify any potential financial benefits. The financial mechanism should reflect all costs and risks associated with mining in the Area.

■ **Message 2:** **Be inclusive of stakeholder interests**

The payment regime must be designed with foresight and be sufficiently responsive to the concerns and priorities of diverse stakeholders, including indigenous and civil society actors as well as future generations.

■ **Message 3:** **Deliver optimal returns to Humankind**

The payment regime needs to be designed with the interests of Humankind, and in particular of developing countries rather than contractors at its centre. Ensuring optimal returns requires a financial model that delivers best possible cost structures and timing.

A comprehensive approach for the financial mechanism

The International Seabed Authority (“ISA”) is at a critical juncture as it prepares the regulations that are to govern future minerals exploration and exploitation in areas beyond national jurisdiction (the “Mining Code”). Parallel to this, the ISA must develop a benefit-sharing mechanism that conforms to the wider context of the common heritage doctrine and the requirement that mining activities in the Area must benefit humankind as a whole, as articulated in the UN Convention on the Law of the Sea 1982 (UNCLOS). The implementation of these principles must be informed by current scientific knowledge and reflect the spirit of the 2030 Agenda for Sustainable Development as adopted by the UN General Assembly in September 2015. This conceptual approach has implications for the entire deep-sea mining value chain and requires that activities such as shipping, processing, financing and other related activities all be held to the same appropriate standards in terms of their impacts on climate, the environment, and biodiversity. This extends to social and governance issues such as meeting the needs of developing countries, inclusivity, and procedural transparency. The commitment of the ISA member states to the transition to a sustainable economy requires that these concerns not only be addressed when assessing deep seabed mining proposals and monitored throughout projects, but that they also be fully reflected in the financial mechanism.

Deep seabed mining will inevitably degrade the ecosystems of the seafloor and water column. Hence, all potential options, including alternatives to seabed mining, should be properly considered and integrated into the financial model. Given the potential harms associated with mining activities in the Area and our limited knowledge of the deep ocean, strict adherence to the precautionary approach is crucial to protect the marine environment. From an economic perspective, this will require a full assessment of the impact of any proposed mining activities on the ecosystem services provided by the deep ocean. These need to be comprehensively and accurately accounted for, whereby

any purported benefits of mining activities must be assessed against the costs inflicted on nature. The prior and proper valuation of the direct and indirect benefits stemming from marine ecosystem services is a requirement that would support long-term sustainability, provide effective indicators and decision-making tools, and enhance transdisciplinary approaches.

One relevant yardstick by which the economic viability of an activity can be measured is the calculation of “no net loss”. The principle of “no net loss”, according to which damages resulting from human activities must be balanced by at least equivalent gains, has been embraced by governments and international organizations around the world and should be taken up by the ISA. Its adoption would require that seabed mining activities in the Area only be considered if, taking all potential external costs into account, a net benefit can be clearly established.

UNCLOS furthermore mandates that mining activities in the Area must not be placed at a competitive advantage over land-based mining. This requires much more than the mere comparison of rates and charges imposed on mining activities on land and in the Area. Rather, it requires a holistic assessment of both the competition issues that could arise from commencing deep seabed mining activities and of the implications of activities for the global commitment to the transition to a circular economy. This assessment should be conducted within the ISA and with all other stakeholders prior to the commencement of any mining activities. This integrated approach also needs to be clearly reflected in the payment mechanism as this is the primary tool for quantifying payments and thus determining the relative competitive advantage of operators. A purely technical assessment of royalty rates in terrestrial mining is grossly insufficient to deal with this challenge.

As deep-sea mining revenues must be managed on behalf of *humankind* as a whole, ISA must ensure transparency and distribution equity. Transparency



This hermit crab carrying a zoanthid anemone in a protective symbiosis was located at a depth of 2680 m on a polymetallic nodule field in the mid-Pacific. © NOAA OE

requires full financial disclosure, for instance through the public auditing of any deep seabed mining contracts. The adoption of project-style accounting would enable the ISA to fulfil its obligation to deliver accountability and fairness. In addition, this would facilitate the operations of the financial payment mechanism, irrespective of whether it is based on royalties or a hybrid approach. Indeed, rather than adopting a royalty-based approach by default, all potential payment options should be considered in the development of an effective fiscal regime for the deep-sea mining sector. A particular concern from an equity perspective is the timing of payments. As experience in other sectors shows, upfront licence payments are both economically effective, in that they would deliver the most efficient production, and they also allow immediate distribution to the ISA as the guardian of the common heritage of mankind. While the ISA Finance Committee has not yet presented its proposals for the equitable sharing of benefits, the design of the payment mechanism will determine which amounts will be available to share and when.

As the present Covid-19 crisis has shown, human interference in the natural environment can have dramatic consequences. The marine life of the deep sea provides us with critical benefits and even health solutions. An enzyme used in PCR tests to detect

SARS-CoV-2 was originally isolated from a microbe found in marine hydrothermal vents, for example. Given the vast and varied services provided by the deep ocean, including carbon sequestration, buffering of global warming, and food provision, there is a responsibility to ensure that we pursue a very careful and considered approach before engaging in potentially harmful new activities in these ecosystems. The discussion of the potential benefits of deep-sea mining lends itself to a scenario approach as a technique to engage a broader range of stakeholders and could help to reconcile conflicting interests. With the aid of scenarios, it might be possible to re-address deep seabed mining as only one trajectory, amongst many, for the use (or non-use) and development of the ocean floor in the future. Preparatory work of this nature is an important aspect in developing a robust financial mechanism.

The International Seabed Authority is accountable for the common heritage of humankind and is responsible for ensuring that the resources of the Area benefit humankind as a whole. It will only be possible to deliver a net positive balance of benefits if the financial incentives and yardsticks are set appropriately. A comprehensive payment mechanism will play an important part in achieving this.

Reflect the risks to the deep-sea environment

The financial mechanism needs to be structured to appropriately reflect all potential costs and risks – especially to the marine environment – that will result from mining activities. Given the unique characteristics of the deep ocean, with its slow life cycles and complex ecosystem interactions, combined with our still limited knowledge of this vast and remote region, this is a challenging task that will require significant research effort. The MIT consultants engaged by ISA have, based on the brief given by the ISA Secretariat, developed a model for a payment mechanism that reflects the perspective of Contractors as to required returns. This royalty-based model does not address the broader issues covered in this policy brief, nor does it take environmental costs into account. Please see Annex 1 (page 14) for an overview of this proposal. Instead, the financial model needs to be based on an ecosystem approach to the governance of the Area, complemented by precautionary decision-making based on the holistic assessment of the impact of mining activities on the resilience of deep-sea ecosystems and the resultant loss of ecosystem functions as well as potential impacts on planetary health.

Deep-sea ecosystems are complex and provide a wide range of benefits to humanity. Natural capital accounting provides a tool to measure the value of these benefits and weigh them against costs. Intact ecosystems provide a renewable natural capital stock that can continue to provide ecosystem services and benefits indefinitely. Ecosystem services have been categorized in different ways: Provisioning services such as fishing are maintained by regulatory services such as nutrient cycling, which in turn supports many essential functions for the health of marine ecosystems. The use of the natural capital approach and of an economic valuation of ecosystem goods and services provides us with a toolkit to help quantify ecosystem services and thus enable an assessment of whether potential economic benefits from mining and particularly payments under the finance mechanism can justify the loss of natural capital caused by mining activities.

A comprehensive assessment of natural capital and ecosystem services is needed

The model used to calculate the financial benefit has to include a comprehensive assessment of the impact of proposed mining activities on the natural capital of the Area and on ecosystem services as well as on potential other uses of the deep sea in order to be consistent with UNCLOS. These include not only any quantifiable local impacts, such as the removal of endemic species directly located on or around nodules, but also its potential contributions to the cumulative cost of ongoing ocean change as well as its potential to contribute to tipping points and systems change.

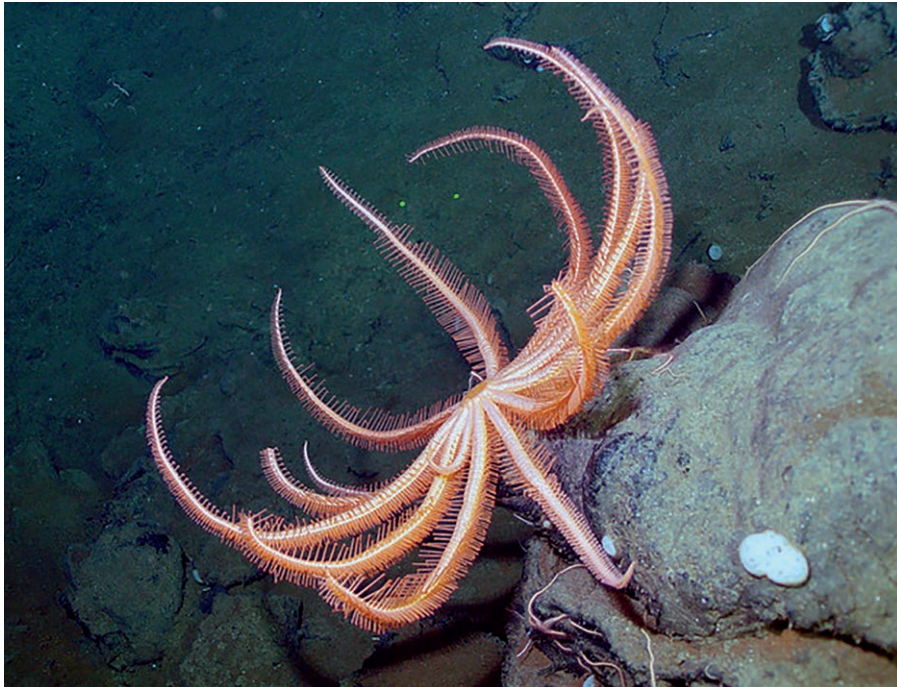
Another economic cost of deep-sea mining that will need to be considered is its carbon footprint. In addition to the greenhouse gas emissions resulting from the construction of equipment, shipping and materials processing, which could partially be addressed through a comprehensive carbon levy, mining in the Area may well impair the ocean's ability to cycle and store carbon, which would need to be fully assessed. Approaches to assess the value of protecting deep-sea biodiversity and to quantify the costs of increased risk and volatility of outcomes, including in remote locations and complex marine value chains, have already been developed and applied in other jurisdictions.

Any plan of work needs to include a full analysis

As part of their application for a mining contract, contractors are required to submit a “plan of work” for approval with their application for a mining contract. The plan of work should demonstrate that the proposed project will deliver a net positive benefit, taking all potential external costs into account. This should include a full economic analysis and risk

assessment, covering climate impacts (CO₂), marine pollution (toxicity), ecosystems and biodiversity (species and habitats), efforts to minimize impacts (carbon pricing), and noting any additional flanking

measures (carbon offsets etc) the Contractor intends to put in place. The inclusion of this data in the plan of work should be a necessary pre-condition for approval.



A deep ocean sea star located at a depth of 2230 m near a hydrothermal vent field in the northeast Pacific. © V. Tunnicliffe

Be inclusive of stakeholder interests

UNCLOS safeguards the rights and interests of developing states with respect to the mineral resources of the international seabed. The rights and interests of future generations in the mineral resources of the Area, as well as to a healthy and productive ocean in general, also deserve full consideration and protection when it comes to decision-making. A fair and equitable approach to the payment mechanism needs to go beyond a mechanistic approach and fully engage with issues of inclusive participation and a just transition. The commitment of ISA member states to implementing the 2030 Agenda for Sustainable Development means that issues of poverty, of equality of opportunity and of sustainable development need to be at the centre of the financial mechanism to guarantee that benefits can be shared equitably.

The rights and interests of developing countries

UNCLOS unequivocally affirms that “activities in the Area shall [...] be carried out for the benefit of [Hu]mankind as a whole, [...] taking into particular consideration the interests and needs of developing States [...]”.¹ This clearly emphasizes two central requirements when considering the conduct of activities in the Area: firstly, such activities must be “for the benefit of [Hu]mankind as a whole” and secondly, that “the interests and needs of developing States” be considered especially. In other words, it must be demonstrated that the exploitation of minerals in the Area would benefit humankind as a whole – and developing countries especially – before any such activity could be approved.

UNCLOS further emphasizes the need to promote the “effective participation of developing States”.² It is indeed debatable whether developing countries are actually ‘participating’ in activities in the Area or ‘benefit’ from such activities if they merely act as the sponsors of private contractors based in developed countries, without any direct or effective control of the actual operations. If such sponsorship arrangements are not subject to deeper scrutiny, private contractors will not only gain access to reserved areas (i.e. areas set aside for developing countries) but may also be able to dictate payments to developing countries. This is in addition to the potential exposure to liability under international law if a sponsoring State fails to meet direct obligations or due diligence obligations with regards to the sponsored mining entity.³

Whilst countries may look to receive financial benefits through a distribution via the benefit-sharing mechanism, in particular developing countries that do not directly participate in activities in the Area, it remains uncertain whether and when such a distribution would materialize. Finally, the interests of developing countries whose economies rely on land-based mining must be safeguarded from the conduct of activities in the Area. UNCLOS recognizes that such countries must receive adequate protection⁴ and due compensation⁵. Such adverse impacts deserve careful consideration as they constitute a ‘cost’ arising from activities in the Area. This also has a direct consequence with respect to the amount of money that is eventually available for equitable distribution, since the affected countries would presumably be entitled to receive such compensation ahead of any wider distribution.

¹ Article 140(1) of UNCLOS.

² Article 148 of UNCLOS.

³ See the 2011 Advisory Opinion of the Seabed Disputes Chamber of the International Tribunal for the Law of the Sea on the Responsibilities and Obligations of States Sponsoring Persons and Entities with respect to Activities in the Area (ITLOS Case Number 17).

⁴ Article 150(h) of UNCLOS.

⁵ Section 7 of the Annex to the Implementing Agreement on Part XI of UNCLOS 1994.

The rights and interests of future generations

The common heritage doctrine places a strong emphasis on intergenerational equity. It embraces the concept of sustainable development and fully encompasses the vested rights and interests of future generations in the Area and its mineral resources. In this context, the rights and interests of future generations include not only the option and ability to utilize mineral resources at a later date, but also (and especially) to a healthy and productive ocean to meet their needs and livelihoods. Consequently, the 'costs' associated with activities in the Area must include the loss of opportunity for future generations to the utility of the minerals and other resources of the Area and to a healthy ocean. Likewise, the application of 'benefits' arising from such activities must not be limited to the present generation but should also be considered from the perspective of future generations. The payment mechanism must account for such considerations and protect the rights and interests of future generations. In assessing whether the mechanism is adequate to this task, discussions at the ISA must consider an appropriate discount rate, the possibility of keeping payments in a specialist fund for equitable investments, and other related concepts.

Procedural equity and inclusivity

A broad effort is required to achieve procedural equity in which all voices and opinions are heard during the development and design phases of the financial mechanism. It is not sufficient to see this purely through the lens of financial distributions which may in any case only occur at some distant time in the future but rather as part and parcel of how financial payments operate right from the beginning of any contract that is approved. The ISA could start to reach out to international youth organizations, local and indigenous groups, as well as global development and sustainability NGOs, in order to give them a stronger voice in decision-making at the ISA, such as by facilitating the participation of such groups at meetings, working groups and workshops. Their voices need to be heard.



This goosefish was identified at a depth of 1150 m on a Pacific seamount with a cobalt crust. © NOAA OE

Design the payment regime to deliver optimal financial returns

The financial regime is key to ensuring the delivery of an optimal financial return. A basic aspect of optimising payments requires an assessment of the financial model as a whole to determine the best timing and cost structure for the venture. This relates to both initial capital expenditures and operating costs. To take one example, if a new technique that would allow a much cheaper solution is likely to appear in the market at a future date, for instance due to developments in another field, it would make financial sense to defer investments, thereby allowing payments to be optimized. If on the other hand, there would be clear financial benefit to mining now rather than later, this should also be disclosed and considered.

There are many other factors that could enter this equation. Any venture with a large financing cost component (the large upfront investment in infrastructure that is required for deep seabed mining, for example) will be affected by borrowing costs, which generally reflect perceived risk. If risks can be reduced prior to expenditure, for instance through better science or greater collaboration, this will reduce costs and again help to optimize payments. Borrowing costs will also depend significantly on the broader state of the capital markets as well as on the creditworthiness of the borrower. Low borrowing costs will directly benefit project profitability.

Defining optimal financial returns goes far beyond mere financial maximization and takes wider societal concerns fully into account with the aim of aligning the payment mechanism with the overall ambitions of the Mining Code.

Humankind to receive the majority of any benefits

The starting point for any payment mechanism is humankind's ownership of the mineral resources of the Area. Deep-sea mining activities must accordingly be managed for the public good in a manner that is transparent and ensures distribution equity. The payment regime should be aligned with the overall interests of the member states of the ISA as a whole in all cases. Contractors act as third parties to undertake activities on behalf of humankind. In order to optimize payments to humankind, ISA must ensure that it will receive the majority share of any financial benefits that accrue from activities in the Area. Securing "at least 50%" under all scenarios does not only appear to be intuitively a more equitable outcome but is also more likely to deliver more substantial and significant financial compensation to humankind. This must hold under a variety of different scenarios and should not be vulnerable to variations in minerals market prices, for example. It should be noted that even if ISA secures the "lion's share" of financial benefits, falling metals prices could substantially reduce the total amount payable. The most attractive outcome would therefore be one where the ISA receives an agreed amount upfront and does not incur further risks.

The proposed royalty-based mechanism is unsuitable

The financial mechanism presently proposed as an annex to the Mining Code is solely based on the calculation of a royalty rate, that is a pre-agreed percentage of a notional value of a nodule in terms of its mineral content. At the most recent meeting of the Working Group in February 2020, consultants to the ISA suggested that ideally royalties would be based

on the nodule price. However, no market modelling has been undertaken to date to calculate such a price⁶. Instead the metal content of the nodules is used to derive an amount on which the royalty percentage is based. This is not adequate as it neglects any commercial dynamics between the mining contractor and the processing company. Not only does it risk transfer pricing and other arrangements that will be outside the regulatory purview of the ISA, it also means that additional potential environmental impacts along the metals supply and processing chain are ignored.

Discourage wasteful activities

Optimising financial returns also means utilising the payment mechanism to incentivize good behaviour. The design of the financial mechanism should discourage wasteful activities and prioritize delivery by the ISA on its broader mandate.

Circular material flows could secure economic and environmental benefits by reducing the impact of activities on natural capital and offer a promising tool for sustainable development. As countries integrate circular economy approaches into their strategies to deliver on the SDGs, public and private sector actors will increasingly focus on designing products and services with zero waste, re-use and redeployment in mind. The impacts on overall demand for raw materials are likely to be significant. Electronic goods, for example, are only recycled to a small extent at present, yet they contain a whole range of valuable metals; the widespread adoption of a circular economy approach could accordingly dampen demand for new metals significantly and reduce the need for new mining projects.

For each mining project, a full analysis of the value chain, sourcing and design and use choices could reveal multiple opportunities to reduce use, improve outcomes and deliver benefits throughout the process. In the case of deep seabed mining, a holistic cradle-to-grave assessment approach will be required, spanning the entire life-cycle from exploration and extraction to restoration and/or remediation.

Prioritize the delivery of benefits

Such holistic assessments would help the ISA to identify priorities for the delivery of benefits. In many cases, the early distribution of benefits will be more attractive as it reflects the time value of money preferences and removes the potential risk that mining activities could fail to deliver a worthwhile financial benefit. Economists have identified auction-based licence allocations with upfront payments as the most efficient and financially effective means of delivering concessions. Countries that adopted this approach, for example in the telecommunications sector, were able to raise many billions in advance of any commercial activity. Whilst it may not be possible to apply this approach in the case of deep seabed mining, the reliance on the proposed royalty-based mechanism is highly concerning. If, for example, a contractor were to discontinue mining activities after several years, but prior to the sale of any extracted metals, humankind would not derive any benefit from the exploitation of its common heritage, irrespective of any social or environmental harms incurred. Thus, any form of earlier contribution to the delivery of benefits should be considered and at least discussed.

⁶ Presentation to the Open-Ended Informal Working Group of the Council in respect of the development and negotiation of the financial terms of a contract under article 13, paragraph 1 of Annex III to the United Nations Convention on the Law of the Sea and under section 8 of the Annex to the Agreement relating to the implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982 held 13–14 February 2020 in Kingston, Jamaica

Conclusion

The payment mechanism is a critical part of the Mining Code and must be designed so that it reflects the broader ambition of the International Seabed Authority and principle of the Common Heritage of Humankind. The most recent version of the payment regime model discussed by the International Seabed Authority in October 2020⁷ shows that this is not currently the case; on the contrary, key issues have been neglected, including the potential competitive impact(s) of seabed mining on land-based mining, particularly in developing countries, and the delivery of optimal returns to humankind as a whole. On the other hand, the consultants confirmed initial concerns raised in relation to the complexity of implementing the proposed royalty regime and the identification of appropriate comparable effective tax rates as well as the daunting challenge of delivering appropriate financially compensation for environmental impacts and potential liabilities. Instead, the present approach focuses substantially on the financial “burden” facing contractors and leaves the “risk of failure” with the international community.

This policy brief suggests the need for a fundamentally different approach that is based on UNCLOS and upholds the intrinsic value of the international deep seabed Area as a Common Heritage of Mankind, a unique and precious biodiversity habitat, and blue natural capital. In addition to the preparatory work undertaken to date, further efforts are needed to align the proposed mechanism with the broader considerations of the international community’s commitments to sustainable development and a just transition that conserves nature and provides for livelihoods.

The authors propose that the financial mechanism can and should be developed further so that it reflects the risks to the deep-sea environment, is inclusive of all stakeholder interests, and can deliver optimal returns to humankind as a whole. This would enable stakeholders to assess the costs and benefits of potential seabed mining activities fully and impartially before engaging in this endeavour. ■

⁷<https://www.isa.org.jm/event/webinar-comparative-analysis-seabed-mining-and-land-based-mining>

This policy brief deals with a specific element of the benefit-sharing regime of the International Seabed Authority, namely, the financial payment mechanism. This is a critical component since it determines how much and when money will be available for transfer to the ISA. This policy brief hopes to encourage further reflections on this process and the approach required.

This policy brief does not purport to address a wider range of issues that potentially have financial implications for the International Seabed Authority, its member states, sponsoring states, contractors and other parties. Such issues are to be addressed elsewhere within the Mining Code. Nevertheless, as these are significant considerations, we provide here a non-exhaustive list of financially relevant aspects:

- The modalities to design an appropriate mechanism for the equitable sharing of benefits, i.e. the actual sharing of financial and other economic benefits arising from activities in the Area, are under the purview of the Finance Committee and have not been made publicly available at this stage.
- The Exploitation Regulations will provide for a number of direct payments, such as administrative fees and annual fees, contributions into environmental compensation funds etc. The amounts and their timings will have a direct economic impact on each individual mining contractor.
- Additional obligations such as for insurance, performance guarantees, or full environmental remediation will affect the costs of contractors and the risk profile for the ISA.
- The Exploitation Regulations can also significantly impact the return profile if a contractor, as presently proposed, is able to use their contract as security against borrowings.
- Likewise the lean organisational structure of the ISA translates into different costs and risks compared to a more robust organisational set-up as an independent regulator.

Other sectors and regulatory regimes may offer useful examples of how to best address this wide range of issues. In practice, it will not be realistic to settle the financial payment aspects for the benefit sharing mechanism independently from addressing the broader financial implications of the Mining Code overall.

This policy brief argues that a comprehensive approach that takes the wider economic costs and benefits into account (in particular with respect to the marine environment) would not only reflect the spirit of Article 140 (2) UNCLOS and the Common Heritage principle but would also provide a pragmatic way forward.

Annex I: An overview of the recommendations for a system of payments proposed by MIT consultants

The proposed economic model currently under discussion within the International Seabed Authority for a payment mechanism for the extraction of polymetallic nodules in the Area¹:

- Recommends a payment system based around a two-stage variable ad-valorem system, charging 2% of the nodule value at the outset of the collection operation, with a variable rate ranging from 5% to 9% of the nodule value from year five of collection operation.²
- Alternatively, a fixed two-stage ad-valorem system has been proposed, paying 2% for the first five years, rising to a fixed rate of 6% thereafter.³
- A blended system combining a fixed ad-valorem through mining operations and a profit-based payment that begins in year five of operations is deemed unviable (i.e. not cost-effective for the ISA) by the consultants.⁴
- Assumes that a typical exploitation contract will involve two collectors, each with a dedicated surface vessel, which together would collect from a gross area of 12500 m² over the life of the mine (30 years). Thus, the average annual collection per mining site is estimated at 3.86 million dry tonnes per year.⁵
- Estimates the efficiency of metal recovery to be 90% for manganese, nickel, and copper, and 80% for cobalt.⁶
- Does not account for external costs, including environmental costs associated with mining activities (such as impacts on ecosystem services, biodiversity, and resource waste). These matters are beyond the scope of the MIT study.⁷

¹Extracted from Randolph Kirchain, Richard Roth, Frank R. Field, III, Carlos Muñoz-Royo, and Thomas Peacock (MIT Materials Systems Laboratory), October 2020, 'UPDATE: Report to the International Seabed Authority on the Development of an Economic Model and System of Payments for the Exploitation of Polymetallic Nodules in the Area Based on Stakeholder Feedback', at: https://isa.org.jm/files/files/documents/MIT_0.pdf and <https://isa.org.jm/files/files/documents/Nodule%20Financial%20Payment%20System%20Report%20October%202020%20V3.pdf>.

² *Ibid.*, see paragraphs 63-64.

³ *Ibid.*, see paragraph 66.

⁴ *Ibid.*, see paragraph 38.

⁵ *Ibid.*, see paragraph 23.

⁶ *Ibid.*, see paragraph 30.

⁷ *Ibid.*, see paragraph 4.

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© Hans-Peter Damian

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© Pradeep Singh

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Institute for Advanced Sustainability Studies (IASS) e. V.

The Institute for Advanced Sustainability Studies (IASS) conducts research with the goal of identifying, advancing, and guiding transformation processes towards sustainable societies in Germany and abroad. Its research practice is transdisciplinary, transformative, and co-creative. The institute cooperates with partners in academia, political institutions, administrations, civil society, and the business community to understand sustainability challenges and generate potential solutions. A strong network of national and international partners supports the work of the institute. Among its central research topics are the energy transition, emerging technologies, climate change, air quality, systemic risks, governance and participation, and cultures of transformation. The IASS is funded by the research ministries of the Federal Government of Germany and the State of Brandenburg.

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