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Challenges and opportunities for Ecosystem-based Management in seabed conservation: case study on deep-sea mining in the Area

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Revised Version

A thesis submitted to the Instituto Oceanográfico of the Universidade de São Paulo in partial fulfilment for the degree of Doctor of Science, Oceanography, with emphasis in Biological Oceanography.

Advisor: Prof. Dr. Alexander Turra

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Dedico esta tese às mulheres que caminham comigo. Vocês foram e são minha fonte de força, inspiração e resiliência.

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RESUMO

SÁ, Maila Paisano Guilhon e. **Desafios e oportunidades para a Gestão Baseada em Ecossistemas na conservação de fundos marinhos**: estudo de caso sobre mineração de mar profundo na Área**.** 2023. 209 f. Tese (Doutorado) – Instituto Oceanográfico, Universidade de São Paulo, São Paulo, 2023.

A Gestão Baseada em Ecossistemas (GBE) é uma abordagem que visa gerenciar as atividades humanas sob uma perpectiva holística e integrativa. A GBE é listada dentre as boas práticas para governança do oceano, que se reflete em seu provisionamento como um dos princípios norteadores no código de mineração atualmente em desenvolvimento pela Autoridade Internacional dos Fundos Marinhos (AIFM) estabelecida no âmbito da Convenção das Nações Unidas sobre o Direito do Mar (CNUDM) em 1982. A AIFM é responsável por regular atividades de mineração na "Área", nos fundos marinhos marinhos além da jurisdicção nacional, cujos recursos minerais são considerados patrimônio da humanidade. Tendo em vista a grande lacuna de conhecimento existente em relação aos processos e benefícios advindos de serviços ecossistêmicos de mar profundo, bem como ao alto potencial de impacto atribuido a atividades de mineração de mar profundo (MMP) em escala comercial, a adoção da GBE nesse contexto faz-se de suma importância. Assim, o presente estudo teve por objetivo avaliar oportunidades e desafios para GBE no regime de MMP na Área. Neste trabalho, dividido em quatro capítulos, utilizou-se como referencial teórico princípios de GBE amplamente reconhecidos na literatura. O primeiro capítulo incluiu uma avaliação sistemática do potencial de reconhecimento de princípios de GBE no conjunto de regulações e recomendações que compõem o Código de Mineração da AIFM. Em seguida, avaliou-se a percepção de stakeholders da AIFM em relação à importância de GBE para o manejo da MMP; à presença de GBE nos processos da AIFM; ao potencial impacto que distintas percepções poderiam ter sobre a tomada de decisão; e discutiu-se recomendações para melhoria. Os dois capítulos finais abordaram o processo de Avaliação de Impacto Ambiental (AIA) e discutiram as atuais práticas de avaliação de impacto nas etapas de prospecção, exploração e explotação de MMP e o potencial de contribuição de GBE para AIA. O presente estudo identificou a existência de uma série de desafios para GBE no regime da AIFM que incluem: a ausência de definição e clareza quanto aos objetivos e implicações de GBE para o regime de MMP; ausência da lógica de serviços ecossistêmicos; limitações no reconhecimento de aspectos sociais como intrínsecos à GBE; engajamento insuficiente de stakeholders; incoerência de requerimentos entre as fases de exploração e explotação; mecanismos deficientes ou inexistentes para fiscalização de conformidade e insuficiência de mecanismos vinculantes. Em contrapartida, as oportunidades identificadas incluem: a promoção de espaços e grupos temáticos para discutir o tema; o desenvolvimento de materiais e ações de capacitação que ampliem o entendimento do assunto; estabelecimento de processos de revisão e aprovação de documentos bem definidos e o desenvolvimento de mecanismos que melhorem a participação e engajamento de stakeholders. Embora a adoção e implementação de práticas de governança e manejo compatíveis com a GBE seja um grande desafio, a AIFM possui a oportunidade e respaldos técnicos necessários para se

destacar de forma pioneira na gestão e conservação do patrimônio da humanidade, pertencentes às presentes e futuras gerações.

Palavras-chave: Gestão Baseada em Ecossistemas. Mineração de mar profundo. Áreas além da Jurisdição Nacional. Autoridade Internacional dos Fundos Marinhos. Avaliação de Impacto Ambiental.

ABSTRACT

SÁ, Maila Paisano Guilhon e. **Challenges and opportunities for Ecosystem-based Management in seabed conservation**: case study on deep-sea mining in the Area**.** 2023. 209 f. Thesis (Doctorade) – Instituto Oceanográfico, Universidade de São Paulo, São Paulo, 2023.

Ecosystem-based management (EBM) is an approach that aims to manage human activities from a holistic and integrative perspective. EBM is listed among the good practices for ocean governance, which is reflected in its provision as one of the guiding principles in the mining code currently developed by the International Seabed Authority (ISA), an organization established under the United Nations Convention on the Law of the Sea (UNCLOS) in 1982. The ISA is responsible for regulating mining activities in the "Area", the seabed beyond national jurisdictions, whose mineral resources are considered the common heritage of humankind. Given the large gaps in knowledge regarding the processes and benefits arising from deep-sea ecosystem services, in conjunction with the high potential impact attributed to commercial-scale deep-sea mining (DSM) activities, the adoption of EBM in this context is of paramount importance. Thus, this study aimed to assess challenges and opportunities for EBM in the DSM regime in the Area. This work, divided into four chapters, was based on EBM principles widely recognised in the literature. The first chapter included a systematic assessment of the potential for recognition of EBM principles in a key set of regulations and recommendations that comprise the ISA Mining Code. Next, ISA stakeholders' perceptions of EBM were assessed in relation to its importance for the management of DSM; the consideration of whether EBM is recognized as contained in ISA processes; whether different EBM perceptions may impact decision making and assessed stakeholders' recommendations for improvement. Finally, a case study on the Environmental Impact Assessment (EIA) process was proposed, divided into two chapters, which addressed the current impact assessment practices for prospecting, exploration and exploitation stages of mineral resources in the Area and the potential for EBM principles to contribute to the EIA process. The study identified several challenges for EBM at the ISA regime that included: the lack of a definition and clarity on the objectives and implications of EBM for the ISA regime; the absence of the logic of ecosystem services; limitations in the recognition of social aspects as intrinsic to EBM; insufficient stakeholder engagement; inconsistency of requirements between exploration and exploitation phases; weak or non-existent mechanisms of compliance and insufficient binding mechanisms. On the other hand, opportunities identified included: the promotion of spaces and thematic groups to discuss the topic; the development of materials and training actions that broaden the understanding of the topic; the establishment of well-defined documents' review and approval processes; and the development of mechanisms to improve stakeholder participation and engagement. Although the adoption and implementation of governance and management practices compatible with EBM present a major challenge, the ISA has the opportunity and technical support necessary to stand out as a pioneer in the management and conservation of the common heritage of humankind, which belongs to present and future generations.

Keywords: Ecosystem-based Management. Deep-sea mining. Areas beyond national jurisdiction. International Seabed Authority. Environmental Impact Assessment.

SUMMARY

1. INTRODUCTION

The perception of the world by human societies is constantly evolving. Currently, it is largely accepted that human activities are changing the dynamics of socio-ecological systems. The consequences of an unbalanced interaction between humanity and natural systems are seen in plain sight and take different forms, from natural disasters to global pandemics. These examples are timely evidence of how human systems and all their spheres (social, economic, cultural), are inherently linked to the so-called natural systems in a continuous feedback looping. In other words, it reinforces the idea that "*economies and societies are [seen as] embedded parts of the biosphere*" (ROCKSTRÖM; SUKHDEV, 2016). Premised on that, any distinction between social and natural systems is arbitrary (BERKES, 2011; PIET *et al*., 2020).

Impacts arising from human activities have reached all parts of the globe (Halpern et al., 2012), including remote areas such as the deep ocean (RAMIREZ-LLODRA *et al*., 2011), the portion of ocean waters from 200m down the surface to the ocean bottom, reaching depths close to 11km (CHIBA *et al.*, 2018; JAMIESON *et al.*, 2019). Adding to the human misuses and overexploitation of marine resources, effects arising from climate change can additionally alter the functioning and services provided by the deep-sea (LEVIN; LEBRIS, 2015; LEVIN *et al*., 2020a that translate into well-being of societies (MEA, 2005) through the provision of food, energy, minerals, culture, knowledge, pharmaceuticals, etc., whereas helping to maintain the climate balance of the planet, through carbon sequestration (ARMSTRONG *et al.*, 2012; THURBER *et al*., 2014; LE; LEVIN; CARSON, 2017).

Ocean processes and functions take place in an interconnected realm and therefore, cannot be limited by governance arrangements or artificial limits established. Such interconnected nature is acknowledged by the constitution of the oceans - the United Nations Convention on the Law of the Sea (UNCLOS, 1982 – Preamble). Among others, UNCLOS regulates activities in the marine realm and establishes rules for the delimitation of maritime zones. Although established in 1982, the instrument only came into force later when the Agreement on the Implementation of Part XI of UNCLOS (1994 Agreement) ended controversies and sealed the compromise for a deep-sea mining regime in international waters.

Generally speaking, UNCLOS establishes two distinct legal regimes that apply to areas beyond national jurisdiction (ABNJ), namely the High Seas (UNCLOS, 1982 - Part VII) and the Area (UNCLOS, 1982 - Part XI). Currently, a legally binding treaty aiming for the conservation and sustainable use of biodiversity in ABNJ is under negotiations - the Biodiversity Beyond National Jurisdiction Instrument - the "BBNJ Instrument" (ILBI, 2022).

The seabed and its subsoil in ABNJ are denominated “the Area” (UNCLOS, 1982 - Article 136). In this respect, the International Seabed Authority (ISA) is the organization responsible for organizing and controlling mineral activities taking place in the seabed beyond national jurisdictions (UNCLOS, 1982 - Article 156 and 157), which should be carried out for the benefit of the mankind as a whole (UNCLOS, 1982 – Article 140).

The ISA comprises signatory’s parties from UNCLOS, which includes 167 Member States and the European Union. The governance structure of the ISA comprises four active organs: the Assembly, the Council, the Legal and Technical Commission (LTC) and the Secretariat. The Assembly is the supreme organ of the ISA and consists of all UNCLOS Member States (UNCLOS, 1982 - Article 156.2 and 160). The Council is the executive body of the ISA and consists of 36 members elected by the Assembly, according to a regime of chambers established by UNCLOS (UNCLOS, 1982 - Article 161 e 162). The LTC is a subsidiary organ of the Council established to formulate rules, regulations and procedures as well as to provide recommendations for Council’s approval regarding several matters (UNCLOS, 1982 - Article 165). The Secretariat is the administrative organ of the ISA responsible for supporting the Council and Assembly on their requests and administer other day-to-day functions of the ISA (UNCLOS, 1982 - Article 166).

Mining activities are regulated by the Mining Code, and broadly comprise three stages: prospection, exploration, and exploitation. Prospection refers to the search for mineral deposits at strategic locations to determine abundance and extraction feasibility without exclusive rights. When a plan of work for exploration is approved, a contract is established between the ISA and contractors which is bound to the Exploration Regulations. The Exploration Regulations provide that the contractors have the exclusive right to conduct exploration activities for a particular resource type for a period of 15 years (which can be extended upon request). Exploration activities include the collection of baseline data for the elaboration of technical and economic feasibility studies, as well as the performance of tests of mining equipment (ISA, 2010, 2012a, 2013). All activities performed shall be reported to the ISA via annual reports (ISA, 2015). The last stage referring to the commercial-scale extraction of minerals is named exploitation. Nonetheless, exploitation activities are not yet in place as the regulations for such activities are currently under negotiations at the ISA. State enterprises or private companies in association with Member States are eligible to apply for a contract with the ISA (UNCLOS, 1982 – Article 153.2.b).

Polymetallic nodules (PMN), seafloor massive sulfides (SMS), and cobalt-rich ferromanganese crusts (CRC) are the denominations given to the mineral aggregates currently regulated by the ISA. PMN are potato-shape structures, rich in minerals such as Mn and Fe oxides but also contain relevant quantities of Cu, Co, Ni, Mo, Pt, Te and Zn, as well as rare earth elements (REE) (HEIN; KOSCHINSKY, 2014). PMN occur predominantly on the surface of sediment-covered abyssal plains and origin from hydrogenetic (minerals precipitate from cold seawater) and diagenetic (minerals precipitate from pore waters within the sediment) processes (SPC, 2013a; SPC, 2013b; HEIN *et al.*, 2013; KOSCHINSKY *et al*., 2018; HEIN; KOSCHINSKY, 2014). The occurrence of PMN is described for depths between 3000 and 6000m, with the most significant abundances registered in the Clarion-Clipperton Zone (CCZ), in the easter Pacific Ocean. PMN was the first mineral resource regulated by the ISA, with the first contract for its exploration granted in 2001. As of now, nineteen contracts have been awarded to PMN exploration, seventeen of which are in the CCZ.

SMS deposits are three-dimensional structures resulting from the interaction of the deep-sea cold waters and the hydrothermal fluids (magma) expelled in geologically active areas along mid-ocean ridges. Hydrothermal vents are described to occur in water ranging from 250-4000m in depth (KOSCHINSKY *et al*., 2018; SPC, 2013b). Metals of economic interest contained in SMS include Fe, Cu and Zn, Ag and Au, and small quantities of REE (KOSCHINSKY *et al*., 2018). So far, seven contracts for the exploration of SMS have been awarded, including four in the Mid-Atlantic Ridge.

Among the mineral aggregates, CRC is the least explored, accounting for five contracts granted of which three are located in the Western Pacific Ocean. CRC precipitate in hard substrates free of sediments (HEIN; KOSCHINSKY, 2014), such as the flanks of seamounts, ridges, guyots, and plateaux at depths of 400 to 7000m (SPC, 2013b). Nevertheless, optimal conditions for the formation of the thickest and most metal-rich structure are described as being between 800 and 2500m (HEIN *et al*., 2013). As PMN and SMS, CRC are rich minerals of relevance for the development of green technologies (HEIN *et al*., 2013) as Fe, Mn and rare metals.

Environmental parameters and ecological dynamics broadly differ among deep-sea ecosystems, although general commonalities are present (RAMIREZ-LLODRA *et al*., 2010). Contrary to previous assumptions, the deep-sea houses vast biodiversity adapted to conditions of high pressure, absence of light, and limited food resources. Due to that, ecological processes in the deep sea (e.g., growth, reproduction, recovery) are slow (JONES *et al.*, 2019; SIMON-

LLEDÓ *et al*., 2019; SMITH *et al*., 2021). Against the advance of human activities in the deep sea, the United Nations General Assembly (FAO, 2009; UNGA, 2007) established criteria for the identification of and protection of Vulnerable Marine Ecosystems (VME) as an effort to minimize destructive fishing practices on the high seas. These include geological features such as seamounts and hydrothermal vents, as well as assemblages of organisms known to occur in such formations (e.g. cold water corals). Although VME regulations and guidelines are not legally binding, they reflect a widespread recognition of the need for protection for these sites, including against DSM activities (CHRISTIANSEN *et al*., 2022; WATLING; AUSTER, 2017). As another criterion, Ecologically and Biologically Significant Areas (EBSAS) established by Convention on the Biological Diversity (CBD) can contribute to informing areas of special protection where DSM should not take place (SECRETARIAT OF THE CONVENTION ON BIOLOGICAL DIVERSITY, 2009; CBD, 2014; CHRISTIANSEN *et al*., 2022).

A primary concern related to the start of DSM is the limited knowledge available on deep-sea biodiversity, processes, functions, and the underestimated benefits arising from it in the form of ecosystem services (ARMSTRONG *et al*., 2012; LE; LEVIN; CARSON, 2017; MONTSERRAT *et al*., 2019; THURBER *et al*., 2014). As a result, there is limited understanding of the expected impacts and effects arising from DSM, especially relating to the considering the long duration expected from future commercial activities. Broadly, impacts foreseen arising from DSM activities include (1) removal of fauna attached to minerals as substrate; (2) generation of sediment plumes; (3) contamination of the seawater by heavy metals released during the resuspension of sediments and through the returning water; (4) change of water temperature; (5) sound, vibration and light; (6) cumulative impacts within and beyond the area of mining activity (both vertically and horizontally) (DRAZEN et al., 2020; KOSCHINSKY *et al*., 2018; LEVIN; AMON; LILY, 2020; MILLER *et al*., 2018; NINER *et al*., 2018).

While numerous impacts are expected from DSM, the ISA is responsible for preventing the harmful effects arising from DSM activities and ensuring the marine environment's effective protection (UNCLOS, 1982 - Article 145), including by applying, as far as reasonable possible, a precautionary approach (ISA, 2012, 2013 – Regulation 31.2; ISA, 2010 – Regulation 33.2). Against the potential of DSM to cause serious harm to the marine environment, the ISA regime foresees the development and performance of precautionary instruments, including Environmental Impact Assessments (EIAs) and Regional Environmental Management Plans (REMPs) (JAECKEL, 2015). The first Environmental Management Plan (EMP) was

established in the CCZ (ISA, 2011, 2012b) based on the concerns of the scientific community with respect to the cumulative impacts arising from multiple mining operations. The main component of the EMP-CCZ is a network of mining exclusion zones, denominated Areas of Particular Environmental Interest (APEIs) (WEDDING *et al*., 2013, 2015). The development of REMPs is foreseen to take place in all regions where mining interest exists (ISA, 2018).

DSM activities in the Area have been argued as means to facilitate the transition to the next generation of renewable technologies (HEIN *et al*., 2013) while acknowledging an equitable sharing of benefits. Along with that, DSM is recognized by some as a modality that can help alleviate the social and environmental pressures and impacts commonly reported for land-based mining activities (HAUGAN *et al*., 2020; THOMPSON *et al*., 2018). Conversely, there is little to no evidence that aspects beyond the focus on the economic rationale (i.e., natural, social, cultural) (CARVER *et al*., 2020; CHILDS, 2020; CONDE *et al*., 2022) are properly reflected in the ISA regulatory framework or practice (GUILHON; MONTSERRAT; TURRA, 2020; GUILHON *et al.*, 2022; cap. 5). Adding to that, an attempt to accelerate the process of adopting exploitation regulations by the Republic of Nauru in invoking a legal provision that compels the ISA to complete the regulations in two-years' time might result in commercial scale mining commencing in the near future even in the absence of consensus at the ISA (for more information on that matter, refer to Singh, 2021).

At the same time, numerous obstacles remain that add to many challenges in developing an effective regulatory framework to manage DSM. The existence of a high level of uncertainties and knowledge gaps relating to deep-sea ecosystems and the potentially irreversible DSM impacts in time and space (including in the context of climate change); the need to balance social and economic trade-offs as well as to apply the precautionary approach in light of a new industry arising; the administration of several potentially conflicting interests at stake; and the management of resources that are the common heritage of humankind are only some of the wide ranges of challenges existent in the context of negotiations for DSM in the Area. Considering that, establishing a transparent, equitable, participative and robust system for governance and management for DSM activities requires the adoption of an approach that addresses such multiplicity and complexity.

The recognition that solutions for planetary challenges require the integration of an array of subjects and disciplines is at the core of Agenda 2030. Established in 2015 under the United Nations General Assembly, the Agenda 2030 addresses significant societal complexities such as poverty, health, energy, gender, education, climate change, ocean, and partnerships,

among others. Efforts directed to the ocean are represented by SDG 14 – Life below water – devoted to "*Conserve and sustainably use the oceans, seas and marine resources for sustainable change*". The SDG 14 provides a platform to catapult the adoption and operationalization of an ecosystem approach (EA) (UNGA, 2017; DIZ, 2019). The importance of EA in the Agenda 2030 is reflected in Target 14.2[1] which accounts for "*Number of countries using ecosystem-based management approaches to manage marine areas*" as an indicator of its fulfillment (UNEP, 2021).

Although only more recently gaining evidence, the concept behind EA is not new. In the international realm, Long, Charles and Stepherson (2015) indicate that ocean health aspects firstly gained international recognition as guiding principles for the establishment of the United Nations Convention on the Law of the Sea (UNCLOS). Others refer to the first utilization of EA as a framework under the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR), adopted in 1980 (DE LUCIA, 2015; ENRIGHT; BOTELER, 2020). Despite the evidence on its first recognition dating back many years, EA has only more recently gained prominence in timely ocean debates and agendas, both at international and national levels (CBD, 2005; ENRIGHT; BOTELER, 2020; GELCICH *et al*., 2018; ICES, 2017; XAVIER *et al*., 2022) including in the context of DSM in the Area (GUILHON; MONTSERRAT; TURRA, 2020; GUILHON *et al.*, cap 2; ISA, 2019, 2012).

Advocated as a "*best environmental practice for oceans governance*" (GELCICH *et al*., 2018), EBM is a response to siloed approaches, which have failed to integrate the existing array of multi-ocean-uses and sectoral goals (LESLIE; MCLEOD, 2007; LINK *et al*., 2019), among jurisdictions and agencies (RUDD *et al*., 2018), and considering emerging stressors such as climate change (LILLEBØ *et al*., 2020). According to EBM, human well-being and a healthy ocean are the primary desired management outcomes, one intertwined with the other (LIEBERKNECHT, 2019). For such, functional and harmonious integration of socio-ecological elements is required (DELACÁMARA *et al*., 2020), which can be evaluated across sectors, governance levels, types of knowledge (scientific and traditional), stakeholders and different legal and management strategies (MOYNIHAN, 2020; ENGELER; BOTELER, 2020). Despite figuring as a promising approach, EBM has several challenges, including relating to its terminology, definition, principles embedded, and the definition of primary objectives and goals of its application (ARKEMA *et al*., 2006; CBD, 2007; KIRKFELDT,

[1] *By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans* (UNGA, 2015).

2019; LINK; BROWMAN, 2014; LONG; CHARLES; STEPHENSON, 2015, 2017; MCLEOD; LESLIE, 2009; MCLEOD *et al*., 2005).

Concerning its terminology, EA can be referred to under different terminology without an explicit preference for use in the literature (KIRKFELDT, 2019). Nomenclatures such as *ecosystem management*, *ecosystem-based approach*, *ecosystem approach for management*, *and ecosystem-based management*, among others (see Kirkfeldt, 2019 – Appendix C), are often used interchangeably and largely overlap each other (DELACÁMARA *et al*., 2020). Moreover, Kirkfeldt (2019) suggested that the adoption of a determined nomenclature may be linked to certain aspects, i.e., a focus on natural ecosystems or specific sectors (e.g. *ecosystem-based fisheries management*), acknowledgment of humans as part of ecosystems, and the inclusion of cumulative impacts. For discussions herein proposed, the terminology EBM was adopted following Long, Charles and Stephenson (2015).

There is no consensus among the scientific community on a universal description or definition to EBM. The formulation and adoption of EBM definitions seem to "*accurately meet[s] the needs of the particular context or the particular task at hand*" (DE LUCIA, 2015). In other words, definitions are proposed based on the interests at stake, which vary according to the agencies, groups of interest, and organizations. As exemplified by De Lucia (2015), the definition proposed by the Secretariat of the Convention on Biological Diversity (2004) represents a more conservation-linked narrative: "*a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way*" and that "*recognize that humans, with their cultural diversity, are an integral component of many ecosystems*." Others, alternatively, see EBM as a "*primary way of managing human activities affecting marine ecosystems*", highlighting it as an approach that reconciles the exploration of natural resources with the maintenance of its sustainability (ICES, 2020).

Further, EBM is seen as a "slippery" terminology (GRUMBINE, 1994) or a "wicked problem" with no definitive formulation or objectivity (BERKES, 2011; DELACÁMARA *et al*., 2020). In such context, adopting a combination of EBM elements or principles reflecting its precepts (Table 1) (LONG; CHARLES; STEPHENSON, 2015, 2017) allows for more flexibility and objectively guiding its practice (GUILHON; MONTSERRAT; TURRA, 2020; GUILHON *et al*., 2022; SECRETARIAT OF THE CONVENTION ON BIOLOGICAL DIVERSITY, 2004). Meanwhile, the adoption of a set of principles for a determined context should not be arbitrary (SECRETARIAT OF THE CONVENTION ON BIOLOGICAL DIVERSITY, 2004). This should include a scoping process to determine a "fit-for-purpose"

guidance. Otherwise, its application will be only partial and, most likely, ineffective. In the context of this study, the principles indicated by Long, Charles and Stephenson (2015) were used as a starting point for analysis.

Table 1. The twenty-six Ecosystem-Based Management (EBM) principles identified by Long et al. (2015) and used as the conceptual framework for developing discussions throughout the thesis.

EBM Principles
Sustainability
Account for Dynamic Nature of Ecosystems
Consider Ecosystem Connections
Consider Ecological Integrity and Biodiversity
Acknowledge Ecosystem Resilience
Consider Cumulative Impacts
Consider Effects on Adjacent Ecosystems
Acknowledge Uncertainty
Apply the Precautionary Approach
Consider Interdisciplinarity
Use of All Forms of Knowledge
Use of Scientific Knowledge
Implement Adaptive Management
Conduct Appropriate Monitoring
Develop Long Term Objectives
Explicitly Acknowledge Trade-Offs
Integrated Management
Decision Reflecting Societal Choice
Promote Organizational Change
Promote Stakeholder Involvement
Commit to Principles of Equity
Consider Economic Context
Recognize Coupled Social-Ecological Systems
Use of Incentives
Consider Appropriate Spatial and Temporal Scale
Recognize Distinct Boundaries

Other challenges to EBM include a lack of a clear legal basis comprised of law, regulations, treaties and polices (mandate) to support EBM, an insufficient allocation of financial resources and capacities for its implementation, scarcity of knowledge available, institutional fragmentation and conflicts, and lack of incentives (CHRISTIANSEN *et al*., 2022; LINK *et al*., 2019; MACPHERSON *et al*., 2021; RUDD *et al*., 2018).

As a not one-size-fits-all approach (CBD, 2008; DELACÁMARA *et al*., 2020), EBM should be adapted to each context of management and/or governance. In that aspect, it is argued that scientific efforts should be more dedicated to effectively implementing it than to establishing a universally accepted definition (LINK; BROWMAN, 2014). In line with that, the present work is not dedicated to conceptual discussions of terminology nor definitions, but rather focuses on investigating the potential for its implementation using the DSM regime in the Area, which provides for the adoption of EBM as one of its fundamental principles (ISA, 2019 – Draft Regulation 2.e.iii).

Broadly, the present work aims to investigate the challenges and opportunities for EBM in the context of governing and managing mineral resources in the Area. For that, the thesis comprises four chapters and a conclusion section. Chapter 1 systematically explored the evolution in the reference (direct or indirect) of EBM principles in key regulatory documents of the DSM regime, and, based on that, discussed the potential for implementation by contractors. Chapter 2 referred to an investigation, based on questionnaires and in-depth interviews, regarding the perception of stakeholders from the ISA on their understanding of EBM and its potential applicability to the DSM regime. Chapters 3 and 4 proposed a case study regarding the requirements and practices for Environmental Impact Assessment (EIA). More specifically, chapter 3 addressed the current procedural requirements for impact assessment during prospecting, exploration, and exploitation and provided recommendations to improve the practice of EBM. Based on the literature available and experience from the authors, chapter 4 proposed an exercise on what an EBM-guided EIA process would look like.

This work is a timely contribution to current under development regime of DSM in the Area. As the regulations for exploitation are still undergoing, there is a great opportunity for results obtained through this work to effectively contribute to reflections, reformulations and reviews of regulations and practices, leading to a process strongly supported by EBM. Moreover, this work can contribute to improve harmonization and coherence between regimes in ABNJ in line with the international agendas supporting practices towards a sustainability and conservation, not only in the Area, but in the international ocean realm as a whole.

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2. RECOGNITION OF ECOSYSTEM-BASED MANAGEMENT PRINCIPLES IN KEY DOCUMENTS OF THE SEABED MINING REGIME: IMPLICATIONS AND FURTHER RECOMMENDATIONS (CHAPTER 1)

MANUSCRIPT PUBLISHED ON THE ICES JOURNAL OF MARINE SCIENCE

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Abstract

New human uses on the marine environment, such as deep-sea mining (DSM), have necessitated the adoption of more holistic approaches such as ecosystem-based management (EBM) to secure sustainable development. The United Nations Convention on the Law of the Sea (UNCLOS) and the rules, regulations, and procedures adopted by the International Seabed Authority (ISA) represent the main regulatory framework to govern DSM activities. This study aimed to examine whether UNCLOS and ISA documents include references to EBM principles, and if these references vary in documents through time. Following a literature review, 26 EBM principles were collated into 8 general categories, and their adherence to 5 key documents related to the DSM regime was analysed. Results demonstrated a trend in recognizing EBM principles in documents over time, especially in the Draft Regulations for Exploitation. However, the mere recognition of EBM principles in the regulatory framework does not guarantee that the approach will be clearly understood and appropriately incorporated by contractors throughout the process. For such, further clarification on the meaning of the Ecosystem Approach in the DSM context and building the capacity of the ISA Legal and Technical Commission are among the recommendations presented by this study.

Keywords: areas beyond national jurisdiction, best environmental practices, ecosystem approach, marine minerals resources governance, seabed mining

2.1 Introduction

In a global economy that is highly dependent on natural resources (Merrie et al., 2014), a great challenge exists in ensuring a sustainable use of these resources while ensuring the effective protection of natural environments (UNEP—United Nations Environmental Programme, 2012). Anthropogenic impacts do not only inflict direct harm to the environment but would also affect long-term human well-being and survival through the continuous degradation of ecosystem services (MEA—Millenium Environment Assessment, 2005; Bennett et al., 2015; Sandifer et al., 2015; Schmidt, 2015). Consequently, the adoption of approaches that are compatible with ecosystem-based management (EBM) (CBD - Convention on Biological Diversity, 2000; Arkema et al., 2006; McLeod and Leslie, 2009a; Long et al., 2015) such as integrated management (Bennet et al., 2015; Diaz et al., 2015; Raymond et al., 2017), adaptive management (Kaufman et al., 2009; Agardy et al., 2011; Williams and Brown, 2014), and marine spatial planning (Ehler and Douvere, 2007; Douvere, 2008; Halpern et al., 2012; Collie et al., 2013) has become ever so necessary as part of management solutions.

2.1.1 EBM

EBM (also called "Ecosystem Approach" or "Ecosystem Approach for the Management of Human Activities"), is a holistic concept that aims to reach a balance between conservation, sustainable use, and fair and equitable sharing of benefits provided by the use of natural goods and services (Secretariat of the Convention on Biological Diversity, 2004). Its adoption has been pursued in key global resolutions and documents (CBD - Convention on Biological Diversity, 1995; UN - United Nations, 2002, 2012; UNGA - United Nations General Assembly, 2015). In practice, EBM advocates that any human intervention occurring in natural systems should be preceded by a robust comprehension of how the ecosystem operates, or in other words, must consider and appreciate the structure and functions of socio-ecological systems that maintain environmental integrity (Curtin and Prellezo, 2010; Bryhn et al., 2017). In addition, EBM considers humans and all forms of human interactions with the environment, such as activities, habits, lifestyle, uses, threats, and pressures (McLeod et al., 2005), to be of major importance and seeks to include this human dimension into governance and management arrangements. In this context, EBM is recognized as a best practice for oceans governance (Gelcich et al., 2018) and its sustainable use (ISA - International Seabed Authority, 2017), albeit the fact that there is still no consensus on its definition and scope, which may compromise its practice (Long et al., 2015).

EBM implementation requires an appropriate degree of coordination among national and international jurisdictions as well as intergovernmental agencies with typically different mandates, priorities, practices, values, and objectives, thus adding substantial complexity to negotiations (Link et al., 2019). Furthermore, EBM is considered as an approach that is perceptive to several contexts of information availability, stakeholder participation, and governance structures (Arkema et al., 2006; Tallis et al., 2010).

2.1.2 The deep-sea, mineral resources of "the Area" and EBM

The deep sea is the least known environment on Earth (Penman et al., 2011). In the last decades, the discovery of mineral resources and possibilities of other uses in the deep sea, such as oil and gas extraction, bioprospecting, and CO2 storage activities, have resulted in an increased economic activity (Merrie et al., 2014; Petersen et al., 2016; Sharma, 2017).

Deep-sea mining (DSM) activities in the "Area", the seabed beyond national jurisdictions, are planned for future commercial extraction of mineral resources such as polymetallic nodules (PMN) (SPC - Secretariat of the Pacific Community, 2013a), seafloor massive sulphides (SMS) (SPC - Secretariat of the Pacific Community, 2013b), and cobalt-rich crusts (CRC) (SPC - Secretariat of the Pacific Community, 2013c).

Impacts from DSM may range from pollution caused by the formation of sediments plumes and contamination of seawater during the extraction of metallic resources (Schmidt, 2015; Christiansen et al., 2020) to noise, vibration, light, loss of biodiversity, and significant (potentially irreversible) damage to a variety of deep-sea habitats and ecosystems (Jones et al., 2018; Lodge and Verlaan, 2018; Miller et al., 2018; Montserrat et al., 2019).

The many levels of uncertainty associated with scientific knowledge in the Area related to the potential significant environmental consequences of DSM (Washburn et al., 2019) require the adoption of a precautionary approach to management (Jaeckel, 2015; Levin et al., 2016; Niner et al., 2018). This comprises proactive and anticipatory actions (UNGA - United Nations General Assembly, 2006; Jaeckel, 2015), with both these elements compatible with EBM. In the face of many human uses of the marine environment, a more comprehensive spectrum of marine uses, their impacts, and external pressures, such as climate change (Levin et al., 2020), should also be featured as part of a more holistic governance and management processes.

Mineral resources found in "the Area" are considered to be the common heritage of all humankind (UNCLOS - United Nations Convention on the Law of the Sea, 1982). In effect, this means that these minerals belong to humankind as a whole, including future generations

(Hunter et al., 2018). As such, EBM advocates for a fair and equitable management of seabed mineral resources requiring a strong and participatory involvement of all stakeholders, including the lay public.

2.1.3 The international DSM regime

The International Seabed Authority (ISA), established through the United Nation Convention on the Law of the Sea (UNCLOS - United Nations Convention on the Law of the Sea, 1982), is the international organization responsible for administering the mineral resources of the "Area". The ISA is responsible for the elaboration of a regulatory regime to govern and manage all mining activities in the Area. In doing so, the ISA is under the obligation to "ensure the effective protection for the marine environment from harmful effects which may arise from such activities [mining activities in the Area]" as prescribed in Article 145 of UNCLOS.

The ISA is currently developing the "Mining Code", represented by the set of rules, procedures, regulations, and recommendations that constitutes the DSM regime (Markus and Singh, 2016). On the one hand, regulations are binding instruments that regulate the prospecting, exploration, and exploitation (forthcoming) of minerals in the Area (ISA - International Seabed Authority, 2010, 2012a, 2013a, 2019). On the other hand, recommendations issued by the ISA's technical body, the Legal and Technical Commission (LTC), are non-binding instruments that contractors, the interested parties that hold an exploration contract with the ISA, are requested to observe as much as possible (Ginzky et al., 2020). Since the regulations that would enable exploitation activities are presently under negotiations at the ISA, current ongoing activities in the Area are focused solely on mineral exploration.

To date, 30 exploration contracts have been awarded, with most of them in a fractured region and nodule-bearing named the Clarion-Clipperton Zone (CCZ), located in the eastern Pacific Ocean (ISA - International Seabed Authority, 2020a). Once the regulations to enable exploitation activities are formally adopted by the ISA, which is expected to be the case in the near future, applicants may proceed to apply to conduct the commercial extraction of minerals in the Area, turning deep seas into an official source of raw material.

2.1.4 EBM in DSM instruments

EBM is thus an environmental management strategy considered as applicable for activities in the Area (Warner, 2020). Understanding how EBM has currently been incorporated by institutions and policies in governance systems is imperative to guarantee a safer and more

sustainable use of marine resources (Gelcich et al., 2018). For the DSM regime, the incorporation of EBM has been explicitly referenced for the development of Regional Environmental Management Plans (REMP), such as for the CCZ (ISA - International Seabed Authority, 2012b; Wedding et al., 2013, 2015), and is also guiding the establishment of no-mining areas (Areas of Particular Environmental Interest) in the Mid Atlantic Ridge (Dunn et al., 2018). In addition, there is a call for the application of EBM in the current Draft of Regulations on Exploitation of Mineral Resources in the Area.

Few studies have conducted an in-depth discussion on how certain principles considered as compatible with EBM (Long et al., 2015) could be implemented in the DSM context (Jaeckel, 2015, 2016; Jaeckel et al., 2017). In this respect, it is anticipated that the ISA will provide conditions for EBM to be recognized and adopted by contractors. As such, the more explicit EBM principles are, the more likely stakeholders (especially contractors) will incorporate them as part of their commitment to protect the marine environment, as materialized through the contracts awarded by the ISA.

Thus far, no systematic research has been conducted on whether and how principles that are currently recognized as compatible with EBM are, in fact, incorporated into the DSM regime, and whether the recognition of EBM by the ISA has changed over time (as reflected in the different regulatory instruments it adopts). The present study also attempted to conduct this analysis and sets out to explore whether the existing ISA regulatory framework provides sufficient reference to established EBM principles and provides appropriate indications for its implementation by contractors. Finally, the study also considered the possible implications that could result from an unclear, or lack of, EBM incorporation and provided recommendations for the improvement of EBM for the DSM regime.

2.2 Methods

The material analysed Five documents considered as principal instruments applicable to DSM activities were analysed. A brief description of the documents and the sections chosen for analysis are found in Table 1, while a more detailed description is available under Supplementary Material SI.

For the analysis, the documents were categorized into two primary groups: Global Conventions (UNCLOS - United Nations Convention on the Law of the Sea, 1982; UN - United Nations, 1994) and the Mining Code (ISA - International Seabed Authority, 2020a).

Owing to Article 2, Paragraph 1 of the Agreement, which states that: “The provision of this Agreement and Part XI shall be interpreted and applied together as a single instrument”, the UNCLOS and the Agreement on Part XI were analysed together. Thus, for the purposes of this study, these instruments have been treated collectively and thus counted as one document.

As part of the Mining Code, seven distinct documents were preliminarily analysed.

With respect to Exploration Regulations, the Regulations of the Prospecting and Exploration for PMN (ISBA/19/C/17), SMS (ISBA/16/A/12/Rev.1) and CRC (ISBA/18/A/11) were analysed. As for Recommendations and Guidance, both the “Recommendation for the guidance of contractors for the assessment of possible environmental impacts arising from the exploration of marine minerals in the Area” (ISBA/25/LTC/6/ Rev.1) and “Recommendations for the guidance of contractors on the content, format and structure of annual reports” (ISBA/ 21/LTC/15) were selected for the analysis. Finally, the current version of the draft on the Regulations for Exploitation of Mineral Resources in the Area (ISBA/25/C/WP.1), hereinafter referred to as the “Exploitation Draft” (ED) and which is now being negotiated at the ISA, was analysed.

Following the preliminary analysis, it was ascertained that there were no significant differences in the content of regulations for Prospecting and Exploration activities related to the three mineral resources regulated by the Mining Code. Accordingly, only the document for PMN (ISA - International Seabed Authority, 2013a) was included in the content analysis, totalizing four documents to be analysed as object of this study. Hence, the results of the analysis is also applicable to the content of the SMS (ISA - International Seabed Authority, 2010) and CRC (ISA - International Seabed Authority, 2012a) regulations. The same logic applied to the analysis of ISA recommendation for the annual report in which only Annex I (applicable to PMN) was analysed, but the results are representative of the contents in Annexes II and III (applicable to SMS and CRC, respectively).

Table 1. Documents analysed and their role in the DSM process.

Primary Group	Document	Official identification	Year	Reference in the text	Analysed sections	Subject
Global conventions	United Nations Convention on the Law of the Sea	UNCLOS	1982	UNCLOS	Part XI and XII and Annex III	Defines maritime zones within and outside the national jurisdictions (the Area and the High Seas), regulates navigational rights, economic jurisdictions, conservation and management of living marine resources, and protection of the marine environment, and presents a bidding procedure for settlement of disputes between States. The UNCLOS also creates the International Seabed Authority and describes its objective and functional structure. Besides this, the document characterizes and provides the first guidelines for the conduction of prospecting, exploration, and exploitation activities in the Area
	Agreement relating to the implementation of Part XI of the Convention	The Agreement	1994	The Agreement	Entire document	Created in an attempt to achieve universal participation in the UNCLOS. Although the Agreement XI represents a physical separated document, the analysis of its content was conducted jointly with the UNCLOS, once Article 2, Paragraph 1 of the Agreement states that: "The provision of this Agreement and Part XI shall be interpreted and applied together as a single instrument (. . .)"
Mining Code	Regulation on prospecting and exploration for polymetallic nodules in the area and related matters	ISBA/19/C/17 but applicable to ISBA/16/A/12/ Rev.1 and ISBA/18/A/11	2013	Prospecting and Exploration Regulations (PER)	Preamble, Parts I, II, III, and V	Provides guidelines to interested parties to submit prospection and exploration applications regarding polymetallic nodules, as well as comply with other requirements demanded by the ISA. In addition, issues such as preservation of the marine environment, confidentially, and general procedures are also discussed
	Recommendation for the guidance of contractors for the assessment of possible environmental impacts arising from exploration for marine minerals in the area	ISBA/25/LTC/6/ Rev.1	2020	Environmental Recommendations (ER)	Parts I, II, III, and IV	Describes procedures to be followed in the acquisition of baseline data and monitoring to be performed during and after any activities in the exploration area with potential to cause serious harm to the marine environment The recommendation also defines requirements for obtaining baseline data, the conduction of an environmental impact assessment requirements (if applicable), and monitoring activities
	Recommendation for the guidance of contractors on the content, format, and structure of annual reports	ISBA/21/LTC/15	2015	Annual Reports Recommendations (ARR)	Part I and II and Annex I	Describes the general requirements for annual reports and provides specific guidance on information that should be presented for reporting on the exploration activities for the three mineral categories regulated by the ISA
	Draft of Regulations on Exploitation of Mineral Resources in the Area	ISBA/25/C/WP.1	2019	Exploitation Draft (ED)	Preamble, Parts I, II, and IV and Annexes IV and VII	The draft is a guideline for contractors to obtain an exploitation license

2.2.1 Principles underlying EBM

A total of 26 EBM principles were selected for this analysis. These principles have been derived from 13 publications, following a literature survey (Long et al., 2015). To facilitate the analysis and further discussion, the principles were collated into eight general categories, similar to those previously proposed by Arkema et al. (2006): (i) Core; (ii) Ecological; (iii) Impacts; (iv) Knowledge; (v) Management; (vi) Participation; (vii) Socio-economic; and (viii) Spatial and Temporal Scales (Table 2).

Table 2. Description of Ecosystem-Based Management (EBM) principles, adapted from Long et al. (2015) in general categories and the respective acronyms developed and adopted by this study.

General Categories	EBM Key Principles	Acronym
Core	Sustainability	S
Ecological	Account for Dynamic Nature of Ecosystems	ADNE
	Consider Ecosystem Connections	CEC
	Consider Ecological Integrity and Biodiversity	CEIB
Impacts	Acknowledge Ecosystem Resilience	AER
	Consider Cumulative Impacts	CCI
	Consider Effects on Adjacent Ecosystems	CEAE
Knowledge	Acknowledge Uncertainty	AU
	Apply the Precautionary Approach	APA
	Consider Interdisciplinarity	CI
	Use of All Forms of Knowledge	UAFK
	Use of Scientific Knowledge	USK
Management	Implement Adaptive Management	IAM
	Conduct Appropriate Monitoring	CAMo
	Develop Long Term Objectives	DLTO
	Explicitly Acknowledge Trade Offs	EATO
	Integrated Management	IM
Participation	Decision Reflecting Societal Choice	DRSC
	Promote Organizational Change	POC
	Promote Stakeholder Involvement	PSI
Socio-economic	Commit to Principles of Equity	CPE
	Consider Economic Context	CECo
	Recognize Coupled Social-Ecological Systems	RCSES
	Use of Incentives	UI
Spatial and Temporal Scales	Consider Appropriate Spatial and Temporal Scale	ASTS
	Recognize Distinct Boundaries	RDB

2.2.2 The analysis

The study conducted was based on a semi-quantitative content analysis (Neuendorf, 2004), which involved a careful reading and interpretation of the content present in the five documents mentioned in the "The material analysed" section. To minimize the subjectivity that is inherent to this form of analysis, a list assigning tentative definitions of the EBM principle was used to guide the interpretation of the relevant provisions in the documents (Supplementary Material SII). As the contents of the document were studied, the relevant provisions therein were assessed, so as to ascertain whether EBM principles are featured in either a clearly defined manner or otherwise, and were classified accordingly.

Given the fact that the interpretation of the legal language varies from rather vague and very general to clearer and more specific, statements provisions were ranked based on a score, as follows: 0 (zero), if considering EBM, the principle was expected to be present within a provision but was not identified; 1, if the principle was difficult to be interpreted from the text (not clear), and thus considered as indirectly mentioned; and 2, if the principle is clearly mentioned or easily discernable. Not applicable (N/ A) was used for documents or sections in which the principle was not identifiable but was also considered as having no application to the subject. Considering the application of the scores, the authors presuppose that the higher the score that the principle received, the lower the chances are of the principle being misinterpreted or overlooked by the reader with respect to that specific provision.

Those provisions that were identified as reflecting EBM were identified and a score (i.e. 1 or 2) was assigned to the respective principle (Supplementary Material SIII). Thereafter, the scores for each section analysed for each document were transferred to a general table (Supplementary Material SIV). In cases where the principle received scores of 0 and 1, 0 and 2, or 1 and 2 for the same section, the highest score was represented followed by an asterisk (*) symbol. An example on how these provisions were assessed in relation to the principles and how the principles scored is found in Table 3.

Table 3. Example of interpretation of EBM principle (listed by Long et al., 2015), based on the definitions adopted by the authors (Supplementary Material II) in an extract from a document analyzed: 1 – implicitly mentioned or 2 – explicitly mentioned.

Principle	Definition adopted by the authors	Example of extract from the documents analyzed
Consider Ecosystem Integrity and Biodiversity (CEIB)	"Maintenance of biodiversity at biological community, habitat, species and genetic levels and maintain the ecological processes that support both biodiversity and resource productivity."	Score 1 - "During exploration for marine minerals, the International Seabed Authority is required to, among other things, establish and keep under periodic review environmental rules, regulations and procedures **to ensure effective protection for the marine environment** from harmful effects which may arise from activities in the Area (...)" (Item 1, Environmental Recommendations - ER, ISBA/25/LTC/6/Rev.1)
		Score 2 - "It is important to obtain sufficient information from the exploration area to document the natural conditions that exist prior to test mining, **to gain insight into natural processes such as dispersion and settling of particles and benthic faunal succession**, and to gather other data that may make it possible to acquire the capability necessary to make accurate environmental impact predictions" (Item 13, Environmental Recommendations - ER, ISBA/25/LTC/6/Rev.1)

The scores obtained in Supplementary Material SIV were adjusted so that the highest value was considered for each principle in each document. The same logic was used to calculate the final score obtained for each document (represented by the highest value obtained between sections) and the sum of scores from all documents for each principle, shown on the column "Overall Score" (Table 4).

Table 4. Final scores for each document analysed related to the recognition of the 26 principles and the correspondent general category.

General Categories	EBM Key Principles (Long et al, 2015)	UNCLOS (1982) + XI Agreement (1994)	PER (2010, 2012, 2013)	ER (2020)	ARR (2015)	ED (2019)	Overall total
Core	Sustainability	2*	1*	1*	0	2*	2*
Ecological	Account for Dynamic Nature of Ecosystems	N/A	1	2	N/A	2	2*
	Consider Ecosystem Connections	0	0	2*	2	2*	2*
	Consider Ecological Integrity and Biodiversity	2*	2*	2*	2	2*	2*
Impacts	Acknowledge Ecosystem Resilience	0	0	2	2	2*	2*
	Consider Cumulative Impacts	N/A	0	2	N/A	2*	2*
	Consider Effects on Adjacent Ecosystems	2*	2	2	N/A	2*	2*
Knowledge	Acknowledge Uncertainty	1	2*	2	2*	2*	2*
	Apply the Precautionary Approach	1	2	2	N/A	2	2*
	Consider Interdisciplinarity	N/A	2*	1	2	2*	2*
	Use of All Forms of Knowledge	2*	2*	2	N/A	2	2*
	Use of Scientific Knowledge	2	2	2	2	2	2
Management	Implement Adaptive Management	N/A	2*	2	N/A	2*	2*
	Conduct Appropriate Monitoring	2	2*	2	2	2	2*
	Develop Long Term Objectives	N/A	N/A	0	2	0	2*
	Explicitly Acknowledge Trade Offs	N/A	0	1*	N/A	1*	1*
	Integrated Management	1	2	0	N/A	2	2*
Participation	Decision Reflecting Societal Choice	N/A	N/A	0	N/A	0	0
	Promote Organizational Change	1	N/A	0	N/A	0	1*
	Promote Stakeholder Involvement	2	N/A	2	2	2	2*
Socio-economic	Commit to Principles of Equity	2	2	0	N/A	2	2*
	Consider Economic Context	1	1	N/A	N/A	2*	2*
	Recognize Coupled Social-Ecological Systems	0	0	0	N/A	2*	2*
	Use of Incentives	N/A	N/A	N/A	N/A	2	2
Spatial and Temporal Scales	Consider Appropriate Spatial and Temporal Scales	N/A	N/A	2	N/A	2	2
	Recognize Distinct Boundaries	0	0	0	N/A	0	0

The score represents that the principle should be possible to recognize but it was not; 1 represents that the principle was considered as difficult to be recognized; and 2 refer to easily recognizable principles. Numbers containing an asterisk (*) symbol represent divergence of score among section of the same document or within documents, in the case of UNCLOS and XI Agreement analysis (to obtain the results of the analysis by section analysed, please check the Supplementary Material SIV).

The temporal analysis was performed based on the percentage calculation of EBM recognition in documents. The calculation was conducted considering the sum of scores received by each document divided by the maximum amount that could possibly be obtained by the said document according to the author's content analysis.

Hypothetically, if all EBM principles (26) were considered as applicable and easily identifiable (Score 2), the maximum sum that the document could receive is 52. In cases where some principles were considered as not applicable (N/A) in a document, the total amount that the said document could receive was calculated after deducting the value of N/A. For example, if a document was considered as having five N/A principles, the maximum value that it can achieve in total sum is 42. This is because 2 points (maximum score obtained by a principle) were deducted for each N/A entry and then subtracted from the total possible amount of 52 points, thus totalling 42 points. In this case, the percentage would be calculated from dividing the total amount scored by the document by 42. For calculations involving the general categories, the same logic was adopted by considering the maximum amount of points that could be obtained within each general category for each document.

As a visual way of representing possible variations in EBM recognition across time, the results obtained from the calculations mentioned above were plotted in radar charts. The radar charts should be understood as follows: the more EBM is recognizable in the documents, the less sharp and more external - in relation to the central axis - the radar chart should be.

As it is impractical, and beyond the scope of this paper, to discuss the incorporation of each of the 26 principles in detail for the five documents in this manuscript, the study focused primarily on discussing improvements for those receiving the scores of "0", "1", or containing a (*) symbol. The discussion was framed based on the general categories analysed (see Table 2).

2.3 Results

In general, EBM principles were found to be reflected in all documents (Figure 1). The percentages showed a clear trend of increase in EBM recognition over the documents, represented as: 62% for the United Nations Convention on the Law of the Sea (UNCLOS); 63% for Prospecting and Exploration Regulations (PER); 65% for Environmental

Recommendations (ER); 90% for the Annual Report Recommendations (ARR) (ISA - International Seabed Authority, 2015); and 83% for the ED (ISA - International Seabed Authority, 2019).

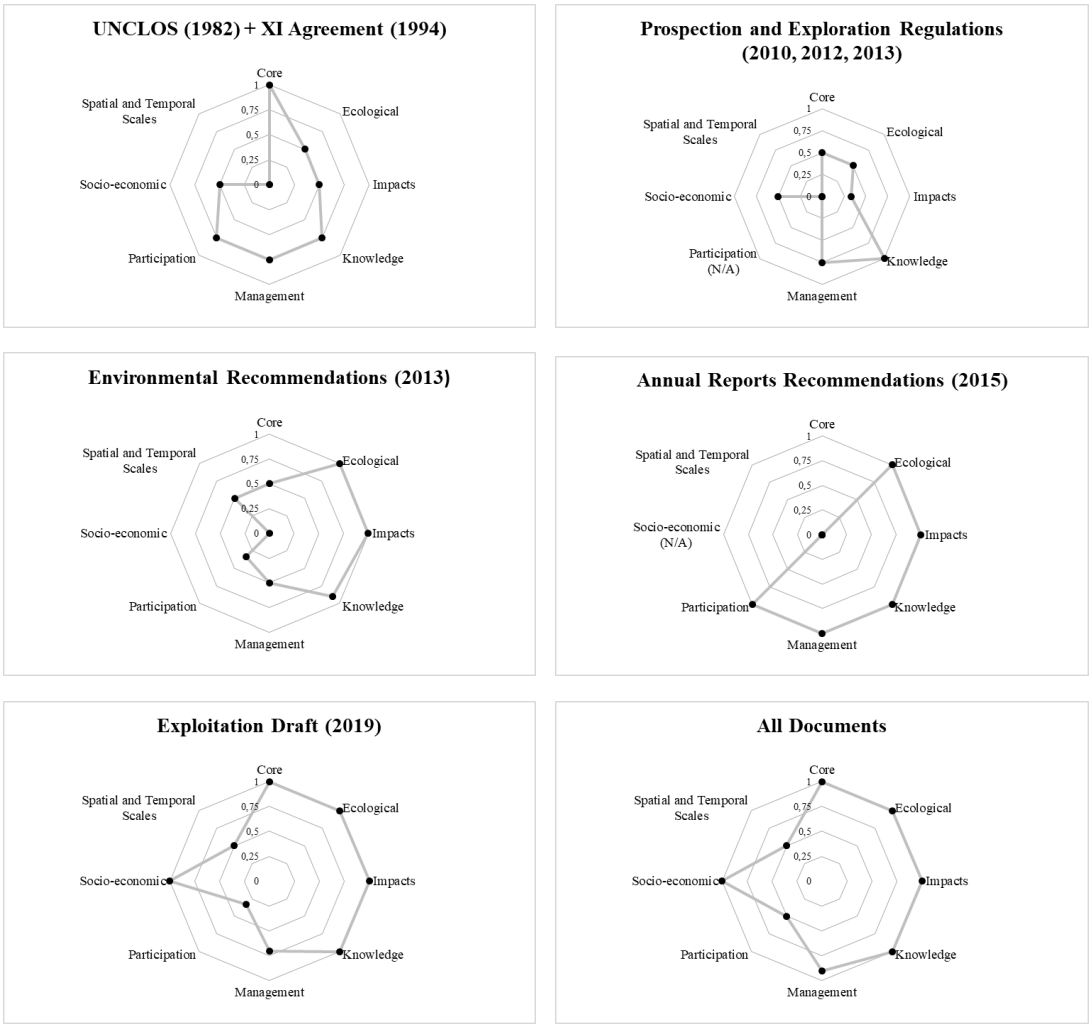

Figure 1. Radar charts representing the percentage of EBM recognition for each general category of principles in deep-sea regulatory documents, for the period between 1982-2019, followed by a radar chart considering all analyzed documents together. Principles categories considered as Non-applicable for a document are indicated in the charts as N/A. The more external the radar chart output are, the more EBM categories were recognized in the document.

The highest percentage of EBM recognition as seen in the ARR document is mainly related to the fact that most of the information required to be included in the Annual Reports should follow the environmental baseline information guidance provided by the LTC recommendations (ISA - International Seabed Authority, 2020b). Then, it is expected that the EBM lacks identified for the ER document remains for ARR. Therefore, ED should be considered as the document that effectively demonstrated the highest acknowledgment of EBM in this study.

Radar charts demonstrate the percentage of incorporation of EBM principles by each general category for each document (Figure 1). Between the documents, it is evident that the ED radar chart exhibited the highest presence of EBM principles (represented by its expansion in the opposite direction of the central axis) achieving maximum configuration for the Core,

Ecological, Impacts, Knowledge, and Socio-economic categories (Figure 1). When considering all of the radar charts, the one representing "All documents" presented the most balanced result, but with deficiencies remaining in the Participation and Spatial and Temporal Scales categories, respectively.

In relation to a possible trend in the recognition of EBM principles through time, the analysis showed that many principles not recognized in UNCLOS were reflected in the ED, such as Consider Ecosystem Connections (CEC), Acknowledge Ecosystem Resilience (AER), and Recognize Coupled Social-Ecological Systems.

Within the general categories, Knowledge was the most consistent one, keeping high values of recognition from PER to ED. Important improvements were also observed for both Ecological and Impact categories, which kept high values of EBM recognition from ER to ED. Management presented a percentage of at least 50% for all the documents in which the principles were applicable (Figure 1). Other general categories, such as the Core and Socio-Economic categories, presented extreme variations among documents with some values achieving 100% (Core for UNCLOS and ED; Socio-economic for ED) and others rated as 0% (Core for ARR; Socio-economic for ED).

Participation principles were considered as N/A for PER, whereas the Socio-Economic and Spatial and Temporal Scales principles were evaluated as N/A for ARR. In all other cases, at least one principle of the general categories was reflected in at least one section of the documents.

All of the 26 principles were considered as applicable to the ED document. The highest number of N/A classification was observed for the ARR (16). In all the situations where applicable, the Use of Scientific Knowledge (USK) principle received the maximum score of 2. In this respect, it should be emphasized that the fact that a document receiving a score of 2 for the incorporation of an EBM principle does not necessarily mean that the said principle is sufficiently incorporated into the entire document. Rather, this merely means that the principle was identified by the authors, without necessarily guaranteeing that this will be equally clear to all readers.

In contrast, principles such as Decision Reflecting Societal Choice and Recognize Distinct Boundaries were classified as 0 whenever applicable (Table 4), which contributed to the lowest general recognition observed in the study, performed by Participation and Spatial and Temporal Scales categories. In relation to EBM recognition, the PER presented the highest presence of zero for the final scores (seven), which means that seven principles were not

recognized in any of the analysed sections. The partial or total lack of EBM recognition in a document can also be verified by the presence of the (*) symbol, which means that a document that presented the maximum score of 2 at Table 4 received a score of 1 or 0 in at least one of the sections analysed. In the case of a score of 1 accompanied by a (*) symbol, it means that the document scored also a zero, for at least to one section. The ED was the document that presented the greatest amount of * symbols and, thus, stands out as the biggest potential for improvement. In this aspect, the ER document can be considered as where EBM was more often fully recognizable, given that it was the one that presented more scores of 2 that was not accompanied by the (*) symbol.

The "Overall total" column (Table 4) presents a score of 2 for all but four principles (Explicitly Acknowledge Trade-Offs, Decision Reflecting Societal Choices, Promote Organizational Change, and Recognize Distinct Boundaries). This indicates that they are not effectively translated into the seabed mining regime documents. On the other hand, four principles (Use of Scientific Knowledge, Promote Stakeholder Involvement, Use of Incentives, and Consider Appropriate Spatial and Temporal Scales) were considered as explicit for all documents in which they were considered applicable. Finally, the Use of Incentives principle was considered as containing the highest number of N/A entries, presented in four of the five documents analysed.

2.4 Discussion

2.4.1 General

Until recently, EBM in the context of areas beyond national jurisdiction has primarily been discussed in relation to fishing activities (Druel et al., 2012; Gjerde et al., 2013, 2016; Long et al., 2017) and has rarely been applied to new uses in deep-sea areas, such as mining (Jaeckel, 2015, 2016; Jaeckel et al., 2017). The present study conducted a comprehensive systematic evaluation of the presence of EBM-related principles, as currently recognized within academic literature, in the main DSM regulatory framework. The increased recognition of these principles in documents through time, especially in the most recent, such as the ED, may be construed as a progressive consideration of best environmental practices (Gelcich et al., 2018) in processes related to marine issues, including DSM (Warner, 2020).

As mentioned earlier, the fact that a document received a score of 2 does not necessarily mean that it is satisfactorily incorporated into DSM framework. Rather, the score represents that EBM was easily recognizable in the analysed documents and, thus, there is a higher

potential of EBM being acknowledged by contractors and reflected in DSM activities. EBM should also be recognized by the Legal and Technical Commission (LTC), the technical and advisory body of the ISA, while reviewing paperwork submitted by contractors as well as when reviewing and issuing recommendations related to prospecting, exploration, and exploitation applications for approval by the Council. Such paperwork includes, among others, plans of work, annual reports, environmental impact assessments, environmental management and monitoring plans, and closure plans. Deficiencies in articulating EBM through regulations, guidelines, and recommendations can lead to a lack of its recognition by the contractors and consequently a failure in compliance, which compromises the underlying rationale for which the ecosystem approach is demanded (ISA - International Seabed Authority, 2012b, 2019). Accordingly, it is the responsibility of the ISA to urgently provide clarity on the meaning of "the application of the ecosystem approach", as seen in the ED; or as the goal for the CCZ-REMP "Manage the Clarion-Clipperton Zone consistent with the principles of integrated ecosystem-based management" (ISA—International Seabed Authority, 2012b) so that EBM can be assimilated by ISA Member States, the LTC members, contractors, and other stakeholders involved in the process.

Before proceeding to discuss EBM incorporation for each general category, it is necessary to underline several critical aspects regarding the limitations of EBM incorporation in DSM as identified for all the analysed documents.

First, the term "Ecosystem Approach" was only recognized explicitly in the ED. This may be connected to the fact that there has been a broader involvement of the scientific community and other stakeholders in the elaboration of the document (Mengerink et al., 2014; ISA - International Seabed Authority, 2017). However, the lack of definition and scope of what an Ecosystem Approach encompasses for the DSM process (DOSI - Deep Ocean Stewardship Initiative, 2019; Clark et al., 2020) reflects a still incipient transition, and ambivalent commitment to the approach, thereby making difficult its proper and practical application.

Second, although it is not stated as a principle by Long et al. (2015), transparency is directly related to satisfactory EBM application (Ardron et al., 2018). The lack of transparency and availability of documents submitted by contractors to the ISA can be considered as a major limitation for EBM implementation in DSM. Ardron et al. (2018) and an ISA technical study (2017a) discussed this issue and proposed good practices in transparency for DSM processes. A lack in transparency may compromise the accountability of the process to society, stakeholders, and experts external to the ISA. While contractors and the ISA (to some extent)

treat certain information on commercial, economic and strategic issues for each separate DSM project as confidential, this restriction of data availability should not be applied to information related to the protection and preservation of the marine environment (Willaert, 2020).

Considering that the ED represents the future regulatory framework for commercial mining, the recognition of EBM in a clear and practical manner is essential. As negotiations on the ED are still ongoing, there are opportunities for positive changes and further incorporation of EBM in the document. For other documents, especially the PER, ER and ARR, there is also room for improvement, for instance through periodic reviews and amendments.

2.4.2 Considerations by general categories

2.4.2.1 Core

Ensuring the protection of the marine environment is a matter of intergenerational justice, in which the present generations is required to consider the needs and interests of future generations (Fitzmaurice, 2018). Following this logic, Sustainability is one of the main EBM objectives (Long et al., 2015) but also represents one of its main challenges (McLeod and Leslie, 2009b). Moreover, the special status of the Area makes it obvious that the interests of future generations have to be respected when mining activities are being considered in the present day (Wolfrum, 1983; van Doorn, 2016). Although the principle was identifiable in the UNCLOS and the ED introductory section, it should be more explicitly reflected in the guidelines for the development of Environmental Impact Statements (EIS) and Environmental Management and Monitoring Plans (EMMP) as part of, for example risk assessments and objectives and goals of such instruments.

2.4.2.2 Ecological

The principle Account for the Dynamic Nature of Ecosystems was considered as difficult to recognize in the PER document. Adequate baseline surveys combined with monitoring of conditions over time to understand the variability of key environmental factors are needed (Clark et al., 2020), otherwise the factors that are causing or contributing to the changes in an environment could be misinterpreted. To address that, the likely effects of a contractor's program of activities and of monitoring plans should be considered (ISA - International Seabed Authority, 2010, 2012a, 2013a) even for activities such as exploration that are assumed to not have great potential impacts (Lodge and Verlaan, 2018).

The main gap with respect to the CEC principle predominantly relates to the lack in considering ecosystem services (see Montserrat et al., 2019). According to EBM, the most

relevant indicator of ecosystem health is reflected through the capacity of systems to deliver ecosystem services (McLeod et al., 2005; Rosenberg and McLeod, 2005). Ecosystem services implicitly consider ecosystem structure and functions as ecological intrinsic parameters (Armstrong et al., 2012; Thurber et al., 2014) and are considered as a key concept for EBM efficiency (MEA - Millenium Environment Assessment, 2005). According to Thornborough et al. (2019), ecosystem services are implicitly engrained in the current EIS template (Annex IV in the Draft Regulations) through the inclusion of biodiversity and ecosystem functions, albeit not explicitly articulated (ISA - International Seabed Authority, 2019). A clearer consideration of ecosystem services is expected to be realized as a result of increased incorporation of EBM into DSM regulatory framework (ISA - International Seabed Authority, 2016) and is currently advocated for by experts (DOSI - Deep Ocean Stewardship Initiative, 2019).

Consider Ecological Integrity and Biodiversity was explicitly recognized in the Regulation 2.e.i of the ED. A fundamental consideration for the development of environmental objectives shall be the protection and conservation of the Marine Environment, including biological diversity and ecological integrity (ISA - International Seabed Authority, 2019). Information about the conservation status of habitats (Maes et al., 2012), biodiversity, and ecosystem processes (Danovaro et al., 2008) is fundamental to the comprehension of ecosystem functions and, consequently, services.

The ISA should therefore require contractors to demonstrate the recognition and maintenance of ecosystem services, i.e. using ecosystem structure, function, and processes as a core parameter for impact assessment in both exploration and exploitation phases, as well as in environmental management and monitoring plans.

2.4.2.3 Impacts

With respect to the principle Acknowledge Ecosystem Resilience (AER), gaps were observed in the UNCLOS and PER documents. Although AER is absent for the PER document, the ISA does provide guidance for its incorporation through the ER (ISA - International Seabed Authority, 2013b).

The resilience of an ecosystem represents the ability of a system to maintain the same structure and functions under a disturbance scenario (Gollner et al., 2017). Resilience measures are still a gap in knowledge, due to the current low levels of scientific understanding in deep-sea ecosystem functioning (Levin et al., 2016; Le et al., 2017). Recovery, that demands enhancement of baseline investigations as a precondition for being able to predict ecological responses to human induced changes in a mining context (Levin et al., 2016) can be considered

as a proxy for resilience and therefore constitutes an important measure for ecosystem health (Gollner et al., 2017). Although new developments have been advanced (Da Ros, 2019), the use of recovery as an indicator still demands further investigations (Danovaro et al., 2020). In this sense, recovery could potentially represent a compliance with the requirement to "ensure the effective protection of the marine environment" in a disturbance scenario.

The principle Consider Cumulative Impacts is not present in the PER (Jaeckel, 2015), but information on cumulative impacts is requested by the ER. Considering that contractors should refer to ISA - International Seabed Authority (2020b) to obtain guidance on for environmental baseline studies (monitoring and assessment) (ISA - International Seabed Authority, 2015), the principle was categorized as N/A for the ARR. Given to the absence of the principle in PER, contractors could underestimate possible ecosystem changes caused by exploration activities apart from those listed as having potential to cause serious harm. Le et al. (2017) support the necessity of DSM regulations to incorporate a systematic identification of cumulative impacts including from other mining events or multiple human activities, which may cause or contribute to more changes in ecosystem services in addition to DSM alone. If not managed effectively, cumulative impacts in a DSM region may cause species extinction and changes in community structure and functions (Van Dover, 2014), while causing serious harm to the marine environment (Levin et al., 2016). As opposed to Annex IV of the ED where cumulative effects together with spatial and temporal scales are recognized, the same was not observed in the Environmental Monitoring and Management Plans (EMMP), which may compromise the establishment of strategies by contractors such as the use of area-based tools for marine protection.

Similarly, a shortcoming regarding the assessment of the possible effects from mining activities in adjacent areas (Consider Effects on Adjacent Ecosystems) was observed for Part IV and Annex VII of the ED. Plumes from mining activities can reach distances of up to 100km from the mining area (Wedding et al., 2013) and, therefore, would obviously affect areas much larger that the mining site (Schmidt, 2015), causing substantial damages to deep-sea biodiversity in the vicinity (Levin et al., 2016). This information should be considered in the guidance not only for impact assessment but also for the establishment of effective management strategies.

2.4.2.4 Management

According to Craik (2020), to obvious need to Implement Adaptive Management in the DSM regime should be given particular attention due to the many uncertainties related to

scientific knowledge of the deep sea but also because of the ambiguity related to the obligation of the ISA to ensure the "effective protection for the marine environment from harmful effects" (Article 145 of UNCLOS - United Nations Convention on the Law of the Sea, 1982). Even though there are challenges related to its implementation, Jaeckel (2016) proposes several options, such as amending regulations, revising recommendations, constantly reviewing the programme of activity, and the regular update of environmental management plans, as opportunities to improve adaptive management strategies in the ISA regulatory framework.

Integrated Management requires that all the diverse uses of the marine environment be taken into account within the management process. This recognition is of major importance for DSM, in particular for contractors to assess (direct and indirect) impacts associated with DSM activities. Consequently, a lack of appreciation for the principle may hinder the evaluation of potential cumulative impacts by contractors, as well as its magnitude, especially in environmental assessment and monitoring. Directions for integrated management implementation should be made clear, throughout all mining-related phases, including when submitting information that accompanies an application to conduct prospecting and exploration in a certain area.

In relation to Explicitly Acknowledge Trade-Offs, according to the US Ocean Commission Report (2000, p. 48) and reaffirmed by Sanchirico et al. (2013), there is a challenge associated with the assessment of trade-offs between potential benefits from conservation versus conventional uses of resources. Ochoa and Urbina-Cardona (2017) suggest that this may create confusion and weaken arguments when considering trade-offs between conservation and mining for terrestrial areas. Arguably, this is also the case for DSM. In the DSM context, this could greatly hamper the perception of contractors and, therefore, result in a failure to acknowledge trade-offs in line with EBM, for example when deciding what technology to be used for test-mining activities, and criteria for the establishment of Preservation Reference Zones (PRZ), which represent control areas that should not be impacted by mining-related activities, and an Impact Reference Zones (IRZ), which represent areas to assess the potential effects caused by the activities. While an environmental guideline for the establishment of PRZs and IRZs is not yet available by the ISA, scientific efforts (Jones et al., 2020) and workshops (ISA - International Seabed Authority, 2018) have developed objective recommendations more compatible with EBM, such as "Each PRZ will be suitable to serve as a reference area containing a stable biota (...) representative habitats, biodiversity and ecological function potentially impacted by mining in the IRZ".

Experts have also recognized the need to incorporate long-term goals (Develop Long-Term Objectives) in environmental strategies and planning instruments (ISA - International Seabed Authority, 2017). Long-term objectives should also be incorporated into the guidelines for the initial phases of the mining process, such as for EIA and monitoring activities related to exploration activities, but particularly into the EIS in the exploitation phase. An impact assessment and a program for monitoring activities should ideally be described by contractors together with short-, medium-, and long-term goals, potential risks, and proposed actions related to its mitigation.

2.4.2.5 Participation

Decision Reflecting Social Choice was not recognized in any of the documents analysed. The mineral resources of the Area are the common heritage of humankind and thus the participation of civil society in decision-making is of major importance (Jaeckel et al., 2017; Bourrel et al., 2018; Christiansen et al., 2016, 2018). To facilitate participatory decision-making, the need for a social license-to-operate has been suggested (Mason et al., 2010; Durden et al., 2018; Filer and Gabriel, 2018). According to Mason et al. (2010), for onshore mining activities, "a specific term, 'social license' is used by the mining industry to refer to community sanctioning and tacit acceptance of mining operations". In addition to the process of a stakeholder map proposed by Mason et al. (2010), information on costs and benefits related to ecosystem services to those that benefit from the services can contribute to effective identification and participation of stakeholders (Thiele et al., 2020).

For Promote Organisational Change, the principle was only implicitly recognized in the UNCLOS, and there is no clarity on how the named "competent international organizations" could work "in formulating and elaborating international rules, standards and recommended practices and procedures (...), for the protection and preservation of the marine environment". To comply with promoting organizational change the ISA, Member States and contractors could propose the creation of committees (Grumbine, 1994) together with international organizations and universities aiming to cover knowledge gaps about the deep sea, as well as how to deal with management issues to comply with the responsibility to protect and preserve the marine environment.

Participation principles were mainly identified in the ED. The principle Promote Stakeholder Involvement was identified for all documents in which it was considered as applicable. However, as mentioned above, it does not necessarily mean that the principle is sufficiently incorporated into the DSM regime, but rather that it is easily identifiable in all

documents. Stakeholder participation is pivotal in environmental management processes, particularly in decision-making steps at scoping stages, review, and outcomes of environmental monitoring programs (Durden et al., 2017, 2018), including during the exploration phase (Willaert, 2020).

2.4.2.6 Socio-economic

The fact that mineral resources of the Area are the "common heritage of mankind" reinforces the importance of the need to Acknowledge Couple Socio-Ecological Systems. The principle asserts that humans and the environment are intrinsically linked and have, thus far, co-evolved (Shackeroff et al., 2009). Its acknowledgement demands for the generation of knowledge on the relationships between humans and the environment that supports them (Stori et al., 2017). In the ED, the reference to a "sociocultural environment" for example is limited to human uses and sites of archaeological or historical importance. For an effective incorporation of the principle into the process, it would be expected that the logic related to the interactions between humans and the environment, as well as its consequences, was more explicitly referenced throughout the text.

In the DSM context, the principle Commit to Principles of Equity can be related again to the designation of the seabed mineral resources of the Area as the "common heritage of mankind" (CHM). According to Bourrel et al. (2018), an appropriate mechanism of benefit sharing should be established to guarantee the protection of such benefits for current and future generations. Jaeckel et al. (2017) highlights that the principle serves as a guideline to decisions related to resource management and, together with Bourrel et al. (2018), provides recommendations as to how this should be translated into practice in the light of the many challenges faced by its implementation, such as the numerous (and sometimes conflicting) interests and a concrete representation of humankind. Although, the principle is generally well recognized, a lack of clarification as to what exactly it comprises may impair the ability of the ISA to approve a financial mechanism that is appropriate and compatible with equity.

The UNCLOS does mention the provision of financial incentives by the Authority to contractors (Annex III, Article 13d and f), although none of these are related to environmental issues.

The Use of Incentives represent guiding forces that can lead to a behaviour change and to certain political outcomes, especially related to the protection of biodiversity or sustainable use of ecosystems (FAO - Food and Agriculture Organization of the United Nations, 2003; Jones et al., 2013). Environmental incentives, together with a better guidance of what represents

a “healthy development of the world economy” (Article 150 of the UNCLOS), can better guide contractors to behave in a manner that is more compatible with sustainability and therefore, EBM.

2.4.2.7 Spatial and temporal scales

The determination of spatial and temporal scales of impacts is a tool for identifying the significance of DSM impacts on the marine environment (ISA - International Seabed Authority, 2017). Among the greatest challenges, Considering Appropriate Spatial and Temporal Scales is the current lack of a proper understanding of the ecosystem functions in the deep sea (Levin et al., 2016). There is a need for strong and orientated baseline assessment, monitoring strategies, and environmental impact assessments (Danovaro et al., 2017). EBM-related tools, such as Marine Spatial Planning, and designation of Marine Protected Areas, for example, are seen as a strategy to reduce the spatial and temporal scales of impacts (Berg et al., 2015; Wedding et al., 2015; ISA - International Seabed Authority, 2017). Information on the communities potentially affected in a mining site should be as refined and specific as possible, based on the best available scientific evidence, order to provide more accurate predictions on the extent and duration of impacts. Otherwise, measures such as IRZ and PRZ that are designated in contract areas (ISA - International Seabed Authority, 2010, 2012a, 2013a), as well as Areas of Particular Environmental Interests (APEIs) that are established via regional environmental management plans, may be inappropriately located (Dunn et al., 2018; Jones et al., 2020).

The assessment of spatial and temporal scales of impacts is also relevant to the establishment of adequate management boundaries (Willsteed et al., 2017), which is in accordance with the principle Recognize Distinct Boundaries. Annex VII of the ED requires contractors to submit information on “The location and planned monitoring and management of preservation reference zones and impact reference zones, or other spatial management plan tools” (Regulation 2.h.i). However, there is no mention of what the basis of the establishment of such zones should be. Since the maritime zones have been drawn arbitrarily pursuant to UNCLOS and not based on ecosystems, it is necessary to also consider the potential transboundary environmental impacts that mining activities in the Area could cause to the maritime areas of adjacent coastal States, and to create mining buffer zones at the boundaries where necessary (Singh and Pouponneau, 2018).

2.5 Final remarks

The present study demonstrated that most of the 26 EBM principles are recognized in selected DSM documents. However, as repeatedly point earlier, this does not necessarily ensure that these EBM principles will be efficiently recognized by contractors and incorporated into the paperwork submitted to the ISA. Ascertaining this in reality, however, will only be possible through an actual appraisal of the paperwork submitted by contractors. Nevertheless, there is a serious limitation with respect to the availability of these documents by ISA, an issue already raised in previous investigations and workshops, and that has been reinforced by the present study.

Based on the findings here, it can be concluded that EBM incorporation appears to be increasing with time in key documents related to the DSM regime. This observation coincides with an increasing recognition of EBM as a concept related to best environmental practices. Improvements in the analysed documents are still required so that EBM principles are satisfactorily incorporated into DSM framework.

Several general conclusions and recommendations that may help advancing EBM incorporation can be drawn from this study, which at the same time covers several identifiable gaps, namely:

- Especial attention is required to the inclusion of a wording that better reflect EBM principles related to Management, Participation and Spatial and Temporal Scales categories;
- EBM elements are all interlinked and, accordingly, the approach can only be successful when applied in an integrated manner;
- The ISA should provide a clear definition and scope of the ecosystem approach as it is understood and to be applied in the context of the DSM process;
- There it should be explicit incorporation of the terms and logic associated with ecosystem services in the relevant documents;
- Data collection that enable the characterization of ecosystem functions and services by contractors, as well as how the activities will impact them, should be prioritized and strengthened;
- To promote a more inclusive participation in decision-making processes, the communication with stakeholders should be improved, especially in relation to the general public;

- A dedicated guide of EBM incorporation in all steps of the DSM process could help clarify how EBM recognition in the process can be improved. This document should contain a clear step-by-step description of the DSM process (e.g. represented in a flowchart). It should also present possibilities of EBM incorporation (opportunities, rather than only limitations) for each stage of the process; and
- Building the expertise of ISA's Legal and Technical Commission, or even better, the creation of specialized expert group(s) to enhance the incorporation of EBM into the regulatory framework and the implementation process.

The above measures can also strongly augment the ongoing negotiations development of the ED and its path of development. This especially relates to Part IV of the ED, on the "Protection and Preservation of the Marine Environment" and the development of a framework for Environmental Management and Monitoring Plan, which currently has numerous inadequacies regarding EBM. Although some regulations and recommendation are already established and in force, there is a room for improvement to ensure greater alignment of these documents with EBM, for example through review and amendment processes. A more detailed analysis informed by EBM for each step and paperwork submitted to the ISA by contractors will ensure greater confidence and legitimacy in the process and thereby contribute to introducing more responsible practices into DSM regime.

Even though there are many obstacles for incorporating EBM in the DSM regime, this study aimed to represent a timely opportunity for operationalizing EBM looking into what could be changed or improved by the ISA. Adhering to EBM for DSM activities calls for an anticipatory and holistic view, considering factors such as ecosystem particularities, data and technology availability, and financial resources. Each mining project is unique and EBM should therefore be flexible, robust, and adaptable according to different contexts. Its application, however, should be optimized, to ensure a process that considers and minimizes impacts of DSM and other uses of the marine environment to deep-sea ecosystem services, given its unquestionable importance to human health and development.

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2.7 Supplementary Materials

Global Conventions

United Nations Convention on the Law of the Sea - UNCLOS - 1982 and Agreement relating to the implementation of Part XI of the Convention - 1994

The UNCLOS is a treaty created in 1982 and currently adopted by 168 countries (UNTC, 2019). The Convention entered into force in 1994 and is currently considered the constitution of the seas (UN, 1998). The UNCLOS defines maritime zones within and outside the national jurisdictions (the Area and the High Seas) and present the legal status of resources in these areas (Druel and Gjerde, 2014). Additionally, regulates navigational rights, economic jurisdictions, conservation and management of living marine resources, protection of the marine environment and present a biding procedure for settlement of disputes between States.

The UNCLOS formally creates the International Seabed Authority and describes its objective and functional structure. Besides this, the document characterizes and provides the first guidelines for the conduction of prospecting, exploration and exploitation activities in the Area.

The Agreement relating to the implementation of Part XI of the Convention, the so called "Agreement", was created in an attempt to achieve universal participation in the UNCLOS. This happened in face of a parallel seabed mining regime created by industrialized nations such as France, Germany, Italy, Japan, UK and US, the Reciprocating States Regime (Jaeckel, 2015b) by the time of UNCLOS creation. Although the Agreement XI represents a physical separated document, the analysis of its content was conducted jointly with the UNCLOS, once Article 2, paragraph 1 of the Agreement states that: "*The provision of this Agreement and Part XI shall be interpreted and applied together as a single instrument (...)*".

For Global Conventions, parts considered relevant to environmental aspects of deep-sea mining were chosen (Lodge & Verlaan, 2018): The Area (**Part XI + Agreement**), Protection and Preservation of the Marine Environment (**Part XII**) and the Basic Conditions of Prospecting, Exploration and Exploitation (**Annex III**).

The Part XI provides general provisions, principles governing the Area, introduces the International Seabed Authority, its principles, organs and financial arrangements, legal status, privileges and immunities of its members as well as establishes the Seabed Disputes Chamber. Additionally, one of the main highlights of Part XI is related to its designation of non-living resources of the deep seabed beyond national jurisdiction as the common heritage of mankind (Warner, 2014).

In general, Part XII discuss matters related to the protection and preservation of the marine environment, especially with regard of hazardous activities that may pollute the marine environment. Regarding this, sections discuss subjects such as sources of marine pollution, monitoring and assessment, global and regional cooperation and enforcement.

Finally, Annex III brings the first guidelines to the conduction of activities such as prospecting, exploration and exploitation, many of which will be repeated in the specific regulations later developed. Even though some parts of the documents may present similar topic the analysis of both was conducted so that possible modifications in EBM use could be analyzed over time.

Mining Code

Regulation on prospecting and exploration for Polymetallic Sulphides in the Area (ISBA/16/A/12/Rev.1) - 2010; Cobalt-rich Ferromanganese Crusts in the Area (ISBA/18/A/11) - 2012 and Polymetallic Nodules in the Area and related matters (ISBA/19/C/17) – 2013

These regulations, from now on named as “Prospecting and Exploration Regulations” (PER), have as main subject to provide the legal framework to interested parties to apply and carry out prospection and exploration. This includes issues such as measures for the preservation of the marine environment, transparency and general procedures are also discussed.

The sections analyzed for this study encompassed: Preamble + Part I (Introduction); Part II (Prospecting); Part III (Application for approval of a plan of work for exploration in the form of a contract) + Part V (Protection and preservation of the marine environment). The Annex I (Notification of intention to engage in prospecting) and Annex II (Application for approval of a plan of work for exploration to obtain a contract) were not incorporated into the analysis in order to not duplicate information provided by parts above mentioned. The Part II and V were analyzed together because the protection and preservation of the marine environment are related to exploration activities.

For prospection activities, the potential prospector, name received by interested parties before signing an exploration contract, must present a notification document in which he commits to, among other factors, protect and preserve the marine environment. After approval, the prospector should also deliver the Authority with an annual report.

In order to obtain an exploration contract the applicant is required to elaborate and submit a plan of work to the Authority. This document must contain information on the

applicant's technical and financial capacity and a plan of work. Regarding environmental information, the applicant must submit: (i) a programme description for investigating environmental and oceanographic baselines; (ii) a preliminary assessment of the potential impacts the activity poses to the marine environment and (iii) measures for preventing, reducing and controlling pollution and other hazards. The ISA also requests the contractor to indicate Preservation- and Impact Reference areas for later monitoring of environmental effects of mining.

After the exploration contract has been granted, the contractor is obliged to present annual reports covering the programme of activities conducted in the exploration area. Every five years these reports are/should be evaluated from the side of ISA. Among the information required, the document should present results of environmental monitoring including observations, measurements, evaluations and analyses of environmental parameters. This information is intended to monitor possible harmful effects of exploration activities on the marine environment (Lodge et al., 2014). All environmental information should be publicly available, however, so far neither annual reports nor vealations have been made openly accessible.

Recommendation for the guidance of contractors for the assessment of possible environmental impacts arising from exploration for marine minerals in the Area (ISBA/25/LTC/6/Rev.1) – 2020

The ISBA/25/LTC/6/Rev.1, from now on named "Environmental Recommendations" (ER), provides an updated version for ISBA/19/LTC/8 (ISA, 2013b), which was created in a context of developing a comprehensive set of environmental guidelines for the three types of resources found in the Area (Lodge et al., 2014). This recommendation is the result of a periodical review and update, according to current scientific knowledge and information available (ISA, 2002, 2010b).

The document's purpose is to provide a guideline for contractors to (i) *to define oceanographic, chemical, geological, biological and sedimentary properties to be measured and the procedures to be followed by the contractor to ensure effective protection for the marine environment* (…); (ii) *to facilitate reporting by contractors*; (iii) "*to provide guidance to potential contractors in preparing a plan of work for exploration of marine minerals* (…)" (ISA, 2020b). According to Lodge et al. (2014) the recommendation shall be considered as best environmental practice.

After the approval of an exploration contract and one year before exploration activities to begin, the contractors shall deliver to the ISA an environmental baseline study, a monitoring programme and an impact assessment of potential impacts. Baseline studies will be used in the future as monitoring indicators for changing in the marine environment coming from activities.

For the present study it was analyzed the items I + II (Introduction and Scope) and III to VI (Environmental Baseline Studies, Data collection, reporting and archival protocol, Cooperative research and recommendations to close gaps in knowledge and Environmental impact assessment during exploration).

This recommendation, together with the regulations for prospective and exploration activities represent ISA guidelines to initiate exploration activities, and so, reflects what the Authority recognizes as crucial information to be acknowledge regarding the marine environment condition before and during prospecting and exploration activities. These documents indicate how the Authority deals with the identification of drivers that may cause changes in the marine environment as well as monitoring activities.

Recommendation for the guidance of contractors on the content, format and structure of annual reports (ISBA/21/LTC/15) – 2015

The document, from now on described as “Annual Report Recommendations” (ARR), describes the general requirements for annual reports and provides specific guidance on information that should be presented for reporting on the exploration activities for the three mineral categories regulated by the ISA (2015).

According to regulations on prospecting and exploration activities, the contractor must present an Annual Report to the ISA covering the programme for conducted activities. Besides results for the exploration work, the guidelines encompasse directions for presenting information related to environmental monitoring and assessment, training programmes, international cooperation and a programme of activities to the following year. The sections analyzed comprised the Section II and Annex I.

Draft of Regulations on Exploitation of Mineral Resources in the Area - 2019

The document ISBA/23/LTC/CRP.3* (ISA, 2017b) dates from August 2017. That was the first official version of the draft regulations that guides future commercial deep-sea mining. After revisions, the most recent version is ISBA/25/C/WP.1 (ISA, 2019), from now on named

as “Exploitation Draft” (ED), was made available and, like the previous one, went through a process of open contributions and is still currently under revision.

The most recent version of the Exploitation Draft was investigated in this study. The document is extensive and deals with all aspects relevant to applicants and contractors of commercial deep-sea mining. Six parts of relevance for the present work were chosen for analysis: (i) Preamble + Part I (Introduction); (ii) Part II + Part IV (Applications for the approval of Plans of Work in the form of contracts; Protection and preservation of the Marine Environment), Annex IV (Environmental Impact Statement) and Annex VII (Environmental Management and Monitoring Plan).

Similarly to what was proposed to the Exploration Regulations, Parts II and IV were analyzed together, as both present guidelines on how to deal with the protection and preservation of the marine environment during exploration activities.

The elaboration of an Environmental Impact Statement intents to provide information to assess the likely environmental effects of the mining activity. The Environmental and Monitoring Plan should present information about the monitoring programme and necessary risk assessment and management techniques.

Supplementary Material II

The following definitions were taken from the studies surveyed in the review of Long et al., (2015) or other literature considered relevant for the principles elaboration, including ISA definitions. The abbreviations were provided by the authors.

Core

Sustainability (S) – The term represent the maintenance of aspects of the ecosystem through time.

Ecological

Account for Dynamic Nature of Ecosystems (ADNE) – Management consider that ecosystems are intrinsically dynamic and subject to natural changes. The acknowledgement of natural dynamic and variability in ecosystems allow managers to distinguish natural changes from changes and impacts derived from external drivers (e.g., climate change; urbanization) or management actions.

Consider Ecosystem Connections (CEC) – Management acknowledges and considers the internal and external connections among ecosystem's biotic and abiotic components. As an example, considers the links between ecosystem's structure, functions and services within an ecosystem and with adjacent ecosystems, and how management activities may impact them.

Consider Ecological Integrity & Biodiversity (CEIB) – Maintenance of biodiversity at biological community, habitat, species and genetic levels and maintain the ecological processes that support both biodiversity and resource productivity.

Impacts

Acknowledge Ecosystem Resilience (AER) – The extent to which a system can maintain its structure, function and identity in the face of disturbance can enable us to better predict how systems will respond not only to a growing array of perturbations, but also to a spectrum of management alternatives.

Consider Cumulative Impacts (CCI) – Impacts resulting from incremental changes caused by other past, present or foreseeable actions, contributing to overall ecosystem change and the cumulative effect determining how the ecosystem continues to function.

Consider Effects on Adjacent Ecosystems (CEAE) – Managers should consider the effects (actual or potential) of their activities on adjacent or other ecosystems, including coastal areas.

Knowledge

Acknowledge Uncertainty (AU) – Inevitable uncertainty in the status and dynamics of any ecosystem, knowledge about the system, and the effects of potential management actions. Management must determine how to proceed in implementing policy with imperfect information and substantial uncertainty in most.

Apply the Precautionary Approach (APA) - Where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat. Can also be seeing as a conservatively management when threats to the ecosystem are uncertain.

Consider Interdisciplinarity (CI) – Bases management on scientific understanding from several disciplines.

Use of All Forms of Knowledge (UAFK) –The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices. In cases where only scientific knowledge was mentioned, the authors opted by only using the "Use of Scientific Knowledge" principle. Additionally, the analysis considered as UAFK expressions such as Best Available Techniques, Best Environmental Practices, Good Industry Practices, Standards and Guidelines, already defined by the ISA at the Exploitation Draft.

Use of Scientific Knowledge (USK) – Management considers scientific knowledge as basic information for management processes.

Management

Implement Adaptive Management (IAM) – Adaptive management assumes that scientific knowledge is provisional and focuses on management as a learning process or continuous experiment where incorporating the results of previous actions allows managers to remain flexible and adapt to uncertainty. In the present investigations, it is related to a review process regarding regulations and studies conducted by the Authority and interested parties according to new available knowledge and with aim of improving the management of areas impacted by deep-sea mining related activities.

Conduct Appropriate Monitoring (CAMo) – A discussion on an "appropriate" monitoring of deep-sea mining areas is beyond the scope of this study. Instead, the principle was considered

based on statements recognizing that ecosystem changes (in this case, caused by deep-sea mining activities) are observed to improve management.

Develop Long Term Objective (DLTO) – Goals must be explicitly stated in terms of specific "desired future trajectories" and "desired future behaviors" for the ecosystem components and processes necessary for sustainability. Furthermore, these goals should be stated in terms that can be measured and monitored. According to the recommendation related to the annual reports that contractors must deliver to the ISA, a long-term objective represent 10-15 years (ISA, 2015).

Explicitly Acknowledge Trade Offs (EATO) – Seek appropriate trade-off (balance) between and integration of conservation and the use of marine resources (e.g biological diversity). The principle was considered when management decisions were based on trade-offs that considered the protection of deep-sea ecosystems/services.

Integrated Management (IM) – Management plans integrates different environment elements/uses/institutions under the same management system. Management comprises, but is not limited to, sectoral, spatial, governmental, scientific disciplines, international integration.

Participation

Decisions reflect Societal Choice (DRSC) – Management recognizes that its objectives are a matter of societal choice, determined through negotiations and trade-offs among stakeholders having different perceptions, interests, and intentions. Different sectors of society view ecosystems in terms of their own economic, cultural and societal needs, and such diversity should be taken into account. Societal choices should be expressed as clearly as possible and equally accessed by all stakeholders.

Promote Organizational Change (POC) – Promotion of changes in the structure of management agencies and the way they operate. These may range from the simple (forming a interagency committee) to the complex (changing professional norms, altering power relationships).

Promote Stakeholder Involvement (PSI) – Management involves stakeholders in the entire management process, considers stakeholders' opinions and aim to balance local interests with

the wider public's. Degree of involvement of stakeholders through the process can vary from information to empowerment, depending on each process or phase of the process.

Socio-economic

Commit to Principles of Equity (CPE) – Equity implies that similar options are available to all parties, a principle of stewardship by governments and the community. Efforts are made to establish and preserve equity in all its forms (intergenerational, intra-generational, cross-sectoral, cross-boundary and cross-cultural), with special attention given to rights of minorities.

Consider Economic Context (CECo) – Integrates economic factors into the vision for the ecosystem.

Recognize Coupled Social-Ecological Systems (RCSEC) – Recognize the importance of considering the social dimension into management decisions, for example through the acknowledgement of human's education, activities and well-being as part of the ecosystems.

Use of Incentives (UI) – Consideration of market incentives for management for a sustainable use of natural resources.

Spatial and Temporal Scales

Consider Appropriate Spatial and Temporal Scales (CASTS) – Defining "appropriate" spatial and temporal scales is beyond the scope of this work. Boundaries for management will be defined operationally by users, managers, scientists and indigenous and local peoples and should be appropriate to management objectives. In that sense, the principle was recognized when documents explicitly defined the use of the scales, even without specification.

Recognize Distinct Boundaries (RDB) – Consideration of natural/ecological boundaries for management instead of political/artificial boundaries.

Supplementary Material III - Description of parts identified as EBM (bold) in deep-sea mining guidelines with its respective classification in brackets. ADNE= Account for Dynamic Nature of Ecosystems; AER= Ackowledge Ecosystem Resilience; APA= Apply the Precautionary Approach; AU= Acknowledge Uncertainty; CAMo= Consider Appropriate Monitoring; CASTS = Consider Appropriate Spatial and Temporal Scale; CEC= Consider Ecosystem Connectios; CCI= Consider Cumulative Impacts; CEAE = Consider Effects on Adjacent Ecosystems; CEIB= Consider Ecological Integrity and Biodiversity; CECo= Consider Economic Context; CI= Consider Interdisciplinarity; CPE= Commit to Principles of Equity; DLTO= Develop Long Term Objectives; DRSC= Decisions reflect Societal Choice; EA=Ecosystem approach; EATO= Explicitly Acknowledge Trade Offs; IAM= Implement Adaptive Management; IM= Integrated Management; POC= Promote Organizational Change; PSI= Promote Stakeholder Involvement; RCSEC= Recognize Coupled Socio-Ecological Systems; S= Sustainability; UAFK= Use of All Forms of Knowledge; USK= Use of Scientific Knowledge and UI= Use of Incentives.

	Score 1	Score 2
UNCLOS	143.2: "*The Authority shall promote and encourage the conduct of marine scientific research in the Area, and shall coordinate* ***and disseminate the results*** *of such research and analysis when available*." **(PSI)** 145: "*Necessary measures shall be taken in accordance with this Convention with respect to activities in the Area to ensure* ***effective protection for the marine environment*** *from harmful effects which may arise from such activities."* **(CEIB;S)** 145.a:*"****the prevention, reduction and control*** *(...), and of interference with the* ***ecological balance*** *of the marine environment ,(...)"* **(APA, CEIB)** 145.b:"*the* ***protection and conservation of the natural resources*** *of the Area (...)"* **(CEIB;S)** 147.1:"*Activities in the Area shall be carries out with* ***reasonable regard for other activities*** *in the marine environment"* **(IM)** 150:" *Activities in the Area shall (...) be carried out in such a manner as to foster* ***healthy development of the world economy*** *and balaced growth of international trade (...)* **(CECo)** 150.f:"*the promotion of* ***just and stable prices remunerative to producers and fair consumers for minerals*** *derived both from the Area and from other sources (...)"* **(CECo)** 150.j:"***conditions of access to markets for the imports of minerals produced from the resources of the Area and for imports of commodities produced*** *from such minerals shall not be more favourable than the most favourable applied to imports from other sources."* **(CECo)** 192:"*States have the obligation to* ***protect and preserve the marine environment****."* **(CEIB;S)** 194.2:"*States shall take all measures necessary to ensure (...) that pollution arising from incidents or activities (...) does not* ***spread beyond the areas where they exercise sovereign*** *(...)"* **(CEAE)** 195:"*(...) States shall act so as not to transfer, directly or indirectly, damage or hazards* ***from one area to another*** *or transform one type of pollution into other."* **(CEAE)** 197:"*States shall cooperate (...), directly or* ***through competent international organizations****, in formulating and elaborating international rules, standards and recommended practices and procedures (...), for the protection and preservation of the marine environment, (...)"* **(POC)** 206: *When States have reasonable regard for believing that planned activites under their jurisdiction or control* ***may cause substantial pollution of or significant and harmful changes to the marine environment , they shall, as far as practicable, assess the potential effects of such activities in the marine environment****(..)* **(AU)**	136:"*The area and its resources are the* ***common heritage of mankind****"* **(CPE)** 137.2:"*All rights in the resources of the Area are vested in* ***mankind as a whole*** *(...)"* **(CPE)** 140.1:"*Activities in the Area shall (...) be carried out for the* ***benefit of mankind as a whole*** *(...)"* **(CPE)** 140.2:"*The Authority shall provide for the* ***equitable sharing of financial and other economic benefits*** *(...)"* **(CPE)** 141:"*The Area shall be open to use exclusively for peaceful purposes (...)****without discrimination*** *(...)"* **(CPE)** 142.2: *"****Consultations****, including a system of prior notification,* ***shall be maintained with the State concerned****, with a view to avoiding infringement of such rights and interests. In cases where activities in the Area may result in the exploitation of resources lying within national jurisdiction,* ***the prior consent of the coastal State concerned shall be required****."* **(PSI)** 143.1:"*Marine scientific research shall be carried out (...) for the* ***benefit of mankind as a whole*** *(...)"* **(CPE)** 143.2:"*The Authority shall promote and encourage the* ***conduct of marine scientific research*** *in the Area, (...)"* **(USK)** 143.3:"*States Parties may carry out* ***marine scientific research*** *in the Area (...)"* **(USK)** 143.3.b:"*ensuring that programmes are developed (...)****for the benefit of developing States and technologically less developed States*** *(...)"* **(CPE)** 144.1.a:"*to acquire technology and* ***scientific knowledge*** *relating to activities in the Area"* **(USK)** 144.1.b:"*to promote and encourage* ***the transfer to developing States*** *of such technology and scientific knowledge (...)"* **(CPE;PSI)** 144.2:"*(...) the Authority and States Parties shall cooperate in promoting the transfer of technology and scientific knowledge relating to activities in the Area so* ***that the Enterprise and all States Parties may benefit therefrom****.(...)"* **(CPE; PSI)** 145.a:"*the prevention, reduction and control of pollution and other hazards to the marine environment,* ***including the coastline****, (...)"* **(CEAE)** 148:"*The* ***effective participation of developing States*** *in activities in the Area shall be promoted (...),****having due regard to their special interests and needs****, and in particular do the* ***special need of the land-locked and geographically disadvantaged*** *(...)"* **(CPE)** 150:" *Activities in the Area shall,(...) be carried out in such a manner to (...) and promote international cooperation for the over-all development of all countries,* ***especially developing States*** *(...)"* **(CPE)** 150.b:*"****ordely, safe and rational*** *management of the resources of the Area, including the efficient conduct of activities in the Area and, in accordance with* ***sound principles of conservation*** *(...)"* **(S;USK)** 150.g: *"the enhancement of opportunities for all States Parties, irrespective of their social and economic systems or geographical location, to participate in the development of the resources of the Area and the prevention of monopolization of activities in the Area;"* **(CPE)** 150.h: *"****the protection of developing countries from adverse effects on their economies or on their export earnings*** *resulting from a reduction in the price of an affected mineral, or in the volume of exports of that mineral, to the extent that such reduction is caused by activities in the Area (...)"* **(CPE)** 150.i: *"the development of the* ***common heritage for the benefit of mankind as a whole****;"* **(CPE)** 194.5."*The measures (...) shall include those necessary* ***to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species*** *(...)"* **(CEIB)** 200:"*States shall cooperate, directly or* ***through competent international organizations****, for the purpose of promoting studies, undertaking* ***programmes of scientific research*** *and encouraging the exchange of information and data acquired about pollution of the marine environment."* **(USK)** 201:"*(...) States shall cooperate, directly or* ***through competent international organizations****, in establishing appropriate* ***scientific criteria*** *for the formulation and elaboration of rules, standards and recommended practices and procedures for the prevention, reduction and control of pollution of the marine environment."* **(USK)** 202.a:"*promote programmes of* ***scientific, educational, technical and other assistance to developing countries*** *for the protection*

Score 1		Score 2
		and preservation of the marine environment (...)." **(CPE; PSI;UAFK; USK)** 204.1:*States shall (...), directly or* ***through the competent international organizations*** *,****to observe, measure, evaluate and analyse, by recognized scientific methods****, the risks or effects of pollution of the marine environment."* **(AMo;USK)** 204.2:*"(...) States shall keep under surveillance the effects of any activities (...) in order to determine whether these activities are likely to pollute the marine environment."* **(CAMo)** 205: "States shall publish reports of the results obtained pursuant to article 204 or provide such reports at appropriate intervals to the competent international organizations**, which should make them available to all States**." **(PSI)**

	Score 1		Score 2
XI Agreement	S.1.5.d:*"Monitoring and review of trends and developments relating to deep seabed mining activities, including* ***regular analysis of world metal market conditions and metal prices, trends and prospects****."* **(CECo)** S.1.5.e:*"Study of the* ***potential impact of mineral production from the Area on the economies of developing land-based producers*** *(...)"* **(CECo)** S.1.5.g*:"Adoption of rules, regulations and procedures incorporating* ***applicable standards*** *for the protection and preservation of the marine environment"* **(UAFK)** S.1.9:" *(...) if the prevailing* ***economic circumstances*** *do not justify proceeding to the exploitation stage."* **(CECo)** S.5.1.c:*"(...) States Parties shall promote* ***international technical and scientific cooperation*** *with regard to activities in the Area (...) or by* ***developing training, technical assistance and scientific cooperation programmes*** *in marine science and technology and the* ***protection and preservation of the marine environment****."* **(CEIB;S)** S.6.1.d:*"(...) There shall be* ***no preferential access to markets*** *for such mineral or for imports of commodities produced from such minerals ,(...)"* **(CECo)** S.7.1: *"The policy of the Authority of assisting developing countries which suffer serious adverse effects on their export earnings or economies resulting from a reduction in the price of an affected mineral or in the volume of exports of such mineral, to the extent that such reduction is caused by activities in the Area, (…)"* **(CECo)**		S.1.5.e:*"Study of the* ***potential impact of mineral production from the Area on the economies of developing land-based producers*** *(...)"* **(CPE)** S.1.5.h:*"Promotion and encouragement of the* ***conduct of marine scientific research*** *with respect to activities in the Area (...)* **(USK)** S.1.5.i:*"Acquisition of* ***scientific knowledge*** *and monitoring of the development of marine technology relevant to activities in the Area (...)* **(USK)** S.5.1.b:*"If the Enterprise or developing States are unable to obtain deep seabed mining technology, the Authority may request all or any of the contractors (...)* ***to cooperate with it in facilitating the acquisition of deep seabed mining technology, (...) a developing State or States*** *(...)* **(CPE)** S.5.1.c:*"(...) States Parties shall promote* ***international technical and scientific cooperation*** *with regard to activities in the Area (...) or by* ***developing training, technical assistance and scientific cooperation programmes*** *(…)"* **(UAFK;USK)**
Prospecting and Exploration Regulations	**Preamble + Part I**	1.3.c: " (...) ***state, condition and quality of the marine environment***" **(CEIB)** *1.3.f " (...) a significant adverse change in the marine environment according to the rules, regulations and procedures adopted by the Authority on the basis of* ***internationally recognized standards and practices****."* **(UAFK)**	Intro:*"(...) the seabed and ocean floor and the subsoil thereof beyond the limits of national jurisdiction, as well as its resources, are the* ***common heritage of mankind****, the exploration and exploitation of which shall be carried out fot the benefit of mankind as a whole (...)"* **(CPE)** *1.3.c: "Marine environment includes the* ***physical, chemical, geological and biological components, conditions and factors which interact and determine the productivity, state, condition and quality*** *of the marine ecosystem (...)* **(CEIB)**
	Part II	3.4.d.i.b:"***Protection and preservation of the marine environment.****"* **(CEIB;S)** 5.2: *"Prospectors shall cooperate with the Authority in the establishment and implementation of programmes for monitoring and evaluating the potential impacts of the exploration and for exploitation"* **(CAMo)**	2.2:"*Prospectors and the Authority shall* ***apply a precautionary approach****, (...)"* **(APA)** 3.4.d.i.a:*"Cooperation in the training programmes in connection with marine scientific research and transfer of technology (...) referred to in articles 143 and 144 of the Convention; (...)"* **(CPE)** 5.1:" *Each prospector shall take necessary measures to prevent, reduce and control pollution and other hazards to the marine environment from prospecting, (...),****applying a precautionary approach*** *and* ***best environmental practices****(...)"* **(APA;USK)**

	Score 1		Score 2
Prospecting and Exploration Regulations	**Part III + Part V**	18.a.:"*studies to be undertaken in respect of the* ***environmental, technical, economic and other appropriate factors*** *(...)* **(CECo)** 21.4.b:"*Provide for* ***effective protection and preservation of the marine environment****, (...)."* **(CEIB;S)** *28.1:"The contractor and the Secretary-General shall jointly undertake a periodic review of the implementation of the plan of work (...).****The Secretary-General may request the contractor to submit such additional data and information****(...)."* **(IAM)** *28.2:" (...) the contractor shall indicate indicate its programme of activities for the following five-year period,* ***making such adjustments*** *(...).* **(IAM)** 31.1:"*The Authority shall (...) and keep under periodic review environmental rules, regulations and procedures* ***to ensure effective protection for the marine environment*** *from harmful effects."* **(CEIB;S)** 32.1: "*Each contract shall require the contractor* ***to gather environmental baseline data and to establish environmental baselines*** *(...) against which to assess the likely effects of its programme of activities (...) and a programme to monitor and report on such effects. (...)"* **(ADNE)**	18.a.:"*studies to be undertaken in respect of the* ***environmental, technical, economic and other appropriate factors*** *(...)* **(CI)** 18.b:" (..) *that would enable an assessment of the* ***potential environmental impact, including, but no restricted to, the impact on biodiversity*** *(...)"* **(AU;CEIB)** 18.c:"*A preliminary assessment of the* ***possible impact*** *(...)"* **(AU)** 21.4.b:"*Provide for effective protection and preservation of the marine environment including, but not restricted to,* ***the impact on biodiversity****"* **(CEIB)** 21.4.c."*Ensure that* ***installations are not established where interference may be caused to the use of recognized sea lanes (...) or in areas of intense fishing activity****."* **(IM)** 27:" *(...) each contract shall include as a schedule a practical programme for the training of personnel of the Authority* ***and developing States*** *(...)* **(CPE)** 31.1:*"The Authority shall (...) and* ***keep under periodic review*** *environmental rules, regulations and procedures to ensure effective protection for the marine environment from harmful effects"* **(AM)** 31.2:*"In order to ensure effective protection for the marine environment from harmful effects (...), the Authority and sponsoring states may* ***apply a precautionary approach*** *(...)" and* ***best environmental practices"*** **(APA;UAFK)** 31.4:*"The Comission shall develop and implement procedures for determining, on the basis of the* ***best scientific and technical information*** *(..)"* **(UAFK)** 31.5:*" (...) each contractor shall take necessary measures to prevent, reduce and control pollution and other hazards (...)* ***applying a precautionary approach and best environmental practices****."* **(APA;UAFK)** 31.6:*"Contractors (...) shall cooperate with the Authority in the establishment and implementation of* ***programmes for monitoring and evaluating the impacts of deep seabed mining*** *on the marine environment."* **(CAMo)** 32.1:*Each contract shall require the contractor to gather environmental baseline data and to establish environmental baselines (...) against which to* ***assess the likely effects of its programme of activities*** *(...) a****nd a programme to monitor and report on such effects****. (...)"* **(AU;CAMo)** 32.2:*"The contractor shall report annually (...)* ***results of the monitoring programme****."* **(CAMo)** 34.4:"*Contractors shall take all measures necessary to ensure that their activities are conducted as not to cause serious harm to the marine environment, (...) and that such serious harm or pollution (...)* ***does not spread beyond such area.****"* **(CEAE)** 42.2: *"****If, in light of improved knowledge or technology****, it becomes apparent that the Regulations are not adequate, any State party, the Legal and Technical Commission or any contractor through its sponsoring State may at any time request the Council (...)* ***revisions to these Regulations****."* **(IAM)**

	Score 1		Score 2
Environmental Recommendations	**Intro + Section II**	1:" *(...) the International Seabed Authority is required to (...) keep under review environmental rules, regulations and procedures to ensure* ***effective protection for the marine environment*** *from harmful effects"* **(CEIB;S)** 7:"*Mechanical removal without initial processing at the seabed was deemed the* ***most likely technology to be used*** *(..)"* **(EATO)** 9.a:"*To define oceanographic****, chemical, geological, biological and sedimentary properties*** *to be measured (...)"* **(CI)**	1:"*During prospecting and exploration for marine minerals, the International Seabed Authority is required to (...) together with sponsoring States,* ***apply a precautionary approach****". "In addition, contract for mineral exploration in the Area require the contractor to (...) assess the* ***likely effects of its programme of activities*** *under the plan of work for exploration on the marine environment and a* ***programme to monitor*** *and report on such effects."* **(APA; AU; CAMo)** *2:"(...) taking into account the views of recognized experts in that field."* **(PSI)** 3:"*(...)The workshop participants noted the need for clear and common methods of environmental characterization based on established* ***scientific principles*** *(...)." "(...) the Legal and Technical Comission (...) later revised (...) in light of* ***increased understanding.***" **(IAM;PSI;USK)** 4:"*(...)The recommendations of the workshop were based on the* ***current scientific knowledge*** *of the marine environment (...)"* **(USK)** 7:"***It is likely that future mining operations will employ techniques not considered here****. Given that the recommendations contained herein are based on the* ***current scientific knowledge of the marine environment*** *and the technology to be used at the time at which they were prepared, they may require revision at a later date, taking into account the progress of science and technology (...).To facilitate the review, it is recommended that the Authority* ***convene workshops*** *(...) in which (...)****experts from the scientific community, , international and governmental organizations and non-governmental organizations, are invited*** *to participate"* **(AU;IAM;PSI;USK)** 7:" *Mechanical removal without initial processing at the seabed was deemed the* ***most likely technology to be used*** *(..)"* **(AU)** 8.a:*"An impact assessment of the* ***potential effects on the marine environment*** *of all proposed activities (...)* **(AU)** 8:b"*A proposal for a* ***monitoring programme*** *to determine the* ***potential effect*** *in the marine environment (...)* **(AU;CAMo)** 9:"*The present recommendations describe the procedures to be followed in (...), and the* ***monitoring to be performed*** *during and after any activities in the exploration area with potential to cause serious harm to the environment.(...)"* **(CAMo)**

	Score 1		Score 2
Environmental Recommendations	**Section III to VI**	14:"*(...) shall collect data for the purpose of establishing baseline conditions of* ***physical oceanography, chemical oceanography and geological,, biological and other parameters that characterize the systems likely to be impacted*** *(...)"* **(CI)**	13:"*It is important to obtain sufficient information from the exploration area (...) to gain insight into* ***natural processes such as dispersion and settling of particles and benthic faunal succession****, (...). The* ***impact of naturally occurring periodic process on the marine environment may be significant but is not well quantified****.(...).* ***It is therefore important to acquire as long a history as possible of the natural responses of sea-surface, mid-water and seabed communities to natural environmental variability****"* **(ADNE;CASTS; AU; CEIB)** 15.d.vi: "*Establish time series stations* ***to evaluate temporal variations*** *in water column and seabed communities;"* **(CASTS)** 15.d.vii: "*Assess regional* ***distribution of species and communities/assemblages as well as genetic connectivity*** *of key species;"* **(CASTS, CEIB)** 15.e: "*Record and describe bioturbation activity and mixing of sediments;"* **(CEIB)** 15.f: *"Evaluate* ***linkages between pelagic and benthic habitats****,* ***including fluxes to the sediment: gather time series data*** *on the sinking flux (...) from the upper water column to the seabed;"* (**CEC; CEIB; CASTS**) 15.g: *"Measure sediment community oxygen consumption as a metric of whole community (largely microbial) function;"* **(CEC; CEIB)** 15.h: "*Evaluate the* ***food web structure*** *of the pelagic and benthic habitats.*" (**CEIB**) 16: " *(...) These data will be used for regional environmental management and assessment of* ***cumulative impacts.****"* **(CCI)** 17.d: *"****Meiofaunal and microbial community structure and biomass*** *associated with the polymetallic sulphide deposits should be obtained (...)"* **(CEC; CEIB)** 17.c: *"The distribuition abundance, species strucuture and diversity of the dominant taxa in each subhabitat (...) should be determined (...);"* **(CEC;CEIB)** 18.a: "*Both* ***spatial and temporal*** *replicate biological samples should be obtained using appropriate sampling tools in each subhabitat. A statistically defensible number of replicate samples per stratum is recommended for* ***collection of specimens and to assess species richness****;"* (**CASTS; CEIB; USK**)18.b:*"Phototographic or video transects should be undertaken* ***to determine habitat type, community structure and association of megafauna with specific types of substrata****.* ***Abundance, percentage cover and diversity of megafauna****(...)"* **(CEC;CEIB)**18.c: "*Demersal fishes and other nekton living over the sea floor should be assessed (...). Seamounts can be important ecosystems with a variety of habitats for a number of fish species that form aggregation there for* ***spawning or feeding*** (**AU;CEIB**) 19: *"The types of data to be collected, the frequency of the collection and the analytical techniques (...) should follow the best available methodology and the use of an international quality system and certified operation and laboratories"* **(UAFK)** 28:*"****Cooperative research may provide additional data*** *for the protection of the marine environment and may be cost-effective for contractors."* **(PSI)** 29:*"Interactions between* ***multiple oceanographic disciplines and multiple institutions can be useful in closing gaps*** *in knowledge (...). The Authority should serve in an advisory capacity to mining contractors in terms of identification of cooperative research opportunities,* ***but contractors should seek their own links to academic and other professional expertise.****"* **(USK)** 30:*"****Cooperative research programmes*** *may prove especially synergistic, bringing together the* ***expertise, research facilities, logistic capability and common interest of mining companies and cooperative institutions and agencies*** *(...)* **(PSI; USK)** 31: "*To answer questions on the environmental impacts of future mining, specific experiments, observations and measurement must be conducted. (...)"* (**AU;USK**) 35:*"(...) Impact assessment must be based on a properly designed* ***monitoring programme*** *that should be able to* ***detect impacts in time and space*** *to provide statistically defensible data."* **(CAMo; CASTS)** 36: *"****Environmental impacts are expected*** *to be at the sea floor and also may occur at any discharge depth (if applicable) in the water column.* ***The impact assessment should address not only areas directly affected by the activity but also the wider region impacted by near-bottom plumes, the discharge plume, and material released by transporting the minerals to the ocean surface****, which will depend on the technology used."* **(AU; CEAE)** 37: *" For environmental assessments, this test phase should be* ***monitored intensively****, as should tests of any test-mining component. When mining tests have already been carried out, even if by another contractor, the* ***knowledge gained through those tests should be applied****, where appropriate,* ***to ensure that unanswered questions are resolved by new investigations****."* **(AU;CAMo;IAM)**

	Score 1		Score 2
	Section III to VI		38: "*The implementation of a **good monitoring programme** to detect any disturbance that may occur beyond the impact reference zone as a result of testing (…). Preservation reference zones will be important in **identifying natural variations** in environmental conditions against which impacts of mining tests will be assessed. (…)* (**ADNE; CAMo**) 39: "*Each contractor should include, in its programme for specific activity (…), a **specification of the events that could cause suspension or modification of the activities owing to serious environmental harm** (...)*" **(AU)** 40.b: "***Changes in species composition, diversity and abundance of pelagic (where applicable) and benthic communities ,** including rates of **recolonization, changes in foundation species, three-dimension-habitat-forming species, ecosystem engineers, bioturbation rates, chemical effects and changes in behaviour of key species (…)**;*" **(AER;CEIB)** 40.c: "*Possible changes in communities microbes and protozoa, **in adjacent areas** not expected to be perturbed by the activity (...).*" **(AU;CEAE;CEIB)** 40.f: *"**Levels of metal found in key and representative benthic biota** subjected to sediment from the operational and discharge plumes;"* **(CEIB)** 40.h: "***Changes in fluid flux and response of organisms to change**s in hydrothermal settings, if relevant;"* **(CEIB)** 40.i: "*Changes in water currents and the **response of organisms to change** in circulation.*" **(CEIB)**
	Score 1		**Score 2**
Annual Report Recommendations	**Section II + Annex I**	10.e:*"A **gap analysis** and future strategy to achieve the goals of the five-year programme (...)"* **(AU)**	6: "Reports should present the results of the work of the reporting year with reference to the approved plan of work for exploration. The contractor should indicate its short-term (1 year), medium term (5 years) and **long-term (10-15 years)**" **(DLTO)** 9.d:"*An interpretation of findings, including comparisons with published data from other studies"* **(USK)** 9.e.f.g.h:"*Information on **physical oceanography** (...).,Information on **chemical oceanography** (...).,Information on **biological communities** (...)., Information on **ecosystem functioning** (...).* **(CI)** 9.h:*"Information on **ecosystem functioning** (...).* **(CEC)** 10.a:*"(...) including information on a **monitoring programme before, during and after** specific activities **with potential to cause serious harm."*** **(AU; CAMo)** 10.e:*"An examination of the **recovery over** time of seabed communities following disturbance **experiments conducted** on the seafloor"* **(AER, USK)** 10.h:*"A comparison of environmental results in similar areas to understand **species ranges and dispersal** (...).* **(CEIB)** 13: *"The contractor is requested to provide detailed information on the implementation of the training programme (…)"* **(PSI)** 14.*The contractor is requested to provide information on: (a) Participation in **cooperative programmes** sponsored by the Authority; (b) **Cooperation with other contractors**; (c) **Other international cooperation*** **(PSI)**

		Score 1	Score 2
Exploitation Draft	**P+ Part I**	**Part I** 2.b*:" (...) activities in the Area shall be carried out in such a manner as* ***to foster the healthy development of the world economy and the balanced growth of international trade*** *(…)"* **(CECo)** 2.b.vi: *"The promotion of just and stable prices remunerative to producers and fair to consumers for minerals derived both from the Area and other sources, and a the promotion of long-term equilibrium between supply and demand"* **(CECo)** 2.e: *"Provide, (…),* ***for the effective protection of the Marine Environment*** *from the harmful effects which may arise from Exploitation (…)* **(CEIB;S)** 2.e.v: "*Access to data and information relating to the* ***protection and preservation of the Marine Environment****;"* **(CEIB;S)**	P:"*Reaffirming the fundamental importance of the principle that the Area and its Resources are* ***the common heritage of mankind.****"* **(CPE)** P*:"(...) the Exploitation of the Resources of the Area shall be carried out* ***for the benefit of mankind as a whole*** *(...)"* **(CPE)** **Part I** 2.a:"*Recongnize that the rights in the Resources of the Area* ***are vested in mankind as a whole****, (...)"* **(CPE)** 2.b*:" (...) activities in the Area shall be carried out in such a manner as to foster the healthy development of the world economy and the balanced growth of international trade, and to promote international cooperation for the overall development of all countries,* ***especially developing States*** *(...)"* **(CPE)** 2.b.ii:"***The ordely, safe and rational management of the Resources*** *of the Area, including efficient conduct of activities in the Area and, with* ***sound principles of conservation****, the avoidance of unnecessary waste."* **(S,USK)** 2.b.iv "*(…) and transfer of technology to the Enterprise and developing States as provided for in the Convention and the Agreement"* **(CPE;PSI)** 2.b.vii "*The enhancement of opportunities for all States Parties, irrespective of their social and economic systems or geographical location, to participate in the development of the resources of the Area and the prevention of monopolization of activities in the Area"* **(CPE)** 2.b.viii:*"****The protection of developing countries from serious adverse effects on their economies or on their export*** *earnings resulting from a reduction in the price of an affected Mineral or in the volume of exports of that Mineral, to the extent that such reduction is caused by activities in the Area"* **(CPE)** 2.b.ix: "*The development of the common heritage for the benefit of mankind as a whole (…)"* **(CPE)** 2.b.x: *"That conditions of access to markets for the imports of minerals produced from the resources of the Area and for imports of commodities produced from such minerals shall not more favourable that the most favourable applied to imports from other sources*" **(CPE)** 2.c: *"Ensure that the Resources of the Area are Exploited in accordance with sound commercial principles, and that Exploitation is carried out in accordance with Good Industry Practices;* **(UAFK)** 2.e.i: "*A fundamental consideration for the development of environmental objectives shall be the* ***protection and conservation of the Marine Environment****, including* ***biological diversity and ecological integrity****;"* **(CEIB)** 2.e.ii:"*The application of the* ***precautionary approach*** *(...)"* **(APA)** 2.e.iii:"*The application of an* ***ecosystem approach****;"* **(EA)** 2.e.iv: *"****The application of "the polluter pays" principle through market-based instruments, mechanisms*** *and other relevant measures;"* **(CECo)** 2.e.vii: "*Encouragement* ***of effective public participation****;"* **(PSI)** 2.g: "Provide for the prevention, reduction and control of pollution and other hazards to the Marine Environment, including the coastline;" **(CEAE)** 2.g:"*Incorporate the* ***Best Available Scientific Evidence*** *into decision-making processes;"* **(USK)** 2.h:"*Ensure the effective management and regulation (...) in a way that promotes the development for the* ***common heritage of mankind****."* **(CPE)** 3.c:"*The Authority shall develop, implement and promote* ***effective and transparent communication, public information and public participation procedures****;"* **(PSI)** 3.d: *"The Authority shall* ***consult and cooperate with sponsoring States, flag States, competent international organizations and other relevant bodies as appropriate****, (…)"* **(PSI)** 3.e:"*Contractors, sponsoring States and members of the Authority shall cooperate with the Authority in the* ***establishment and implementation of programmes to observe, measure, evaluate and analyse the impacts of Exploitation on the Marine Environment,*** *(...) and to extend such cooperation and colaboration to the implementation and further development of* ***Best Environmental Practices*** *in connection with activities in the Area."* **(CAMo;PSI;UAFK;USK)** 3.f:"*Members of the Authority and Contractors shall use their best endeavours, in conjunction with the Authority, to,* ***cooperate with each other, as well as with other contractors and national and international scientific research and technology development agencies*** *(...)"* **(PSI)** 3.f.ii: "*Identifying gaps in scientific knowledge and developing targeted and focused research programmes to address such gaps"* **(AU)**

Exploitation Draft	**P+ Part I**		3.f.iii:"*Collaborating with the* ***scientific community to identify and develop best practices and improve existing standards and protocols with regard to the collection, sampling, standardization, assessment and management of data and information****;* **(UAFK)** 3.f.iv: "*Undertaking* ***educational awareness*** *programmes for Stakeholders relating to activities in the Area; (...)"* **(PSI)** 3.f.v: *"Promoting the advancement of marine scientific research in the Area for the benefit of mankind as a whole; (...)* **(CPE;USK)** 3.f.vi: *"Developing* ***incentive structures, including market-based instruments, to support and enhance the environmental performance of Contractors*** *beyond the legal requirements (...)"* **(CECo, UI)** 4.1: "Contractors shall take all measures necessary to ensure that their activities are conducted so as not to cause Serious Harm to the Marine Environment, including, but not restricted to, pollution, under the jurisdiction or sovereignty of Coastal States, **and that such Serious Harm or pollution (…) does not spread into areas under the jurisdiction or sovereignty of a coastal State**" **(CEAE)** 4.3: *"****Any coastal State which has grounds for believing that any activity under a Plan of Work in the Area by a Contractor is likely to cause Serious Harm or a threat of Serious Harm to its coastline or to the Marine Environment under its jurisdiction or sovereignty may notify the Secretary-General in writing*** *(…). The Contractor and its sponsoring State or States shall be provided with a reasonable opportunity to examine the evidence, if any, and submit their observations thereon to the Secretary-General (…)* **(PSI)**
Exploitation Draft	**Part II + Part IV**	**Part II** 13.4.e:*"Provides, under the Environmental Plans,* ***for the effective protection of the Marine Environment****, in accordance with the rules, regulations and procedures, in particular the fundamental policies and procedures under regulation 2"* **(S)** **Part IV** 44: *"The Authority, sponsoring States and Contractors shall each, as appropriate, plan, implement and modify measures necessary for ensuring the effective protection for the Marine Environment (…)* **(CEIB;S)** 45.c: *"Mitigation measures.* **(CEIB)** 47.a: "*Identifies, predicts, evaluates and* ***mitigates*** *the biophysical,* ***social*** *and other relevant effects of the proposed mining operation* **(RCSES)** 51.b:*Implement all applicable Mitigation and management measures* ***to protect the Marine Environment*** *(…)* **(CEIB)**	**Part II** 11.1.a:"*Place the Environmental Impact Statement, the Environmental Management and Monitoring Plan and the Closure Plan on the Authority's website (...),* ***and invite members of the Authority and Stakeholders to submit comments in writing*** *in accordance with the Guidelines*;" **(PSI)** 11.5: *" (…).* ***Such report on the Environmental Plans or revised plans shall be published on the Authority's website*** *and shall be included as part of the reports and recommendations to the Council (…)"* **(PSI)** 12.4:"*The Comission shall, in considering a proposed Plan of Work, apply the Rules of the Authority in a uniform and non-discriminatory manner, (...), and in particular to the extent to which the proposed plan of Work contributes to realizing* ***benefits for mankind as a whole***." **(CPE)** 13.3.a: *"The necessary technical and operational capability to carry out the proposed Plan of Work in accordance with Good Industry Practice (…)* **(UAFK)** 13.3.b: *"The technology and procedures necessary to comply with the terms of the Environmental Management and Monitoring Plan and the Closure Plan, including the technical capability to monitor key environmental parameters and to modify management and operating procedures when appropriate;"***(CAMo)** 13.3.c: *"Established the necessary risk assessment and risk assessment systems to effectively implement the proposed Plan of Work in accordance with Good Industry Practice, Best Available Techniques, and Best Environmental Practices (…)"* **(UAFK)** 13.3.e: *"The capability to utilize and apply Best Available Techniques"* **(UAFK)** 13.4.d:"*Provides for Exploitation* ***activities to be carried out with reasonable regard for other activities in the Marine Environment, including, but not limited to, navigation, the laying of submarine cables and pipelines, fishing and marine scientific research****, (...)*" **(IM)** **Part IV** 44.a:"***Apply the precautionary approach*** *(...) to the assessment and management of risk of harm to the Marine Environment from Exploitation in the Area;"* **(APA)** 44.b: "***Apply the Best Available Techniques and Best Environmental Practices*** *in carrying out such measures"* **(UAFK)** 44.c:"***Integrate Best Available Scientific Evidence*** *in environmental decision-making, including all risk assessments and management undertaken in connection with environmental assessment, and the management and response measures taken or in accordance with Best Environmental Practices (...)*;" **(UAFK;USK)**

Exploitation Draft	**Part II + Part IV**		44.d: "*Promote accountability and transparency in the assessment, evaluation and management of Environmental Effects from Exploitation in the Area, including through the timely release of and access to relevant environmental data and information and opportunities for* ***stakeholder participation***" **(PSI)** 45.a:*"Environmental quality objectives, including on biodiversity status, plume density and extent, and sedimentation rates"* **(CEIB)** 45.a: *"Monitoring procedures; (…)"* **(CAMo)** 47.1.a: "*Identifies, predicts, evaluates and mitigates the biophysical, social and other relevant effects of the proposed mining operation* **(AER, I)** 47.1.c: *"Identifies measures to manage such effects within acceptable levels, including through the development and preparation of an Environmental Management and* ***Monitoring Plan****"* **(CAMo)** 47.3.a: *Inclusive of a prior environmental risk assessment;* **(IM)** 47.3.b: *Based on the results of the environmental impact assessment;* **(IM)** 47.3.c: *In accordance with the objectives and measures of the relevant regional environmental management plan. (…)* **(IM)** 47.3.d: *"Prepared in accordance with the* ***applicable Guidelines, Good Industry Practice, Best Available Scientific Evidence, Best Environmental Practices and Best Available Techniques****"***(UAFK)** 48.1: *(…) The plan will set out commitments and procedures on how the mitigation measures will be implemented,* ***how the effectiveness of such measures will be monitored***, ***what the management responses will be to the monitoring results*** *and what reporting systems will be adopted and followed"* **(CAMo)** 48.3.a: *Based on the environmental impact assessment and the Environmental Impact Statement;* **(IM)** 48.3.b: *In accordance with the relevant regional environmental management plan. (…)* **(IM)** 47.3.d: *"Prepared in accordance with the* ***applicable Guidelines, Good Industry Practice, Best Available Scientific Evidence, Best Environmental Practices and Best Available Techniques****, and consistent with other plans in these regulations, including the Closure Plan and the Emergency Response and Contingency Plan"* **(IM;UAFK)** 50: *"A Contractor shall not dispose, dump or discharge into the Marine Environment any Mining Discharge, except where such disposal, dumping or discharge is permitted in accordance with:(a)The assessment framework for Mining Discharges set out in the Guidelines; and (b)The Environmental Management and Monitoring Plan* **(IM)** 51.a: ***Monitor and report annually*** *(…) on the Environmental Effects of its activities on the Marine Environment (…)* **(CAMo)** 51.b:*Implement all applicable* ***Mitigation*** *and management measures to protect the Marine Environment (…)* **(AER)** 51.c: *"Maintain the currency and adequacy of the Environmental Management and Monitoring Plan during the term of its exploitation contract in accordance with* ***Best Available Techniques and Best Environmental Practices and taking account of relevant guidelines****"* **(UAFK)** 53.1.a: "*The currency and adequacy of its Emergency Response and Contingency Plans based on the identification of potential Incidents and in accordance with* ***Good Industry Practices, Best Available Techniques, Best Environmental Practices and the applicable standards and Guidelines****; (…)"* **(UAFK)** 53.2: *"Contractors, the Authority and sponsoring States shall* ***consult together, as well as with other States and organizations which appear to have an interest, in relation to exchange of knowledge, information and experience relating to Incidents*** *(…), and shall cooperate with and draw on the advice of other relevant international organizations"* **(PSI)**

Exploitation Draft	**Annex IV** **Annex IV**	3.7:"*Provide* ***an account of alternative options that were considered and rejected in favour of the current proposal.*** *Aspects should include the selection of the mining site, mine production scenarios, transport and materials handling and shipboard processing"* **(EATO)** 6.4*:"Summarize key findings regarding* ***the sociocultural environment***" **(RCSES)**	1.2:*"Provide information on the viability of the proposed development, its economic context (...), and* ***include a description of the benefits to mankind***" **(CECo;CPE)** 2.1: *"****Outline the national and international legislation, regulation or guidelines that apply to the management*** *or regulation of Exploitation in the Area, including how the proposed operation will comply with them"* **(IM)** 2.2:"***Outline any other legislation, policies or regulations that do not necessarily apply specifically to seabed mining or the environment****, but may be relevant to the proposal (e.g. shipping regulations, maritime declarations, marine scientific research, climate change policies, Sustainable Development Goals)."* **(IM)** 2.3*:"List* ***the international agreements applicable to the operation****, (…),* ***and applicable regional agreements****"* **(IM)** 2.4: *"Discuss applicable* ***standards and guidelines*** *that will be adhered to or aligned with throughout the operation (…)"* **(IM)** 3.3.1*:"Provide an overview* ***of the spatial and temporal scale of the mining operation****, including volume of material to be recovered, processed and deposited or discharged into the water column or back to the seabed. (...)"* **(CASTS)** 4,5,6:"*Description of the existing* ***physicochemical environment****"; "Description of the existing* ***biological environment****", "Description of the existing* ***socioeconomic environment***"; **(CI)** 4.3*:"Describe* ***any prior research/Exploration that could provide relevant information*** *for this Environmental Impact Statement and future activities. (…)"* **(UAFK)** 4.6:" *Detail is required in the regional setting, (…), and should include* ***changes in physical conditions and processes according to depth and horizontal distance*** *from the proposed mining site (…)."* **(ADNE;CEIB)** 4.9: "*Provide a description of applicable potential* ***natural hazards for the site****, including volcanism, seismic activitiy, cyclone/hurricane trends, tsunamis, etc*." **(ADNE)** 4.11: "*Provide a description of the level of gas and chemical emissions* ***from both natural and anthropogenic*** *activities in the Area (…)*" **(ADNE;CCI)** 5.2:"*(…) References* ***to relevant technical data and previous studies*** *should also be included*" **(UAFK)** 5.3:"*Describe* ***any prior research/Exploration that could provide relevant*** *information for this Environmental Impact Statement and future activities. (…)*" **(UAFK)** 5.4:"***Address diversity, abundance, biomass, community-level analyses, connectivity, trophic relationships, resilience, ecosystem function and temporal variability****. (…)*" **(AER;CASTS;CEC;CEIB)** 5.4.3: " *This should include consideration of species* ***richness, biodiversity, faunal densities, community structures and connectivity****, etc.* ***Bioturbation*** *should also be covered in this section*." **(CEC;CEIB)** 5.4.4*:" (…) The summary should consider early* ***life-story stages, recruitment and behavioural information***." **(CEC, CEIB)** 6.2:"***Fisheries*** *(...),* ***Marine Traffic*** *(...),* ***Tourism*** *(...),* ***Marine scientific research****, (...)* ***Area-based management tools*** *(...)*" **(IM)** 7.a:"*The impact and extent of any actual or* ***potential impact, including cumulative impacts***;" **(AU;CCI)** 7.3: "*Provide a description of* ***potential effects on air quality from the surface or subsurface operations*****" (AU;CEAE)** 7.11:"*Maritime safety and* ***interactions with shipping***" **(IM)** 7.13:"*The nature and extent of any interactions between various impacts, where they may have* ***cumulative effects, must be considered on both spatial and temporal scales*** *over the lifetime of the mining operations*" **(CASTS;CCI)** 8.a: "*The nature and extent of any actual or* ***potential impact, including cumulative impacts***" **(AU;CCI)** 8.c: "*It is important that these sections make clear expected* ***longevity of unavoidable (residual) impacts and whether or not the biological environment is expected to recover****, (...)*" **(AER;AU;CASTS)** 8.6:"*Describe estimated effects on the ecosystem* ***or where linkages between the various components above are known***." **(AU)** 8.7:"*The nature and extent of any interactions between various impacts, where they may have* ***cumulative effects****, must be considered on both* ***spatial and temporal scales*** *over the lifetime of the mining operations*" **(CASTS;CCI)** 9:" *(....) provide a detailed description and evaluation* ***of potential impacts of the operation to the socioeconomic components*** *(....)*" **(AU;RCSES)** 9.a: "*The nature and extent of any actual or potential impact,* ***including cumulative impacts***" **(AU;CCI)** 9.4*:"(...) description of* ***economic benefits or impacts, including any applicable social initiatives****."* **(CECo;RCSES)** *9.5:"Potential* ***cumulative effects*** *should also be included*" **(CCI)** 11.3.2:"*Summarize the monitoring plan approach and programme*." **(CAMo)** 11.4.1:"*Outline how the* ***results of monitoring studies*** *will be reported to the Authority*." **(CAMo)** 13:"*Describe the nature and extent of consultation(s) that have taken place with parties identified who have existing interests in the proposed project area and* ***with other relevant stakeholder***." **(PSI)** 13.2:"***List any relevant stakeholder*** *that have been consulted and explain the process by which stakeholders were identified.*" **(PSI)**

			13.3:" *(...) Include a description of* ***key concerns and comments identified by stakeholders*** *and whether or not the applicant intends to address these concerns, and, if not, describe the reasons for that decision*." **(PSI)**
Exploitation Draft	**Annex VII**		2.g:"*A description of the* ***planned monitoring programme****, and the overall* ***approach, standards, protocols, methodologies, procedures and performance assessment*** *of the Environmental Management and Monitoring Plan, including the necessary risk assessment and management techniques, including* ***adaptive management techniques*** *(…)*." **(CAMo, IAM, UAFK)** 2.h:"*Details of the proposed monitoring stations across the project area, including the frequency of* ***monitoring and data collection, the spatial and temporal arrangements*** *for such monitoring (...)*" **(CAMo, CASTS)** 2.i: *"The location and planned monitoring and* ***management of preservation reference zones*** *and impact reference (…)"* **(ADNE)** 2.j:"*A description of* ***relevant environmental Standards and indicators (trigger and threshold points****), including decision rules based on the results of the monitoring of these indicators*;" **(UAFK)** 2.k:"*A description of a system for ensuring that the plan shall adhere to* ***Good Industry Practice, Best Available Techniques and Best Available Scientific Evidence*** *(...)*; **(UAFK)** 2.m:"*A description of the technology to be deployed, in accordance with* ***Good Industry Practice and Best Available Techniques***;" **(UAFK)** 2.n: "Details of the training programme for all persons engaged or to be engaged in activities in the project area" **(PSI)** 2.p:"*Details of ongoing* ***consultation with other users of the Marine Environment***" **(IM; PSI)**

Supplementary Material IV – Detailed scored for sections of each document analyzed. In cases where the principle received both the scores of 1 and 2 for the same section, the highest score was represented, followed by an asterisk (*) symbol.

General Categories	EBM Key Principles (Long et al, 2015)	UNCLOS (1982) + XI Agreement (1994)	Prospecting and Exploration Regulations (2010, 2012, 2013)			Recommendation for the assessment of possible environmental impacts (2020)		Guidance for annual reports (2015)	Exploitation Draft (2019)			
		Part XI, XII + Annex III	Preamble + Part I	Part II	Part III + Part V	Intro + Section II	Section III to VI	Section II + Annex I	Preamble + Part I	Part II + Part IV	Annex IV	Annex VII
Core	Sustainability	2*	0	1	1	1	0	0	2*	1	0	0
Ecological	Account for Dynamic Nature of Ecosystems	N/A	N/A	N/A	1	N/A	2	N/A	N/A	N/A	2	2
	Consider Ecosystem Connections	0	0	0	0	0	2	2	0	0	2	0
	Consider Ecological Integrity and Biodiversity	2*	2*	1	2*	1	2	2	2*	2*	2	0
Impacts	Acknowledge Ecosystem Resilience	0	0	0	0	N/A	2	2	0	2	2	0
	Consider Cumulative Impacts	N/A	N/A	0	0	N/A	2	N/A	N/A	0	2	0
	Consider Effects on Adjacent Ecosystems	2*	N/A	N/A	2	N/A	2	N/A	2	0	2	0
Knowledge	Acknowledge Uncertainty	1	N/A	0	2	2	2	2*	2	0	2	0
	Apply the Precautionary Approach	1	N/A	2	2	2	N/A	N/A	2	2	N/A	N/A
	Consider Interdisciplinarity	N/A	0	0	2	1	1	2	N/A	2	2	0
	Use of All Forms of Knowledge	2*	1	0	2	N/A	2	N/A	2	2	2	2
	Use of Scientific Knowledge	2	N/A	2	2	2	2	2	2	2	2	2
Management	Implement Adaptive Management	N/A	N/A	0	2*	2	2	N/A	0	N/A	0	2
	Conduct Appropriate Monitoring	2	N/A	1	2	2	2	2	2	2	2	2
	Develop Long Term Objectives	N/A	N/A	N/A	N/A	N/A	0	2	N/A	0	0	0
	Explicitly Acknowledge Trade Offs	N/A	N/A	N/A	0	1	0	N/A	N/A	0	1	0
	Integrated Management	1	N/A	0	2	N/A	0	N/A	N/A	2	2	2
Participation	Decision Reflecting Societal Choice	N/A	N/A	N/A	N/A	N/A	0	N/A	N/A	N/A	0	0
	Promote Organizational Change	1	N/A	N/A	N/A	N/A	0	N/A	0	N/A	N/A	N/A
	Promote Stakeholder Involvement	2	N/A	N/A	N/A	2	2	2	2	2	2	2
Socio-economic	Commit to Principles of Equity	2	2	2	2	0	0	N/A	2	2	2	N/A
	Consider Economic Context	1	N/A	N/A	1	N/A	N/A	N/A	2*	N/A	2	N/A
	Recognize Coupled Social-Ecological Systems	0	0	0	0	0	0	N/A	0	1	2*	0
	Use of Incentives	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2	N/A	N/A	N/A
Spatial and Temporal Scales	Consider Appropriate Spatial and Temporal Scales	N/A	N/A	N/A	N/A	N/A	2	N/A	N/A	N/A	2	2
	Recognize Distinct Boundaries	0	N/A	N/A	0	N/A	0	N/A	N/A	0	0	0

3. ECOSYSTEM-BASED MANAGEMENT THROUGH THE LENS OF INTERNATIONAL SEABED AUTHORITY STAKEHOLDERS: CURRENT STATUS, IMPLICATIONS AND OPPORTUNITIES FOR THE DEEP-SEA MINING REGIME (CHAPTER 2)

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Abstract

The ocean is becoming increasingly threatened by human activities, which can undermine the health of its ecosystems. Consequently, it is essential to manage human activities considering an ecosystem perspective, such as through Ecosystem-based Management (EBM). EBM is an approach that seeks to harmonise human uses, usually sectoraly managed, with a holistic, participative, and integrative understanding of the state of the ocean and how potential pressures can impact the maintenance of ecosystems' integrity, processes, functions, and services. EBM implementation in scenarios of limited knowledge and potentially irreversible impacts, such as deep-sea mining (DSM), is be highly appropriate. The International Seabed Authority (ISA), the international organization with the mandate to award exploration and exploitation contracts for minerals on the international seabed, has recognized the need to incorporate the ecosystem approach in its recent instruments but has not specified how to implement it. Through a quali-quantitative approach, comprising an online survey and in-depth interviews, ISA stakeholders have been questioned on their perception on the current status, implications and opportunities of EBM for the deep-sea mining regime. In general, the findings reveal that ISA stakeholders perceive EBM as more related to Ecological and Impact aspects. Most participants do not recognize EBM within the ISA, but when they do, they mostly relate it to management instruments such as Regional Environmental Management Plans and Environmental Impact Assessments. Among participants, most recognize that a lack of consensus regarding EBM can have an impact in decision-making

and EBM operationalization. According to stakeholders, opportunities to improve EBM implementation include collaboration with other organizations already familiar with EBM, capacity development activities, workshops, and side-events. The clarification on what EBM entails for the seabed mining regime should be a matter of major interest to the ISA and all its stakeholders, as the mineral resources found in the Area are the common heritage of humankind, and therefore, its maintenance must be ensured to future generations.

3.1 Introduction

Over the years, national and international agendas for the ocean have more frequently stressed the importance of adopting an ecosystem approach, in line with more holistic and integrative management practices (Gelcich *et al.*, 2018; Warner *et al.*, 2020), in opposition to managing single species or a specific sector. Ecosystem-based Management (EBM) is advocated in recent global commitments, such as the Agenda 2030 for Sustainable Development (Diz, 2019; UN, 2015). The Agenda 2030, in particular the Sustainable Development Goal 14 - focused on the ocean - should be reconciled among all marine sectors, including emerging industries such as deep-sea mining in areas beyond national jurisdiction (ISA, 2018; Singh, 2021).

EBM focuses on interactions among ecological and social systems and stakeholder groups and communities interested in the present and future health of coastal and marine areas (Leslie and McLeod, 2007). EBM practices require redefining the "roles of humans in nature", in which human activities and uses should be harmonized with natural ecosystems' spatial and temporal scales (De Lucia, 2015; Grumbine, 1994). Nevertheless, EBM implementation remains a fuzzy topic, primarily due to the diversity of nomenclatures and definitions attributed to it, but also to several challenges encompassing its operationalisation.

Several EBM-related nomenclatures exist, including the ecosystem approach, ecosystem approach for management, ecosystem-based management, ecosystem-based management approach, and ecosystem-based approach, among others. [2] Such terminology is usually used interchangeably; however, some authors have argued that there is a consistent conceptual divergence between terminologies and, therefore, these should not be used as synonyms (Kirkfeldt, 2019). Likewise, there is no universal definition for EBM (and its related terminology). More

[2] Other existent terminologies are more focused on a sectoral approach to fisheries and include: ecosystem-based fisheries, ecosystem-based fisheries management and ecosystem approach to fisheries.

frequently, EBM is defined by a set of principles (CBD, 2000; Delacámara *et al*., 2020; Long *et al*., 2015, 2017), which can vary depending on the context and scale of implementation (Delacámara *et al*., 2020; Link and Browman, 2014). Despite the absence of consensus, EBM definitions found in the literature hold some commonalities (Delacámara *et al*., 2020), and a rough general understanding exists among scientists (ICES, 2016; Mashak *et al*., 2017) (e.g. an integrative, non-siloed, holistic approach). In contrast, divergences seem to be centered on the consideration of the human dimension as an intrinsic component of ecosystems (Delacámara *et al*., 2020; ICES, 2016), as under the logic of socio-ecological systems (Piet *et al*., 2020). In addition to challenges surrounding a common definition, a comprehensive ecosystem overview is demanded by EBM, which can be added as a challenge to its implementation. Due to that, the approach is not rarely perceived as aspirational, utopic or even as a "wicked solution for wicked problems" (Berkes, 2012; Defries and Nagendra, 2017; O'Higgins *et al*., 2020; Piet *et al*., 2020). Finally, issues related to EBM operationalization seem to be less related to a lack of mandate (Link *et al*., 2018) than to the way it is interpreted and implemented for a given set of variable conditions across various jurisdictions (Enright and Boteler, 2020; Link *et al*., 2018).

More implicitly, EBM has been advocated in instruments such as the United Nations Convention on the Law of the Sea (UNCLOS) and the United Nations Fishing Stocks (De Lucia, 2019; Diz, 2019; Guilhon *et al*., 2020). Alternatively, a more explicitly mention is included on the drafts for the future legally binding instrument on marine biodiversity beyond national jurisdiction (BBNJ) (Christiansen *et al*., 2022) and in the regulatory framework for the deep-sea mining regime in areas beyond national jurisdiction (known as “the Area”) (Guilhon *et al*., 2020), administered by the International Seabed Authority (ISA), both under the regime of UNCLOS.

Efforts towards the commercial extraction of minerals from deep-ocean deposits have been argued to be necessary to facilitate the transition to the next generation of technologies (Hein *et al*., 2013), while acknowledging an equitable sharing of benefits as the mineral resources in the Area, the common heritage of humankind (UNCLOS, 1982 - Article 136). Established under Article 156 of UNCLOS, the ISA is responsible for the development, implementation, and management of a regime for deep-sea mining activities (DSM) in the Area. The organizational structure of the ISA comprises four main operational organs: the Legal and Technical Commission (LTC), the Council, the Assembly, and the Secretariat. The LTC, a subsidiary organ of the Council currently comprising 30 individual experts (ISA, 2022), is established to provide recommendations to the Council

(UNCLOS, 1982 - Articles 163 and 165) and attend to its instructions. The Council is the executive organ of the ISA, comprising 36 member States elected for four-year terms among Assembly members (UNCLOS, 1982 - Articles 161.3 and 162.1; 1994 Agreement - Section 3.15). Consisting of all State parties to UNCLOS, the Assembly is the supreme organ of the ISA (UNCLOS, 1982 - Articles 160.1 and 156.2) that provides the final approval of recommendations provided by the LTC and regulations approved provisionally by the Council (UNCLOS, 1982 – Article 162.2.o.ii). The Secretariat comprises the Secretary-General and staff (UNCLOS, 1982 – Article 166.3), and fulfils administrative roles at the ISA. Among others, the function of the Secretariat includes producing reports that facilitate deliberation and decision-making, producing publications, organizing meetings, seminars and workshops, and ensuring compliance with plans of work for exploration and exploitation (ISA, 2022).[3] Moreover, other groups play an important role as ISA stakeholders, influencing the decision-making processes. These include contractors, scientists, NGOs members, legal and political experts, civil society members and members of intergovernmental organizations, among others (Levin *et al*., 2020a).

The regulations that will guide the commercial extraction of seabed mineral resources in the future are currently under discussion at the ISA through a Draft for Exploitation activities (DEA). While there is no consensus on the final content of the DEA, the ISA has granted 31 exploration contracts to interested parties (mostly private companies sponsored by UNCLOS Member States), the contractors, to conduct research and test-mining activities exclusively in an area defined by the respective contract (ISA, 2010, 2012, 2013). Most of the contracts so far awarded are for polymetallic nodules concentrated in the abyssal plain area of the Clarion-Clipperton Zone (CCZ), on the Northeast Pacific Ocean. Exploration contracts for other mineral resources, such as polymetallic sulphides and cobalt-rich crusts, respectively, have been issued in areas of hydrothermal vents and seamounts ecosystems in the Atlantic and Indian Oceans (Levin *et al*., 2020a).

An explicit reference to EBM is currently observed in two different instruments of the ISA regulatory framework. In 2012, the term "ecosystem-based management" first appeared as one of the goals of the CCZ Environmental Management Plan (CCZ-EMP). According to the document, among other goals, the CCZ-EMP will "Manage the Clarion-Clipperton Zone consistent with the

[3] https://isa.org.jm/secretariat

principles of integrated ecosystem-based management" (ISA, 2011 - para. 35.d). The "application of an ecosystem approach" was later described as a sound principle to be applied for "the effective protection of the marine environment from the harmful effects which may arise from Exploitation" in the DEA (ISA, 2019). Although there has been an increase in the recognition of EBM principles into the seabed mining regulatory framework over time (Guilhon *et al*., 2020; Warner, 2020), that has not been accompanied of further clarification nor guidance relating to practical implications from the terminology by the ISA. Such conduct may restrict wording to an empty scientific jargon, compromising an efficient translation and communication to decision-makers (Amon *et al*., 2022) and, consequently, resulting in non-existing or failed implementation.

The development of a pathway to the clarification of what entails EBM and how it is to be implemented under the ISA regime could benefit from the understanding of how stakeholders involved in the process perceive EBM and its influence to effectively manage ecosystems in the Area and the mineral resources therein. The present study was motivated by the assumption that different perceptions may result in conflicting decision-making and frustrated compliance, particularly in a process where several economic and political interests are at stake. More specifically, this article addresses key aspects of stakeholder's perceptions regarding the ISA regime on: (i) what is EBM and what is its importance for DSM in the Area (Section 3.3.1 and Section 3.4.1); (ii) if and where do stakeholders perceive EBM implementation at the ISA regime (Section 3.3.2 and 3.4.2); (iii) the impacts that a lack of a clear definition may have in decision-making and EBM operationalization (Section 3.3.3 and 3.4.3) and what are the opportunities to improve EBM incorporation in the regime including who should lead such changes (Section 3.3.4 and 3.4.4). Finally, concluding remarks are provided, evidencing that, Ecological and Impact aspects are the most commonly relatable attributes of EBM, while aspects encompassing humans as an intrinsic part of the ecosystem remain l. Other than that, the creation of spaces to broaden discussions on EBM within the ISA is highly recommended among participants (Section 3.5).

3.2 Methods

3.2.1 Research Design

The study adopted complementary quantitative and qualitative approaches to collect data, which included an online survey and online interviews with representatives of different stakeholder groups, respectively. Prior to the circulation of the questionnaire and performance of interviews, a

multidisciplinary expert committee comprised of social, political, economic, legal and natural sciences experts reviewed and discussed the online survey and interview script, providing feedback and recommendations on the documents' structure and content. In addition, the research proposal was evaluated and approved by an ethical committee (please refer to the Ethics Statement section).

3.2.2 Data gathering

Four main aspects were addressed by the online questionnaire and in-depth interviews (Figure 1). Details regarding the approaches and data analysis are addressed below.

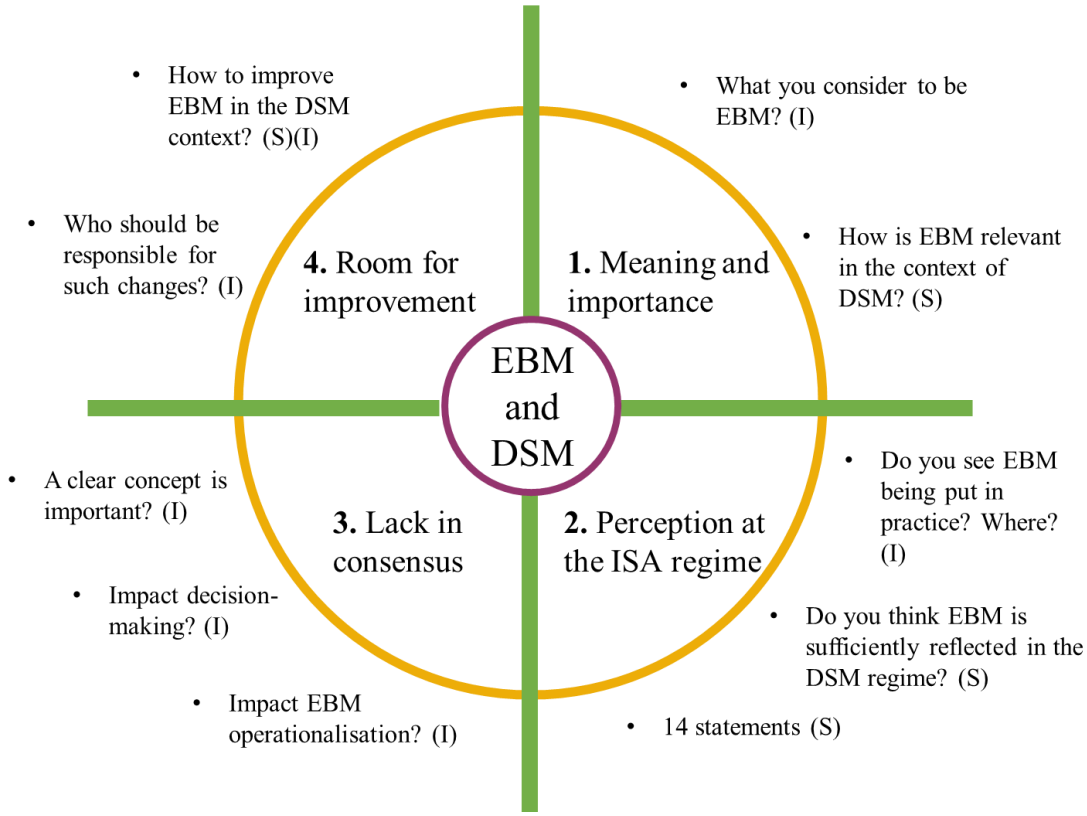

Figure 1. Graphic representation of the strategy adopted by the present study. The center circle represents the main objective of the study, which refers to the evaluation of ISA stakeholders' perception of EBM for the DSM regime administered by the ISA. For that, four aspects were explored: 1) identification of EBM meaning and importance for the DSM regime administered by the ISA; 2) perception regarding current EBM implementation; 3) if a lack of consensus on EBM at the ISA regime could impact decision-making and the operationalization of the approach, and 4) what are opportunities to improve EBM and who should take part on such changes. More externally to the figure, the respective guiding questions for each aspect are presented. Questions presented at the online survey are accompanied by (S) and inquiries performed during the in-depth interviews are represented by (I).

3.2.2.1 Online survey

A link to an online survey was widely circulated through a mailing list of a deep-sea network of specialists comprising natural and social scientists, law experts, consultants, decision-makers, early career researchers, students and other stakeholders interested in the interface of deep-sea science to policy. Moreover, the link was circulated among subscribers of an international newsletter dedicated to the topic of DSM. Other than that, emails were sent individually to people known to be involved with DSM discussions taking place at the ISA. The participation of respondents was anonymous, although they were asked to provide their background and current work positions (without affiliation). As represented in Figure 1, the survey addressed the following issues: meaning and importance of EBM in the context of the ISA; perception of EBM incorporation in the mining regime and opportunities for improvement. These issues were addressed based on open-ended questions.

As an additional approach to identify if and where stakeholders perceive EBM in the DSM regime, fifteen statements comprising different aspects were attached to a five-point Likert scale: "strongly disagree", "somewhat disagree", "neither agree or disagree", "somewhat agree" and "strongly agree" (Supplementary Material). The option "I don't know" was also included as a possible answer. The statements regarded the potential for application to the DSM regime considering core EBM principles (Long *et al*., 2015), and based on the authors' experience and publications on the ISA regime. The use of Likert scale statements provides a valuable opportunity to ensure that potential divergences in stakeholders' perceptions are captured based on the very same assumption (Bryman, 2012). In other words, participants were exposed to the same information and were able to express their opinion on a specific aspect of the ISA regime presented through the statements, independently of their previous knowledge or familiarity with EBM. Respondents were given the opportunity to provide other feedback or comments on the statements if deemed it necessary.

Thirty-five respondents completed the online survey (Table 1). Natural scientists and legal experts comprised 77% of the total respondents, whereas social scientists, economists, policy experts and diplomats presented low numbers of participation. The low participation of social scientists and economists was expected, as these professionals remain underrepresented in the context of DSM discussions. Six participants self-identified as policy experts, whereas only one indicate being a "policy expert" as its primary role. Only one participant self-identified primarily

as a “diplomat”, although it would be expected that all the participants who self-identified as Council and Assembly would be diplomats. In that respect, four respondents self-identified as members of the Council, three as the Assembly (two of which also self-identified as Council), two as members of the LTC and an additional two as ISA observers. Based on these numbers, the views of members of the ISA (Assembly, Council, LTC and Secretariat) may be underrepresented in the findings of the survey. Therefore, the survey results should be carefully examined as they represent a limited view of participants from the organisation responsible for regulating and managing DSM activities. As is part of the category “others”, two participants have self-identified as “expert” and “environmental consultant”. No participant has self-identified as a student, ISA Secretariat member, or contractor.

Table 1. Qualitative (left column) and quantitative (right column) primary self-identification of participants from the online to assess the role of EBM for DSM in the Area; the perception of participants in relation to EBM incorporation and the opportunities for improvement. The participants listed also responded to fifteen Likert-scale statements that aimed to evaluate participants’ perception of EBM for specific aspects of the DSM regime. The numbers indicated on the table reflect the primary category filled in by respondents, without considering other categories related to occupation also present in the survey (e.g. delegates of the Assembly, Council, LTC, ISA Observers, NGO members, international organisation representatives, contractors) were not accounted in the table.

Stakeholder category	Number of participants
Natural scientist	14
Legal expert	13
Policy expert	2
Economist	2
Social scientist	1
Diplomat	1
Others	2
Total	35

3.2.2.2 In-depth interviews

Based on their recognised involvement with environmental matters pertinent to discussions under the ISA regime, 2 stakeholders from 8 different stakeholders groups (totalizing 16 participants) were invited to in-depth interviews. Interviewees were invited based on their role and involvement with DSM matters (e.g., publications and participation im ISA sessions and

discussions). Interviewed stakeholders included two members of natural scientists, legal experts, consultants, members of NGO's, contractors and members of the LTC, Assembly and Council. Members of the ISA staff and Secretariat were also invited to participate of the interviews, but there was no response to our contact. The interviews aimed to complement and deepen the online survey information regarding the perceptions of what EBM is and its importance, including perceptions of its current implementation and potential impact in decision-making under the ISA and recommendations for improvement.

An interview guideline was prepared to provide the individual interviews with roughly the same structure, while simultaneously opening the conversation for diverging narratives and customised queries. Each interview was recorded, transcribed, and sent back to the interviewee as a register of their participation.

3.2.3 Data analysis and discussion

3.2.3.1 Open-ended questions

Responses from questions regarding the definition and importance of EBM for DSM were subjected to content analysis and categorised into groups reflecting the groups of EBM principles proposed by Guilhon *et al.* (2020) (Section 3.3.1) in an analysis of key documents of the ISA regulatory framework for DSM (the Mining Code): Core, Ecological, Impacts, Knowledge, Management, Participation, Socio-economic, and Scales (Table 2). Examples of the establishment of the categories based on the content analysis are available as Supplementary Material.

Table 2. The twenty-six Ecosystem-Based Management (EBM) principles recognized in a literature survey promoted by Long et al. (2015) are presented in the middle column. The principles have been divided into general categories (left column) in a previous analysis of the Mining Code proposed by Guilhon et al. (2020).

General Groups	EBM Principles
Core	Sustainability
Ecological	Account for Dynamic Nature of Ecosystems
	Consider Ecosystem Connections
	Consider Ecological Integrity and Biodiversity
Impacts	Acknowledge Ecosystem Resilience
	Consider Cumulative Impacts
	Consider Effects on Adjacent Ecosystems
Knowledge	Acknowledge Uncertainty
	Apply the Precautionary Approach
	Consider Interdisciplinarity
	Use of All Forms of Knowledge
	Use of Scientific Knowledge
Management	Implement Adaptive Management
	Conduct Appropriate Monitoring
	Develop Long Term Objectives
	Explicitly Acknowledge Trade-Offs
	Integrated Management
Participation	Decision Reflecting Societal Choice
	Promote Organizational Change
	Promote Stakeholder Involvement
Social-economic	Commit to Principles of Equity
	Consider Economic Context
	Recognize Coupled Social-Ecological Systems
	Use of Incentives
Spatial and Temporal Scales	Consider Appropriate Spatial and Temporal Scale
	Recognize Distinct Boundaries

Commonalities arising from responses to other open-ended questions originated general categories (with the exception of ‘yes’ or ‘no’ questions) and were grouped and discussed based on a minimum of two responses on the same topic. To incorporate as many views as possible on the subject, both the online questionnaire and the interview structure contained a question on the perception of respondents with respect to potential pathways to improve EBM incorporation in the ISA regime. These, nevertheless, were only discussed qualitatively to avoid possible double counting from respondents that participated in both of the online survey (anonymous) and in-depth interviews.

3.2.3.2 Likert scale

Responses to Likert scale statements are presented as percentages to support the discussion of respondents’ perceptions of EBM implementation in the ISA regime. Whenever available,

comments related to the reasoning of respondents to the ranking are also considered to discuss the data.

3.3 Results

3.3.1 EBM definition and its importance for DSM in the Area

When asked how they would describe EBM, responses from interviewees were grouped into nine main categories (Figure 2.a), whereas fourteen categories were obtained when respondents from the online questionnaire were asked about the importance of EBM to the management of DSM activities in the Area (Figure 2.b).

Ecological and Impact principles were the most identified responses in both methodological approaches. Interconnections between and within ecosystem components, including in relation to adjacent systems or units (both vertically and horizontally), were the most cited aspect associated with a definition of EBM, as referred to by 50% of the interviewees. Following, interviewees strongly related EBM to an approach that should identify, assess, and manage cumulative impacts. Although more discreetly, aspects related to Management and Socio-economic principles were also referred to by interviewees.

More categories of principles were observed in responses to why EBM is important to manage DSM activities (Figure 2.b). Respondents referred to the categories of Core, Knowledge and Scales in addition to Ecological, Impacts, Management and Socio-economic observed for interviews responses. Respondents seem to acknowledge EBM as valuable approach for DSM as it addresses existent knowledge gaps, and that is science-based. Other than that, aspects related to the holistic nature of EBM and having sustainability as one of its outcomes were pointed out by respondents as valuable aspects of consideration under the management of DSM activities. Aspects of participation were not mentioned by any respondent from the online questionnaire or interview.

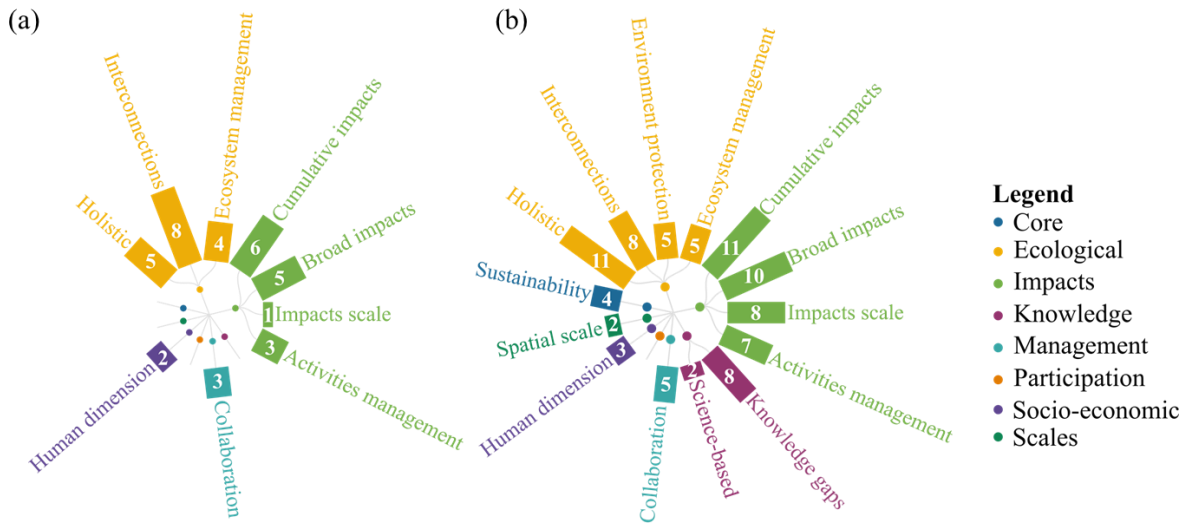

Figure 2. Responses obtained by participants based on qualitative (categories) and quantitative (number of mentions) analysis of answers provided by interviewees (N = 16) on what they understand EBM to be (Figure a) and by respondents from the online survey (N=35) on why EBM is important in the context of DSM (Figure b). The qualitative and quantitative information obtained were classified on EBM principles categorised following Guilhon et (2020).

3.3.2 Recognition of EBM within the ISA regime

With two exceptions (the statements related to the EBM principles "Acknowledge Uncertainties" and "Consider Interdisciplinarity"), all statements presented a higher number of answers to "strongly disagree" than "somewhat disagree". For "strongly agree" and "somewhat agree", a similar number of citations were computed for "Consider Ecosystem Connections", "Consider Cumulative Impacts and Consider Effects on Adjacent Ecosystems" and "Recognise Coupled Social-Ecological Systems", while "strongly agree" prevailed for "General", "Acknowledge Uncertainty", "Implement Adaptive Management" and "Participation – Stakeholders", and "Transparency – General". Strongly agree was absent for "Use all Forms of Knowledge".

In general, respondents mostly disagreed with statements considering practices consistent with EBM within the ISA regime. More specifically, more than 60% of respondents disagree that the ISA currently provides clear guidance on how to intend to apply, enforce, and comply with EBM (as provided by the General statement). Following that, disagreement rates above 50% were observed for Ecological, Impacts, Knowledge (Use All Forms of Knowledge), Management (Implement Adaptive Management), Socio-economic, Scales, and Transparency (General). The statements with higher rates of agreement were observed for the EBM categories concerning

Knowledge (Acknowledge Uncertainties – 42,9%; Consider Interdisciplinarity – 34,3%) and Management (Integrated Management – 37,1%). Approximately 20% of respondents did not know how to answer a statement posed about Transparency (Figure 3).

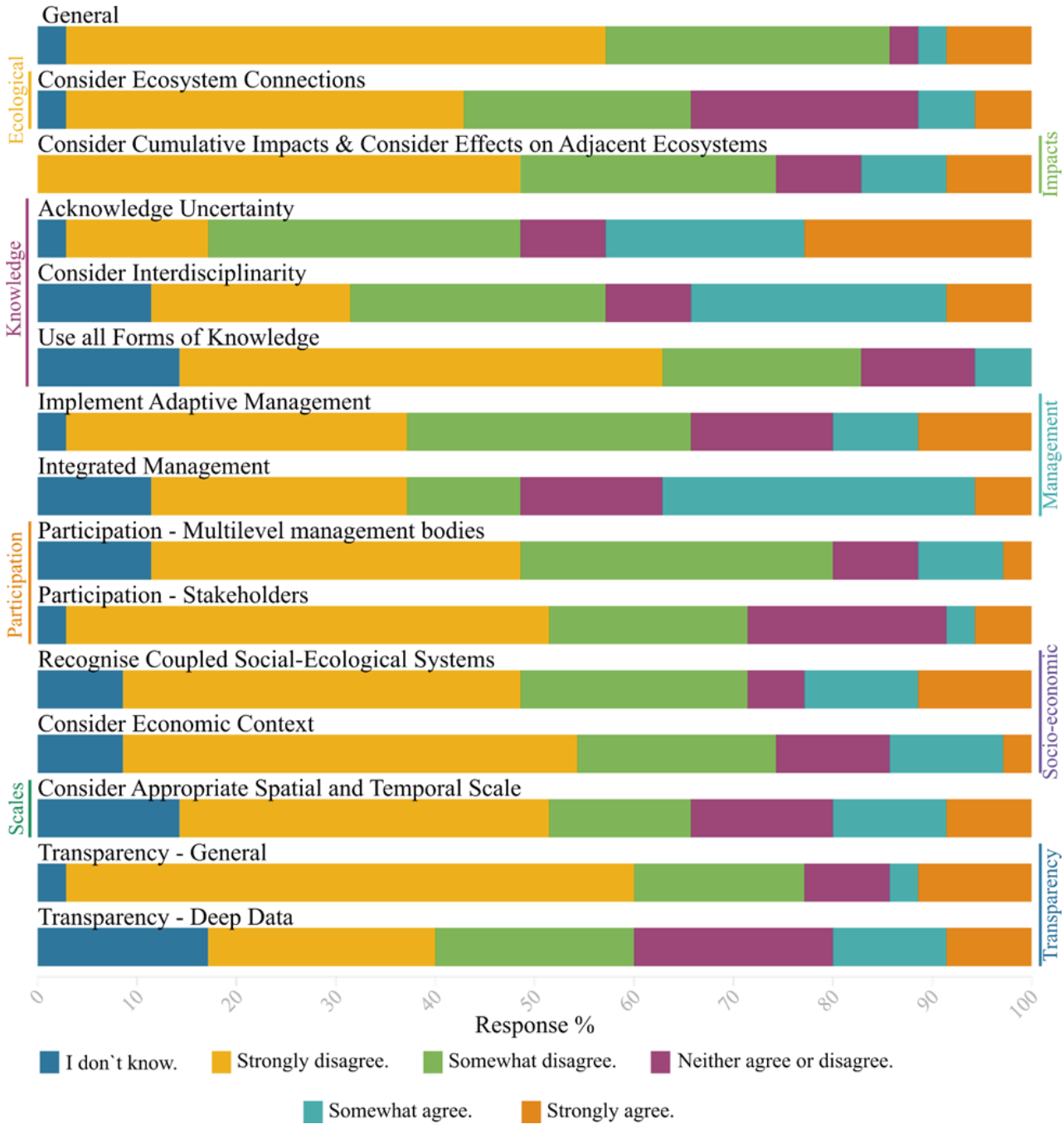

Figure 3. Results (percentage) were obtained for the fifteen statements included in the online survey aimed to provide a common background to evaluate to what extent respondents recognize EBM as included in the current ISA regime. Each statement is related to one or more EBM principles, as indicated at the top of each bar. As indicated in the figure legend, respondents were presented with six Likert-scale categories of response ranging from “strongly agree” to “strongly disagree”. Additionally, respondents were also present with the option “I don’t know”. EBM general groups, as proposed in Guilhon et al. (2020), are vertically described perpendicularly to the respective statements they represent. The content of each statement is available in the Supplementary Material.

Whenever asked if they think that EBM is sufficiently reflected in the current regime administered by the ISA, close to 83% of the survey respondents answered “no”, while 8,6% answered “yes” and 8,6% did not know or did not respond to it. According to two of those who responded affirmatively, the ISA has been implementing adequate guidelines and environmental requirements, such as the practice of Environmental Impact Assessment (EIA) and Environmental Management and Monitoring Plans (EMMP). A third respondent did not provide any example. The respondent who answered “I don’t know” highlighted that it was too early to speak about EBM and exploitation as no standards or guidelines were presented by the ISA.

Respondents who do not consider EBM as sufficiently reflected in the ISA regime referred to: a lack of definition and clarification on the application of the term (9); issues with environmental requirements (7) - including standards, guidelines, a plan to assess ecosystem-level responses, insufficient mention of cumulative impacts, lack of mentioning ecosystem services and consideration of water column processes; lack of coordination with other institutions/bodies (4); lack of requirements during the exploration stage (4); issues with EIA, REMPs and transparency (3 for each); and others more punctually mentioned (5). For the latter, reasons included: the lack of requirement by UNCLOS, the insufficient application of the precautionary approach, the lack of a final mechanism that reflects the common heritage of humankind and the rush for exploitation activities to start. Lastly, a participant pointed out that such a requirement may never be sufficiently reflected.

Interviewees were asked to provide a few examples of where they have seen the EBM approach incorporated into the regime. Most participants related EBM at the ISA regime to the development of REMPs (9). Although perceiving REMP as a management approach compatible with EBM, most of those who mentioned REMPs recognised that it is “not really in practice”, “not enough”, “only partially” or “not appropriately”. Others situated parts of the process of planning and developing REMPs as evidence that EBM is “behind the thinking”. Examples included the development of regional environmental assessments - including aspects of ecosystem functioning, and exercises to identify cumulative impacts performed during workshops organised by the ISA. Further, requirements under the ISA regulations, such as the requirement for the assessment of impact during test-mining activities and the submission of Environmental Plans (EIS, EMMP and Closure Plans) when applying to exploitation contracts, have been raised. More specifically, a participant highlighted that such steps in the process require the recognition of other uses, which is

a primordial step in the assessment of cumulative impacts. Other two perceived that requirement of an EIA/EIS (including requirements for presenting ecosystem services and connectivity aspects, according to one) could be *per se* understood as acknowledging EBM. Extensive requirements for baseline studies during the exploration phase - including data beyond the seafloor - were also raised as measures in consonance with EBM. In this aspect, two other participants acknowledged an "expansion" in the requirements of baseline data as actions toward EBM.

Finally, three participants responded that they did not recognise EBM as being put in practice by the ISA. According to one, "[as exploitation is not in place] *there has really been no forum where (...) an ecosystem-based management could be showcased*". This statement reinforces the perception of stakeholders who currently perceive requirements compatible with EBM as currently lacking in the exploration stage but also underlines the view of some who believe that EBM should only take part during the exploitation phase. We argue that EBM must be part of the process from early stages to make sure that necessary questions are raised, efforts to fill gaps are in place, remaining uncertainties are acknowledged, and the values of those more or less directly involved with the process (and its potential impacts and effects) are appreciated.

3.3.3: Decision-making and EBM operationalisation under the ISA

Seventy-five per cent (75%) of interviewees perceive a lack of consensus regarding EBM as a factor that can impact decision-making. According to them, a lack of common understanding can lead to different interpretations, preventing setting standards and leaving room for gaps in compliance. The existence of economic and political interests was also given as a reason for the importance of clarifying an EBM mandate for the deep-sea mining regime. Among those who do not see a lack of EBM consensus impacting decision-making (12,5%), some stated that there is already a general understanding of EBM within the ISA, but argued that an alignment between delegations could be beneficial, and the foreseen standards to be adopted should allow to align expectations regarding EBM implementation. The remaining 12,5% did not know how to answer this question.

About two-thirds of interviewees (64%) perceived a lack of consensus as potentially impacting EBM operationalisation under the ISA regime, and 29% believed there is no impact. According to those who do not foresee an impact, EBM should not be compromised if the necessary

expertise is enrolled with the development of the regulatory framework (including standards), as well as with the elaboration of baseline studies and EIA/EIS. Nevertheless, all participants agreed that it would be important to set a definition of EBM under the ISA regime. Among those who do not perceive a lack of understanding as impacting decision-making, there is an understanding within the LTC and Secretary-General and therefore, an alignment with member-states through, e.g., side-events or development of policy-briefs, may suffice to ensure that all the actors at the ISA are on the same page. Other than that, a participant perceived that future exploitation guidelines issued by the LTC should align potential divergences in understanding among stakeholders.

According to respondents, the lack of a common understanding may lead to different interpretations, which can impact the negotiations and, therefore, EBM operationalisation. Among responses, participants raised considerations on if and how to approach aspects other than those related to the natural environment (i.e., social, economic, cultural), especially considering the political and economic states intrinsic to the negotiations processes. Other than that, respondents perceived that different understandings might impact the monitoring of compliance and enforcement.

3.3.4 Opportunities for improvement

The highest number of citations, both from interviewees and respondents from the online questionnaire, included aspects related to (a) the importance of clarifying an EBM mandate under the ISA and (b) increasing discussions on the subject. According to participants, more clearance is needed from the ISA in terms of what are the elements that encompass EBM, as well as with respect to what is expected in terms of compliance with EBM. Among those who perceive the need for further discussions on the topic, capacity development activities, the development of a policy briefs and side events with delegations were raised as possible ways forward. Yet on a general matter, respondents referred to the need for: a better integration between the ISA and other sectors, organisations (e.g., OSPAR) or previously established management measures (e.g., EBSAs); an improvement in transparency, involvement of stakeholders, incorporation of independent and external science and a better acknowledgement and reduction of uncertainties.

With respect to more specific recommendations, the results were more oriented towards the improvement of management instruments and data collection. The improvement of REMPs

substance and procedure was the aspect more frequently mentioned. Additionally, the inclusion of more clear and comprehensive templates for EIA/EIS/EMMPs and the need for standardisation of technologies, data analysis and dissemination were also mentioned as aspects requiring further attention. Among interviewees, the need for data that allows for EBM was also expressly mentioned. According to respondents that raised issues with data, the consideration of interconnections with water column ecosystems, acknowledgment of ecosystem functions and services and the establishment of thresholds and tipping points were referred to aspects playing a major role in enabling EBM.

Whenever asked whom they consider the responsible parties in improving EBM implementation in the ISA, most respondents (62%) perceived that such change should be led by the States parties of the ISA. Respondents also mentioned the importance of involving the "community" relating and affected by deep-sea mining discussions, including through national populations hearings, input from scientists, and conversations with other organisations and actors enrolled in ocean's management, such as, for instance, those involved with the BBNJ discussions. Nonetheless, less frequently, the Secretariat and the LTC were also mentioned as parties potentially playing a role in improving EBM implementation. Finally, two respondents perceived the ISA as in the right direction for the implementation of EBM.

3.4 Discussion

3.4.1 EBM definition and its importance for DSM in the Area

The findings follow the evidence of other investigations with respect to stakeholders' perceptions of EBM. Views mostly related to Ecological and Impact principles and less focused on social sciences issues were also observed among participants from an Atlantic Ocean Research Alliance workshop with respect to EBM (ICES, 2016). In the present study, participants made references to the Ecological principles of EBM, which included "to take a holistic approach to the ecosystem", "the consideration of the marine environment as a whole", and "consider interactions within an ecosystem". In relation to Impacts principles, mentions mainly included the acknowledgement and consideration of cumulative impacts, together with a wider consideration of impacts both in terms of effects and scale. The consideration of the ecosystem as a whole was part of the paradigm shift represented by EBM, which included the recognition of humans and non-

humans alike as entities interconnected by places, processes, individuals and communities (De Lucia, 2015).

Albeit discreetly, the recognition of a human dimension as an aspect of EBM appeared among responses and encompassed the importance of factoring human elements (economic, social, and cultural) as part of management. As reflected by the lack of mentioning of Participation principles, it seems that stakeholders, in general, do not factor" it as an intrinsic component of EBM. In that sense, a trend in transitioning from an eco-centric to a more anthropocentric approach regarding EBM (Aas *et al*., 2020) seems to be yet restrained to concepts such as ecosystem services (De Lucia, 2015), in which humans are placed as direct or indirect beneficiaries from natural ecosystems, without acknowledging and factoring societal values or shared responsibilities that are linked to participation. These, nevertheless, are already recognised as EBM components in the related literature (Long *et al*., 2015; O'Higgins *et al*., 2020; Sardà *et al*., 2014).

The categories of EBM principles mentioned by stakeholders were amplified whenever respondents were asked why EBM is important to manage DSM activities under the ISA regime. Survey respondents mentioned the existence of uncertainties related to deep-sea ecosystems and processes (lack of scientific knowledge), and the foreseen (yet uncertain) extension of impacts to be caused by future large-scale DSM activities. In consonance with that, the adoption of a precautionary approach and the implementation of a science-based decision-making, cornerstones of EBM, is of great relevance to the DSM regime (Christiansen *et al*., 2022; Guilhon *et al*., 2020; Jaeckel, 2015), as highlighted on responses associated with Knowledge principles. Other forms of knowledge, such as those provided by indigenous people and local communities, should also be included in the context DSM discussions and decision-making (Amon *et al*., 2022; Guilhon *et al*., 2022; Tilot *et al*., 2021), although not raised by any respondent.

The establishment of collaboration mechanisms was considered by respondents as an important EBM aspect to DSM. Political will is required for successful collaboration endeavours, as in consonance with EBM (Engeler and Boteler, 2021). According to participants, collaboration efforts should be considered in light of other human activities taking place in the marine realm as well as with the mandate of other management organisations, including the BBNJ negotiations in progress.

On the Core principle, two different views of sustainability were raised by participants. One refers to EBM as important to "achieve sustainable use of mineral resources", whereas others see

it as relevant to the "sustainable management of natural resources". Sustainability is the ultimate objective of adopting EBM (De Lucia, 2015), and therefore it is embedded in it (ICES, 2005). Although the terminology is usually used to relate to the importance of guaranteeing the interests of the current and future generations, especially in the context of the Area's minerals, which are a "common heritage of humankind" (UNCLOS, 1982 - Article 136; Guilhon *et al*., 2020), the wording adopted may reflect different expected outcomes, which, in turn, can be primarily based on interests. To "achieve sustainable use of mineral resources" may suggest a prioritisation of an exploitation view, potentially implying that the primary objective is to guarantee that the activity (exploitation) is sustainable, ensuring that the mineral resources of the Area are not exhausted for current and future generations. Alternatively, a more conservationist view is reflected in the responses addressing the "management of natural resources" (Le Tissier, 2020), which can be interpreted as a concern focusing on the maintenance of natural resources (ecosystems) over time. In line with EBM, such conservation of marine resources should reflect the latest view, and focus on the maintenance of ecosystem structure, functions, and services (Guilhon *et al*., 2020). In both scenarios, the view of sustainability is debatable, as minerals on the deep form in the scale of millions of years and considering that deep-sea mining activities are frequently associated with potentially causing irreversible impacts (Singh, 2021; Levin *et al*., 2020a).

3.4.2 Recognition of EBM within the ISA regime

Concepts such as cumulative impacts and ecosystem services are often linked to EBM terminology. Under the ISA regime, the acknowledgement of cumulative impacts is contained as an express requirement in the DER (Guilhon *et al*., 2020); however, it remains one of the main scientific gaps in informing DSM decision-making (Amon *et al*., 2022). The requirement of assessing ecosystem services as part of baseline studies and as part of the process of assessing impacts is absent in the Mining Code (Guilhon *et al*., 2020) and was also listed as an existing scientific gap (Amon *et al*., 2022). As mentioned by respondents, the interconnection of ocean ecosystems and processes, both vertically and horizontally, reflects the holistic approach proposed by EBM. Nevertheless, the consideration of the water column aspects as part of baseline

information and in the assessment of environmental impacts for test-mining of components during exploration is, so far, limited[4] (Amon *et al*., 2022).

The importance of better integration between the ISA regime and other organisations and instruments, e.g., BBNJ instrument, in light of EBM, and steps to improve the coherence between the two regimes have been discussed by Christiansen *et al*. (2022). Another key aspect raised is that EBM requirements are missing for the exploration stage. That aspect raises concerns, given that the exploration stage is of utmost importance to collect, analyze, and evaluate data, including in terms of assessment of impacts and monitoring during and after test-mining (Guilhon *et al*., 2022; Guilhon *et al*., cap.5). Test-mining activities provide evidence that can help balance trade-offs in relation to exploitation (Ginzky and Singh, 2021).

Having REMPs as a reference to EBM under the ISA regime is somewhat expected. EBM wording is contained within the EMP-CCZ as one of its goals (ISA, 2011 - para. 35.d), therefore, facilitating stakeholders relating to it. Other than that, EBM is frequently related to the concept of marine protected areas (MPAs). In the case of the current EMP-CCZ, the Areas of Particular Environmental Interest (APEIs) have a similar role to MPAs, as they should represent a precautionary measure that safeguards key ecological processes within areas that are biogeographically representative of the location. In practice, APEIs are non-permanent protected areas where no exploration or exploitation activities are allowed (core areas of 200x200 km^2) accompanied by buffer areas (100 km) (Wedding et al., 2013, 2015). In 2012, the ISA Council approved the first network of nine APEIs distributed outside of contract areas (ISA, 2012). More recently, as a result of scientific workshops and the review process conducted by the LTC, four new APEIs were included in the network of MPAs taking into consideration internationally accepted criteria (ISA, 2021).

Shortcomings of REMPs procedure and substance in reflecting EBM hamper its potential to be instruments that effectively contribute to enhancing coherence for management and

[4] Considerations regarding the current lack of considering adjacent ecosystems (e.g. water column) in Environmental Impact Statements submitted by contractors for the performance of activities with impact to cause harm to the marine environment were also raised during stakeholder consultations, which can be found here: https://www.lbeg.niedersachsen.de/startseite/bergbau/offshore/aktuelle_projekte/aktuelle-projekte-offshore-124111.html ; https://economie.fgov.be/en/themes/enterprises/deep-sea-mining/workshops-and-public/environmental-impact-statement ; https://www.dosi-project.org/wp-content/uploads/DOSI_Submission_MoESEIS.pdf ; https://www.pewtrusts.org/-/media/assets/2020/05/code-project-comments-regarding-eis.pdf

conservation in ABNJ (Christiansen *et al*., 2022). Moreover, it compromises the ISA's mandate to "*ensure effective protection for the marine environment from harmful effects which may arise*" from activities in the Area (UNCLOS, 1982 - Article 145). Christiansen *et al*. (2022) provides an extensive list of recommendations to improve REMPs-related practice, including amendments in the scope and procedure for REMPs that derived from an expert workshop, followed by a formal collective submission from Germany, the Netherlands and Costa Rica to be appreciated by the Council of the ISA (ISA, 2020a, 2020b)[5].

Whenever exposed to specific situations, through the proposed statements, the majority of respondents do not perceive EBM as currently reflected in the ISA regime. The responses provided for the General statement reinforce the perception that for stakeholders, the application, enforcement, and compliance with EBM are unclear under the ISA regime, standing out as an issue that requires further discussion.

As observed in responses for the statements relating to Ecological and Impact principles do not seem to be fully integrated into the ISA regime. However, high rates of "somewhat disagree" may indicate that stakeholders perceive the maintenance of ecosystem structures and functions and the consideration of cumulative impacts as aspects as being partially addressed in the regulatory framework of the ISA.

In terms of Knowledge, the highest rates of disagreement were obtained for the statement related to the acknowledgement of traditional/local/indigenous knowledge for informing decision-making processes. There is no reference to the use of traditional knowledge as part of the Mining Code (Guilhon *et al*., 2020; Tilot *et al*., 2021), despite the evidence that coastal communities can be exposed to the effects of activities taking place in ABNJ (Popova et al., 2019). Conversely, the acknowledgement of uncertainties and consideration of interdisciplinarity as part of the regulatory framework of the ISA seems to remain as an uncertain matter, as observed by more balanced responses obtained among those that agree and disagree with it.

The statement related to Integrated Management presented the most similar rates of agreement and disagreement. The harmonisation between DSM and the Sustainable Development Goals (SDGs) of the Agenda 2030 remains an open debate (Singh, 2021; Stuchtey *et al*., 2020). As part of its Strategic Plan for 2019-2023, the ISA has identified nine strategic directions in line to

[5] As of the date of August 2022 there was no reaction from the ISA with respect to this submission.

the achievement of SDGs other than the 14, including SDGs 1, 4, 5, 7, 8, 9, 10, 12, 13, 16 and 17 (ISA, 2018, 2021). In a report informing the contributions of the ISA to the achievement of the Agenda 2030, however, there is no reference to the existence of synergies between the SDGs, nor how it plans to deal with trade-offs within the DSM context (Kroll *et al*., 2019; Singh, 2021a).

Participation seems to be a controversial issue among ISA stakeholders, as the responses to the statements seem to reflect that there is no do not seem to have a position on if the ISA present an adequate strategy for stakeholders' engagement and communication. Issues relating to such aspects have been pointed out by several authors at different stages of the DSM process (Guilhon *et al*., 2022; Guilhon *et al*., cap. 5; Jaeckel and Ardron, in press; Ardron, 2018; ISA, 2022).

Issues of transparency have been reported in relation to numerous aspects of the DSM regime, including in relation to plans of work, annual reports, REMPs and EIS (Tilot *et al*., 2021; Christiansen *et al*., 2022; Amon *et al*., 2022; Guilhon *et al*., 2020, 2022) and are largely addressed by the literature (Ardron *et al*., 2018; Christiansen *et al*., 2016. With respect to the platform *DeepData*, launched in 2019 by the ISA[6], stakeholders seem to not have a very clear opinion, although the highest percentage was obtained for the category "disagree". The *DeepData* database has the potential to expand access to scarce deep-sea knowledge, as well as to address transparency issues raised with respect to the ISA regime. However, so far, the *DeepData* is yet fully operational or interlinked to other global databases (Amon *et al*., 2022). In addition, some respondents have reported that the platform is not user-friendly and raised difficulties in extracting data from it.

3.4.3: Decision-making and EBM operationalisation under the ISA

A great number of EBM (and correlated terminology) definitions are available in the literature. Among such definitions, several have been issued by international organisations, varying in content according to their mandates and objectives. [7] Efforts aiming to identify elements that are embedded in EBM (Arkema *et al*., 2006; CBD, 2000; Engeler, 2015; Garcia *et al*., 2003; Long *et al*., 2015; UNGA, 2006) as well as discussions related to the use of terminology (Kirkfeldt, 2019;

[6] https://www.isa.org.jm/deepdata

[7] See references from the Convention on Biological Diversity (https://www.cbd.int/ecosystem/description.shtml), OSPAR Commission (https://www.ospar.org/site/assets/files/1232/jmm_annex05_ecosystem_approach_statement.pdf), International Council Exploration for the Exploration of the Sea (https://www.ices.dk/sites/pub/Publication%20Reports/ICES%20Outreach,%20Newletters%20and%20Insights/ICES%20and%20EBM%202020.pdf) and FAO (https://www.fao.org/3/Y4470E/y4470e00.htm).

Le Tisser, 2020; Stephenson *et al*., 2021) add to the puzzle. The importance of determining a clear definition and scope for the EBM in the context of DSM is key and represents a critical step toward its operationalisation and compliance (Christiansen *et al*., 2022; Guilhon *et al*., 2020;) in order to avoid its reduction to an abstract, unspecific and jargon-limited terminology (Amon *et al*., 2022).

As EBM definition and scope remain unsettled topics including within academic literature and discussions, it is not likely neither expected from the ISA to provide a final solution to such an intricate matter. However, as the responsibility of establishing a coherent regulatory framework for DSM falls within the remit of the ISA, it is expected the organization to clarify how EBM is to be reflected and complied within its mandate. Moreover, the debate on a final text to regulate exploitation activities is a timely opportunity to include clear and assertive wording on EBM scope and expected practical implications. Importantly, to be effective, EBM should be reflected throughout the regime of the ISA, including prospecting and exploration regulations. For such, changes can be debated and accommodated during the regular reviews performed by the LTC and approved by the Council.

EBM wording should set the basis for a transversal logic to be encapsulated in all procedural steps and substance for the different stages of mining. Practically, such logic should be embedded in the process of planning, elaborating, delivering, and reviewing (if applicable) plans of work, annual reports, EIS, EMMPs, Closure Plans and REMPs (Guilhon *et al*., 2020; Guilhon *et al*., 2022; Guilhon *et al*., cap. 5). According to participants, the efforts of determining meaning for EBM under the ISA could be accomplished through different efforts, such as co-designed inter-sessional working groups, side events, policy-briefs and be largely informed, if applicable, through a guideline document.

3.4.4 Opportunities for improvement

The issue of capacity development, communication and EBM is not exclusive to the ISA context (ICES, 2016; Marshak *et al*., 2017). A suggestion to overcome such challenges includes engagement with other organisations and processes dealing with EBM as a mandate and learning from their expertise. For instance, the ISA could collaborate more closely with BBNJ ongoing discussions, which also account for EBM as one of its guiding principles and approaches (ILBI, 2022). Further, the ISA could exchange (e.g., through workshops) and collaborate with other institutions that have familiarity with the subject (e.g., CBD, OSPAR, FAO, NOAA) as reflected

in the Strategic Plan 2019-2023 (ISA, 2018; Jaeckel, 2020). In fact, such efforts could increase coherence among international treaties and instruments (Christiansen *et al*., 2022), which is desirable under the UN Decade of Ocean Science for Sustainable Development, a commitment formalised by the ISA (ISA, 2022). Issues related to the improvement of transparency and consideration of inputs from external science by the ISA have been largely acknowledged and discussed in the literature (Ardron *et al*., 2018; ISA, 2022; Amon *et al*., 2022; Craik and Gu, 2021; Christiansen *et al*., 2016; Markus and Singh, 2016; Willaert, 2020; Ginzky *et al*., 2020; Guilhon *et al*., 2020; Guilhon *et al*., 2022).

3.5 Final remarks

Different EBM views exist between ISA stakeholders, which reflect other findings presented in the literature. More prominently, principles associated with Ecological and Impacts aspects were more frequently perceived as in association with EBM. The narrative of considering the ecosystem in a holistic way does not account for human spheres beyond the concern of impacts resulting from DSM activities and their effects on marine ecosystems. As seen in other studies, the perception of human aspects such as cultural or social values, as well as humans as part of one integrated system, as part of EBM remains limited.

Considering the complexity that permeates EBM structural discussions, it is not expected of the ISA to provide a solution for this entangled question. However, as the regime assigns the concept as part of its regulatory framework, it is expected that the ISA provides enough elements to reach an understanding between stakeholders and the possibility of compliance by contractors. As a recommendation, the establishment of a task force can be of valuable contribution to boosting discussions on the theme. Such efforts could be optimised, for instance, through the establishment of closer collaboration and exchange with other international entities and experts with experience in the topic. Based on these inputs, Member States, the LTC, Observers, independent scientists, and other stakeholders can put their values and interests on the table and, together, reach a consensus among the actors on how EBM should be understood and applied within the ISA. The creation of spaces to broaden this discussion, such as initiatives on capacity development, workshops, policy briefs and side events will ensure that all the interested stakeholders will get sufficiently familiarised with EBM to reflect their expectations when a final text on the topic is discussed at the ISA.

A translation of EBM towards what it encompasses for the seabed mining regime should be a matter of major interest to the ISA and all stakeholders, especially as the mineral resources found in the Area are the common heritage of humankind, and therefore, its maintenance must be ensured to future generations. Despite being an arduous task, we echo Delacámara *et al.* (2020) that there is a need to start somewhere.

Ethics Statement

The proposal of study, together with the structure and content of the online survey and interviews, were reviewed and approved by the Research Ethics Committee - Human Beings (CEP) of the Institute of Biosciences from the University of São Paulo. Interviewees provided their written informed consent to participate in this study.

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Supplementary Materials

Online Questionnaire

1) What professional background(s) and current work position do you self-identify with? (you can select more than 1 option)
   - Natural scientist
   - Social scientist
   - Legal expert
   - Economist
   - Policy expert
   - Diplomat
   - Student
   - NGO representative
   - International organization representative
   - LTC member
   - ISA Secretariat staff
   - ISA Contractor
   - ISA Observer
   - Council delegation
   - Assembly delegation
   - Advisory role
   - National ministry or advisory body
   - Other (specify): _____

2) Can you describe, in your own words, how Ecosystem-based Management is relevant in the context of DSM in the Area?

Statement	Strongly disagree	Disagree	Somewhat disagree	Neither disagree or agree	Somewhat agree	Agree	Strongly agree
1. The ISA has provided clear description on how it intends to apply, enforce and comply with EBM, including by providing clear guidance to contractors on how to do so on a project-level.							
Comments:							
2. The maintenance of ecosystem structures and functions to protect and preserve the marine environment are a priority objective of the current ISA regulatory system.							
Comments:							
3. The potential cumulative environmental impacts caused by other sectoral uses, adjacent mining activities, or external factors (e.g. climate change) are being adequately accounted for in the development of plans of work, EIAs, monitoring programs and ISA regional							

environmental management plans (REMPs).							
Comments:							
4. The legal and regulatory framework imposed by the ISA requires contractors to address uncertainties related to mitigating the potential impacts of mining activity.							
Comments:							
5. Environmental impact/risk assessments satisfactorily integrate interdisciplinary baseline information.							
Comments:							
6. Traditional, local or indigenous knowledge is sufficiently informing discussions and negotiations at the ISA.							
Comments:							

7. There are clear procedural requirements for the acknowledgment of new scientific knowlegde in REMP and EIA processes.							
Comments:							
8. The ISA Voluntary Commitments to support the Implementation of SDG 14 reflect the organization's awareness of its responsibility to contribute to the achievement of additional SDGs as an integrated whole							
Comments:							
9. There is adequate involvement of international or sectoral organisations and regional management bodies in the development of REMPs.							
Comments:							
10. ISA stakeholder engagement and public communication strategies are adequate.							
Comments:							

11. The ISA Mining Code* reflects a clear recognition that human well-being is dependent on a healthy deep-sea.							
Comments:							
12. The Mining Code* sufficiently internalizes social, economic and environmental effects of mining activities requirements as precluded by an adaptive management							
Comments:							
13. Baseline studies and EIAs are being fed by data/information that robustly reflects the natural scale of change in the respective ecosystem both in regard to temporal and spatial extent.							
Comments:							
14. There is an adequate level of transparency in ISA work and decision-making.							

Comments:							
15. The ISA DeepData* follows best practices on transparency when sharing non-confidential data and information submitted by contractors.							
Comments:							

Open Questions

3) Apart from being mentioned as a guiding principle in the current exploitation draft, do you think EBM is sufficiently reflected in the current seabed mining regime administered by the ISA? If yes, how? If no, why not? If you prefer, you can distinguish between exploration and future exploitation.

4) Please suggest how to improve implementation of EBM in the developing seabed mining regime of the ISA.

5) Is there any additional feedback you would like to provide us with?

Semi structured in-depth expert interview: interview guideline

1. Can you give a brief description of what you consider to be EBM? *(Can you think of words/ components that come to mind when thinking of EBM?)*
2. In what context of ISA/ISA-related work did you come across the EBM concept? *(Can you give 2 or 3 examples where you recognise it?)*
3. Where do you see it being put into practise? *(Do you see the EBM concept linked to specific instruments or concrete tools that will help implement it? How is EBM implementation ensured? Do you see any instruments/ tools or any other examples that would suggest that these principles are being put into practice?)*
4. Do you think there is a common understanding of EBM across the various stakeholders and relevant actors at the ISA? *(Do you think different actors/ stakeholders are having different opinions on what comprises EBM?)*
    a) yes
        i. Is there any stakeholder groups that share a similar idea of EBM?
        ii. What is the common ground of their understanding?
        iii. Do you see this particular common understanding having an impact in the ISA decision-making/ enforcement? *(consensus on documents, ...)*
    b) no
        i. Do you think this will have an impact on the ISA decision-making/ enforcement?
        ii. Do you think this (the lack of a common understanding) could negatively affect the implementation of EBM?
5. Do you have any specific recommendations as to what you would like to see changed with respect to the implementation of EBM in the ISA? Or where you see potential to improve? *(structure/ content of regulations, governance regime)*
        i. Can you identify responsible parties?
6. Do you think having a clear concept of EBM would be important?

Table 3. Excerpts from quotes based on participants' responses relied upon in determining the categories and correspondent EBM classification.

General categories of EBM principles	Category	Definition	Quotes
Core	Sustainability	Relevant to the sustainability of natural, mineral resources or activities	"*Balance (...) to achieve* ***sustainable use of mineral resources***"; "*I think this is a basis for the* ***sustainable management of marine resources***"
Ecological	Holistic	Consideration of a holistic approach towards the ecosystem/ecosystem as a whole	"*(...), I would understand it as a* ***holistic management approach***"; "*It's* ***management of the entire ecosystem*** *(...)*"
	Interconnections	Acknowledgement of the existing interconnections between/within ecosystem units	" *(...) needs to take into consideration that* ***everything is interconnected*** *(...)*"; "*So that's not just one species, or one community of species that´s* ***everything from microbes through to whales***"
	Environmental protection	Strategy to guarantee/ensure the protection of the marine environment	"*Ecosystem-based management is important in the context of DSM to* ***ensure effective protection for the marine environment*** *from harmful effects, as required under UNCLOS*"; "*It's highly important for the* ***protection of marine environment***"
	Ecosystem management	Focus on the management of natural systems and/or ecosystems	" *(...) management takes into account* ***broader ecosystem matters*** *such as effects of the plumes on the marine environment (...)*"; *"****It's management of the entire ecosystem****, and that means taking into account everything from, at a species level all the way up to incorporating, for instance, the functions and the services that the ecosystem provides (...)"*

Impacts	Cumulative impacts	Acknowledgement/accounting/management/assessment of cumulative impacts	"*So you don't look only at **cumulative effects** between deep sea mining, fisheries and other activities but also background such as climate change*"; "*It is important that takes into account **all [these] different and varied impacts** when trying to figure out a sensible management approach*"
	Broad impacts	Impacts and effects from DSM and other activities should be broadly considered. (in terms of processes, structure and functions of ecosystems	"*(...) an ecosystem based approach would be to put that into the bigger context and **look at the implications of it on a wider scale** (...)*"; "*(...) it needs to take into consideration the **broader effects** that that might have on the wider, the system function*"
	Impact scales	Impacts should be considered in a wider scales of space (neighbouring areas/region)	"*(...) management takes into account broader ecosystem matters such as **effects** of the plumes on the marine environment, **from the benthic organisms all the way up to the surface potentially** (…)*"; "*(...) where there is a need to consider multiple **contractor operations** across a **regional scale** of ecosystem structure and function (...)*"
	Activities management	Management of human uses/deep-sea mining activities	"*(...) **a management approach to activities**, which focuses on the ecosystem as a whole and integrating different aspects of the ecosystem (...)*"; "*it is only logical that any regulation and **management of marine activities** must follow EBM*"
Knowledge	Knowledge gaps	Limitated knowledge on baseline data, ecosystem processes and DSM impacts	"*We do **not yet understand** how impacts in mining areas will affect the broader ecosystems*"; "*There are **species we are only just discovering** in the seabed which is critical to understand as a baseline before mining begins"*

	Science-based	Management based on scientific knowledge	*"an objective and **science-based approach** makes it particularly suited to be used in the Area";* *"The current box-shape protection areas are not fit for purpose and **policy driven rather than science driven***"
Management	Collaboration	Importance of collaborating or coordinating efforts with other organisations/sectors	*" (...) this needs to be done in **cooperation with other competent organisations***"; "*(...) they need not to consider only DSM in silos, but to **foresee effective and efficient coordination with other activities***"
Socio-economic	Human dimension	Consideration of humans as an integral part of the ecosystem	"*I think (...) part of the ecosystem based approach is **factoring humans***"; "*So not just focusing on discrete or specific environmental elements or factors,(...), but also considering possible economic, social or cultural elements, **in other words human elements***"
Scales	Spatial scales	Reference to spatial scales as part of management strategy	"*Here, EBM is about articulating **scales from local to mesoscale***"; "*Balance ecological, social and governance principles on appropriate **spatial** and temporal **scales***"

4. REVISITING THE ASSESSMENT OF ENVIRONMENTAL IMPACTS ARISING FROM DEEP SEABED MINING IN THE AREA: REGULATORY REQUIREMENTS AND SHORTCOMINGS IN CURRENT PRACTICES AT THE INTERNATIONAL SEABED AUTHORITY (CHAPTER 3)

MANUSCRIPT PUBLISHED ON THE JOURNAL ENVIRONMENTAL IMPACT ASSESSMENT REVIEW

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Abstract

More than five decades ago, Environment Impact Assessment (EIA) emerged in domestic legislation as a tool to respond to increased human pressures on the natural realm. Although the theory and practice of conducting EIAs have evolved over the years, several shortcomings for an effective implementation remain, hampering it from consolidating as a tool to promote Ecosystem-based Management (EBM). The challenges undermining an effective implementation of EIAs are magnified when considered under the scope of offshore extractive activities taking place in areas beyond national jurisdiction, such as deep seabed mining (DSM) on the international seabed (or 'the Area'), which is governed by an international organization known as the International Seabed Authority (ISA). DSM activities are anticipated to cause extensive environmental harm, which may compromise the still poorly understood processes, functions, and services in the deep ocean. Since its inception, the ISA has taken measures to address the assessment of environmental impacts arising from DSM activities at the various stages of the mining process, which range from prospecting, exploration, and future exploitation. Nevertheless, a detailed description of the

procedures to assess impacts at different stages of mining is absent in the literature, remaining a puzzled topic. This paper seeks to clarify the ISA's procedural framework for the assessment of environmental impacts arising from the different mining stages and reveals that its current practices do not represent a comprehensive, transparent, or participative EIA process that conforms with EBM. Consequently, the ISA's existing approach to the EIA process and its potential to support informed decision-making is doubtful. Based on the identified shortcomings, this paper provides some recommendations for improvement of EIA practices at the ISA.

Key words: Environmental Impact Assessment, Environmental Impact Statement, Ecosystem-based Management, seabed minerals, International Seabed Authority.

4.1 Introduction

Following the increase of harm to the environment caused by human activities, Environmental Impact Assessments (EIAs) were first required as a formal procedure within the US National Environmental Policy Act of 1969. In more than 5 decades, the practice of conducting EIAs has been undergoing changes and has evolved from a purely environmental-centred dimension to a more integrative, precautionary, and participative process (Glasson and Therivel, 2019). Such changes are reflected, for example, by the inclusion of the social component in the current definition provided by the International Association for Impact Assessment (IAIA, 1999): "*the process of identifying, predicting, evaluating and mitigating the biophysical, social and other relevant effects of development proposals prior to major decisions being taken and commitments made*".

The conduct of EIAs facilitates informed decision-making as it provides information on the potential environmental impacts that may result from the carrying out of a certain activity, identifies the available alternatives, and can help balance interests from the proponent, regulatory organization, society and other stakeholders. Although EIAs are known as an important practice to help guiding decision-makers on whether or not an activity should be permitted, many practice-related issues may arise, even in well-consolidated industries such as offshore exploration of oil and gas (Ellis *et al*., 2017; Barker and Jones, 2013). In general, the literature on EIA has focused on procedural issues associated with effectiveness, e.g., low quality information, weak participation, lack or limited assessment methods and little incentive for auditing (Glasson and

Therivel, 2019), and have included the perspectives from researchers and regulators (Nita *et al*., 2022; Singh *et al*., 2020; Roos *et al*., 2020). Less attention, however, has been dedicated to reflecting upon how EIA can influence decision processes (Bartlett and Kurian, 1999). Cashmore (2004) argued that a lack in discussing substantive outcomes of EIA may be related to repercussions to individuals (or organizations), but also due to a wide recognition of EIA as a practical tool. The theory on EIA is rooted in implicit operational models, each one comprising of certain assumptions, including those proposed by Bartlett and Kurian (1999): the information process, the symbolic politics, the political economy, the organisational politics, the pluralist and the institutionalist model. Further, Cashmore (2004) discussed the advancement of the theory on the role of science in EIA, proposing models within the paradigms of EIA, as applied or civic science. A transformation on how EIAs are currently understood, developed, evaluated and implemented is arguably needed (Doelle and Sander, 2020). The present study, however, does not intend to engage with EIA theory but rather seeks to explore the practicalities in the context of deep seabed mining (DSM).

Within national jurisdiction, EIAs typically relate to the prior assessment of effects of individual sectoral projects where the technology, its operations and the general expected environmental impacts are broadly known to the national regulator, but an in-depth study is needed to better understand the specific impacts that are expected to occur if the planned project is allowed to take place (Glasson and Therivel, 2019). To this end, the practice of requiring EIAs within domestic legal systems has been well developed over the years, whereby prior EIAs feature as an integral part of the decision-making processes under public administrative law. In contrast, EIAs are not very comprehensively addressed in areas beyond national jurisdiction (ABNJ), which consists of the Area and the High Seas.

In seabed areas beyond the limits of national jurisdiction, also known as the Area, all mineral resources are the common heritage of mankind and access to these resources are regulated by the International Seabed Authority (ISA), an international organization established and mandated under the United Nations Convention on the Law of the Sea 1982 (UNCLOS). As part of its mandate to develop rules, regulations and procedures for the exploration and exploitation of the mineral resources of the Area, the ISA bears significant environmental responsibilities to ensure the effective protection of the marine environment from the harmful effects of mining activities (UNCLOS, Article 145). As will be further explored in this paper, such responsibilities include the

obligation to require and regulate the assessment of environmental impacts across the various stages of mining activities.

A separate regime exists for the High Seas, i.e., the surface and water column in ABNJ. Here, the freedom of the high seas apply and the conduct or implementation of EIAs is currently weak due to the lack of legally-binding requirements, compliance and enforcement mechanisms (Druel, 2013; Warner, 2014). Other shortcomings of EIA in ABNJ include the lack of globally applicable criteria to be employed, and the limited capabilities of institutional frameworks in this region (Ma *et al*., 2016). That said, the currently ongoing negotiations to develop an internationally legally binding instrument on the conservation and sustainable use of biodiversity in areas beyond national jurisdiction (or BBNJ) provides some optimism in this respect, since EIAs have been identified as one of the four key pillars that this forthcoming instrument is expected to address (UNGA, 2018).[8]

In contrast with other management instruments (such as Strategic Environmental Assessments), EIA practices are typically project-specific and therefore limited in considering broader policy-level factors, such as environmental and sustainable goals and aspects such as cumulative and long-term effects impacts (Craik and Gu, 2021). Nevertheless, prior EIA of individual projects are considered essential for implementing a precautionary, ecosystem-based management (EBM) (Clark et al., 2020; Laffoley *et al*., 2004; Warner, 2020; Wawrzyczek *et al*., 2018). McLeod et al., (2005) define EBM as "*an integrated approach to management that considers the entire ecosystem, including humans*." To reflect EBM, a robust data synthesis and evaluation should encompass environmental parameters, components of biological communities and the environment, assessment of ecosystem functions (i.e., trophical linkages, energy flow, community relationships) and ecosystem services (Clark *et al*., 2020). In addition, EBM considers humans and all forms of human interactions with the environment to be of major importance and seeks to include this human dimension into governance and management arrangements (Guilhon *et al*., 2020). In an EIA in line with EBM, baseline information on social, economic, and cultural aspects should be provided and evaluated against risks for potential effects arising from the activity proposed on ecosystem functions and services, including in terms of cumulative effects (Turra *et*

[8] It is important to note that the assessment of all environmental impacts cause by mining-related activities in the Area will be governed by rules, regulations and procedures adopted by the ISA and not the forthcoming BBNJ instrument (although both the ISA regime and the forthcoming BBNJ regime should seek to ensure coherence with each other).

al., 2017). Yet, in line with EBM, EIAs should safeguard transparency in information and ensure the involvement of all relevant stakeholders throughout the process (Andrade and Turra, 2021; Durden *et al*., 2018; Guilhon *et al*., 2020). The adoption of such an approach can bring robustness to the EIA process (Andrade and Turra, 2021) while reducing the chances of unexpected challenges and future judicial issues (Turra *et al*., 2017).

In instances where the EIA process is based upon poor-quality information (Pope et al., 2013), its outcome only functions in theory, rather than as an effective management measure that would, in practice, safeguard the marine environment. In this aspect, the mere conduct of an EIA and delivery of an Environmental Impact Statement (EIS) *per se* should not be considered as an application of EBM. Instead, requirements reflecting EBM should be clearly stated in order to effectively provide the pathway for its implementation (Guilhon *et al.*, 2020). The planning and development of the objectives, procedure, and content of EIAs, and consequently, the EIS, towards environmentally sustainable levels under an effective regulatory practice (Morrison-Saunders *et al.*, 2014; Sinclair *et al*., 2017) should therefore be carefully considered, to reflect a concrete and effective EBM implementation.

Since its inception, the ISA has taken measures to address the assessment of environmental impacts arising from DSM activities at the various stages of the mining process as part of its responsibility under Article 145 of UNCLOS. Through a comparative analysis of eleven EIA systems and following the core stages of the process, Craik and Gu (2021) insightfully reflected on EIA for DSM, posing valuable recommendations to improve the process regulated by the ISA. Nevertheless, a step-by-step clarification and reflection on the assessment of environmental impacts throughout the different stages of the DSM process remains absent in the literature, and the subject remains a puzzled topic. Disentangling the subject and critically analysing the requirements and shortcomings in current practices could, in fact, help to guide next steps towards a more comprehensive and robust EIA process, which should strongly reflect on giving effect to the relevant EBM principles in the context of DSM (as discussed elsewhere in Guilhon *et al*., 2020). In this context, this paper seeks to describe the current practices of the ISA and critically examine, based on the literature and expertise of the authors, how the assessment of environmental impacts is regulated throughout the various stages of the mining process, as well as to provide some recommendations for improvement.

4.2 Assessment of environmental impacts which may arise from DSM activities in the Area

The protection of the marine environment, both in areas within national jurisdiction and in ABNJ, is a legal obligation required of all States and relevant intergovernmental organizations as per Part XII of UNCLOS. In particular, when there are reasonable grounds to believe that "*planned activities under their jurisdiction or control may cause substantial pollution or significant and harmful changes to the marine environment*", States are obliged to assess the potential effects of the planned activity on the marine environment and publish the respective reports (UNCLOS, Article 206). However, UNCLOS does not provide any explicit requirements to further elaborate on how such assessments should be conducted and what should be their content. Thus, the precise implications of Article 206 are uncertain (Oude Elferink, 2012), although, as things currently stand, it would appear to be largely at the discretion of each State, according to its own capabilities and requirements under domestic legislation, to determine how to conduct such assessments and what these should contain (Craik, 2008). To this end, the risks or effects of pollution on the marine environment have to be observed, measured, evaluated and analysed (UNCLOS, Article 204), as well as published and made available to the competent international organizations and all States (UNCLOS, Article 205). Additionally, EIAs are recognized as key components to ensuring effective protection of the marine environment (Billett et al., 2019), which converges with the obligation of the ISA to take necessary measures to ensure the effective protection of the marine environment from the harmful effects which may arise from DSM activities (UNCLOS, Article 145).

Mining of polymetallic nodules, seafloor massive sulphides and cobalt-rich crusts, organized and controlled by the ISA in ABNJ, occur in habitats such as abyssal plains, hydrothermal vents and seamounts, respectively, and are located in deep, remote, vulnerable and largely undisturbed areas of the ocean (Levin *et al*., 2020). In general, these habitats house a vast amount of biodiversity adapted to conditions of high pressure, limited availability of food, darkness, and characterized by limited reproduction, long life cycles (Danovaro *et al*., 2017), and thus, slow recovery from disturbances (Vanreusel *et al*., 2016; Vonnahme *et al*., 2020). Although general commonalities exist between deep-sea habitats, the environmental parameters and ecological dynamics within them are quite specific (Ramirez-Llodra *et al*., 2010), and DSM-related activities and management measures must account for such specificities. Due to technological and access constraints, many gaps in knowledge and uncertainties remain with respect to the occurrence

of biodiversity, processes and functioning of deep ocean ecosystems (Koschinsky *et al*., 2018; Smith *et al*., 2020; Washburn *et al*., 2019). The extent of the anticipated environmental harm from DSM activities in the Area include loss of biodiversity, sublethal effects of vibration, pollution by light, noise and contaminants as well as the effects of presumably extensive and long-lasting sediment-plumes (Levin *et al*., 2020; Miller *et al.*, 2018; Niner *et al*., 2018). As the ocean is an interconnected realm, impacts are also expected to reach overlying waters, compromising pelagic and benthopelagic biota, processes, and services (Christiansen *et al.*, 2020; Drazen *et al*., 2020). Due to the wide range of risks, DSM activities should be subjected to comprehensive assessments and permitting processes so as to ensure that the environmental impacts expected to follow from future commercial operations are understood and limited to a degree that is compatible with applicable environmental thresholds as well as protection and conservation goals. Consequently, as a guardian of the common heritage of humankind, the ISA has to make sure that the potential economic benefits from enabling DSM are not outweighed by the loss of natural capital, impairment of ecosystem services and other environmental costs that are to be borne by present and future generations (Thiele *et al*., 2021).

The ISA comprises all contracting parties to UNCLOS (i.e., 167 Member States and the European Union). As part of its mandate, the ISA is to develop the mineral resources of the Area on behalf of humankind as a whole while ensuring the effective protection of the marine environment from the harmful effects of mining activities. The organization is comprised of three main bodies: the Legal and Technical Commission (LTC), the Council and the Assembly. The LTC, a subsidiary organ of the Council currently comprising 30 individual experts, is established to provide recommendations to the Council (UNCLOS, 1982 - Articles 163 and 165) and attend its instructions. The Council is the executive organ of the ISA, comprising 36 member States elected for four-year terms by and from among the member States of the Assembly (UNCLOS, 1982 - Articles 161.3 and 162.1; 1994 Agreement - Section 3.15) Finally, consisting of all State parties to UNCLOS, the Assembly is the supreme organ of the ISA (UNCLOS, 1982 - Articles 160.1 and 156.2) that provides the final approval of recommendations from the LTC and regulations approved provisionally by the Council (UNCLOS, 1982 – Article 162.2.o.ii).

In addition, the ISA is expected to design an equitable benefit sharing mechanism for the distribution of its financial revenues. In this respect, the ISA is a unique international organization in that it also serves as a regulator (for DSM in the Area) with the power to approve (or reject)

mining applications made by Member States or state-owned entities and private actors sponsored by Member States. The latter, being non-state actors (and thus, not subjected to international law), also add to the uniqueness of the ISA as they are able to hold contracts with the ISA and conduct mining operations through sponsorship of an appropriate Member State. While the contractor is responsible to meet its contractual obligations and remains the primary actor that is accountable for environmental harm (which can be enforced against it through the domestic legal system of the sponsoring State), sponsoring States may also be exposed to liability for environmental harm under international law under certain circumstances. In that aspect, whether the standards adopted by the ISA are also applicable by national jurisdictions due to provisions contained UNCLOS is a contentious matter. According to the text contained in Articles 208 and 209, laws, regulations and measures to prevent, reduce and control pollution of the marine environment that shall not be less effective than international rules. This may lead to an ambiguous understanding that the ISA will set the minimal standards (including for EIAs) that should be meet by States. This remains an open debate, as the ISA only regulates activities taking place in the Area, and due to issues related to the capacity of all States to comply with such standards. Nevertheless, discussions taking place at the ISA can certainly play an important role in informing the development of regulatory regimes within national jurisdictions.

The obligation to conduct EIAs prior to the conduct of certain DSM activities in the Area was clarified in an Advisory Opinion delivered by the Seabed Dispute Chamber of the International Tribunal for the Law of the Sea in 2011 (ITLOS, 2011). To support its findings relating to environmental impact assessments for DSM activities, the Chamber relied on an earlier decision by the International Court of Justice (ICJ) in the *Pulp Mills on the River Uruguay* case, in which the ICJ observed that conducting prior EIAs may be considered as a requirement under general international law where there is a risk that the proposed activity may have significant adverse impacts in a transboundary context (ICJ, 2010). In the 2011 Advisory Opinion, the Seabed Disputes Chamber opined that prior EIAs for certain DSM activities should be considered an obligation not only under UNCLOS but also under customary international law, although it did not elaborate on the content or substance of such EIAs (ITLOS, 2011). The Seabed Disputes Chamber went on to observe that the obligation to conduct EIAs, where required, is a direct obligation of sponsoring States, i.e., States that agree to sponsor state-owned enterprises or private entities to conduct mineral exploration or future exploitation in the Area, which means that the failure to ensure that

a satisfactory EIA process has been undertaken could expose the sponsoring State to liability under international law (ITLOS, 2011). In practice, the direct obligation of sponsoring States to conduct EIAs can be fulfilled by requiring and ensuring that the sponsored entity carries out such assessments in accordance with the requirements laid down by the ISA as well as in compliance with any national laws of the sponsoring State.

Despite the ISA regulation efforts, numerous flaws and shortcomings relating to impact assessment have been highlighted in the literature. Generally, existing publications cover aspects related to EIAs conceptual structure or procedural steps (Bradley and Swaddling, 2018; Durden *et al*., 2018; Ellis *et al*., 2017; Lallier and Maes, 2016), while others provide more emphasis on the general content of EIAs, such as scientific information and data to be incorporated into the EIS (Bräger *et al*., 2018; Clark *et al*., 2020). However, none of them clarifies when to conduct the assessment of environmental impacts arising from DSM activities in the Area, nor the regulatory requirements for impact evaluation in each of the mining stages.

Generally speaking, DSM activities in the Area comprise various stages, which broadly range from prospecting, exploration, and exploitation (which can be further subdivided into pre-commercial production and commercial production).[9] Given that the environmental implications pertaining to the assessment of environmental impacts tend to differ across the various stages, it is necessary to consider the applicable ISA requirements in the order that correspond and apply to the various stages of the process, as well as to reflect on how the status quo can be improved. These will be addressed next.

4.2.1 Prospecting: no obligation for prior assessment of impacts

In general terms, prospecting refers to the search for mineral deposits at strategic locations in order to determine abundance and extraction feasibility. At the prospecting stage, interested parties study the opportunities for future resource exploitation but without exclusive rights. No prior contract from the ISA is needed, although the subject of prospecting is generally covered under existing Exploration Regulations for all three mineral deposits in the Area (ISA, 2010, 2012,

[9] In addition to the above, there is also a post-exploitation or closure stage of DSM where all commercial mining activities in the contract area have ceased. It is to be noted that upon the closure of mine sites, adherence to a closure plan and post-closure environmental monitoring is still necessary in order to ensure that actual long-term impacts are measured and contained by using all necessary means (Van Nijen et al., 2018).

2013). In practice, a potential prospector is required to notify the ISA of its intention to engage in prospecting activities in the Area. Such notification should contain the coordinates for the broad area that will be prospected as well as a general description of the prospecting activities (such as the details of the prospector as well as proposed dates and duration for prospecting). Upon receiving such notification, the ISA Secretary-General shall determine whether the notification meets formal requirements as well as to ascertain whether an existing contract exists for the areas that are intended for prospecting activities. Prospecting is not allowed for the same mineral type in areas where an ISA contract exists. As such, prospecting activities are not subjected to a formal approval process at the ISA unlike exploration and exploitation activities, as will be discussed shortly.

4.2.1.1 Current practice at the ISA

While prospectors are under obligation to take steps to minimize or eliminate adverse environmental impacts from prospecting applying a precautionary approach and best environmental practices, the conduct of prospecting activities do not require an EIA and submission of an EIS. Moreover, in order to move to the next stage, i.e., exploration, proponents have to submit an application to the ISA. If approved, the application would result in the execution of a contract with ISA, through which the contractor acquires the exclusive right to explore the contract area(s) for a particular resource type for a period of 15 years. It should be noted that prospecting is discretionary under UNCLOS (i.e., not a strict requirement or precondition in order to apply for an exploitation contract), although the knowledge gathered from the prior conduct of prospecting activities would obviously be useful in terms of assuring a successful application process for an exploration contract. In this respect, the prospecting regime at the ISA appears to have been underutilised to date, generally being carried out under the guise of independent marine scientific research (and thus, falling largely outside the regulatory reach of the ISA until an exploration application is eventually submitted).

4.2.1.2 Recommendations for improvement

It is generally accepted that prospecting activities, like exploration activities for the most part, will not cause significant harm to the marine environment. However, the Exploration Regulations could be revised to draw a distinction between the conduct of marine scientific research and prospecting activities to clarify in what cases the conduct of independent scientific

research qualifies as prospecting, and to insist that proper notification is given to the ISA in the case of the latter. That said, there is a possibility that such a notification might prompt other interested parties to submit an application for the approval of a plan of work for exploration covering the same area. Consequently, there should be regulatory safeguards to ensure that prospectors that have submitted a notification to the ISA over a certain area are given preference over others with respect to the submission of an exploration application.

More importantly, as to improve surveillance on activities, the Exploration Regulations should require applicants to establish time frames to prospecting activities (including to specify maximum durations allowed for prospecting in any given area), and, in cases where there is willingness to proceed further, prospectors should submit an exploration application. Additionally, it may be worth considering if prospectors should be required to provide financial guarantees to the ISA if sampling activities are undertaken, for instance where certain geophysical methods or dredging techniques are deployed, which could cause environmental harm depending on their intensity, duration and frequency. Such activities should also be subject to a preliminary assessment of environmental impacts, like in the case of an application for an exploration contract, which will be discussed next.

4.2.2. Prior to exploration: preliminary assessment of environmental impacts

As mentioned earlier, an application for an exploration plan of work that has been approved by the ISA will take the form of an exploration contract where the contractor would acquire the exclusive right to explore the contract area(s) for a particular resource type for a period of 15 years (which can be extended upon request). Exploration contractors have certain rights and interests on one hand, as well as responsibilities and obligations on the other. As such, a formal approval process is put in place and the requirement of sponsorship from an appropriate Member State is mandatory for state-owned enterprises and other private actors wishing to conduct exploration activities.

4.2.2.1 Current practice at the ISA

When applying for an exploration contract, applicants are required to submit "*a preliminary assessment of the possible impact of the proposed exploration activities on the marine environment"* within their first 5-year plan of work (ISA, 2010, 2012, 2013). Little is known on

whether (and in which form) this requirement is met, as the respective documents submitted to the responsible ISA organ for consideration, the Legal and Technical Commission (LTC), are treated as confidential. Indeed, in the absence of clear guidance and a model template, it is entirely plausible that such a preliminary assessment could merely consist of statements of a very general and unspecific nature. If the ISA, in particular the Council (acting based on the recommendation of the LTC) decide to approve the application of the plan of work for exploration, an exploration contract would be negotiated and awarded to the applicant, which only then can initiate exploration activities.

4.2.2.2 Recommendations for improvement

It is suggested that the ISA revises the Exploration Regulations, or alternatively, directs the LTC to issue recommendations that provide more clarity on how to conduct, and the expected contents of, "a preliminary assessment of the possible impact of the proposed exploration activities on the marine environment". Ideally, this should include the provision of guidelines and a model template for applicants to meet to ensure a level playing field. Moreover, while the requirement of a preliminary impact assessment may be adequate to guide the first phases of a more comprehensive and holistic EIA, e.g., in view of certain unexpected effects of exploration activities (Nakajima *et al*., 2015), there is neither any strong evidence in practice on the usage of such a document as part of a process to guide the activities of the contractor during the following 5-year plan-of-work and first review (which should take place each five years according to the Exploration Regulations), nor of its application in the subsequent steps of assessing impacts of exploration activities. It is noted that the Chair of the LTC presents a report to the Council of the ISA each year underlining the progress made by exploration contractors in terms of environmental baseline studies and other exploratory activities (that contractors are required to provide in their annual reports to the ISA, which are not publicly released). However, these documents are entirely formal and do not inform the Council on the details of contractors and deficiencies in their reporting. Therefore, the Council does not have the means to make informed decisions or apply any pressure on contractors in cases where contractors have not followed their respective 5-year plan-of-work or failed to provide adequate information in this respect. Indeed, the Council has not taken any notable measures to address the poor performance or direct non-compliance of contractors thus far.

More importantly, such a "preliminary assessment of the possible impact of the proposed exploration activities on the marine environment", as the name suggests, should not be confused with the conduct of an actual EIA process. The former, though not defined in the Exploration Regulations, appears to only involve a brief or general statement concerning potential effects of the activities, whereas the latter involves a lengthy and comprehensive process, which will be discussed below. In other words, the Exploration Regulations do not require prospective applicants to conduct an EIA and submit an EIS together with its application for the approval of a plan of work for exploration to the ISA. The requirements to conduct an EIA and submit an EIS with its exploration application. These will be discussed next.

4.2.3 During exploration: assessment of environmental impacts of certain activities

As explained above, exploration activities are governed by the relevant Exploration Regulations adopted by the ISA. Additionally, from an environmental perspective, the "Recommendations for the guidance of contractors for the assessment of the possible environmental impacts arising from exploration for marine minerals in the Area" (ISA, 2020a) issued by the LTC (hereinafter referred to as 'LTC Recommendations') would apply as well. Generally, most exploration activities are not expected to have the potential to cause significant harm to the marine environment (Lodge and Verlaan, 2018). However, the LTC Recommendations establishes a list of activities that may be conducted during the exploration stage, including e.g., test mining activities, which could cause significant environmental harm, and thus, would require the planning and conduct of an EIA. Indeed, current scientific knowledge indicates that substantial impacts to biotic communities may result from test mining activities involving the testing of equipment or systems that are conducted during the exploration stage (Gollner *et al*., 2017; Jones *et al*., 2017; Vanreusel *et al*., 2016). Therefore, assessing and evaluating the extent of impacts during exploration, through a proper EIA process, is critical.

4.2.3.1 Current practice at the ISA

During exploration, contractors have the option to undertake testing of equipment and systems at any scale so long as these do not constitute a commercial operation, i.e., with a limited temporal and spatial extent. Although the conduct of test mining during the exploration phase is

optional, it has been proposed that the ISA requires at least some form of compulsory test mining already at the exploration phase in order to better ascertain the environmental impacts that will arise from DSM activities (which will enable the ISA to set appropriate environmental thresholds and standards) and the ability of operators to address and manage these impacts (which will allow the ISA to make more informed decisions when considering a subsequent application for exploitation) (ISA, 2019a; Singh, 2021). Pursuant to the LTC Recommendations, at least 12 months before the plan to conduct any exploration activity categorized by the ISA as having potential to cause significant harm to the marine environment, an exploration contractor intending to conduct any of such activities has to submit an Environmental Impact Statement[10] (EIS) (ISA, 2020a - part VI, B). Although LTC Recommendations are non-binding documents, contractors are expected to comply with its requirements to the best of their abilities (Lodge, 2015; Markus and Singh, 2016).

With regards to the exact requirements, the LTC Recommendations can be rather confusing since it does not clearly differentiate between an EIA and an EIS. For instance, the section that lists the activities which require the elaboration of EIS in the LTC Recommendations[11] is titled "Activities requiring environmental impact assessments during exploration", and paragraph 33 also mentions the need for an environment impact assessment in addition to a monitoring plan. Without any additional clarifications, however, the term "environmental impact statement" appears for the first time in paragraph 34, throughout section E (EIS reviewing process), and in Annex III (EIS template). Consequently, it is not clear if and how the ISA differentiates between an EIA and EIS at the exploration stage.[12]

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[10] As of January 2022, four EISs have been submitted by exploration contractors to the ISA. The first two were delivered in 2018 by Global Sea Mineral Resources (GSR, 2018), sponsored by Belgium, and the Institute for Geosciences and Natural Resources (BGR, 2018), sponsored by Germany. Both contractors submitted an EIS to evaluate the locomotion and collection performance of a pre-prototype vehicle for the collection of polymetallic nodules in their respective contract areas in the Clarion-Clipperton Zone, in eastern Pacific Ocean. In 2020, the Government of India, through the Ministry of Earth Sciences (MoES), submitted an EIS for the testing of its nodule collector in the contract area located in the Central Indian Ocean Basin (MoES, 2020). Most recently, the Government of the Republic of Nauru and its sponsored entity, Nauru Ocean Resources Inc. initiated a consultation process on an EIS for testing the prototype of a nodule collector (NORI, 2021).

[11] The said LTC Recommendations was first issued by the LTC in 2013 (see ISBA/19/LTC/8). After an extensive review process (see ISBA/25/C/19 – para. 16 to 18), the document was replaced by ISBA/25/LTC/6/Rev.1 and ISBA/25/LTC/6/Rev.1/Corr.1 adopted by the LTC in 2019.

[12] This matter is also pertinent for the next stage, i.e., when applying for an exploitation contract, which will be discussed later.

According to the LTC Recommendation, "*documenting natural conditions prior to test-mining or testing of mining components are essential to monitor changes resulting from these activities (…)*" (ISA, 2020a - Recommendation 14) to "*ensure that no serious harm is caused to the marine environment from activities (…)*" (ISA, 2020a - para 11.b). More specifically, a monitoring programme is expected *during and after the test of mining activities* (ISA, 2020a – para 11.c), although no further details are given, such as on the selection of monitoring variables or the monitoring period prior and after testing. Contractors are only required to provide the ISA with a description of the status of a regional and local environmental baseline (ISA, 2020a - Recommendation 38.q) and to delineate an impact reference zone (IRZ or test site) and a preservation reference zone (PRZ or control site) (ISA, 2020a - Recommendation 38.o). In the absence of specific rules, the LTC Recommendations indicate that the IRZ "*should be the site where the test-mining and related direct impacts are to occur*" and the PRZ "*should be carefully located and far enough away to not be affected by testing activities (…)*" (ISA, 2020a - Recommendation 38.o). Moreover, PRZs "*will be important in identifying natural variations in environmental conditions against which impacts of the mining tests will be assessed*" (ISA, 2020a - Recommendation 38.o).

Once an EIS is submitted to the ISA (ISA, 2020a – para 41.a), it will be checked by the Secretary General (ISA, 2020a - para 41.b) for completeness against the template established by the ISA (ISA, 2020a – Annex III). If the submission is incomplete, the Secretary General will contact the contractor to seek additional information, which should be provided within 30 days, although a request of a reasonable extension is possible (ISA, 2020a - para 41.b). Following this, the LTC will initiate the review of the EIS for "*completeness, accuracy and statistical reliability*" (ISA, 2020a – para 41.c). In the event the EIS has not been subjected to public consultation, the LTC (through the ISA Secretary General) may encourage the sponsoring State to require the conduct of such consultation by the contractor or to conduct such consultation itself (ISA, 2020b – para 41.d). In the event the sponsoring State decides to conduct stakeholder consultation, the LTC (through the Secretary General) may request the sponsoring State to forward all comments submitted by stakeholders. This will then be passed on to the contractor, while any available information concerning such stakeholder consultation will be published on the ISA website (ISA, 2020a – para 41.d). However, if the sponsoring State does not intend to conduct or require the conduct of stakeholder consultation, the EIS will be published on the ISA website for public

comments for 30 days (ISA, 2020a – para 41.e). Thereafter, all stakeholder comments received by the Secretariat and LTC comments from the initial review will be transmitted to the contractor (ISA, 2020a – para 41.f), who is then expected to provide a response within 60 days (ISA, 2020a – para 41.g). Premised on this, the LTC will then continue to finalize its review and provide its recommendations to the Secretary General if the EIS should be incorporated into the programme of activities under the contract (ISA, 2020a – para. 41.h). If the LTC does not recommend the incorporation of the EIS into the programme of activities, the contractor has 30 days to provide additional information, or alternatively, to revise and resubmit the EIS (ISA, 2020a – para. 41.i). However, the LTC Recommendations are silent on what happens next, including an omission to stipulate that contractors may not proceed with the test mining activity until the EIS is incorporated into the programme of activities. This theme will be further discussed below. The complete process for impact assessment during exploration is summarized in Figure 1.

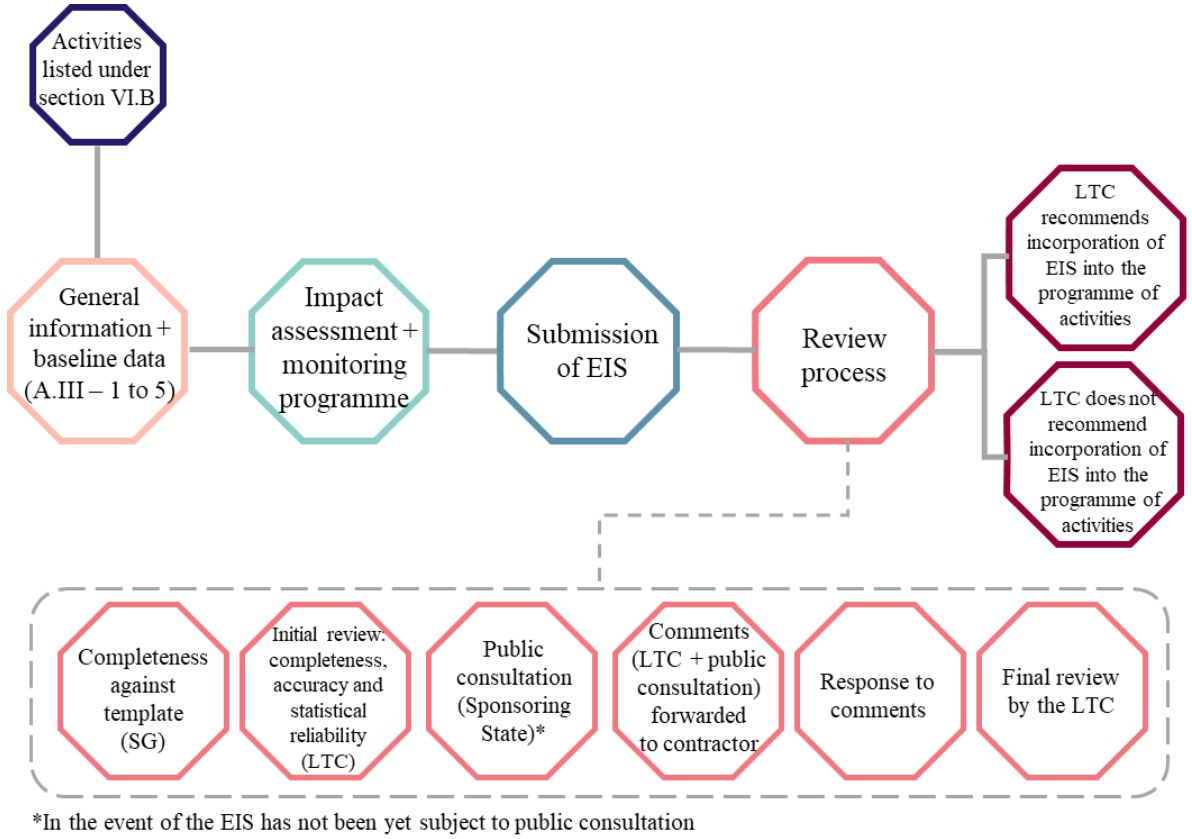

Figure 1. Steps comprising the assessment of environmental impacts during exploration activities according to ISBA/25/LTC/6/Rev.1 (A. = Annex; i. = item). For exploration, no screening nor scoping phases are required by the ISA, instead the need of elaborating an EIS and its content are based on a list of activities "with potential to cause serious harm" (dark blue hexagon) and a data checklist (rose hexagon). As part of the EIS, a monitoring program should be present (green hexagon), but

there is no clarity on what it should be the content of such a program. After submitting the EIS for evaluation by the ISA (blue hexagon), that there is no formal acceptance or clear authority to reject the EIS as part of the regulatory review (coral hexagons) while external consultation could benefit from more transparency (discussed further in the text). After evaluation, the LTC should recommend or not the incorporation of the EIS in the programme of activities (wine hexagons). It remains unclear what procedures should be followed by the contractors, as well as what are the implications, if an EIS is not recommended by the LTC.

4.2.3.2 Recommendations for improvement

As noted earlier, the LTC Recommendations seem to conflate an EIA with an EIS. [13] It is recommended that the LTC Recommendations be revised to provide clarity (whereby the distinction is clearly explained) and consistency throughout the document. Such clarification is of great importance considering that an EIA comprises a whole comprehensive process, based on several steps and elaborated from a pre-established practice; while EIS is the report (usually resulting from the EIA) containing the information that should support decision-making. Therefore, such terminology should not be used interchangeably (Clark *et al*., 2017).

Furthermore, there is a serious lack of detail with respect to the impact assessment process and evaluation of the EIS pursuant to the LTC Recommendations. The absence of clarity and consistency needs to be addressed urgently as it can undermine a level playing field among contractors. As a result, the EISs submitted by contractors may be of vastly varying detail and quality, resulting in a difficult analytical process to the ISA, at least from a political standpoint, to subject each of these assessments to an equal and objective evaluation.

In contrast with an EBM approach, in which decisions should be well-informed and based on precaution, the LTC Recommendations currently lack more prescriptive provisions on what constitutes a qualitatively sufficient baseline knowledge. This is especially the case with respect to assessing risks and effects of the mining activities in question, as well as the decision-making processes for grading risk and effects. The proposition of alternative action scenarios, and the discussion of gaps and uncertainties in both knowledge and assessment, are absent as well, nevertheless represent key issues towards effective management of DSM activities (Amon *et al*., 2022). Another aspect that requires more elaboration is the monitoring plan that is expected to accompany the EIS. As it currently stands, the LTC Recommendations are very brief on monitoring requirements.

Another pivotal theme that warrants closer scrutiny is the consultation process. As explained above, the LTC Recommendations tolerates the situation where contractors elect to

[13] This also seems to be the case in the current draft of exploitation regulations, which will be discussed below.

conduct the consultation process only at the very end of the impact assessment process. This reduces the possibilities of contractors to effectively consider and incorporate feedback from stakeholders as opposed to when external consultations are conducted earlier on and in a continuous fashion. In accordance with EBM, consultation with experts and other stakeholders should take place from the beginning of the process, including before the elaboration and submission of the EIS (Guilhon *et al*., 2020; Andrade *et al*., 2021; Durden *et al*., 2018). That was not the case for the four EIS submitted thus far to the ISA for test-mining activities, which were only subjected to public consultation after submission to the ISA. Moreover, it also appears to be discretionary for contractors or sponsoring States to acknowledge and disseminate all received comments as well as provide a response to all the comments that it has received from stakeholders through the consultation process.[14]

Interestingly, the LTC Recommendations do not provide any information covering the scenario where the contractor or its sponsoring State had already conducted some form of stakeholder consultation before the submission of the EIS to the ISA. In this respect, it would appear from a perusal of paragraph 41 of the LTC Recommendations that if stakeholder consultation had taken place before the EIS has been submitted to the ISA, there would be no obligation for the contractor or sponsoring State to invite another round of public consultation once the EIS has been submitted to the ISA. This can be derived from paragraphs 41(c) and (d) of the LTC Recommendations, which only prescribe for stakeholder consultations if such consultations have not yet been conducted. It is arguable that it is crucial for the LTC Recommendations to further elucidate on what amounts to adequate consultation here, including whether such consultation could be limited to domestic or a select group of stakeholders as opposed to an open invitation for comments through the ISA website, and whether the contractor or sponsoring State is obliged to forward all comments that were received to the ISA based on such consultations. Finally, contractors should be required to clarify how it had responded to such comments or took them into account when preparing the final EIS that was eventually submitted to the ISA. Such

[14] In the case of EISs submitted by GSR and BGR, the webpage of the ISA provides links to the consultations made by GSR and Belgium as well as BGR and Germany and the responses given to such consultation (see https://isa.org.jm/minerals/environmental-impact-assessments). To the knowledge of the authors, there has not been a public response to the consultation on the EIS conducted by the Government of India, and it remains to be seen how the response to the consultation by NORI and Nauru will be disclosed (if at all).

information would be very useful for the LTC to consider when evaluating the EIS and would promote greater transparency and add more legitimacy to the process.

Apart from that, it remains uncertain how submitted EISs are checked for "completeness" by the ISA Secretary General (paragraph 41(b) of the LTC Recommendations) before the LTC initiates a review of the EIS for "completeness, accuracy and statistical reliability" (paragraph 41(c) of the LTC Recommendations). Presumably, the Secretary General should not only check whether formatting requirements have been met but also scrutinize the EIS to ensure that key information has been included. Additionally, more clarity is needed with respect to the role of the LTC in evaluating the EIS, including whether to review the EIS "for completeness, accuracy and statistical reliability" is an indication that the LTC is not obliged to go beyond these three criteria and undertake a full and substantive evaluation of the EIS. The LTC Recommendations are very ambiguous in this respect.

On the one hand, the LTC Recommendations (paragraphs 41(c) and (h)) provide that the LTC shall review the EIS on the basis of paragraph 65 of Annex I to the LTC Recommendations, which repeats the wording "for completeness, accuracy and statistical reliability" as the criteria for evaluation. On the other hand, the LTC Recommendations also seem to indicate that the review by the LTC ideally involves two stages; first, the LTC will conduct an initial review of the EIS for "completeness, accuracy and statistical reliability" (paragraph 41(c) of the LTC Recommendations), which will be then transmitted to the contractor (together with any comments received from public consultation) and the contractor will be given an opportunity to respond (paragraphs 41(g) and (f) of the LTC Recommendations); and second, the LTC will continue to finalize its review of the EIS after receiving a response from the contractor (paragraph 41(h) of the LTC Recommendations), which suggests that the LTC is expected to conduct a more comprehensive review of the EIS.[15] In these circumstances, it would be more useful for the LTC Recommendations to be more specific on the role of the LTC in reviewing the EIS (Craik and Gu, 2021), including what option would be available in the case of an incomplete or unsatisfactory EIS for exploratory test mining. For instance, if the LTC cannot explicitly reject an EIS, does this mean

[15] However, given that the LTC Recommendations do not cater for the scenario where stakeholder consultations had been conducted before the submission of the EIS, as discussed above, it is not clear whether the same two-stage review process would apply under that scenario as well.

that there are no further obstacles to prevent the contractor from eventually going ahead with the proposed activity?

The room for regulatory intervention (including to explicitly reject the submitted EIS) is also unclear under the LTC Recommendations. Although the LTC Recommendations provides that the LTC could decide to not recommend the incorporation of the EIS to the contractor's programme of activities, the LTC Recommendations could be more explicit on what this entails. Express powers that give the LTC the power to reject an EIS (after giving reasonable opportunities to contractors to make necessary revisions) should either be laid out, or alternatively, an additional regulatory layer should be added where the LTC could make recommendations to the Council to reject an EIS or request for directions on how to proceed. Such measure would strengthen the roles of both the LTC and the Council as regulators of DSM activities which require an assessment of impacts. Until this happens, the conduct of the planned activity should be expressly prohibited (without exception). This is important, given that the review process and decision on whether or not the EIS should be incorporated into the programme of work may take longer than 12 months, especially if prior stakeholder consultations were not conducted beforehand or an EIS resubmission is necessary, which may disrupt the contractor's proposed or planned dates to carry out such activities. Likewise, the role of the Secretary General upon receiving the recommendations of the LTC (paragraphs 41 (h) and (i) of the LTC Recommendations) should be further clarified and perhaps even debated, including whether the Council of the ISA should be involved in the EIS approval (or rejection) process. As opposed to the next stage (i.e., EIS submitted prior to exploitation, which will be discussed shortly), the Council does not have any role or influence with respect to the evaluation of the EIS submitted during exploration.

Finally, the Council should require a review of the LTC Recommendations from time to time, especially where shortcomings have been identified, in order to rectify any ambiguities or deficiencies. Moreover, the Council should require the LTC to report on the extent of contractors' compliance with the LTC Recommendations and to specifically point out which provisions have been neglected or contravened. In particular, the Council should adopt a list of evaluation criteria to be applied by the LTC for this purpose. Such measures would allow the Council to take further necessary action, including to require contractors to explain why certain provisions have not been met and if necessary, to issue compliance notices to the contractor.

Failure to supply adequate or appropriate environmental baseline data, the absence of a robust monitoring plan, containing misleading or inaccurate observations, as well as the lack of effective stakeholder consultation should be acknowledged as grounds to refuse a submitted EIS. Crucially, contractors should not be given any reason to assume that the requirements laid out in the (non-binding) LTC Recommendations and the submission of an EIS for certain exploration activities are only a mere formality or that non-compliance will be tolerated.

4.2.4 Prior to exploitation: EIA/EIS to accompany an application for the approval of a plan of work for exploitation

Once exploration activities are near completion, it is anticipated that some exploration contractors would seek to proceed into the exploitation stage (while others may choose to transact with the data that have been collected during the exploration stage in favour of interested parties instead). The Council of the ISA is currently negotiating a set of regulations that would govern future exploitation activities. Unlike the exploration stage where only certain activities are expected to cause significant environmental harm, thus requiring an EIA/EIS, it is accepted that the exploitation stage entails significant environmental harm. In comparison to the LTC Recommendations in respect to certain activities during the exploration stage as discussed above, the EIA/EIS process prior to the exploitation phase appears to be much further elaborated (although, as explained below, these requirements are still under development and yet to be finalized). The current version of the draft exploitation regulations requires the conduct of an EIA and the submission of an EIS to accompany an application for the approval of a plan of work for exploitation. As opposed to the exploration stage (addressed primarily via the non-binding LTC Recommendations), the EIA/EIS process at the prior to the exploitation phase will be covered under legally-binding regulations that would apply to all future applications to conduct exploitation activities, and is expected to be further elaborated via standards (also legally-binding) and guidelines that will accompany the forthcoming draft exploitation regulations.

4.2.4.1 Current practice at the ISA

While the first version of the draft exploitation regulations made reference to Environmental Impact Assessment (ISA, 2017a)**,** the latest 2019 draft (ISA, 2019b), currently under negotiations refers to an Environmental Impact Statement, which is to be submitted with the

application for exploitation.[16] According to Draft Regulation 47 (1) of the latest version, "*The purpose of the Environmental Impact Statement is to document and report the results of the environmental impact assessment*". Following that, Draft Regulation 47 (2) states the contractors shall deliver an EIS, which shall include a risk assessment, based on the results of the EIA, and in accordance with the respective objectives and measures of the relevant regional environmental management plan. The EIS template provided in Annex IV of the draft exploitation regulations states explicitly that they *"do not intend to be prescriptive, but rather to guide the format and general content of the Environmental Impact Statement"*.[17]

In addition to the requirement to submit an EIS, applicants submitting an application for the approval of a plan of work for exploitation are also required to submit several other documents, which include an Environmental Management and Monitoring Plan (EMMP) and a Closure Plan (CP) (ISA, 2019b - Draft Regulation 7.3). Collectively, the EIS, EMMP and CP are referred to as "Environmental Plans" (ISA, 2019b – Draft Schedule). It is anticipated that the information reflected in the EIS will be used by the applicant to inform and prepare the EMMP and the CP. The EMMP is expected to "*set out the commitments and procedures on how the mitigation measures will be implemented, how the effectiveness of such measures will be monitored, what the management responses will be to the monitoring results and what report systems will be adopted and followed"* (ISA, 2019b - Draft Regulation 48), including the indication on the location and planned monitoring and management of PRZs and IRZs, or other spatial management planning tools (ISA, 2019b - Draft Annex VII.2.i). Finally, the CP (ISA, 2019b - Draft Regulation 59) is expected to lay out the decommissioning and closure of the mine site, including the post closure management and monitoring of environmental effects.

[16] It is interesting to note that at the initial stages of the regulatory development process for exploitation activities, environmental matters (including the guidance for conducting environmental impact assessment) were considered separately (ISA, 2016). As a result, a discussion paper on the development of "Environmental Matters" for the draft of exploitation regulations (ISA, 2017b) provided for comprehensive directions on what would be expected to occur in an EIA, including in terms of procedural steps, information to be provided, participation and review of the process, which do not feature in the current draft.

[17] The work of the ISA with respect to the EIA/EIS process prior to the exploitation phase and the need for a template against which an EIS can be assessed in a consistent, impartial and unbiased way in order to ensure a level playing field for contractors could be traced back to an ISA Workshop in Fiji in late 2011. See ISA Technical Study No. 10, 'Environmental Management Needs for Exploration and Exploitation of Deep Sea Minerals', available at https://isa.org.jm/files/files/documents/tstudy10.pdf.

The Environmental Plans will be evaluated as part of the application for the approval of a plan of work for exploitation, and the LTC will consider these against the contractors' ability to provide "*for the effective protection of the Marine Environment in accordance with the rules, regulations, and procedures adopted by the Authority, in particular the fundamental policies and procedures under regulation 2*" (ISA, 2019b – Draft Regulation 13.4.e). Although such consideration should be based on the fundamental principles and policies as currently set out in the draft regulations[18], the draft regulations do not specify any criteria for evaluation. The three documents are to be delivered as separate reports, although their contents are largely interdependent and partially overlapping. Following the submission of an application for the approval of a plan of work for exploitation, the Secretary General shall determine if the application is complete (ISA, 2019b – Draft Regulation 10.1). If the submission is incomplete, the Secretary General shall notify the applicant, specifying the information which the applicant must submit in order to complete the application together with a justification on why the information is necessary and a date by which the application should be completed (ISA, 2019b – Draft Regulation 10.2).

Thereafter, the Secretary General shall place the Environmental Plans on the Authority's website for 60 days and invite members of the Authority and stakeholders to submit comments (ISA, 2019b – Draft Regulation 11.1.a) as well as request the LTC to provide comments (ISA, 2019b – Draft Regulation Draft 11.1.b). Next, the Secretary General shall provide the applicant with all comments submitted for its consideration. The applicant is expected to consider such comments and provide responses or submit any revised plan within 30 days following the closing comment period (ISA, 2019b – Draft Regulation 11.2). After that, the LTC shall examine the Environmental Plans alongside the received comments or revised documents, together with any responses by the applicant, and any additional information provided by the Secretary-General (ISA, 2019b – Draft Regulation 11.3). After the consultation and review processes above mentioned have been conducted (ISA, 2019b – Draft Regulation 11.5), the LTC shall proceed with the preparation of a report on the Environmental Plans. Such report should include details on the LTC's determination in light of Regulation 13.4.e (on whether the proposed plan of work provides for the effective protection of the marine environment), as well as a summary of the comments or

[18] The fundamental policies and principles for effective protection as provided under Draft Regulation 2.e include the following: the consideration of biological diversity and ecological integrity, the application of the precautionary approach, an ecosystem approach and "the polluters pays" principle, access to data, accountability and transparency in decision-making and effective public participation.

responses obtained during the consultation. This report shall be published on the ISA's website and shall be included in the LTC's overall recommendation to the Council on the application for the approval of the plan of work. It is important to note that the LTC shall not consider the merits of the application itself until the Environmental Plans have been published and reviewed in accordance with the above (ISA, 2019b – Draft Regulation 11.4). Thereafter, the LTC will continue with the assessment of the application for the approval of a plan of work and provide its recommendation to the Council on whether to approve or not the application in accordance with Draft Regulation 15.[19] The complete process for impact assessment as part of an application for exploitation is summarized in Figure 2.

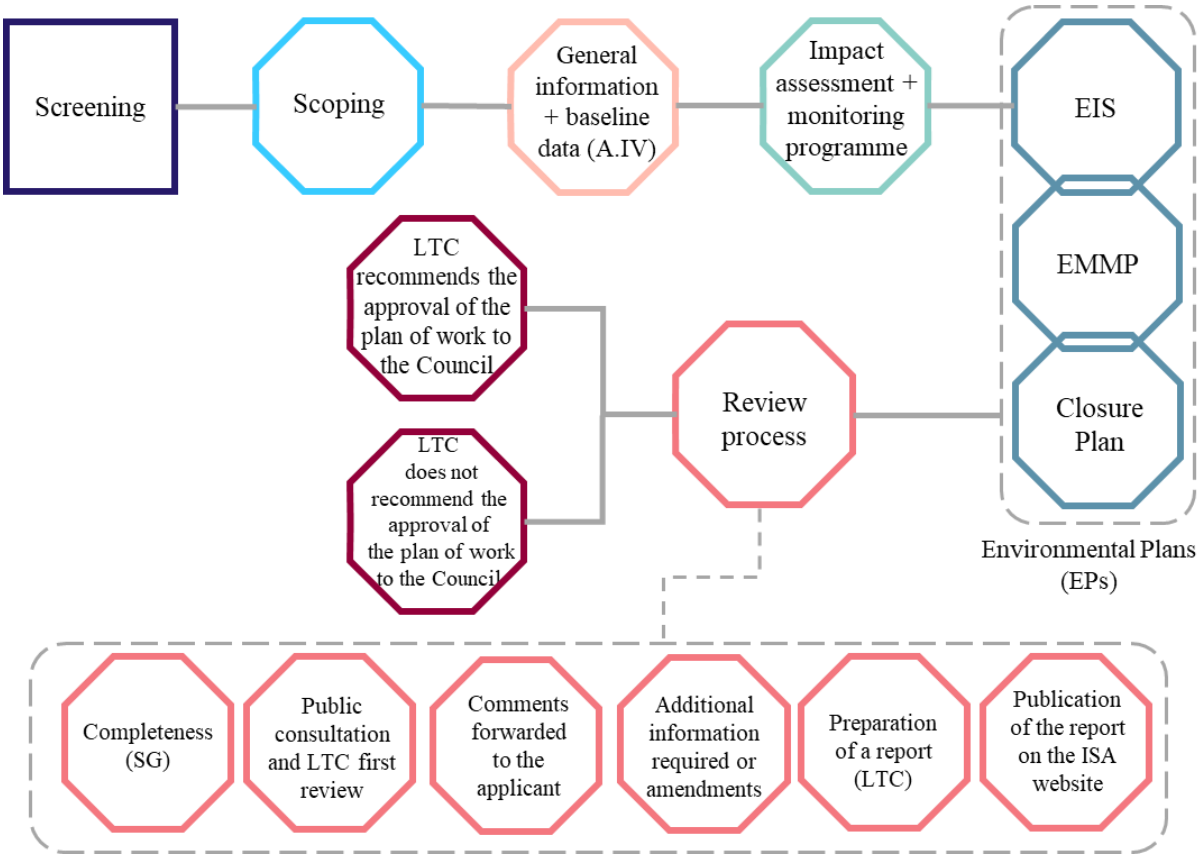

Figure 2. Steps comprising the assessment of environmental impacts foreseen as part of the documentation for applying for an exploitation contract, according to the draft ISBA/25/C/WP.1 (A. = Annex; i. = item). Screening (unlikely needed - blue square) and scoping phases (light blue hexagon) are now present, adding complexity to the process. However, no further information on

[19] At any time prior to making its recommendation to the Council on the plan of work, the LTC may request the applicant to provide additional information (30 days for applicant's response) or amend its plan of work. In the case of the latter, the LTC should provide a brief justification and rationale for the proposed amendment. Within 90 days, the applicant must respond by agreeing to the proposal, rejecting it, or making an alternative proposal (ISA, 2019a – Draft Regulation 14.2).

how to comply with such steps is provided by the draft document. A more detailed EIS template is provided by Annex IV containing the requirements for the impact assessment (rose hexagon). The impact assessment and establishment of monitoring and management measures (green hexagon) will result in three interlinked documents, named Environmental Plans (EPs -blue hexagons), comprising of the Environmental Impact Statement, Environmental Management and Monitoring Plan and the Closure Plan. As part of the Review process (coral hexagons), contractors will receive comments from the LTC and other stakeholders and should review and provide responses to it. The report of the LTC on the EPs will be submitted to the Council as part of its overall recommendations on whether to approve the application (wine hexagons).

In April 2021, draft versions of standards (binding) and guidelines (non-binding) pertaining to the elaboration of EIA (ISA, 2021a), EIS (ISA, 2021b) and EMMP (ISA, 2021c) were made available for stakeholder consultation by the ISA and second draft versions were issued in early 2022 (ISA, 2022a, 2022b, 2022c). Generally, a preliminary examination of the documents reveals a clearer delineation of an EIA process and what should be presented in the subsequent EIS, however there remain significant shortcomings, including with respect to adequate stakeholder participation during the scoping and impact assessment stages of the EIA. Furthermore, the documents lack the inclusion of a pre-agreed and transparent decision-making criteria for evaluating the environmental risk, in particular with respect to marine conservation goals and objectives.[20] These are core characteristics of EBM practice, and at the same time, also crucial for determining the measures for re-establishing a certain environmental quality after mine closure (for which the necessary standards and guidelines have not been developed yet). Although this paper does not aim to analyse in detail the content of such documents, the discussion points hereby raised will help inform ongoing negotiations at the ISA, also with respect of standards and guidelines to be adopted.

4.2.4.2 Recommendations for improvement

The process of submitting an EIS for exploitation could also be improved. It has been pointed out that the logic and the process flow as contained in the current draft for exploitation activities do not follow an overarching environmental assessment framework (ISA, 2019c - comments from Italy). Although screening and scoping phases are tentatively included in the EIA process as part of the assessment of impacts for exploitation activities (ISA, 2019b - Draft Regulation 47.1.b), there is no clarity on how applicants are to comply with such phases. Moreover,

[20] See e.g., Statement by Germany (ISA Council, March 2022) https://isa.org.jm/files/files/documents/Germany-Opening-Statement.pdf.

the scope and content of what would be a satisfactory EIA and subsequent EIS remains very general and are not extensively addressed in the draft text. As previously mentioned, it is anticipated that such aspects will be further developed through future standards and guidelines that are to be adopted.[21] Given that the draft exploitation regulations as well as the accompanying standards and guidelines for EIA and EIS are still under consideration at the ISA, the following discussion is of a general nature and will not involve a detailed examination of the current text (since it is entirely possible for the adopted text to differ significantly as a result of the negotiation process).

Similar to issues raised in relation to the impact assessment process during exploration, it remains subjective, for example, what criteria is going to be used to evaluate adherence to the fundamental policies and procedures of the draft for exploitation regulations.[11] Given the subjectivity of these fundamental policies and principles, the absence of any normative criteria to review an EIS might undermine the need to ensure a level-playing field and non-discrimination among exploitation applications at the ISA. The establishment of a standardized set of requirements for undertaking impact assessments and the criteria for evaluation of submitted EISs are primary matters that should be addressed under the current draft for exploitation activities and elaborated in more detail through the accompanying standards and guidelines. On this note, it is very important to ensure that critical matters, including process-related procedures and assessment criteria, fall under binding standards as opposed to non-binding guidelines. Apart from ensuring that all EIA/EIS requirements under the regulations and binding standards have been met, the LTC should also, while considering the Environmental Plans and in its subsequent report to the Council, ascertain whether and to what extent contractors have complied with the non-binding guidelines. If necessary, contractors can be asked to provide justifications for any non-compliance.

Furthermore, it is relevant to highlight ambiguities concerning the "Encouragement of effective public participation" (ISA, 2019b – Regulation 2.e.vii), whereby the current version of the draft for exploitation activities (similar to the LTC Recommendations during exploration), appears to allow for external comments to be invited only once the EIS has already been elaborated and submitted by the applicant, once again leaving the consultation aspect largely at the discretion

[21] Although a systematic review on the content of the draft standards and guidelines goes beyond the intended efforts of the present manuscript, it is worth noting that in the first round of external consultation, several issues regarding the (lack of) normative requirements for EIA, EIS and EMMP have been raised (Guilhon, pers. com.), including the determination of binding (standards) and non-binding (guidelines) requirements. The first round of stakeholder comments on EIA, EIS and EMMP is available on: https://www.isa.org.jm/mining-code/standards-and-guidelines.

of the applicant. As discussed above, consultation with experts and other stakeholders should, according to EBM, take place from the beginning of the EIA process, including before the elaboration and submission of the EIS, according to accepted norms of public notification and consultation (Warner, 2020).

Moreover, it remains to be seen how applicants will be able to provide reliable data and information to feed into the EIS, particularly if test mining was not conducted earlier during the exploration phase. Without any mandatory requirement for contractors to conduct compulsory test mining during the exploration phase, there is a risk for the EIS that is subsequently prepared to accompany the exploitation application to be over-reliant on models and predictions that have not been validated on the ground (ISA, 2019a; Singh, 2021). Adequacy of reliable baseline data and sufficient knowledge on technical operations must be considered as a pre-condition to carrying out an EIA and used to inform the entire process leading up to the EIS, upon which a robust monitoring plan (tailored to the EIS and with adaptive management elements) should feature in the accompanying EMMP (Craik, 2020).

Finally, although it is noted that the process here differs from an EIS submitted during the exploration phase (whereby the EIS submitted here will be used to inform the Council on whether the application for the plan of work for exploitation should be approved), clear language should be used to ensure that the EIA/EIS process is not a mere formality. It will be recalled that with respect to the EIA/EIS process for certain activities during the exploration stage, the current framework does not anticipate the Council playing a role in the evaluation process (since the exploration application was already previously approved and an exploration contract is in existence). Therefore, the LTC is the sole organ responsible for recommending the incorporation of an EIS in the plan of activities, despite the many ambiguities surrounding its role and function in decision-making. In contrast, at the present stage, the role and function of the LTC is more defined, whereby it is responsible to provide reports on the Environmental Plans and a recommendation to the Council on whether or not to approve an exploitation application, with the final decision resting with the Council.

As with the case for the exploration phase, if the LTC does not have the power to reject an EIS, express powers should be foreseen in the relevant regulations or standards for the LTC to recommend to the Council to disapprove a plan of work for exploitation on the ground of an incomplete or unsatisfactory EIS (which would also apply to other components of the

Environmental Plans). In the case of the existing divergencies among LTC members, the recommendation document to the Council shall, wherever necessary, be accompanied by a summary on the divergences of opinion in the LTC (ISA, 2000). The Council should also encourage the LTC to require applicants to make necessary revisions to their Environmental Plans or plan of work application not only for formal reasons but especially if it determines that environmental requirements cannot be met through the proposed Environmental Plans.

Again, applicants should not be given the impression that the EIA/EIS process is something that is to be taken lightly or that any form of non-compliance would be tolerated. While the ISA may opt to be more amenable during the exploration phase, it cannot afford to be lenient or feeble when activities begin to transition into the exploitation phase. As a first step, the ISA should develop and agree on normative environmental requirements to ensure the effective protection of the marine environment that would apply to exploitation activities. Premised on this, the ISA should then define precise environmental criteria to give effect to Draft Regulation 13.4.e which the LTC should apply when assessing exploitation applications. In the absence of the above, applications for exploitation activities should not be approved.

4.2.5 During exploitation: Potential revisions to the EIS (and other Environmental Plans) prior to commercial production

As noted earlier, the exploitation stage could be divided into two phases, namely, pre-commercial production and commercial production. While the pre-commercial production phase is where the contractor would make all necessary arrangements and secure additional investments for the mining operation, large-scale extraction activities will only commence some years later when the contractor subsequently enters into commercial production where mining operations will take place on a continuous basis.[22]

[22] After the mining activities have ceased, the management and monitoring of residual effects, which may include the implementation of mitigation and remediation measures should be continued during a post-exploitation phase (i.e., decommissioning and closure of mining sites). Such measures should be elaborated upon and presented in a Closure Plan (CP), which is one of the three Environmental Plans (together with EIS and EMMP) to be delivered as part of a plan of work for exploitation. Given that the CP has a limited component of assessment, discussions on the CP in detail go beyond the intended efforts of the present manuscript. As of April 2022, no standards nor guidelines on this subject were issued by the ISA.

4.2.5.1 Current practice at the ISA

Upon successfully obtaining an exploitation contract, the current version of the draft exploitation regulations also requires a future exploitation contractor to submit a feasibility study at least 12 months prior to the proposed commencement of commercial production. In light of the feasibility study, a contractor may be required to revise its approved plan of work in the event of the occurrence of a "material change" (ISA, 2019b - Draft Regulation 25). Apart from that, independent from the feasibility study process, a contractor may also request to the ISA to modify its own plan of work, in which any "material change" would entail an approval process (ISA, 2019b – Draft Regulation 57). "Material change" is defined as "*a change to the basis on which the original report, document or plan, including a Plan of Work, was accepted or approved by the Authority, and includes changes such as physical modifications, the availability of new knowledge or technology and changes to operational management that are to be considered in the light of the Guidelines*" (ISA, 2019b - Schedule). In this respect, if revisions are to be made to the EIS or other Environmental Plans as part of the revisions to the approved plan of work, the process pursuant to Draft Regulation 11 (i.e., public comments and review by the LTC) will have to be repeated.

4.2.5.2 Recommendations for improvement

Currently, the draft exploitation regulations do not actually envisage that the EIA process will have to be repeated as it merely requires the revised Environmental Plans (i.e., the EIS, EMMP and/or CP) to be submitted for external consultation and regulatory review. This does not seem very satisfactory under certain circumstances, for example, if a contractor wishes to employ totally different technologies or techniques than the ones that were initially envisaged when the EIA process was first carried out, or if it is subsequently determined that some assumptions or data that were initially relied upon during the EIA process were fundamentally incorrect, unreliable, or falsified. Consequently, it may be worthwhile to consider inserting requirements in the exploitation regulations where contractors may be required by the ISA to undertake a fresh EIA process and produce a new EIS (as well as an EMMP and/or CP) during the exploitation phase, failing which, the approved plan of work can be suspended, permission to progress into commercial production can be withheld, or the exploitation contract in question can be terminated. Moreover, it is indeed questionable whether the Secretary-General or the ISA Secretariat is the right organ to make a determination on whether or not there has been a "material change", as is currently envisaged under

the draft regulations. Given that this would not be a mere administrative decision but a rather technical and important one, it may be more appropriate for such a determination to be left to the LTC or the Council.

4.3 Assessment of environmental impacts at the ISA: overview of findings and further recommendations

The assessment of impacts prior to exploitation appears to raise similar concerns to that of the assessment of impacts of certain activities during the exploration phase. These include, in particular, inconsistencies relating to stakeholder consultation, the absence of criteria for review and evaluation by the LTC, as well as ambiguities relating to the potential outcomes of the review process and their consequences, as also previously noted by Lallier and Maes (2016). Additionally, the ISA presently does not seem to have the willingness to position itself as a strong regulator (Ginzky *et al*., 2020), including to confer upon itself the requisite regulatory powers or procedural means to effectively steer EIA processes towards desired outcomes. If such concerns are not properly considered by the ISA and its Member States, there would be the possibility that an EIS prepared in relation to a proposed mining activity will only serve as a formality or for informational purposes (i.e., a box ticking exercise), as opposed to fulfilling its envisaged central role in supporting informed decision-making, acknowledging social and cultural values, and based on the best available knowledge, in consonance with EBM.

The requirement for contractors and prospective contractors to consult with stakeholders should be clarified and clearly elaborated, including the need for such consultation to take place at regular intervals during the EIA process (and not just at the end after the EIS is prepared and submitted to the ISA). Sufficient time should be given to stakeholders to respond (Craik and Gu, 2021), and the ISA should also consider requiring sponsoring States and contractors to hold public hearings on the EIS (which is common in domestic legal settings). Stakeholders should be granted access to all relevant data, which should be placed on the public domain, especially with respect to all such data on which the assertions made in an EIS are based (Lallier and Maes, 2016). Moreover, all received comments and input from stakeholders should be published online, with the contractor explaining how these comments have been taken into account in revising the EIS (Craik and Gu, 2021). Individual responses from the contractor on all received comments should be made mandatory (which should involve line-by-line responses). This is a crucial step for the ISA

governance to be in line with best practices in transparency (Ardron *et al*., 2018), but also to not dissuade stakeholders from participating in future consultations.

The ISA might also wish to consider if contractors that found to have submitted sub-standard, incomplete or misleading EIS should face monetary penalties to discourage this practice. Stakeholders have to invest a lot of time and expenses to peruse long and complex documents within a short period of time and at no costs to the ISA or to the contractor or sponsoring State(s). In addition, the ISA should also consider setting up a voluntary trust fund to support and encourage small delegations as well as observers at the ISA to respond to such consultations. The ISA should also design capacity building and training programmes to guide delegates and other stakeholders on how to assess and evaluate an EIS in order to enhance their ability to participate more actively and meaningfully in such consultations.

The ISA might consider the adoption of appropriate mechanisms for grievances with respect to the EIA/EIS process to be voiced, for instance, the establishment of an ombudsperson to act upon complaints from stakeholders. A panel of accredited experts should be invited to participate in the EIA process as well as to evaluate the eventual EIS. Extensive debates on any EIS that have been submitted should take place during ISA meetings, where concerns relating to process or procedure as well as substance can be raised. This might provide the impetus to motivate change through political means at the Council, whereby exploration contractors or applicants for an exploration contract may be required to rectify any deficiencies. Political means seem to be the primary option available, given that there does not appear to be much room for judicial intervention. In this respect, while UNCLOS establishes avenues for dispute settlement, including to litigate disputes before the Seabed Disputes Chamber of the International Tribunal for the Law of the Sea (SDC-ITLOS), the jurisdiction of the SDC-ITLOS is quite limited. It is clear from Article 187 of UNCLOS that legal standing is only conferred to the ISA, Member States, contractual parties, or prospective contractors, and not to stakeholders or the general public. Moreover, Article 189 of UNCLOS substantially limits the jurisdiction and powers of the SDC-ITLOS when it comes to decisions taken by the ISA. Consequently, there does not appear to be much scope for judicial review of an EIS at the moment. In this respect, it might be worth exploring if the ISA could further elaborate on judicial review avenues for Member States to challenge the acceptance of an EIS or for stakeholders to encourage the Council or Assembly to do so, for instance, by invoking the jurisdiction of the SDC-ITLOS. Although this might be difficult to achieve in practice, it should

be noted from a perspective of good governance that most domestic legal systems allow for the judicial review of such decisions on EIAs that are made by government bodies or national regulators.

Two other final points for consideration, in relation to an EIS for test mining during the exploration stage or an EIS accompanying an exploitation application, are transparency in the review process at the LTC and the capability of the LTC to review an EIS, including in light of regional cumulative impacts (Craik and Gu, 2021; Jaeckel, 2015). With respect to the former, the LTC typically meets behind closed doors and its recommendations tend to be brief and not very informative (Singh, 2020). Thus, when reviewing an EIS, opportunities to hold open meetings, at least in part, should be considered, and the LTC should provide more elaborate recommendations summarizing the debate among its members and clearly stating its points of view regarding a submitted EIS. As regards the latter, given that the LTC has a huge workload and limited environmental expertise within its current composition (Singh, 2020), options to commission or request for the views of external experts on the submitted EIS should also be explored. In this respect, mechanisms should be put in place to ensure transparency and consistency in the process to solicit external expertise and elaborate on how such advice should be made available for public scrutiny and taken into consideration as part of the decision-making process (Craik and Gu, 2021; Lallier and Maes, 2016). Additionally, given that the ISA is now at the crucial phase of transitioning from exploration to exploitation and given the important role performed by the LTC, it is important that its composition reflects the expertise that is needed to carry out its many functions, particularly in this instance, with respect to reviewing an EIS. Moreover, pursuant to Article 165(2)(d) of UNCLOS, the LTC is also entrusted to prepare its own assessments of the environmental implications of exploration and exploitation activities in the Area. Here, the establishment of a dedicated scientific or environmental committee, preferably independent (Warner, 2020), to support the LTC seems to be urgently needed and should be discussed at the ISA (Singh, 2021). Without making all these necessary adjustments, it would seem to be plainly obvious that the ISA would not be able to perform its functions as a regulator in a responsible and satisfactory manner.

4.4 Conclusion

In theory, an Environmental Impact Assessment (EIA) as a management tool encompasses a comprehensive and participative process with several pre-established steps. From the above analysis, however, it is quite apparent that the assessment of environmental impacts as required under the ISA regime does not fully conform to how an EIA process is generally understood and described under existing literature and practices (Craik and Gu, 2021; Durden et al., 2018; UNEP, 2018; Warner, 2020). While the ISA regime makes it clear that the submission of an EIS is required in the case of certain proposed activities during the exploration phase and to accompany an application for an exploitation contract, there are many process-related ambiguities concerning how environmental impacts are to be assessed, upon which an EIS is based on and prepared for submission. Without a standardized and well-regulated process, the ISA risks creating a regime that may be pressured into accommodating deficient impact assessments practices and sub-standard EISs, which eventually allows for double standards or differential treatment for contractors and prospective applicants.

As a first step towards the improvement of the assessment of impacts at the ISA, we strongly recommend that the shortcomings observed in this article are carefully considered by the ISA and its Member States. Revisiting the processes upon which the environmental impacts of DSM in the Area are assessed and evaluated would propel the ISA to make necessary adjustments and improvements within the regime, not only through instruments currently under debate, namely the draft exploitation regulations and accompanying standards and guidelines, but also to guide the revision of the LTC Recommendations for exploration activities. In so doing, the ISA regime will move closer towards a more consistent, comprehensive, transparent and participatory practice of assessing environmental impacts that conforms to the general understanding of an appropriate EIA process as well as aligns with EBM. Improving the institutional ability of the ISA to evaluate environmental impacts and regulate DSM will enhance accountability and reduce the risk of potential litigation against itself. Above all, such adjustments and improvements would approximate the ISA to the function of an effective regulator acting on behalf of humankind.

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5. ENVIRONMENTAL IMPACT ASSESSMENT OF DEEP-SEA MINING ACTIVITIES: KEY CONSIDERATIONS TO ENABLE ECOSYSTEM-BASED MANAGEMENT (CHAPTER 4)

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Abstract

The expansion of offshore human activities with potential to cause significant harm to the marine environment, such as deep-sea mining (DSM) in areas beyond national jurisdiction (i.e. the Area), have fostered discussions on the adoption of best practices such as Ecosystem-Based Management (EBM). Therefore, the assessment of the likely impacts arising from high-risk human activities at sea, such as DSM, should be guided by an EBM approach throughout the process. With that in mind, the present study aims to investigate the opportunities for an EBM-guided assessment of environmental impacts in the Area, considering the prevailing regulatory framework established by the International Seabed Authority (ISA). As a first step, an analysis covering ISA documents pertaining to the assessment of environmental impacts was conducted to define the Environmental Impact Assessment (EIA) framework as currently discussed by the ISA. Based on consultation of the literature on EIA for DSM and on the experience of the authors, an exercise of how a comprehensive EBM-guided EIA should look like is proposed. The analysis identified the potential for stronger EBM incorporation in the current impact assessment framework proposed by the ISA, especially as binding requisite for the phases of scoping and assessment of impacts. The ongoing elaboration of binding regulations and standards for the exploitation of minerals in the Area presents a important window of opportunity to shape a robust EBM-guided EIA with respect to mining-related to be expected from mining activities, especially commercial-scale operations.

5.1 Introduction

Deep-ocean ecosystems are increasingly recognized for their crucial contribution to the provision of vital ecosystem services such as climate regulation, carbon sequestration, nutrient (re)cycling, and food provision (Le *et al.*, 2017; Thurber *et al.*, 2014). In spite of increased scientific endeavors to investigate and better understand the deep ocean, the knowledge available on the functioning of such ecosystems is still limited, which substantially restricts the ability of humankind to value the benefits that come from deep ocean as natural capital and also to comprehend what effect human activities, such as deep-sea mining (DSM), will have on them.

Activities related to DSM in the Area (the seafloor and subsoil thereof in areas beyond national jurisdiction, or ABNJ) are organized and controlled by the International Seabed Authority (ISA), an international organisation established under the United Nations Convention on the Law of the Sea 1982 (UNCLOS). Under UNCLOS, the Area and its mineral resources are designated as the common heritage of mankind (UNCLOS, 1982 - Article 136), and that the ISA shall act for the benefit of mankind when administering these resources (UNCLOS, 1982 - Article 140). In executing its mandate, the ISA has already developed regulations to govern the exploration of polymetallic nodules, polymetallic sulphides and cobalt-rich ferromanganese crusts in the Area and is currently negotiating an advanced draft text that would govern the exploitation of these resources. Moreover, the forthcoming exploitation regulations is to be supplemented by standards (binding) and guidelines (non-binding), currently under development, consultation, and review by the ISA[1].

Environmental risks and impacts arising from DSM activities are expected to be significant and can extend far beyond the immediate source of impact in the seabed (Levin et al., 2016; Niner *et al.*, 2018; Ramirez-Llodra *et al.*, 2011; Smith *et al.*, 2020; Van Dover *et al.*, 2017; Washburn *et*

[1] Such standards and guidelines mostly include aspects related to the protection of the marine environment (ISA, 2019 – Draft regulation 1.5). As of May 2022, the ISA has issued eleven documents to the draft of exploitation regulations, all in the form of drafts which include: guidelines on the preparation and assessment of an application for the approval of a Plan of Work for exploitation (ISA, 2022a), standards and guidelines for the environmental impact assessment process (ISA, 2022b), guidelines for the preparation of environmental impact statements (ISA, 2022c), guidelines for the preparation of Environmental Management and Monitoring Plans (ISA, 2022d, 2022e), standards and guidelines to the development and application of environmental management systems (ISA, 2022f), guidelines on the tools and techniques for hazard identification and risk assessments (ISA, 2022g), standards and guidelines for the safe management and operation of mining vessels and installations (ISA, 2022h), draft standards and guidelines on the form and calculation of an Environmental Performance Guarantee (ISA, 2022i), guidelines for the establishment of baseline environmental data (ISA, 2022j) and standards and guidelines for the preparation and implementation of emergency response and contingency plans (ISA, 2022k).

al., 2019). Loss of biodiversity, blanketing of sessile organisms by sediment plumes, contamination of ecosystems by toxic metals, functional disturbances of pelagic communities, and pollution from light, noise and vibration are just a few of the harmful environmental impacts expected from DSM activities. Beyond the direct impacts, the effects of climate change, which also impact the deep ocean (Levin and Le Bris, 2015; Levin *et al.*, 2020b), together with the multiple stressors deriving from human activities, further amplify the negative effects faced by the deep ocean. This is especially concerning since the spatial and temporal dimensions of such threats remain a matter of great uncertainty (Kaikkonen *et al.*, 2018), and thus, difficult to tackle from a regulatory and sectoral perspectives. The high likelihood of DSM to cause significant environmental impact to the marine environment, combined with the current inability to predict the extent of the adverse effects of such activities to ecosystem integrity, functioning and services, call for the adoption of a precautionary management approach (Jaeckel *et al*., 2017), such as embedded in Ecosystem-Based Management (EBM) (Trouwborst, 2009).

The ISA recognizes the ecosystem approach among its fundamental policies and principles in the draft exploitation regulations, however, EBM is not satisfactorily reflected within the ISA regime (Guilhon *et al*., 2020; Guilhon *et al*., 2022). This shortcoming hinders its proper implementation by contractors, which ultimately will be the ones carrying out mining activities. To provide an effective framework for the developing a DSM regime in the Area, EBM must be a cross-cutting issue that permeates all rules, regulations and procedures that comprise the so-called ISA Mining Code, including the assessment of environmental impacts through an Environmental Impact Assessment (EIA). Within the current ISA framework, an EIA should be produced in two distinct moments of DSM-related activities: the test of mining equipment and operation with potential to cause harm effects to the marine environment during the exploration stage (ISA, 2020) and as a requirement to be submitted alongside an application for an ISA exploitation contract (ISA, 2019).

In the context of the above, this paper aims to explore and synthesize how the different stages of an EIA for DSM in the Area can be supported by EBM. We start by underscoring the pertinence of EBM in the context of DSM in the Area, followed by an analysis of the current framework for the assessment of environmental impacts in the context of exploration and future exploitation activities. While discussing each step of the EIA process (i.e. from screening to auditing), we simultaneously explored opportunities to better incorporate EBM into an ideal

framework for the assessment of environmental impacts for DSM activities at the ISA. Other instruments less directly related to the EIA process under the ISA (e.g. Environmental Management Systems), but that may also impact its effectiveness, will also be briefly discussed. We end by presenting some concluding remarks on how to channel efforts towards EBM-guided EIAs for DSM at the ISA.

While this manuscript briefly dialogues with the EIA procedures established by the ISA regulatory framework, we do not intend discuss the ISA's framework for the assessment of environmental impacts in detail here (for more information on this subject, please refer to Guilhon *et al*., 2022). Rather, the main focus is to discuss key considerations that should feature under an "EBM-guided EIA" within the ISA regime in the Area. The approach taken here builds upon previous work that have been undertaken elsewhere. The EBM-related principles discussed here were adopted by Guilhon *et al*. (2020) and used to support other discussions, including stakeholders perception and procedures for EIAs at the ISA regime (Guilhon *et al*., 2022; cap.3).

5.2 Ecosystem-Based Management (EBM)

5.2.1 The concept [2]

EBM has increasingly become a cornerstone of numerous international instruments to regulate offshore human activities towards a healthier, thriving, and productive ocean (Engeler and Boteler, 2020). Since the late 1980s, EBM has gradually received international attention and acceptance as an approach that should guide the quest to limit the effects of human activities on nature to ecologically sustainable levels and to confine them within the limits of the planetary boundaries (CBD, 1995, 2004; UNGA, 2006; Warner, 2020).

Although a universally agreed definition is elusive (Delácamara *et al*., 2020; Kirkfeld, 2019; Long *et al*., 2017), EBM is generally understood as a holistic approach that builds upon the understanding of a given ecosystem, usually spatially defined, in the context of past, present and future pressures as a starting point for decision-making. Its application should not be seen as an end point, but rather as a relational process that must be "adaptive, flexible, networked, connective and iterative" (Macpherson *et al*., 2021) and that informs the adoption and development of goals,

[2] The terminology "EBM" adopted by this article corresponds to the "ecosystem approach" adopted by the Convention on the Biological Diversity (2004), Food and Agriculture Organization of the United Nations (FAO, 2003) and OSPAR Convention (OSPAR-HELCOM, 2003).

strategies, and tools for management.

Different elements or principles are commonly related to EBM (Arkema *et al*., 2006; CBD, 2000; Long *et al*., 2015; McLeod *et al*., 2005;) and can be used as a proxy to evaluate EBM incorporation into the DSM regime for the Area (Guilhon *et al*., 2020). A "one-size-fits-all" approach, however, is not feasible or desirable (CBD, 2008), and the consideration of different principles varies over time and context (Long *et al*., 2015 2017) EBM is a multifaceted concept and the potential for its application should be considered under an array of ecological, social, economic, legal, cultural, and governance aspects. Such considerations should be mainly based on the acknowledgement of environmental limits within ecosystems, aiming for sustainable patterns of resource use and social-ecological integration (Delacámara *et al*., 2020).

More specifically, EBM shifts the perspective from individual or sectoral impacts on the environment to the ecosystem(s) as a whole (Halpern et al., 2008), usually in a particular spatial scale (or area). It requires that human activities are controlled to not permanently degrade or impair the ecosystem's capacity to maintain its integrity, functionality, resilience and unhindered provision of services (Delacámara *et al*., 2020). Diverging from (mis-)management of human activities in the past, EBM prioritizes to know before acting instead of doing it and reacting or, in other words, to act with foresight rather than to react in hindsight (Delacámara *et al*., 2020). EBM requires that risks and impacts are analysed against known environmental long-term objectives and related indicators and thresholds within a participative process (Gonçalves and Xavier, 2021).

A literature review conducted by Long et al. (2015) identified 26 principles that are frequently related to EBM (Table 1). This work guided the undertaking of an evaluation of how and to what degree these principles are reflected in the regulatory framework of DSM in the Area (Guilhon *et al*., 2020). The operationalization of EBM within the ISA regime can be seen as an additional challenge, especially due to the untested nature of the activities and the technologies that will be used, the remoteness, depth and harshness of the environment intended to be mined, as well as the embryonic stage of environmental regulation and institutional capacity for management and enforcement at the ISA (Amon *et al*., 2022; Guilhon *et al*., cap. 3; Levin *et al*., 2020a).

Table 1. The twenty-six Ecosystem-Based Management (EBM) principles identified by Long *et al*. (2015) in a literature review (the middle column). The principles have been divided into general categories (left column) in a previous analysis of the Mining Code proposed by Guilhon et al. (2020). For the present study, each principle received a code number (right column) that will be used in the EBM-guide impact assessment analysis proposed in section 4.

General Groups	EBM Principles	Code
Core	Sustainability	1
Ecological	Account for Dynamic Nature of Ecosystems	2
	Consider Ecosystem Connections	3
	Consider Ecological Integrity and Biodiversity	4
Impacts	Acknowledge Ecosystem Resilience	5
	Consider Cumulative Impacts	6
	Consider Effects on Adjacent Ecosystems	7
Knowledge	Acknowledge Uncertainty	8
	Apply the Precautionary Approach	9
	Consider Interdisciplinarity	10
	Use of All Forms of Knowledge	11
	Use of Scientific Knowledge	12
Management	Implement Adaptive Management	13
	Conduct Appropriate Monitoring	14
	Develop Long Term Objectives	15
	Explicitly Acknowledge Trade-Offs	16
	Integrated Management	17
Participation	Decision Reflecting Societal Choice	18
	Promote Organizational Change	19
	Promote Stakeholder Involvement	20
Social-economic	Commit to Principles of Equity	21
	Consider Economic Context	22
	Recognize Coupled Social-Ecological Systems	23
	Use of Incentives	24
Spatial and Temporal Scales	Consider Appropriate Spatial and Temporal Scale	25
	Recognize Distinct Boundaries	26

5.2.2 EBM in the context of DSM in the Area

Although the UNCLOS does not explicitly makes reference to EBM, there is an implicit acknowledgement of EBM for DSM activities. For example, in the responsibility of the ISA "*to ensure effective protection for the marine environment from harmful effects which may arise from such activities*" (UNCLOS, 1982 - Article 145) (Enright and Boteler, 2020; Guilhon *et al*., 2020). More recently, the ISA's commitment to promote a regime that is compatible with EBM elements is demonstrable in its Strategic Plan for the period of 2019-2023 (ISA, 2018). Again, without explicitly mentioning EBM, this high-level document elaborates on EBM-related components via strategic directions such as the alignment with global commitments (e.g. Agenda 2030 and the Sustainable Development Goals), increased participation of stakeholders, improving transparency, adopting best practices and designing an adaptive regulatory framework, just to name a few. Moreover, according to the ISA Strategic Plan, these strategic directions should "*be supplemented*

by an action plan, including key performance indicators", that currently does not include explicitly refer to EBM (2019b).

The ecosystem approach, according to the terminology used by the ISA, is presently reflected as a fundamental policy and principle in the draft exploitation regulations under discussion at the ISA (ISA, 2019). However, to date, there has neither been any clarification about what the ISA – as regulator – considers to be an ecosystem approach or EBM, nor how mining contractors should relate to and implement such a concept (Guilhon *et al*., 2020). Indeed, such clarification is widely perceived as an important aspect to advance the operationalization of EBM under the ISA regime (Guilhon *et al*., cap. 3). If adopted as it currently stands, the draft exploitation regulations will be the sole document in the Mining Code[3] suggesting the adoption of the approach, although significant gaps remain with regards to recognizing EBM-related elements throughout ISA documents (Guilhon *et al*., 2020; Guilhon *et al*., cap 2). Additionally, there is no explicit mention of EBM in relation to exploration activities, though such consideration would be consistent with requirements under UNCLOS relating to the protection and preservation of marine environment (Jaeckel, 2015).

Turning to EIAs, the assessment of environmental impacts can benefit from operationalizing EBM principles (Wawrzyczek *et al*., 2018) through a systematic, participative, transparent, and science-based approach, which provide a reliable background for ecosystem characterization, including structure, processes, functions, and services. In addition, a description of the area where the activity is intended to take place should collate potential pressures, such as from other uses and natural factors, as well as harbour particularly threatened species and habitats and conservation designations. Premised on the aim to strike an effective balance between the maintenance of ecosystems and use of resources, EIAs should also present alternative options and justification to choosing equipment and location, assess cumulative impacts, and determine appropriate mitigation and monitoring strategies. Finally, the uncertainties that persist should be highlighted and, on the part of the regulator, precautionary decision-making should be taken and reviewed in an adaptive management cycle.

Due to the wide scope of coverage and flexible nature of EBM, the exercise proposed in Section 5.3 do not intend to represent as a singular EBM-pathway for EIAs in the context of DSM.

[3] https://isa.org.jm/mining-code

In fact, investigating and understanding EBM potentialities of operationalization should be a subject of continuous exercise, reflection and interpretation, which this study intends to inform.

5.3 The exercise: EBM-guided EIAs at the ISA

A promising way to improve the operationalisation of EBM within the ISA regime is by ensuring that efforts to assess the likely environmental impacts of DSM-related activities in the Area are guided by EBM principles. For this, we rely on the most recent versions of the Recommendations for exploration activities issued by the Legal and Technical Commission ("LTC Recommendations" – ISA, 2020), the current draft for exploitation regulations (ISA, 2019) and the relevant drafts of standards and guidelines [4], and publications available on the topic.

The present study does not follow the EIA steps provided by the ISA Standards and Guidelines (ISA, 2022b) for the environmental impact assessment process the document does not reflect the EIA for DSM systematically. The EIA process was divided in two different phases: before and after the planned activities requiring an EIA are in place. Such division was established so there is a clear distinction between the steps that are part of the elaboration and development of studies (before submission to the ISA) and the period in which they take place in practice (Table 2). In relation to the steps to take place before activities start, these were based on Guilhon *et al*. (2022). As presented in Table 2, the EIA stages followed the framework foreseen for the exploitation phase, which does not apply integrally for exploration[5] (Guilhon *et al*., 2022). Nevertheless, whenever applicable, the study also explored aspect from the exploration phase. As EBM should be transversal to all EIA steps and DSM activities are expected to occur in extensive time and impact scales, the present work included follow up elements, such as reporting and auditing.

Based on the findings in the EIA literature (focusing on DSM) and on the experience of the authors, EBM principles were attributed to each phase of the EIA. The principle "Use of

[4] The documents considered by the analysis include standards and guidelines for the environmental impact assessment process (ISA, 2022b), guidelines for the preparation of environmental impact statements (ISA, 2022c), guidelines for the preparation of Environmental Management and Monitoring Plans (ISA, 2022d, 2022e), standards and guidelines to the development and application of environmental management systems (ISA, 2022f) and the guidelines on the tools and techniques for hazard identification and risk assessments (ISA, 2022g).

[5] As the findings of Guilhon et al. (2022) reveal, there is no screening or scoping phases foreseen for when contractors submit an EIS for exploration. Additionally, during exploration, a monitoring programme should be contained within the EIS and not separately, as in the case of the Environmental Management and Monitoring Plan (EMMP), to be presented when applying for a plan of work for exploitation. A Closure Plan does not apply for the exploration phase, and an auditing phase is not foreseen.

Incentives" (code 24 in Table 1) was not included following the results of Guilhon *et al*. (2020), which classified the principle as "not applicable" to ISBA/25/LTC/6/Rev.1 and Annex IV of ISBA/25/C/WP.1. Thus, twenty-five EBM principles were analysed against the eight EIA-steps described in Table 2. based on the previous analysis from Guilhon *et al*. (2020). To avoid misinterpretations arising from the use of different textual descriptions to refer to the same principle, the excerpts containing the principles are marked in bold and follow codes, according to Table 1.

The outcomes obtained from our analysis considering EBM principles for each of the EIA steps are summarized in Table 2 and will be further discussed in the following sections in turn.

Table 2. Analysis of applicability of Ecosystem-based Management principles in relation to the phases of an Environmental Impact Assessment (EIA) for deep-sea mining. EIA steps were named and defined based on Guilhon *et al*. (2022) before and after mining-related activities are in place. Moreover, the table was partially based on the content of the draft Standards and Guidelines for EIAs issued by the ISA (ISA, 2021b). EBM principles proposed by Long *et al*. (2015) are represented by the code numbers determined in Table 1. Considerations on EBM for the development of EIS were addressed at the step "Assessment of impacts" whereas EBM principles attributed to the Environmental Management and Monitoring Plan and the Closure Plan are described under "Preparation of Environmental Plans".

Stage	EIA steps	Definition	Applicable EBM principles
Before activities take place	Screening	Step used to determine which projects should be subject to an EIA and to exclude those unlikely to have harmful environmental effects	4,5,6,7,11,12,20
	Scoping	Aims to identify the issues and activities that are likely to be important for the project and its EIA; define the focus of the EIA studies and identify key issues that shall be studied in more detail	2,3,6,7,8,10,11,12,13,16, 17,20,23,25
	Assessment of impacts	Provides the basis for determining the significance of impacts; the development of mitigation to be incorporated into design and project planning; identify and evaluate appropriate measures to avoid or minimize predicted harmful impacts. The output takes the form of an Environmental Impact Statement (EIS)	6,8,9,10,13,17,20,21,22, 23,26
	Preparation of Environmental Plans	The Environmental Plans (EPs) include the EIS, Environmental Management and Monitoring Plan and the Closure Plan	1,8,9,13,14,15,17,19,20,25 (EMMP) 13,14,20,25 (CP)
	External review	EPs are sent for stakeholder to comment	18,20
	Decision-making	Consideration of the proposal by the LTC (report and recommendation to the Council) and Council	19,20
Activities in place	Reporting	Submission of annual reports by contractors	20
	Auditing	Ensures that conditions are met, impacts are adequately monitored, and the effectiveness of mitigation and management measures can be assessed	20

5.3.1 EIA steps - before mining activities take place

5.3.1.1 Screening

The nature of activities that require an impact assessment during exploration, informed through workshops (International Seabed Authority, 1999, 2007), are currently reflected in Section IV.B of the LTC Recommendations (ISA, 2020). For mining activities at the exploitation stage, although screening is mentioned as one of the outsets of the EIA (ISA, 2019 – Draft Regulation 47.b), it appears to be less relevant as commercial scale mining activities will undoubtedly have to

go through EIA processes[6]. In other words, prior to the approval of an exploitation application, all activities relating to actual commercial mining will be subjected altogether to an EIA process and reported in the EIS that, together with the Environmental Monitoring and Management Plan and the Closure Plan (ISA, 2019 – Draft Regulation 7.3) are collectively referred as "Environmental Plans" (ISA, 2019 – Draft Schedule) and should be submitted by applicants as part of the process for the approval of a plan of work for exploitation.

An EIA reflecting EBM principles is expected to account for the environmental conditions in the contract area where test-mining or future exploitation activities are intended and at the time when they are about to take place. Ideally, a screening phase should take place at the beginning of exploration (Clark, 2019). For instance, the presence of **critical habitats or high biodiversity value (#4)** such as Ecologically and Biologically Significant Areas (EBSAs), Vulnerable Marine Ecosystems (VME) or Marine Protected Areas (MPAs) established by other bodies should be acknowledged (Billett *et al*. 2015; Christiansen *et al*., 2022) and considered for evaluation as part of the screening. In case such ecosystem features or management measures are identified, the conduction of test-mining activities (and consequently, approval of a plan of work for exploitation) should not proceed there.

Screening should identify other uses of the marine environment in the space, including where there are several mining contracts (both exploration and exploitation) in the same region. Therefore, already at the screening phase, the **environmental setting (#11, #12)** of the location (Durden et al., 2018), potential **cumulative impacts (#6)** (Billet et al., 2015) and conflicts deriving from other marine uses or parallel exploration/exploitation contracts should be considered, together with the **potential for transboundary effects (#7)** and the **capacity of ecosystems to regenerate (#5)** (Billet *et al*., 2015; Niner *et al*., 2018; Paul *et al*., 2018).

In case of material change during exploitation (i.e. where important elements that formed part of a plan of work that was approved, such as physical modifications, the use of knowledge or technology, or operational plans and management, have changed), screening should define the need

[6] According to the Draft Standard on the EIA process issued by the ISA (ISA, 2022b): "Screening is a step used to determine which projects should be subject to EIA and to exclude those unlikely to have harmful environmental effects. When submitting an application for exploitation, all applicants are required to undertake an EIA. However, there could be situations such as when an exploitation contract has been approved and the project subsequently has undergone a change that could result in different environmental effects that may be of some significance. The screening process should determine whether or not a new EIS (or another mechanism such as an addendum to the EIS) is needed."

for a new (or amended) EIS. To what extent changes in location, technology or knowledge will characterize material change remains unclear (Guilhon *et al*., 2022), however, such determination should be based on the most recent **available knowledge (#11, #12)**. Screening would benefit from **stakeholder consultation (#20)** (Billet *et al*., 2015), especially about inputs coming from independent experts. Moreover, the public should be, at least, notified of the outcomes arising from screening (Bradley & Swaddling, 2018).

5.3.1.2 Scoping

The scoping phase should be based on the screening outcomes. Scoping serves to identify and prioritise those activities of the operation that are likely to cause environmental (or operational/safety) risks by means of an Environmental Risk Assessment (ERA). As a result of this step, a scoping report should be prepared and issued as agreed terms of reference (ToR) (European Commission, 2001). Following this, the prior assessment of impacts will then focus on those actions involving notable risks, establishing an impact hypothesis to be falsified/verified by assessment and monitoring of the actual impacts during the mining operation.

Currently, no scoping is foreseen to the test of mining equipment during exploration activities. Instead, contractors rely on a general list of data requirements provided by the LTC Recommendations (Guilhon *et al*., 2022). Additionally, the LTC Recommendations do not require the consideration of alternatives or the performance of a risk assessment, both of which are usually requested by established EIA frameworks elsewhere. Moreover, contractors seem to hold a large degree of discretion on to what extent information will be provided during exploration (Guilhon *et al*., 2022). Regrettably, this is not an appropriate procedural format to ensure that sufficient and reliable baseline data is collected and assessed against impacts during the exploration stage, particularly considering that such exploratory activities are conducted with the aim of working as an informing continuum towards exploitation (ISA, 2022j). In that sense, a more clear, systematic, and transparent evaluation of EIS delivered by contractors during exploration is required (Guilhon *et al*., 2022).

In relation to exploitation, as for the screening phase, the current draft for exploitation regulations refers the inclusion of a scoping process as part of an EIA that ultimately will result in the production of an EIS (ISA, 2019 – Draft Regulation 47.b) but do not provide any further clarity on how applicants should comply with it (Guilhon *et al*., 2022). Objectives and a general guidance

on scoping are, for the first time, introduced in the draft standards for EIA (ISA, 2022b). According to the document, scoping shall be undertaken with the aim to identify activities that are likely to be important for the mining project (ISA, 2022b – Section C.9.a), define the focus of the EIA studies (ISA, 2022b – Section C.9.b) and identify key issues that should be studied in more detail (ISA, 2022b – Section C.9.c).

In order to achieve that, scoping shall (among others items listed in Section C, item 10 of EIA standards) be undertaken with a "reasonable understanding of environmental setting for the project", include the consideration of alternatives, establish the technical, spatial and temporal constrains for the EIA, comprise an ERA, address inherent uncertainties through a precautionary approach, offer a structured plan for the EIA (including activities to be undertaken in each step and proposed approaches and methodologies for addressing key issues) and produce a scoping report. Although such aspects are of utmost importance in the development of an EIA process, they remain very general as currently described in the ISA draft standards. For instance, the expression "with reasonable understanding of environmental setting" is rather subjective and, without any established criteria for what constitutes "reasonable understanding", there is room for a broad interpretation, potentially resulting in the presentation of insufficient data. Conversely, the draft guideline for EIA seems to present a clearer pathway on what are the steps present within a scoping process and how to comply with them (ISA, 2022b – Draft Guidelines). Nevertheless, in contrast to standards which are legally binding, guidelines are non-binding (and thus, there is no express obligation of compliance).

Insufficiency of baseline information and reliable data has been pointed out as flawed aspects of the EIA process at the ISA. Obtaining satisfactory baseline information[7] through the collection of quality data is key to guarantee that a minimum set of information needed to evaluate future consequences from mining are available and that these are collected and evaluated in line with best scientific standards (**use of scientific knowledge #12**) and delivered by contractors (Billet

[7] By May 2022, the ISA has issued a draft guideline for the establishment of baseline environmental data (ISA, 2022h), which should guide the collection of data by contractors and applicants and should be read with the recommendations for the guidance of contractors for the assessment of possible environmental impact arising from exploration of minerals in the Area (ISBA/25/LTC/Rev.1 and ISBA/25/LTC/Rev.1/Corr.1). The scope of the present manuscript, nevertheless, does not intend to evaluate and discuss the issue of data to inform baseline studies, (i.e., parameters and spatial and temporal variability) that should respond to EBM goals and objectives (for more discussions on this issue please refer to Amon, *et al*., 2022; Clark *et al*., 2019; Diva *et al*., 2022; Clark *et al*., 2019; Christiansen *et al.*, 2022; Hitchin *et al*., 2022; Levin *et al*.., 2009, Tunnicliffe *et a*l., 2020).

et al., 2019). Ideally, baseline information should reflect small-scale local variability and **account for the natural dynamics of benthic and pelagic ecosystems (#2)** in **appropriate spatial and time scales (#25)**. Contractors should be required to deliver quality environmental information that allows for comprehensive understanding ecosystem structure and functioning over space and time, including the **consideration of ecosystem services (#3)** (Billet *et al*., 2019; Guilhon *et al*., 2020), instead of merely providing extensive descriptive information that is of limited use (Clark, 2019). Such information can be supplemented with desktop studies and databases provided by industry, governmental, international organizations, and incorporate local and traditional knowledge (i.e., **using all types of knowledge; #11**) (Collins *et al*., 2013; DOSI, 2021).

Information on natural processes at the appropriate spatial and temporal scale, including the use of models (Clark *et al*., 2017), is extremely relevant to identify those ecosystem changes that are likely to be caused by mining-related activities. Recent discussions based on the literature and consultation with stakeholders have shed some light on the needs and potential pathways in the direction of fulfilling in deep-sea knowledge required under DSM (Amon *et al*., 2022). Additionally, such data should be sufficient and suitable for use in subsequent monitoring and management activities (Billet *et al*, 2019). In consonance with EBM, human and natural systems are to be viewed as constituents of a whole (eco)system under the logic of **coupled socio-ecological systems (#23)**, where socio-economic aspects should be integrated (**consider interdisciplinarity #10**) together with the **evaluation of trade-offs (#16)** (Billet *et al*., 2019). Such approach should guide the consideration of alternatives for the mining project, such as the use of mining technology and mitigation measures employed, the determination of impact and control reference zones. All information obtained should inform the process of ERA.

A preliminary ERA should identify, on a qualitative basis, the type of environmental impacts and extent to which the proposed activities may affect the marine environment (Clark *et al*., 2019; Durden *et al*., 2018; Ellis *et al*., 2017). According to the ISA Guidelines for EIA (ISA, 2022b), as a first step, impacts that could result in harm to the marine environment and potential receptors from such impacts are to be identified. Following that, the magnitude of expected impacts should be measured against the receptor's characteristics such as importance and sensitivity. As the ocean has no physical borders, the identification and assessment of **cumulative impacts (#6)** are key for a robust ERA, whereby the current lack of its consideration at the ISA represents a shortcoming for the EIA processes (Clark *et al*., 2019). Pressures coming from additional mining

activities, other marine uses and impacts due to natural global processes, such as climate change (Cormier *et al*., 2019; Levin *et al*., 2020; UNFCCC, 1992; Warner *et al*., 2018), should be mapped and evaluated as potential sources of combined risks. In comparison to individual effects, the consideration of cumulative impacts should account for intensity, magnitude, extent, and receptors (Judd *et al*., 2015) and be based on the knowledge available and expert input. Here, the consideration of and having due regard for activities other than mining as well as better communication with other user sectors are primordial for the identification of potential **effects in adjacent ecosystems (#7)** (Drazen *et al*., 2020) and a more accurate designation of source of impacts. Ideally, a first, more qualitative ERA should take place during test-mining activities at the exploration phase, and later a more quantitative and detailed ERA, combining field data collection with the scientific knowledge available (including ecosystem modelling tools) (Collins *et al*., 2013), should be included as part of the application to an exploitation contract (Clark *et al*., 2019).

Based on the characteristic of the activity and availability of data obtained during scoping, **the uncertainties (#8)** should be highlighted in the scoping report, including the level of confidence resulting from the ERA that will guide future collection of data and further EIA steps. According to the draft ISA guidelines on EIAs, the identification and detailing of uncertainties should take place throughout the EIA process. An approach to identify uncertainties in line with EBM is described in the guidelines, as follows: "Acknowledge uncertainty, arising when there is incomplete understanding of structures, processes, interactions or system behaviours" (ISA, 2022b – Section F.84.a) and "Uncertainty related to the unpredictability of chaotic (often random) components of complex systems or of human behaviour" (ISA, 2022b – Section F.84.b). Such statements reflect a more encompassing view of what should be considered and assessed in an EIA in consonance with EBM by explicitly taking into consideration existent interlinkages within natural systems (structure, processes, interactions) and acknowledgement of the human dimension (e.g., human behaviour). A scoping report compatible with EBM should also consider the existence of other international commitments, codes, regulations, and practices from other sectors, especially concerning conservation (**integrated management - #17**), although management responsibilities are allocated to different responsible authorities, as currently described as a non-binding requirement under the ISA Guidelines for EIAs (ISA, 2022b).

Moreover, the current draft for EIA standards lacks the consideration of **expert inputs (#20)** (Clark *et al*., 2019; Durden *et al*., 2018) during the scoping exercise. The same is observed

for **stakeholder consultation (#20)** (Murphy, 2020). In that aspect, several concerns have been raised related to the lack of stakeholder involvement in the assessment of impacts under both exploration and exploitation stages of the ISA process (Guilhon *et al*, 2022), which compromises its adherence to participatory and transparency aspects of EBM. Finally, the outcomes of the scoping process should be reviewed considering material changes in the project or new technologies and knowledge available. In case none of it applies, **the scoping process should be reviewed (#13)** every five years to accommodate other potential external changes (Durden *et al*., 2018; Durden *et al*., 2016; ISA, 2019).

Since it is necessary to ensure coherence between all phases of an EIA, ideally from the outset during the exploration stage, a point of attention refers to the transition between scoping and the assessment of impacts. To this end, it must be ensured that there are interchanges between EBM requirements between the two phases, ideally under standard requirements.

5.3.1.3 Assessment of impacts and mitigation

The assessment of impacts forms the core of the EIA process and is carried out with the aim to focus on the main sources of impacts arising from the planned activity and provide information on their nature and extent (Clark *et al*., 2019, 2017). At this stage, the results from the ERA should facilitate the prioritisation of risks to be assessed (SPC, 2016).

Currently, the assessment of environmental impact is only cursorily addressed with respect to mining activities that require an EIA during exploration, namely, test mining (Guilhon *et al*., 2022). In fact, the LTC Recommendations do not provide any clear guidance on how impacts should be assessed and mitigated. The only basic direction is featured in the text and template contained in Annex III of the LTC Recommendations, which provided that the EIS resulting from test-mining activities should document "the way in which environmental assessment has been undertaken, including the predicted impacts of the project, proposed measures for mitigation, the significance of residual effects and the uncertainties that affect the predictions" (ISA, 2020), while the need for contractors to assess and propose mitigation on the physico-chemical and biological environment is stipulated in the same template (ISA, 2020 – items 6 and 7 of Annex III).

Beyond the LTC Recommendations (ISA, 2020), two guideline instruments under discussion at the ISA in relation to exploitation activities have the potential to influence the

assessment of impact during the exploration phase. The first refers to standards and guidelines on the environmental baseline data (as discussed above), which will play a key role in determining what should be addressed under the scoping phase and later prioritized by the phase of assessment and mitigation of impacts. The second is the draft guidelines on the tools and techniques for hazard identification and risk assessments (ISA, 2022g), which states that it should be read in conjunction with the exploration regulations. It is yet to be clarified how future approved guidelines applicable to exploitation will be incorporated into exploration contracts and activities that are already ongoing.

For exploitation, the assessment of impacts and establishment of mitigation measures should be based in a more mature ERA (Washburn *et al*., 2019), which, in turn, is to be developed based on the advancement of data collection and addressing knowledge gaps identified during exploration. According to the current Standards for EIAs, contractors shall consider a) the nature of the impact; b) the potential extent, duration, frequency, and severity of the impact; c) whether the impact is direct or indirect; d) cumulative and combined impacts; e) routine and non-routine impacts, and f) the uncertainty associated with the assessment of impacts (ISA, 2022b – Draft Standard, Section D.12). Further, significance of impacts shall be identified considering regional scales, which should allow mitigation of harmful effects to be considered (ISA, 2022b – Standard, Section D.15). In relation to mitigation, contractors shall apply the mitigation hierarchy, and include the examination of alternatives to establish the most technically and economically feasible, safe, and environmental sound approaches for achieving the project objectives (ISA, 2022b – Draft Standard, Section E.17).

The acknowledgement of uncertainties encompassing the assessment of impacts is a critical aspect of EBM. Uncertainties should be highlighted not only in terms of gaps in knowledge, but also in relation to prediction and modelling predictions and impact significance. Nevertheless, as mentioned above, the draft Standards for EIAs only treat uncertainties under very general terms, which are instead more comprehensively addressed in the draft Guidelines for EIAs. The very same applies for cumulative impacts, and therefore imposing more robust and binding requirements would be critical to ensure that these critical aspects are appropriately reflected in EIAs.

In the practice of domestic EIAs, the assessment of impacts is usually based on the outcomes of the scoping report, usually in the format of a Term of Reference (ToR) developed together with the regulator. In other words, the ToR will focus on the key aspects that should

covered by the assessment of impacts undertaken by the contractor. The current process at the ISA does not anticipate the development of a ToR, which could be seen as a shortcoming. Moreover, social, economic, and cultural aspects are presently not central requirements for consideration as part of the assessment of impacts, and little detail is available on the consideration of this type of information that is to be delivered as part of an EIS for exploitation activities both in the current drafts under discussion for exploitation regulations (ISA, 2019), standards and guidelines for EIA processes (ISA, 2022b) and guidelines for preparing EIS (ISA, 2022c). In this aspect, contractors should be guided on how to **provide the economic context (#22)** within which such activities will benefit the humankind (**commit to principles of equity - #21**) and account for potential costs (Thompson *et al*., 2018), especially for exploitation. The importance of considering socio-economic and cultural aspects on DSM in impact assessments has been highlighted in the literature (Clark *et al*, 2017; Durden *et al*., 2017, Tilot *et al*., 2021), including in terms of potential effects for coastal communities (Popova *et al*., 2018). In this respect, acknowledging that human and environmental dimensions are intertwined (**coupled socio-ecological systems - #23)** and are to be managed as one whole integrated system (**integrated management - #17**) is essential. Further, the acknowledgment of social, economic, and cultural aspects strengthens (and also increase the demand for) the **interdisciplinarity (#10)** aspect that is intrinsic to EBM.

The effects from test-mining and exploitation should not only be managed from the perspective of the seabed alone but be put in context with the long-term full scale effect of such activities on the functioning of the deep sea ecosystem, including the potential impacts to the water column (Christiansen *et al.*, 2019; Drazen *et al.*, 2020) and the vertical and horizontal spatial and temporal extent of the mining-related plumes (Jones *et al*., 2018). A **precautionary management (#9)** of activities can only be successful if applied within the presumed diversity of ecosystem boundaries (**considering distinct boundaries - #26**) (Levin *et al*., 2009).

The ERA, as an element of EIAs, not only highlights the main sources of risk coming from mining-related activities, but also plays a key role in identifying **cumulative impacts (#6)** and **acknowledging uncertainties (#8)** related to the effect of the mining activity. At this phase, like the evaluation of mitigation measures through a mitigation hierarchy (Niner *et al*., 2018), uncertainties can be identified, reduced, and managed when unavoidable (Rouse and Norton, 2010; Clark *et al*., 2019). Moreover, the **adoption of a precautionary approach (#9)** in combination with **adaptive management (#13)** cycles are advisable under great uncertainties scenarios as under

DSM activities (Durden *et al*., 2018; Guilhon *et al*., 2020). With respect to the later, it has been argued that the institutional structure at the ISA under which DSM will operate may pose a challenge to an effective implementation of adaptive management (Craik, 2020), which would require the adoption of procedures that allow for adjustments based on new information or knowledge available (Jaeckel, 2016). One of the proposed approaches to minimize knowledge uncertainties is to enhance the **involvement of stakeholders (#20)** and external experts that could provide further inputs in relation to risks and potential consequences of the proposed activity (Lallier and Maes, 2016; Washburn *et al*., 2019).

Finally, the EIS deriving from the assessment of impacts (both for exploration and exploitation) should contain a summary of the monitoring scheme foreseen during and after the activities subject to the studies are in place. The issue of monitoring will be further addressed in section 5.3.1.4.1.

5.3.1.4 Preparation of Environmental Plans

5.3.1.4.1 Environmental Management and Monitoring Plan

As will become clear with the discussion below, the monitoring and management component of the EIA process at the ISA is rather ambiguous. When planning to conduct activities that require an EIA during exploration, contractors are not required to formally submit an Environmental Monitoring and Management Plan (EMMP). Instead, the contractors should provide a monitoring program detailing the assessment of impacts of test-mining activities, in accordance with a list of "Observations and measurements to be made after undertaking an activity that requires an environmental impact assessment during exploration" (ISA, 2020 - Section D), which should feature in the EIS. This is included in the Template available in the Annex III under the heading "Environmental management, monitoring and reporting" (ISA, 2020 – Template). The submission of such information, however, may vary as contractors are required to "provide the Secretary-General with some or all of the (...) information, depending on the specific activity to be carried out" (ISA, 2020 - Section D.40). Such a broad provision creates an opening for contractors to provide information according to what they deem necessary and poses a challenge for the ISA when evaluating the monitoring and management aspects of exploration activities requiring an EIA such as test mining.

At the exploitation phase, the practice with respect to environmental monitoring and management foreseen by the ISA seems to take a different approach as compared to the general EIA practice. While general EIA practices typically situate the monitoring and monitoring component within the EIS itself, the ISA regime provides that when applying for a plan of work for exploitation, the monitoring and management components should be presented separately from the EIS, i.e. as an Environmental Management and Monitoring Plan (EMMP). Such separation is rather appropriate, as unlike the EIS (which will primarily be used to inform the decision-making process when considering the application), the EMMP will subsist during the life of the mining project and will form the basis for contractors to execute monitoring and management efforts throughout the exploitation phase. Likewise (and relevant to the assessment of impacts), alongside the EIS and EMMP, applicants would also need to submit a Closure Plan for approval together with the application for an exploitation plan of work, which will be discussed later.

According to the draft exploitation regulations "the plan will set out commitments and procedures on how the mitigation measures will be implemented, how the effectiveness of such measures will be monitored, what the management responses will be to the monitoring results and what reporting systems will be adopted and followed". Elements to be contained in the EMMP are listed by Annex IV.2 of the draft for exploitation (ISA, 2019), while additional guidance on the development of EMMPs have been provided by a draft guideline (ISA, 2022d). According to the draft guidelines, among others, an EMMP: should identify scientific uncertainties and include adaptive management strategies and apply the precautionary approach to managing uncertainty; establish specific commitments to auditable and measurable outcomes and clear time frames; and outline the actions that a contractor will take in the event that operations result in unanticipated environmental effects of if EMMP performance objectives are not met (ISA, 2022d – Section II.14). As a guideline, the requirements there listed are not legally binding, and therefore, the quality and robustness of individual EMMPs may vary quite largely.

The EMMP shall provide details regarding mitigation measures and comprise an **appropriate monitoring (#14)** program to verify if the effects of the managed activities are in consonance with the proposed EIS and the regional environmental goals and objectives (**develop long-term objectives – #15**) towards a **sustainable (#1)** management of activities, based on what has been provided by the applicable Regional Environmental Management Plan (REMP) established by the ISA **(integrated management - #17)** (ISA, 2019 - Regulation 48 (a) and (b)).

The parameters to be monitored include those that feature in the baseline studies, the EIA and EIS (ISA, 2022d – Section E.37), including during to exploration phase (ISA, 2022d – Section E.41). Such parameters are expected to be further described in the guidelines for establishment of baseline data, standard and guidelines for EIAs, and guidelines for the preparation of EIS (ISA, 2022d – Section E.37). Therefore, it is key that that the collection of baseline data, and procedures and content highlight the importance of having harmonization between the requirements and procedures of exploration and exploitation phases. Monitoring should include **appropriate spatial and temporal scales (#25),** which together with the monitoring technology, should provide a degree of confidence that environmental effects are as anticipated and that performance standards are being met (ISA, 2022d – Section E.41).

Additionally, details on the implementation of a mitigation hierarchy should be provided in accordance with the application of a **precautionary approach (#9)** (Durden *et al*., 2017; Jones *et al*., 2019, Billett *et al*. 2019) and have **uncertainties acknowledged (#8)**. In this regard, a recent proposal by Germany could include a relevant precautionary mechanism before commercial mining starts. [8] According to the proposal, compulsory testing of full mining systems should be required before the start of commercial production as a "checkpoint" to evaluate the technical capacity of the proponent to conduct mining operations and manage the harmful effects of mining (Singh, 2021). Monitoring and assessment programs, as well as the resulting regulation, should also be reviewed periodically, including by **independent experts (#20)**, and adapted from time to time according to the needs arising from the new information (**adaptive management - #13**). As presented above, aspects encompassing uncertainties, the precautionary approach and adaptive management are currently provided by the ISA guidelines, however, there is no obligation of compliance to it due to its non-binding nature.

As the EMMP is part of the Environmental Plans to be submitted when applying for a plan of work for exploitation, the same EBM principles discussed as applicable to EIS in terms of reporting (section 4.4), external review (section 4.5) and regulatory review and approval (section 4.6), are also applicable to EMMPs.

8 See written comments submitted by the Federal Republic of Germany in respect of the draft exploitation regulations, 2019. https://isa.org.jm/files/files/documents/191015_ISA%20draft%20exploitation%20regulations_comments%20Germany. pdf pp. 5–6 and 19–20.

An EMMP should contain details of the environmental management system (EMS) and the applicant's environmental policy (ISA, 2019 – Draft Annex VII.2.d). According to the draft for exploitation activities, an EMS shall deliver site-specific environmental objectives and standards in the EMMP; be capable of cost-effective, independent auditing by recognized and accredited international and national organizations; and permit effective reporting to the ISA in connection with environmental performance (ISA, 2019 – Draft Regulation 46.2). This description, nevertheless, does not provide clarification on what is the purpose of an EMS.

Some clarification is provided later by draft standards and guidelines released in 2022 (ISA, 2022f). According to the standard draft, an EMS "is that part of the overall mining operational management system applied by a contractor that includes organizational structure, planning activities, responsibilities, practices, procedures, processes, and resources for developing, implementing, achieving, reviewing, maintaining, and reporting on the environmental policy, goals, and objectives and environmental performance." The EMS shall ensure the prevention, reduction, and control of pollution of the marine environment from mining operations is consistent with the environmental objectives and in conformity with recognized standards and systems, including from the International Organization for Standardization (ISO). A proposal on how to design an EMS is further provided by the guidelines on the subject and includes aspects of leadership, requirements, operations, monitoring and performance evaluation and audits (ISA, 2022e). To ensure that contractors are able to develop and implement and effective EMS in line with EBM, contractors would need to adopt necessary measures internally (i.e. **organizational change - #19)** to ensure that it has the requisite technical, scientific, and governance capacity to implement the EMS.

5.3.1.4.2 Closure Plan (pre and post commercial activities)

A Closure Plan (CP) establishes the responsibilities and actions of a contractor during the decommissioning and post-closure of mining activities in the Area. The CP should include the post-closure management and monitoring of residual and natural environmental effects (ISA, 2019 – Draft Regulations 59.1). The CP also applies in case of the temporary suspension of activities (ISA, 2019 – Draft Regulation 29.3). Among other objectives, the CP should ensure that: when of cessation or suspension of activities, a management and monitoring plan is in place for the period prescribed in the CP; any residual negative environmental effects are identified and quantified, and

management responses are considered, including plans for further mitigation or remediation where appropriate; any restoration of rehabilitation commitments will be fulfilled in accordance with predetermined criteria or standards (ISA, 2019 – Draft Regulations 59.2) (**appropriate monitoring - #14**). A CP shall be updated every time there is a material change in a plan of work, or, at least, each five years (**adaptive management - #13**). In that sense, the CP should be closely connected to what is established in the EMMP.

Annex VIII of the draft exploitation regulations provide preliminary guidance on what is expected to be contained in a CP. The requirements for information include: data and information relating to baseline conditions for monitoring measures; an updated environmental impact assessment for the activities that will be undertaken during closure, if any, together with details of the identifiable residual environmental effects; details of the monitoring to be undertaken during and after closure that specify the sampling design (**appropriate spatial and temporal scales - #25**), the methods to be used and the duration of the post-closure activities; details of the management measures to mitigate the residual environmental effects; details of any restoration objectives and activities; and information on reporting and management of data and information post-closure. Annex VIII, nevertheless, does not provide details if the information required for the first and final CP will be different. It is expected that such level of details is provided by the future standards and guidelines on the matter and ensure the involvement of **independent experts and stakeholder consultation (#20)** in the review of plans before the submission to the ISA. External experts should also be involved in the processes of review in light of material change or each five years.

As the CP is part of the Environmental Plans to be submitted when applying for a plan of work for exploitation, the same EBM principles discussed as applicable to EIS and EMMP in terms of reporting (section 4.4), external review (section 4.5) and regulatory review and approval (section 4.6), are also applicable to CPs.

5.3.1.5 External Review

In the case of an EIS submitted to the ISA for test-mining activities during exploration, where the contractor or sponsoring state has not conducted a stakeholder consultation before the submission and does not intend to do so, the ISA will publish the EIS on their website for public comments (ISA, 2020; Guilhon *et al*., 2022).

For EIS submitted as part of a plan of work for exploitation activities, the external consultation process is only foreseen once the ISA has received the full application of a plan of work. Thereafter, the Environmental Plans (comprised of EIS, EMMP and Closure Plan) that accompany the application for the approval of an exploitation plan of work is to be published in the ISA website and open for comments for a period of 60 days (ISA, 2020; Guilhon *et al*., 2022). According to the text in the current version of the ISA Standards for EIAs, the reporting process sets out "(…) concerns raised by consultations and how they have been addressed" (ISA, 2022b, Section F.18). This provision is rather unclear, as the consultations of Environmental Plans are only foreseen to take place after these have been submitted as part of the application. Given the current wording, it is arguable that the current framework somewhat expects that a certain degree of consultation would have already taken place prior to submission to the ISA.

In line with a transparent and participatory process of decision-making, which ought to **reflect societal choice (#18)**, the submission of an EIS or (Environmental Plans in case of exploitation), should only take place after a first round of **external consultation with stakeholders (#20)** (UNEP, 2018) at the very least and ideally, also be evaluated by an **independent environmental committee (#20).** Premised on that, the contractors or applicants should then be able to address the concerns raised by consultations and further detail how these have been addressed. Only then should the EIS be submitted to the ISA for formal review.

As the mineral resources of the Area are the common heritage of mankind (UNCLOS, 1982 - Article 136), stakeholder consultation should be broad and involve scientists, civil society, international organizations, other sectoral parties, and the wider public. Moreover, it is also important to ensure that the exploration contractor or applicant for an exploitation contract be obliged to respond to each of the reviews and comments that are received, and for the ISA or sponsoring State to ensure that all comments submitted, as well as responses and proposed modifications to the respective EIS or Environmental Plans, are made public for the benefit of all stakeholders and interested parties to peruse. This is not the current practice as evident from prior precedents (Guilhon *et al*., 2022). Requests pertaining to a more comprehensive consultation process, including description consultation processes, protocols used for collecting, logging, and responding to stakeholder comments and a list of environmental review and consultation requirements under applicable regulations, are only referred to in the text of the draft Guidelines for EIS for exploitation (item 10, ISA, 2021c), which are non-binding.

5.3.1.6 Decision-making

A high level of transparency should also be implemented in the regulatory review and approval of impact assessments both during exploration and exploitation activities.

In addition, the ISA could **promote organizational change (#19)** through the establishment of a strong specialized scientific and environmental group of independent experts within the LTC or of an **independent expert scientific body (#20)** dedicated to evaluating such studies (Guilhon *et al*., 2022; Singh, 2021), ensuring that dedicated environmental experts are engaged in such decisions (Ginzky *et al*., 2020). The final decision of the regulator should also be made public together with detailed and reasoned considerations reflecting the acceptance or rejection of the EIS (for exploration) and Environmental Plans (for exploitation) (Lallier *et al*., 2016), including conformity with the ToR that should have been elaborated during the scoping phase (Bradley and Swaddling, 2018).

At present, there appears to be no formal decision-making on EIA procedures during exploration and the exploitation project applications adopted by the ISA (Guilhon *et al*., 2022). The LTC Recommendations and the draft exploitation regulations currently do not explicitly give the ISA the power to reject the EIS or other Environmental Plans submitted by the contractor (please refer to Guilhon et al., 2022 for further discussions).

5.3.2 EIA steps – After mining activities are in place

The EIA process does not end after the decision-making steps step (both for exploration and exploitation). After decision-making, the monitoring programme established under the EIS for exploration and the EMMP for the exploitation phase remain as "living instruments" that will secure compliance by contractors with respect to the monitoring programmes and strategies proposed and approved by the ISA. For that, two important stages should be considered: reporting and auditing.

5.3.2.1 Reporting

Both for exploration and exploitation activities, contractors are bound to submit annual reports to the Secretary-General (ISA, 2015, 2019) within 90 days of the end of each calendar year.

For exploration, contractors are requested to provide information on the environmental impact of exploration activities and include information on the monitoring programme before,

during and after activities with potential to cause serious harm (ISA, 2015 – IV.B.a). Additionally, contractors should provide a statement ensuring that activities covered in the annual report have not caused serious harm and present evidence of how this has been determined, as well as provide information on the environmental impact of test-mining activities in the respective impact reference zone (ISA, 2015 – IV.B.b and c). Observations and measurements required during and after mining activities that require an EIA, and that should be submitted in the annual reports are defined in ISA (2020 – Sections C and D).

For exploitation, the format of annual reports are described in Guidelines for EMMPs. Among other information, such annual report should contain information on "the actual results obtained from environmental monitoring programmes, including observations, measurements, evaluations and the analysis of environmental parameters. Reported against, where applicable, any criteria, technical Standards and indicators pursuant to the Environmental Management and Monitoring Plan, together with any response actions implemented under the plan and the actual costs of compliance with the plan" (ISA, 2019 – Draft Regulation 38.2.g).

The annual reports play an extremely important role, as they are the main channel for contractors to communicate compliance monitoring programmes and EMMPs. In practice, this include reporting any environmental effects observed and measures taken to address it. Such annual reports are then submitted to the Secretary-General. Additionally, contractors are bound to submit, at frequencies indicated at the approved EMMP, performance assessments. Such assessments, whose structure and content are indicated in the respective Guidelines (ISA, 2021d), aim to evaluate the compliance with mining operations and the adequacy of the EMMP (ISA, 2021d – Section F.3.50), with criteria under the form of objectives and standards (ISA, 2021d - Section F.4.53).

5.3.2.2 Auditing

Once commercial mining activities start, contractors are required to audit their activities in line with their proposed EMMP. Through audit processes, contractors should assess their progress with the mining project and ensure all contractual conditions are met, impacts are adequately monitored, and the effectiveness of mitigation and management measures can be measured (ISA, 2022b – Section X.120). Such process will then feed into the review of plan of work and EMMP (ISA, 2022b – Section X.121), as well as to verify that the potential impacts that were previously

assessed under the EIS were accurately identified and that the management measures put into place are effective. Contractors should report the results obtained from their monitoring programmes through annual reports, including a statement attesting that all risk management systems and procedures have been followed and remain in place, together with a report on exceptions and the results of any verification and audit undertaken internally or by independent competent persons (ISA, 2019 – Draft Regulation 38.h).

More specifically, the draft of exploitation regulations provides that the EMMP should contain detailed information of mining discharges, which should include a waste assessment and prevention audit (ISA, 2019 – Draft Annex VII.2.o). A preliminary guidance for waste assessment and prevention audit is contained in the draft guidelines for the preparation of Environmental Management and Monitoring Plans (ISA, 2022d). To guarantee the transparency and independence of processes, the auditing by **independent or third-part experts (#20)** should be an obligatory requirement established both at the draft for exploitation activities and as a standard practice under EMMPs.

5.4 Concluding remarks

The analysis above steps and principles clarified the importance of scoping as a crucial phase to ensure that EBM aspects are considered from the outset of the EIA process. Nevertheless, as things currently stand, the ISA regime does not require the performance of scoping when performing an EIA and submitting an EIS for test-mining activities during exploration. For exploitation, the analysis demonstrated that scoping was the EIA stage with the highest number of EBM principles associated to it. This is not surprising, given that scoping will dictate most of the relevant aspects that should be addressed by the impact assessment that follows. We therefore recommend that scoping be made a legally binding requirement when contractors apply for test-mining activities and harmonized with the requirements for the scoping phase when applying for an exploitation contract. In fact, harmonization of requirements and practices between the exploration and exploitation should be observed throughout the EIA process to optimize efforts and ensure cohesion.

The involvement of stakeholders, including the general public and external experts, was observed as applicable to all the phases of an EIA. As currently stands, the ISA practice only invite comments from stakeholders after the EIS (for both exploration and exploitation) has been

submitted to the ISA (Guilhon et al., 2022). This practice does not follow the best practices needed for an EBM-guided EIA process and can be much improved to ensure a more transparent and participative process (Guilhon et al., 2022).

The present study attempted to visualize how an ideal EIA process guided by EBM could look like at the ISA. It should be emphasized again that the study merely serves as a preliminary reflection on how EBM elements can be embedded into the EIA process at the ISA and is not intended to provide a sole and final answer on how this could be achieved. We hope that our findings in this study will contribute to inform further the ongoing debate on the draft exploitation regulations and drafts for standards and guidelines that relate to the assessment of environmental impacts.

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6. CONCLUSION

The present study evaluated the opportunities and challenges to EBM in the context of deep-sea mining (DSM) activities in the Area. To that, we explored different avenues, including core documents of the regulatory regime and stakeholders' perceptions. In addition, we proposed an exercise for a more profound look using the process of Environmental Impact Assessment as a study case. Our findings corroborate that EBM principles, as adopted in this study, are insufficiently reflected in the DSM regime administered by the International Seabed Authority (ISA).

Various challenges were identified throughout the different topics explored as part of this thesis. As the ISA currently indicates that foreseen exploitation activities should account for EBM, a key shortcoming identified encompasses the absence of a definition of EBM, as well as clear guidelines on its application, entails in practice. Although our analysis evidences an increase in the presence of EBM-associated terminology and requirements over the years, there is considerable room for improvement. For instance, there is no evidence of terminology or rationale related to ecosystem services, a primary goal of EBM.

As for ecosystem services, the acknowledgment of social aspects, including elements intrinsic to socio-ecological systems, is deficient. Broadly, these include transparency issues and lack of communication and engagement with stakeholders. The engagement with different stakeholders is a very relevant aspect that can impact the current development and future operationalization of a DSM regime and, therefore, should be properly considered. As also reflected by the literature, our findings demonstrate that there is a different perception of EBM and the potentialities and challenges for operationalizing EBM for DSM. Firstly, not all stakeholders hold the same understanding of what aspects comprise EBM. For instance, it is not unanimous that social aspects (reflected in the present work by socio-economic principles), including stakeholder participation, is a concept intrinsic to EBM. More common associations included Ecological and Impact principles. Other than that, stakeholders primarily associated management instruments such as Regional Environmental Management Plans and Environmental Impact Assessment/Statement as examples of ongoing EBM practices under the ISA.

As reiterated several times in this work, the assumption that a management instrument, even for established practices such as EIA, is inherently compatible with EBM must be carefully

considered, as this may not be the case. This was ascertained by both chapters that adopted EIAs as a study case. Many obstacles to holistic, participative, and integrative practices, in consonance with EBM, were raised for current requirements and procedures as requested by the ISA. Findings in this study indicate that the current EBM practice for EIAs, as currently provided by ISA regulations and recommendations, is flawed. As it stands, the current EIA process favors applicants and contractors, reflecting weak compliance reviews, low decision-making powers from the technical body of the ISA, the Legal and Technical Commission, and limited access to the substance before recommendation by the Council. Such results evidence the need for the ISA to strengthen its capacity as a regulator for mineral activities in the Area. Still, on a procedural matter, there is no anticipated participation of stakeholders, including independent experts, at the early stages of the EIA process. On that, more extension considerations should be regarded in the scoping phase, which is key to define what is the crucial information to be obtained during the assessment of impacts, as well as preliminary risk assessment, in a way to be aligned with EBM. As deep-sea ecosystems are largely unknown and the availability of data is limited, the consideration of expertise is key for determining what is unknown and what is the data to be incorporated into the assessment of impacts. Moreover, as it is a process related to resources considered as the common heritage of humankind, the ISA has the responsibility to communicate, inform and consult the public. At present, such a mechanism does not exist.

Notably, the analysis for the EIA chapters suggested a lack of coherence and consistency between requirements and practices for exploration and exploitation. Such a mismatch may implicate a waste of resources and time for contractors, the ISA, and external stakeholders. Nevertheless, a more systematic study comparing such requirements and discussing shortcomings and implications is recommended as a future study.

Several opportunities have been identified by this work as potential pathways to be taken to improve DSM practices and governance. A crucial aspect to not be overlooked is that the ISA is still currently developing what will compose a complete framework for DSM in the Area. In other words, this means that there is still considerable room to make changes before an exploitation code is agreed upon and commercial-scale activities start. Additionally, the ongoing process of defining Standards and Guidelines, which should be read together with exploitation (and in some cases, exploration) regulations, is a valuable opportunity, especially for determining obligations to be fulfilled by applicants or contractors. Such binding instruments could provide, to the extent

possible, the standardization of data presentation and procedural practices (e.g., EIA, EMMP, and EIS) in line with EBM. Nevertheless, the same does not apply to prospecting and exploration regulations, as these are already upon. For that, the proposal of amendments and reviews is a possible way forward, although changing a text already established could be an additional challenge.

Moreover, a significant opportunity for improvement comprises the multidisciplinary expertise existent and available to support ISA discussions. From natural and social sciences to law, politics, economics, arts, etc., these experts represent the interests of different social groups such as international organizations, civil society, academia, and industries, among others. In that aspect, the ISA can and should take advantage of the advancement of science and other non-formal sources of knowledge brought to the table by these stakeholders as foundations to regulate and develop a regime based on the best information available. The ISA also can be a pioneering regime that indeed acknowledges society's values and aspirations for the short and long term. In that direction, the ISA, with scientists and civil society, should decide the way forward in dealing with the existing uncertainties.

Adopting practices that reflect EBM is arduous and certainly unsuccessful if pursued individually. In that aspect, the ISA currently holds all the aces towards EBM if so desired by its stakeholders. The way forward lies within creating spaces and opportunities for such discussions to unfold. That should include providing the LTC, Council, Assembly, Observers, and members with the possibility of clarifying what EBM entails and what it could look like concerning the different aspects of the governance and management regime. The final say belongs to this community, which should nevertheless be aware of what such a decision (to adopt or not) may implicate. Such discussions can be materialized through creating a task force on the subject that should hold the responsibility to organize discussions and reunite voices through inter-sessional working groups, workshops, capacity development interventions, side events etc.

Recent events aiming to accelerate a consensus on the content of exploitation regulations (i.e., the call for the 2-year trigger rule by the Republic of Nauru) reveal that the present political momentum at the ISA does not play in favor of EBM. A rush in discussions will prevent us from asking the right questions, acting with precaution, listening to all the voices who want to speak, understanding trade-offs, and respecting thresholds. Efforts towards EBM will prevent a shot in the dark of the deep sea that may backfire on us.