

Environmental Impact Assessment process for deep-sea mining in ‘the Area’

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A B S T R A C T

Environmental Impact Assessment (EIA) is key to the robust environmental management of industrial projects; it is used to anticipate, assess and reduce environmental and social risks of a project. It is instrumental in project planning and execution, and often required for financing and regulatory approval to be granted. The International Seabed Authority currently requires an EIA for deep-sea mining (DSM) in areas beyond national jurisdiction (the Area), but the existing regulations present only a portion of a robust EIA process. This article presents an ideal EIA process for DSM, drawing upon the application of EIA from allied industries. It contains screening, scoping and assessment phases, along with the development of an environmental management plan. It also includes external review by experts, stakeholder consultation, and regulatory review. Lessons learned from application of EIA elsewhere are discussed in relation to DSM, including the integration of EIA into UK domestic law, and the reception of EIAs prepared for seabed ore extraction in the Exclusive Economic Zones of New Zealand and Papua New Guinea. Finally, four main challenges of implementing the EIA process to DSM in the Area are presented: 1) EIA process for DSM needs to incorporate mechanisms to address uncertainty; 2) detailed requirements for the EIA process phases should be made clear; 3) mechanisms are needed to ensure that the EIA influences decision making; and, 4) the EIA process requires substantial input and involvement from the regulator.

1. Introduction

Environmental Impact Assessment (EIA) is a key aspect of the planning and environmental management of commercial and industrial projects. The process is used to anticipate, assess and reduce environmental and social risks of a project prior to planning permission or regulatory approval being granted. As such, it is an important point for communication between the proponent, the regulator and stakeholders [1]. It is also often required to secure funding [2].

EIA is also an important mechanism for the International Seabed Authority (ISA), the body governing deep-sea mining (DSM) at the seabed in areas beyond national jurisdiction (‘the Area’). Through EIA, the ISA and its member states can operationalise several of their key obligations, such as applying the precautionary approach [3–5, paragraphs 131–132 in 6] and ensuring effective protection of the marine

environment from harmful effects of DSM, as required by the United Nations Convention on the Law of the Sea (UNCLOS) (Part XI Article 145 [7]). Part XI Article 145 in the EIA process allows identification and mitigation of such harmful effects to facilitate environmental protection.

There is a general consensus on the need for EIA in discussions on environmental protection in the Area across multiple stakeholders, including contractors, industry, intergovernmental organizations, scientists, lawyers and the ISA [8,9]. Moreover, EIA is an independent direct obligation of states under Article 206 of UNCLOS, and the Seabed Disputes Chamber confirmed EIA to be a specific requirement of the sponsoring states’ obligation of due diligence in relation to DSM [10,11]. The EIA process should enable the ISA to ensure that uniform and consistently high environmental standards are applied to all contractors. However, the legal instruments requiring states and

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contractors to undertake EIA are still incomplete, notably lacking a global detailed legally-binding requirement and mechanisms for supervision, compliance and enforcement [12].

This article examines the use of EIA as a tool for environmental protection and management in the context of DSM, drawing upon the application of EIA from allied industries. It concentrates on the EIA process, rather than on the technical aspects of preparing an EIA, which are covered in more detail for DSM by others [e.g. 13–15]. The existing requirements of EIA for DSM [3 Reg. 31(6), 4 Reg. 31(6), 5 Reg. 33(6), 16] contain little detail on its contents, and expansion of the appropriate contents has been proposed [17]; both are critiqued [18]. This article first discusses a number of key concepts relevant to the EIA process, and describes the existing regulatory framework, before outlining the ideal EIA process for DSM incorporating these concepts. It then describes some lessons learned from previous applications of EIA in related situations, and finally summarises the main challenges in implementing this EIA process for DSM under the current regulations.

2. Key Concepts: Uncertainty, the precautionary approach and adaptive management

A high degree of uncertainty exists in all aspects of the environmental management of DSM projects: a lack of environmental understanding at all spatial and temporal scales; mining and support technologies that are still under development; and environmental regulations that are still in draft form. Two key concepts have been identified to address this uncertainty: the precautionary approach [19] and adaptive management [20]. The precautionary approach is particularly relevant to EIA. In general, conducting an EIA is an element of operationalising the precautionary approach (19 chapter 5.4.1.2) and the precautionary approach should be applied at all stages of the EIA process, when evaluating predicted risks and selecting the best environmental practice(s) (BEP) as required by the ISA exploration regulations [3 Reg. 31(6), 4 Reg. 31(6), 5 Reg. 33(6) 16]. Thus, a precautionary approach is also vital to the practical implementation of an EIA.

Adaptive management, both active and passive [21], has been suggested as a mechanism for altering a DSM project to address uncertainties [e.g. 22,23–25]. Adaptive management is a deliberate process of staging an activity with planned monitoring, followed by a review of the monitoring results to improve understanding of the environmental impacts of the activity and the re-evaluation and alteration of the activity for the future [20]. To successfully apply adaptive management, sufficient points for investigation, review of findings, decision-making and implementation of changes are required in the management process. Adaptive management-related decision making could be applied to EIA at similar points to the precautionary approach [26], where there are uncertainties about the potential impacts of a proposed activity. Active adaptive management would require the implementation of experimentation in advance to gather data to inform the EIA, based on preliminary findings. Alternatively, adaptive management has been included in other EIA processes as part of conditions imposed on consent, where an activity must be staged, monitored and reported on before a subsequent stage is undertaken, with specific actions based on the results identified in the EIA [27]. Both the precautionary approach and adaptive management should continue to be integrated into the environmental management of a DSM project through the refinement of the EIA during exploitation by the acquisition and review of monitoring data [26].

3. Existing regulatory framework for EIA in ‘the Area’

The ISA has adopted three sets of regulations for the exploration of different types of mineral deposits [3–5] and recommendations for EIA [16], together referred to as the ‘Mining Code’. The Recommendations are issued by the Legal and Technical Commission (LTC), an advisory

body made of experts that is the subsidiary organ to the ISA Council. Drafting of further regulations to be added to the Mining Code, specifically related to the environment and to exploitation activities, is ongoing [28].

Although the Mining Code is under development, it is possible to describe the current EIA process in the exploration regulations and its anticipated continuation into the exploitation phase. For the approval of a plan of work for exploration, in view of being awarded an exploration contract, an applicant needs to submit to the ISA documentation that includes:

- “(a) A general description and a schedule of the proposed exploration programme, including the programme of activities for the immediate five-year period, such as studies to be undertaken in respect of the environmental, technical, economic and other appropriate factors that must be taken into account in exploration;
- (b) A description of the programme for oceanographic and environmental baseline studies [...] that would enable an assessment of the potential environmental impact, including, but not restricted to, the impact on biodiversity, of the proposed exploration activities, taking into account any recommendations issued by the LTC;
- (c) A preliminary assessment of the possible impact of the proposed activities on the marine environment;
- (d) A description of proposed measures for the prevention, reduction and control of [...] possible impacts, to the marine environment;” [3 Reg. 18, 4 Reg. 20, 5 Reg. 20].

These requirements allow the applicant and future contractor to prepare for the next step in the process, the submission of an EIA prior to the commencement of exploration activities (‘prior EIA’) that were identified as potentially harmful, or that are scoped in by the LTC recommendations [3 Reg. 32, 4 Reg. 34, 5 Reg. 34, 16 § IV, B]. This includes, for instance, the testing of collection systems or equipment, which is an activity pertaining to the exploration phase of DSM in the Area. However, the requirement of conducting a prior EIA in the context of exploration activities in the Area should not be seen as the complete EIA process, but rather as a step in a broader process. Indeed, the milestone of the prior EIA is not followed by a decision-making step, but is part of the requirement to conduct environmental baselines and monitoring studies and to report on them to the ISA [3 Reg. 32, 4 Reg. 34, 5 Reg. 34]. As such, it forms part of the preparation work to refine impact prediction, to evaluate their significance, and to design appropriate prevention, mitigation and management models for the commercial exploitation activities that might follow an exploration contract [16 § IV, B]. While some key steps appear to correspond to the selection of BEP in an EIA process, the existing regulations present only a portion of a robust EIA process, as we discuss below.

4. The ideal EIA process

The context for the EIA will be set by policy preferably augmented by strategic environmental objectives and actions, both of which should be produced by the regulator [29]. The specific environmental goals for the project should be set out by the proponent in line with those in the existing policy and strategic plans. The ISA, sponsoring state, and the contractor all have roles to play in the development of environmental goals for a project. The contractor’s internal environmental policies, which may be documented as part of its environmental management system, provide further context for the EIA, including environmental aims and objectives, responsibilities, procedures, resources, policies, and targets [17,30]. Additional specific targets, such as environmental limits or thresholds, should be provided by the regulator in line with the environmental objectives [18].

An EIA is one component of the environmental management for a project, and fits in the appraisal phase within the larger framework of management activities [26]. The EIA should be undertaken once an

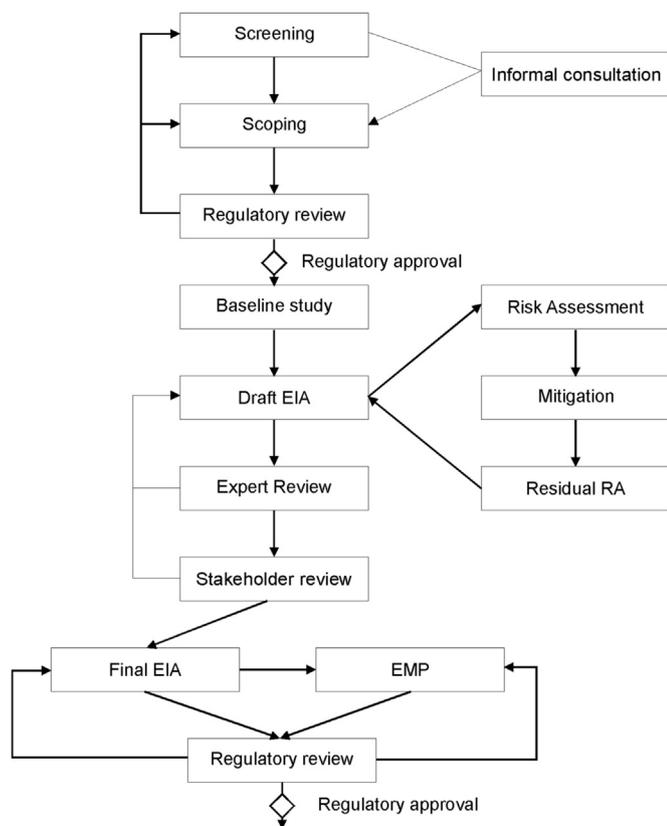


Fig. 1. Flowchart indicating the environmental impact assessment (EIA) process, as adapted for DSM; EMP = environmental management plan; RA = risk assessment.

initial assessment of the environment has been made, and planning has progressed sufficiently for the project plan to be well developed, the environmental risks to be assessed and mitigation options to be identified. In preparation for the EIA, information on the environment should be gained from existing information on the location, expert information [13] and the strategic objectives (above), and synthesized [26]. The mine planning should be forward-thinking, and include details of the exploitation activities through to rehabilitation and closure, with consideration for the environmental aims and thresholds (above) and plans for adaptive management plans made explicit, if applicable. Phases of the EIA process are shown in Fig. 1, and described below.

4.1. Screening

Screening is the process to decide if an EIA needs to take place for a particular activity at a particular location and time [31]. Screening involves a preliminary risk assessment based on project characteristics and knowledge of the environmental setting of the location. Reliable risk assessment requires a value judgement on the threshold above which EIAs will be conducted. In existing international legal instruments, this threshold is often found under the notion of “significant adverse change” [1(3)f in each of 3,4,5]. In most jurisdictions, EIA may be required for projects, and for activities that present modest modifications to an ongoing project. Modifications may themselves require an EIA depending on their scope, magnitude and deviation from the original plan. The screening process would determine these requirements. Material changes to DSM projects are probable, particularly as the envisioned projects are likely to be novel, complex and of long duration. In addition, adaptive management of DSM activities may result in the need for modification of the EIA content or conclusions, based on learnings made through the process of monitoring/sampling and review [26], necessitating a re-screening step.

Four typical approaches are used to determine the need for an EIA:

- 1) preliminary study or initial environmental evaluation, where the need for an EIA is considered through an early assessment, generalised across an industry or area;
- 2) case-by-case, where the need for EIA is individually assessed;
- 3) an established list of projects or activities stating which require or do not require an EIA [as in the LTC recommendations in 16]; and
- 4) by thresholds, where the need for EIA is based on specific measures and limits according to predefined criteria [31].

Owing to the technical and environmental uncertainties of DSM, it is likely that some of these approaches, such as a list of ‘screened in’ activities as done for exploration [16], would not be appropriate, at least initially. It is most likely that the reasonable course of action is to complete screening using a combination of the first and second approaches, until sufficient data is gathered to inform any listing of activities or thresholds required for the latter two approaches. Transparency in decision making, knowledge sharing and clear guidance have been determined as important in screening practices in Europe [31], and should also be applied to DSM practice.

Some activities would obviously require an EIA, such as testing of mining equipment, test-mining operations and commercial-scale mining [16, Recommendation 19]. Environmental experts suggested that material changes to the project (even after regulatory approval) could also require an EIA, for example changes to the ‘the spatial or temporal scope, severity or nature of the potential impacts’, including the ‘timescale for mining, changes to seabed extraction methods..., changes to the nodule processing [method or location]..., changes to storage and transfer systems..., changes to discharge of return fluid’ [18, p.13]. It was also suggested that scientific experiments may require an EIA, and that smaller-scale changes (e.g. changing hydraulic fluid in a vehicle) might require an EIA addendum. Since the understanding of the environmental setting is developing, any major changes to it that could alter the risk assessment should also require an EIA.

4.2. Scoping

Scoping determines what should be covered by the EIA, and should be based on the screening outcomes (Fig. 1). This is an important phase as it determines the most important environmental issues around a project and sets the boundaries for the subsequent EIA. Scoping typically involves a qualitative environmental risk assessment to determine the most important issues to be considered, and includes detailed information on the nature of the project and the environmental setting, regulatory requirements, and stakeholder input. This process may also remove certain issues from consideration, with any exclusions being motivated by and based on robust evidence. In addition, multiple project alternatives may be considered and some may be dismissed during scoping. The alternatives considered should include sufficient detail to facilitate the risk assessment of planned impacts and potential unplanned or accidental impacts. Scoping stimulates ongoing dialogue between the contractor and the ISA on the EIA process and the content of the EIA report and environmental monitoring plan (see below). The scoping phase provides clarity for the actors on the data required to reduce uncertainties in the project options during the subsequent phases, giving contractors more regulatory confidence in their plans and potentially reducing the time required for EIA report approval. In essence, scoping identifies the key issues for consideration and sets the terms of reference for the EIA [1,32]. Contents of a robust scoping for DSM activities were proposed by a group of experts following four years of research [18]. They note the need to document the level of certainty in the data, mining plan or interpretation thereof.

Environmental experts have indicated that the paucity of information on the environment of the areas intended for DSM, both at project and regional scales, currently preclude effective scoping [18]. Substantial investigative work still needs to be conducted to sufficiently improve the environmental evidence base, followed by synthesis and interpretation involving professional judgement by qualified experts. The result would be a quantified understanding of the responses to risk

sources, necessary to assess the risks inherent in the proposed project. These experts considered the production of a regulator-reviewed scoping document to be a necessary phase of EIA of DSM.

The scoping process under national jurisdiction usually requires a regular dialogue between the proponent and the regulator as project options are developed and considered [33]; stakeholder involvement and peer review are also key to the scoping process. This feedback streamlines the process and typically leads to more rapid agreement between parties. How this would work in the context of DSM in ‘the Area’ is unclear as there are currently no clear mechanisms for regular exchange with the competent organs of the ISA. However, scoping discussions are important for all parties, particularly as they allow critical gaps in environmental baseline data and their suitability for assessing risk, uncertainty, impacts, and monitoring to be identified and addressed early in the environmental assessment process, before the full EIA report is submitted. In addition, building trust with stakeholders and communicating the knowledge to foster their meaningful input are both critical to gaining a social licence to operate [34]. Establishing working relationships with stakeholders and seeking a social licence to operate are both advisable in the early phases of a project, particularly as stakeholders may shape negotiations for permitting, as noted for the Solwara-1 project [35] in Papua New Guinea (PNG).

Screening and scoping EIA should occur early in project development, to ensure that risks are appropriately assessed soon enough for alternatives to be considered and mitigation measures to be adopted cost-effectively. The evaluation of project alternatives and mitigation options may require particular data from the baseline studies and the outcomes of exploration or test mining activities, which in turn may depend on particular data collection and/or survey design. For these reasons, the scoping and screening documents should be evaluated by the regulator during the application for a plan of work for exploration [26]. The criteria for evaluation and approval of the scoping and screening documents should be set out by the regulator in advance. Any approval should contain the appropriate conditions. Another advantage to the early review and approval of the screening and scoping documents is the anticipation of any transboundary or regional effects, allowing the regulator to coordinate mining projects across the region. In some jurisdictions, such as the UK, a proponent can apply to the regulator for a formal scoping opinion, which must be provided after 5 weeks [36]. This is typically applied for as it sets the framework for the scoping report. In the USA, the scoping process explicitly includes the option of the entire project proposal being rejected. This should be considered in the case of DSM, in both areas under national and international jurisdiction, to ensure that environmental impacts are seriously considered.

Environmental experts have suggested that the scoping result and document should have a limited validity [18], and should be reviewed and updated when a substantive change to the project plan is made, when new environmental data becomes available, or at least every five years in the absence of these factors to accommodate external changes that may affect it (including changes to regulations, to the strategic assessment and planning, and/or to BEP). This timeline was proposed to allow scoping to be valid for long enough to embark on the next phase of EIA and considering the anticipated timescale for an increase in environmental data, advances in technology, or updating of regulator-provided documents, while constraining validity to ensure that scoping is current (considering the boom-bust nature of mining).

4.3. EIA

The EIA follows the scoping phase (Fig. 1), and should refer to the risks and impacts identified in it. Gathering the required information and preparing an EIA report (also known as Environmental Impact Statement) is the most intensive phase of the EIA process, and the effort involved should not be underestimated. A recent EIA for a seabed iron ore mining project in New Zealand took seven years to prepare and cost

~8 million NZD [37]. Initially, a draft EIA report (often called a ‘preliminary EIA’ elsewhere) is prepared for stakeholder and regulatory review (described below) and adjustment before preparation of a final EIA report.

The key phases of the EIA include the identification of impacts, evaluation of alternative activities and the associated anticipated impacts, and the design and evaluation of mitigation measures following the mitigation hierarchy, as described below [but see 38]. This is reliant on several processes, including review of existing data, gathering and interpretation of new data, ecological risk assessment, mitigation and management planning. Key components include: 1) a description of the purpose and justification of the activity, including environmental goals and viability; 2) a description of the development of the EIA including all regulatory and stakeholder input to date; 3) a description of the impacts and mitigation in spatial and temporal terms; and 4) a synthesis of all information to form the evaluation of impacts, including assessments of interrelationships, cumulative and combined effects, and comparison against regulatory criteria and thresholds (when developed).

A baseline assessment should be planned and completed as part of the exploration phase of a project [3 Reg. 32(1), 4 Reg. 34(1), 5 Reg. 34(1)]. Suggested contents of a baseline assessment have been documented in an ISA Technical Report [17], but will need to be regularly updated to reflect increases in knowledge. The mining plan may be improved based on results from a test mining phase, during which further data on the environmental impacts of mining should have been gained. These data and their interpretation, in addition to previously-collected data and the justification of previously-made decisions for the project [26], should be used in the impact assessment. A well designed baseline study should include a complete assessment of the environment at the mining claim from benthos to sea surface, and would include assessment of the impact, resistance and recovery from test mining impacts, such as those considered high risk by experts [29], and any data collection required to address concerns raised during the scoping phase or gaps identified during the EIA process. Scientific survey design should consider data needed for comparison with future environmental monitoring, while recognising that additional data will be required to support the subsequent project development phase. This preliminary baseline alone may not be sufficient for monitoring and further assessment may be required, particularly after the EIA.

The draft EIA should be developed during the resource appraisal phase of the project; that is, after exploration and before exploitation [26]. The understanding of the environment, most recently improved during the baseline study [as described in 26], is used in combination with up-to-date plans for the mining activity to complete a risk assessment. Detailed information on the specific technologies, logistics and practical implementation of mining plans are required. The risk assessment process aims to identify, evaluate and rank risks associated with the activity, and to identify the relevant BEP. Options for mitigating environmental risks are applied according to a hierarchy [2,26,38,39]: first to avoid/prevent, second to minimise, third to restore when possible, or finally to offset any impacts. There may be scientific and legal challenges in adopting this mitigation hierarchy for DSM [38]. Practical tools for the risk assessment process, such as qualitative and quantitative metrics, and considerations for site-specific modelling, have been proposed by Collins et al. [13]. The draft EIA is then subjected to stakeholder and expert review (Fig. 1), as discussed below.

After public participation, and when stakeholder comments and expert concerns have been addressed, a final version of the EIA report is prepared for submission to the regulator. This will contain the results of environmental risk assessment, details of the comments and concerns and how they were addressed, and detail on the scientific studies as appendices for transparency. A proposed final EIA report may be published for further comment, particularly if there is a major change from the original report as a result of the feedback. The EIA may be

iteratively adapted until all stakeholders are satisfied.

4.4. Environmental Management Plan

An environmental management plan (EMP, also known as an Environmental Management and Monitoring Plan) sets out the environmental management approach for the lifetime of a project. It should include details of the practical implementation of all mitigation measures identified in the EIA, within the context of the contractors' environmental management system, the environmental goals of the project, and regulations. It should explain how environmental objectives, regulations and thresholds will be met and proven to be met. Specifics of the environmental monitoring plan should be included [17,18], and preliminary plans for rehabilitation and long-term monitoring should be set out based on the proposed mining activities and mitigation measures, if completed as planned. This document should outline the roles and responsibilities of all parties in its implementation (ISA, state, contractor and subcontractors), and the anticipated continued communication between proponent and regulator. Particularly in the case of DSM, the EMP should explain any completed or future adaptive management required, and necessary actions and decisions related to that adaptive management process. Some guidance on the preparation of an EMP has been provided in an ISA technical study [17]. The EMP should be submitted to the regulator, along with the EIA, as part of an application for exploitation. It may be iteratively amended following review and prior to approval, in a similar manner to the EIA, until stakeholders are satisfied. The EMP will also be subject to periodic review and re-evaluation once the project has started.

4.5. External review

4.5.1. Expert review

Expert review, by a commissioned body of multiple independent experts, is commonly included at several points in the EIA process for other industries. A body of independent experts is usually commissioned by the regulator, although the costs may be borne by the proponent. Expert review can either happen before public review, so interested parties can comment on the EIA with consideration of the expert comments, or at the final approval phase. Experts are often consulted or involved at the scoping stage, to augment the quality of the future EIA [15]. Experts are consulted from a range of disciplines, including environmental science (oceanographers, marine biologists, ecologists, and geologists, in the case of DSM), marine and environmental policy and management, environmental economics, ethics, and international and environmental law.

Expert scientific review is to focus on the adequacy of the information and whether the conclusions are justifiable based on the available evidence. It is recognised that there may be other normative and political aspects of any decision as part of EIA approval, which would not be part of the remit of an expert review body. The need for impartial expert review in the EIA process for DSM is supported by environmental experts [18].

4.5.2. Stakeholder consultation

Stakeholder participation in the EIA process is an essential component of transparent environmental management at all stages (Fig. 1), and transparency has been identified as BEP in ensuring that quality environmental decisions are taken [15,40]. Stakeholder review is an opportunity for interested and potentially affected parties (including the public at large) to provide input to the EIA process, and thus to the environmental management of DSM. A 'social licence to operate' from stakeholders may be sought [35]. Stakeholders in a DSM project include non-state actors such as environmental groups, other resource users (e.g. the fisheries sector), proponents of other human activities occurring in the same space (e.g., tourism, shipping or cables), and the public. The latter should be defined broadly because deep-sea minerals

are part of the common heritage of mankind [Article 136 in 7; 41]. Scientists and other experts may also be considered stakeholders [42].

Informal consultation often occurs throughout the EIA process in other settings, particularly with the stakeholders that may be directly impacted by the project [33]. This is advisable for the conduct of EIA for DSM activities, considering the potential severity of impacts, the uncertainties pertaining to DSM activities, and the number of exploration contracts in close proximity (e.g. the Clarion Clipperton Zone). Generally, this consultation throughout the process is not overseen by the regulator, and often arises from a proponent's initiative and desire to conduct a comprehensive EIA [33].

Formal stakeholder review should be organised and managed by the regulator [15]. To facilitate it, all EIA documentation (including results of screening and scoping phases, EIA report, EMP and expert review outcomes) should be made freely accessible, for example on a publicly accessible website. It should also be actively disseminated to key stakeholders. There should be a simple and easily accessible mechanism for interested parties to comment on the documents. This will likely be in the form of written comments, although public hearings may also be an appropriate mechanism for feedback. These comments should be made public as far as possible. Comments should be responded to, either individually or by aggregating the comments into focussed issues that can be addressed together. This can either result in changes to the EIA documentation or additional measures imposed by the authorities, and a justification as to why the comment(s) were not addressed should be provided [9,33]. These responses usually form an annex to the EIA documentation.

It is important to define a procedural mechanism to deal with multiple comments by independent experts, direct stakeholders and the general public, and to fully incorporate them in the decision making process in order to ensure meaningful public consultation and informed decisions [15]. This is particularly important for a new industry, such as DSM, where there could be substantial public interest and scrutiny of the EIA report. Stakeholders of seabed mineral exploration have expressed that confirming the integrity of the regulatory system and the process for obtaining impartial information about a project are as important in conferring a social licence as balancing the costs and benefits of a project [34]. To date, the ISA has not designed any public review framework or procedural safeguards for its adequate organisation and consideration [15]. Expert review currently is the duty of the LTC, which is indeed meant to consist of independent experts [Art. 163 and 165 of 7]. However, the current workload of the LTC [43] and the lack of transparency of their proceedings [44] does not ensure effective independent expertise in the consideration of 'prior EIA' or future EIA reports for exploitation applications, nor does their expertise span all applicable disciplines [19 Chapter 8.3]. However, the ISA drafting process for exploitation regulations may add independent expert review and public consultation provisions to the Mining Code [9, Annex II of 45].

4.6. Regulatory review and approval

The final EIA report and EMP are submitted to the regulator for review. In many cases, this process involves a public hearing. The examination and decision making can result in a lengthy process, as shown by the review of the recent Chatham Rise seabed phosphate mining EIA that took 9 months to complete [46].

The regulator would decide whether the EIA and EMP are approved and the project granted approval to operate. In some cases, the regulator would commission an independent expert scientific review of the EIA. Such experts should be independent (i.e. not have had a role in the rest of the EIA process), to avoid conflict of interest.

Any approval of an EIA and EMP is generally accompanied by conditions, including the requirement to follow the EMP (including the mining plan and mitigation measures), to undergo periodic audits by the regulator, to complete stipulated monitoring and reporting, and to

accept the regulator's imposed measures in case of non-compliance. In some cases, conditions involve financial instruments, such as posting performance bond(s), as is currently envisaged in the ISA draft environmental regulations [47 Section 5, draft reg 44, p54–55]. For example, in a national jurisdiction, the New Zealand Environmental Protection Authority (NZEPA) conditions of marine consents include: performance bonds for conditions, public liability insurance, monitoring and reporting the details of the consented activity and its effects, auditing of activity and its effects, reports/records available to audit [23]. In the case of DSM, it is particularly important that the conditions include provisions for accommodating change (and adaptive management), for example what types of change require action, and how that action should proceed (e.g. in the form of amendment of the EIA and EMP, etc.). Periodic review of the EIA and monitoring results, along with current BEP and regulations, have also been suggested [18]. It may be appropriate in some jurisdictions or cases, for the EIA and EMP to be valid for the duration of the project. However, the timescales for change in the understanding of the ecosystem, the environmental processes themselves, or techniques and technologies (for DSM and for environmental monitoring) may be long, necessitating alteration of the EIA and EMP (and thus the extraction operations) at intermediate timescales.

In the case of DSM in the Area, the sponsoring state and the ISA have important roles to play in the review and approval process. As such, there will likely be two levels of regulatory review and approval. The role of the sponsoring state in the process is important, in particular in relation to its due diligence obligation, as identified by the Seabed Dispute Chamber of the International Tribunal for the law of the Sea [10]. Thus, the sponsoring state may have an important role in determining the appropriate content of the EIA. However, it is still unclear how the articulation between the two regulatory levels will occur. The EIA will also need to comply with international legal requirements arising out of legal principles, customary law and treaties, as well as any regulations and standards adopted by the ISA [11].

5. EIA for DSM: lessons from the application of EIA elsewhere

Results of the implementation of EIA in other jurisdictions and for other marine mining projects provide insight into challenging aspects of EIA for DSM that need consideration. In the first decade following the introduction of the EIA system by the EU into UK domestic law [48], improvements to the EIA quality were noted [49]. Namely, environmental factors influenced decision making more heavily, they became more complete in terms of scope and methods used, and EIA reports became more accessible to stakeholders. Similar quality improvements could be expected from EIAs for DSM. However, a review noted several weaknesses [49]: a lack of objectivity in the preparation of the EIA, insufficient monitoring to understand impacts, failing to consider cumulative impacts, weak quality control, and insufficient stakeholder participation. In addition, a 'whole environment' approach was needed, and that the process should be adaptive [49]. These concerns have all been shared in relation to EIAs for DSM [9], and the opportunity to avoid them lies in the development of a robust EIA process.

The EIA for the Trans Tasman Resources Ltd (TTRL) seabed iron ore extraction and processing project in the New Zealand Exclusive Economic Zone (EEZ) and Continental Shelf is a useful comparison to DSM in the Area, in that it involved a proposal for a technology under development to operate where environmental data was scarce, and where adaptive management was to be employed to compensate for the lack of available data. It took seven years to conduct the relevant EIA, which was rejected in 2014 by the NZEPA [37]. A key concern was the 'considerable uncertainty regarding the scale' of effects [37, Point 9, p3], including insufficient detail about aspects of the mining operation, further baseline monitoring (for at least 2 years), and consultations needed to inform the EIA. Thus, the NZEPA suggested that the application was 'premature'. In its decision, the regulator favoured caution and environmental protection, as it was 'not satisfied that the life-

supporting capacity of the environment would be safeguarded or that the adverse effects of the proposal could be avoided, remedied or mitigated' [37, Point 14, p4]. TTRL had suggested some provisions for an adaptive management approach to address adverse effects, but the NZEPA was critical of the qualitative (rather than quantitative) objectives, the lack of an option for scaled or staged implementation, and the omission of alternatives if environmental objectives were not met. It concluded that 'uncertainties in the scope and significance of the potential adverse environmental effects ... cannot be remedied by the imposition of other lawful conditions that we could require based on the evidence before us.' [37, Point 13, p4] The NZEPA expressed specific concern about whether the conditions proposed by TTRL were based on evidence, and 'if they could actually and reasonably be achieved and monitored' [37, Point 783, p165]. TTRL was ultimately narrowly granted consent [50]; however, the decision noted that "an adaptive management approach is not available" and that TTRL failed to consult with some stakeholders, while a breakdown in communication occurred with stakeholders that were consulted. The 'alternative view' from the two dissenting opinions further expressed the continued lack of adequate baseline environmental information, and the high levels of uncertainty as a result of the use of modelled data as inputs to impact models, with little actual data employed. It reiterated the concern that the conditions will "not adequately avoid, remedy or mitigate adverse effects".

A second project of interest to DSM was the proposal by Chatham Rock Phosphate Ltd (CRP) in 2014 to mine phosphorite nodules from Chatham Rise, also within the New Zealand EEZ [46]. The mining method was similar to that proposed for polymetallic nodules in the Area, as it involved removal of hard substrate from a soft sediment seabed using suction, followed by surface processing, and depositing of unwanted material at the seabed. The EIA included some provisions similar to those proposed for DSM, including mining exclusion areas, details of monitoring and environmental surveys, and habitat creation trials. Again, consent was refused by the NZEPA, which cited the lack of certainty about the impact of the mining plans on the environment and the proponent's unwillingness to conduct the considerable pre-mining research and model validation required for an adaptive management approach to be applied. The regulator expressed concern that the adverse impacts from removal of nodules at the seabed could not be avoided, remedied or mitigated, and that hard substrate habitat could not be restored to its previous state. In addition, the return of material to the seabed could adversely impact the benthic habitat at a wider scale, including destruction of potentially unique communities, and rare and vulnerable ecosystems. The plume generated by nodule mining could similarly impact an area much wider than the mined area [51]. In the Chatham Rise case, the affected communities included rare and vulnerable ecosystems. The NZEPA further commented that environmental compensation does not constitute mitigation, and that the conditions proposed could not mitigate the impacts. Finally, the regulator found that the adaptive management approach suggested by CRP lacked sufficient pre-mining research and model validation. CRP was against a staged approach to allow environmental data collection and risk assessment because initial investment costs were high. Plans for a staged approach to mining, which facilitates adaptive management, have also been suggested for DSM. This has raised similar concerns from proponents about up-front costs.

In a third case, an EIA report was completed for proposed mining of polymetallic seafloor massive sulphide deposits in the EEZ of PNG [52], the 'Solwara-1' project. Although the project was granted an environmental licence, an independent review commissioned by an environmental NGO was critical of the lack of sufficient information with which to effectively evaluate the impacts of the project [53]. The review acknowledged that the preparation of the EIA had contributed to the scientific understanding of deep-sea vents, but that the baseline study was still incomplete. It particularly noted the lack of systematic, integrated pelagic and benthic studies to establish a baseline, rendering

risk assessments inadequate for many elements of the mining process, including regular operations and contingency plans in case of accidental or unplanned events. The review also noted that the mitigation measures proposed by Nautilus were reliant on procedures and management plans not yet developed or tested. Stakeholders were critical of the omission of some groups, the lack of public records of engagement, and a lack of transparency in the EIA process, leading to opposition after the mining lease was granted [35].

The evaluation of these three EIAs suggests a common underestimation of the preparation required in three main areas: 1) in establishing the environmental baseline, 2) in developing the specifics of the mining plan, including the details of the adaptive management approach, and 3) in consultation with stakeholders. Lessons from the feedback on environmental baseline studies suggest that improvements should be made: they must be of sufficient duration (i.e. several years), must include sufficient detail on parameters from all aspects of the environment, and the data collected should be synthesized to produce an understanding of the whole ecosystem. The mining plans should include detail on both the planned and unplanned activities (such as potential incidents), sufficient information on risks and potential impacts (which require experimentation or small scale studies), and any plans for adaptive management should be explicit and detailed (not just trial and error). This information on the baseline environmental and mining plan should be presented to both the regulator and stakeholders. More stakeholder consultation is required, that is, to more stakeholders, with more information, and with more time for stakeholders to consider the information and respond. There are also lessons for the regulator, which will result in improvements to EIA; both the process and requirements for EIA must be made explicit, and EIA will be improved by the regulator providing input into the preparation of the EIA, not just at the review stage.

6. Summary of challenges in implementing the EIA process for DSM

Despite the widespread acceptance of EIA as a necessary part of environmental management of DSM, implementing the EIA process for DSM in the Area presents several challenges. These challenges are briefly summarised below.

6.1. EIA process for DSM needs to incorporate mechanisms to address uncertainty

EIA for DSM projects need to address high levels of uncertainty. Currently there is only a very limited evidence base [e.g., 54] for assessing the environmental response to specific mining projects, and environmental baseline data are not as complete as for other similar types of developments (e.g. offshore oil and gas, onshore mining projects). The typical EIA process has mechanisms for documenting and addressing uncertainty, and recommendations for addressing uncertainty in DSM are available [14,19,26]. However, even when properly documented, the consideration of uncertainty is neither secured by procedural nor institutional measures in the current decision making process. Indeed, entities applying for exploration contracts are not currently required to identify uncertainties inherent in their project design and assessments and to demonstrate how these are addressed in their plan of work [19,55]. Similarly, the LTC is not required to communicate any uncertainties to the Council when issuing its recommendations as to whether or not to approve an exploration contract [56].

Multiple activities are likely to require EIAs, including activities or alterations to activities that are considered after exploitation has begun. Each activity (or alteration) should be subject to screening, and EIA where necessary. This may lead to multiple EIAs and EMPs in the life cycle of a single project. These are particularly likely as the DSM technologies and understanding of the environment develop. How

multiple EIAs/EMPs, or the updating of existing EIAs/EMPs, would be implemented within the regulatory framework of the ISA is unclear, but should be considered as the exploitation regulations are developed.

6.2. Detailed requirements for the EIA process phases should be made clear

The requirements for each of the phases of EIA and their components (e.g. scoping, consultation, reporting, etc.), and the criteria for their evaluation should be set out. Progress has been made for environmental baseline data requirements [e.g. 16,57] and the contents of the EIA report or statement [Annex II of 9, 17] but other aspects of the EIA process are missing. Independent guidance on the EIA process is available for DSM [58]. However, procedural safeguards in the ISA Mining Code are still required to ensure that these are adequate for effective environmental management [9,15,56].

6.3. Mechanisms are needed to ensure that the EIA influences decision making

An EIA and EMP should be implemented to reduce environmental risks, not just conducted to quantify compensation (e.g., the monetary quantification of 'unavoidable impacts' in [59]). To be effective, the EIA process should be fully integrated into the ISA contract granting decision making process and accompanied by effective regulatory and management control [56]. As suggested by the ISA Technical Study 11, the ISA in its exploitation regulations will need to reserve for itself substantial power and authority to manage, regulate and oversee the exploitation regime [60], as mandated by UNCLOS (Part XI, Section 4 in [7]). Legal instruments, organisational and fiscal measures are required to ensure compliance and penalise non-compliance in the context of environmental management [60].

It may be possible for EIA, or some aspects of it, such as the EMP, to be integrated with existing requirements for plans of work. In such cases, following the ISA Mining Code's approach for exploration, the plan of work may be annexed to the exploitation contract and adhering to it may become a contractual obligation.

Currently, a major procedural challenge is the timing of EIA in the exploration process. Contractors are not required to produce a full EIA until they have already been granted a 15-year exploration contract, which can only be amended with the consent of both parties [22]. In order for the EIA process to be effective, the ISA would need to be able to require contractors to adjust their operations based on new information obtained during the lifetime of an exploration contract [56]. This is important to address in future exploitation regulations. However, the use of contracts rather than licenses, may prevent effective control over EIA and adaptive management post-approval [22]. One approach may be to have the contracts require contractors to follow regulations and recommendations as may be amended from time to time.

6.4. The EIA process requires substantial input and involvement from the regulator

At present, the institutional capacity of the ISA to address its numerous environmental management tasks is limited [56,61]. Personnel requirements for DSM regulatory bodies necessary for each phase of an EIA are high [62]. The LTC is overstretched [19,55] and annual meetings of the Council provide insufficient decision making opportunities for an active exploitation regime [43]. As the ISA Technical Study No 11 highlights [60], the ISA will need to extend its role as an international organisation with a group of states as decision makers, to an administrative agency that organises, carries out, and controls DSM activities in the Area [56,60]. Insufficient institutional capacity for the EIA process may lead to poorly informed decision making, insufficient quality control over the EIA, and weak compliance and enforcement [62]. Urgent consideration of the establishment of an independent

inspectorate has been recommended [43]. However, the manner by which power is devolved to the inspectorate from other ISA organs is important in its successful and effective overseeing of environmental compliance. Detailed discussions for the funding, planning and implementation of such an ‘administrative agency’ capacity within the ISA are crucial to address in the near future, both for the rising development of DSM in the Area and the protection of the environment for present and future generations [60].

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