frontiers in Marine Science

POLICY AND PRACTICE REVIEWS
published: 30 April 2020
doi: 10.3389/fmars.2020.00247

Options to Improve Transparency of Environmental Monitoring Governance for Polymetallic Nodule Mining in the Area

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This paper proposes institutional innovations to advance a transparent monitoring system for the environmental impacts from mineral development on the deep seabed beyond national jurisdictions managed by the International Seabed Authority (ISA). Using a literature review, ISA's regulations, and five cases of other environmental monitoring of the deep sea, this study observes that ISA's environmental monitoring system for exploration and exploitation currently lacks critical elements to facilitate transparency. Insufficient compliance reporting and review systems, as well as limited access to information by stakeholders, lower the system's effectiveness. ISA has not developed adequate mechanisms to support effective multinational collaboration in monitoring. The ISA monitoring system without these characteristics may not be sufficiently adaptive to allow detection and management of environmental changes in the deep seabed. This study suggests 15 institutional recommendations to ISA in order to enhance transparency for monitoring nodule mining in the Central Pacific deep seabed. Principal recommendations include establishing compliance review committees independent of ISA governing bodies, implementing collective monitoring and reporting by adjacent contractors, and reconsidering the centralized decision-making authority by the Secretary-General to improve confidentiality.

Keywords: the area, deep seabed mining, transparency, environmental monitoring, International Seabed Authority, polymetallic nodule, Global governance, policy recommendations

OPEN ACCESS

Edited by:
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Reviewed by:
Marcus Geoffrey Haward, University of Tasmania, Australia
Jennifer Leigh Bailey, Norwegian University of Science and Technology, Norway

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Specialty section:
This article was submitted to Marine Affairs and Policy, a section of the journal Frontiers in Marine Science

Received: *13 December 2019*
Accepted: *30 March 2020*
Published: *30 April 2020*

Citation:
Komaki K and Fluharty D (2020) Options to Improve Transparency of Environmental Monitoring Governance for Polymetallic Nodule Mining in the Area. Front. Mar. Sci. 7:247. doi: 10.3389/fmars.2020.00247

INTRODUCTION

The International Seabed Authority (ISA) was established under the United Nations Convention on the Law of the Sea (UNCLOS) as the administrative and regulatory body to manage deep seabed mineral mining in "the Area"—seabed, ocean floor, and subsoil beyond the limits of national jurisdiction[1]. Presently, ISA comprises the same 168 members as Parties to UNCLOS and has contracted with 30 mining contractors, which are sponsored by the member States for

[1]UNCLOS Article 1.

exploration of deep seabed minerals. Since 2000, ISA has adopted and amended regulations for the prospecting and exploration of three types of minerals—polymetallic nodules, cobalt-rich ferromanganese crusts, and polymetallic sulfides. Presently, ISA is developing another set of regulations for commercial exploitation of these minerals. This paper focuses on institutional procedures and requirements for environmental impact monitoring, in contrast to delineating scientific and methodological protocols of monitoring (MIDAS, 2015; Bräger et al., 2020). Once commercial seabed mining starts, environmental monitoring is the primary tool to detect and report the harmful impacts caused by development activities. Our study explores how the ISA regulations frame the environmental monitoring system, highlights the system's transparency problems, and examines what could constitute an environmental monitoring system that is more transparent for the ISA regime.

Historical Overview of Seabed Mining in the Exclusive Economic Zones (EEZs) and Beyond

Mineral resources in the seabed, first discovered at the time of Challenger Expedition (1872−1876), became strong interests for nations in the 1950s (Allen, 2014). The United States (US) was one of the leading nations to explore deep seabed minerals and complete environmental impact assessments (EIAs) for mining in the Central Pacific Ocean (US DOC, 1987) until UNCLOS came into force in 1994. Today, the region, the Clarion Clipperton Fracture Zone (CCZ), is the densest (i.e., 16) contract area of ISA and sponsored by the member States: Belgium, China, France, Germany, Japan, the United Kingdom, and more for polymetallic nodules (ISA, 2019a). These sponsoring States are obliged to ensure the contractors' compliance with UNCLOS and ISA regulations during exploration[2] and to apply a precautionary approach and the best environmental practices[3]. Six contractors, sponsored by, for example, the United Kingdom and France, have started their extension period (5 years[4]) of the exploration contract following its initial 15 years (ISA, 2019d). Thus, now is not too early to consider what could be the best practices and effective policies to monitor future deep seabed mining based on the lessons learned in other practices.

Seabed mineral mining in the EEZs is expected to have easier access, positive economic values (Wakefield and Myers, 2016) and fewer environmental impacts per unit area (Hein et al., 2015; Hannington et al., 2017) than in areas national beyond jurisdictions. The ISA's sponsoring States, such as the Cook Islands and Japan, have already started mineral mining within their respective EEZs. In a single-nation management regime, financial instability could directly affect project success, and environmentally sound management could be compromised. For example, Papua New Guinea (PNG) started the first EIA for polymetallic sulfide mining in the EEZ with its contractor, a Canadian mining company, Nautilus Minerals Incorporated (hereafter, Nautilus-Coffey Natural Systems, 2008) in 2007. However, the development of commercial mining ceased 6 years after the EIA because of financial problems and mistrust between Nautilus and the government (Davidson and Doherty, 2017). In the meantime, non-governmental organizations (NGOs) and activist groups strengthened their protests against the project and demanded greater environmental protections (Deep-Sea Mining Campaign, 2018; Mining Watch Canada, 2018).

Challenges for developing nations' EEZ mining projects are potential disadvantages in conducting EIAs because of lower capacities in expertise, insufficient quality control, weak compliance monitoring and enforcement, and less public engagement (Bradley and Swaddling, 2016). Although the Pacific Community and the Secretariat to the Pacific Regional Environment Programme, established by the Pacific Island nations including PNG, developed EIA guidance for seabed mining in the 1990s, the regional approach for its implementation has not been successful (Bradley and Swaddling, 2016; Waiti and Lorrenij, 2017).

Issues in Monitoring the Environmental Impacts Caused by Deep Seabed Mining

A fundamental issue of seabed mining in the Area is that environmental data are substantially lacking in the deep sea to establish ecosystem indicators and thresholds for making policy decisions (Levin et al., 2016; Beaulieu et al., 2017). The detailed biological system remains unknown because deep seabed communities are sparsely distributed and because species are highly localized. Representative sampling of those communities is costly, and investigations of their natural variability usually require between 3 and 25 years (Van Dover, 2011; Levin et al., 2016; Van Dover et al., 2018). ISA does not clearly define harmful effects, items to be observed and assessed in baseline surveys, and processes taken in EIAs (Collins et al., 2013; Jaeckel, 2016; Jaeckel et al., 2016, 2017; Levin et al., 2016; Durden et al., 2017, 2018, Ellis et al., 2017). Thus, some researchers have considered commercial mining activities on the deep seabed to be premature because predicting the impacts on the ecosystem is not possible (Beaulieu et al., 2017; Van Dover et al., 2017).

The current regulations and expert meetings held around ISA on the monitoring system have mainly addressed scientific and technical perspectives, namely, best available science to monitor species and water properties (ISA, 2017c). However, proper governance mechanisms should be discussed more often and implemented to advance the development of the best available science in a transparent manner.

Structure of the Paper

Following this brief introduction, Section "Research Approach for Assessing Transparency of Deep Sea Environmental Monitoring" covers the research approach applied in this paper. The section includes a definition of what is meant by transparency in environmental monitoring and the elements of environmental monitoring used to organize assessments of

[2] Ibid., 139.

[3] Regulation 31 of the ISA regulations for prospecting and exploration amended in 2013 (hereafter, ISA Exploration Regulations) (ISA, 2013b).

[4] Agreement relating to the implementation of Part XI of UNCLOS, Annex, Section "Introduction," Paragraph 9.

ISA's regulations in Section "Potential Issues Identified in the ISA Monitoring Systems". This same framework is employed to examine case studies of deep sea environmental monitoring in EEZs and international waters in Section "Case Studies of Other Environmental Monitoring of the Deep Sea" in order to gain the experience of existing monitoring programs. These assessments are then used to evolve recommendations for ISA to apply as it develops more transparent environmental monitoring in deep seabed minerals mining in Section "Recommendations", followed by conclusions in Section "Concluding Remarks".

RESEARCH APPROACH FOR ASSESSING TRANSPARENCY OF DEEP SEA ENVIRONMENTAL MONITORING

This section explains our scope of transparency and variables in the environmental monitoring that we will examine with respect to the ISA regime.

Definition of Transparency in Environmental Monitoring

Scholars define transparency in general contexts as the system's "visibility and inferability" or "openness" (Heald, 2006; Michener and Bersch, 2013; Gupta and Mason, 2016), or in a narrower meaning, the availability of regime-relevant information (Mitchell, 1998). Transparency is necessary for good governance of environmental management to improve accountability and legitimacy (Mitchell, 2011; Ardron, 2016; Ardron et al., 2018). However, the ISA system is a low-quality monitoring process, in comparison to other international waters management organizations (Ardron, 2016; Jaeckel et al., 2016).

"Transparency of governance" (Mitchell, 2011) is a type of transparency, which is required to observe the actions of the regulators and powerful actors in an institution's governance. For example, if the ISA environmental monitoring regime adopts policies to explain their every decision each time to all stakeholders, which could improve this type of transparency. Transparency can be thought of directional (i.e., up-, down-, in-, and outwards) (Heald, 2006). Transparency upwards occurs when superior hierarchical regulators can observe the behavior and results by those regulated and, vice versa, for transparency downwards with respect to accountability of superior regulators to those regulated. Transparency inwards is achieved when those outside the regime can freely observe information shared within the regime. Transparency outwards happens when the regime's hierarchical subordinates can compare their situations with those outside the system. Good governance needs high levels of effectiveness of transparency policies, however, the level varies by the conditions and types of the policies – e.g., "transparency for governance" is another type of transparency (Mitchell, 2011; explained later). Our paper adopts Mitchell's (1998)'s narrow definition of transparency and assesses the transparency upwards, downwards, and inwards of the ISA regime. The subsequent recommendations discuss effectiveness of policies relevant to the regime's transparency, including other transparency types.

In environmental management regimes, an information system is vital to enhance transparency, and ultimately a system in which more information circulates can increase the regime's effectiveness (Mitchell, 1998; **Figure 1**). According to Mitchell's theory, the system obtains information through the inputs of environmental monitoring reports and releases information through the outputs, such as review of reports and data sharing. Regimes conduct environmental monitoring, usually in a post-decision stage during and after EIAs, to confirm the outcomes of the EIA for the environmental conditions (Ramos et al., 2004). A well-planned monitoring system ultimately results in mutual benefits for project proponents and regulators (Morrison-Saunders et al., 2001). In the Area, the regulator, ISA, has a legal obligation to control the activities of proponents, i.e., contractors and the sponsoring States[5], who are required to cooperate with ISA to implement environmental monitoring programs to protect marine environments[6].

Elements of Deep Sea Environmental Monitoring Systems and Links to Transparency

Seabed environmental monitoring of mining activities comprises monitoring studies, reporting, and review processes, which are followed by compliance monitoring components: review of reports, inspections, enforcement mechanisms, and penalties for non-compliance (Swaddling, 2016). Our paper uses these components as "monitoring elements" to examine transparency issues in the ISA environmental monitoring (**Table 1**). In **Table 1**, the "*what's monitored*" element refers to environmental monitoring studies by contractors, with respect to indicators, thresholds, and activities (Swaddling, 2016). The ISA regulations require transparency from contractors upwards (**Table 1**) to ISA to obtain monitoring results. For this purpose, ISA should provide contractors with clear and specific statements of objectives and criteria for monitoring actions (Clark et al., 2017). The statements justify why particular variables are being assessed and how they are to be measured (Clark et al., 2017). If uncertainty is high, increased levels of monitoring requirements are necessary (Swaddling, 2016).

"*Reporting*" is the primary way for the ISA regime to obtain environmental monitoring information from contractors. The reporting system needs to provide contractors with clear requirements of what to report and scheduled frequency (Swaddling, 2016), as seen in other international monitoring initiatives (Ardron et al., 2018). Reporting effectiveness can change the normative attitude of those making the reports (Mitchell, 1998), and the reporters can be others than contractors if ISA allows it.

"*Review*" of reporting is necessary to assess compliance of contractors with respect to the ISA requirements (Mitchell, 1998; Swaddling, 2016) and the general environmental state

[5]UNCLOS Article 153.

[6]ISA Exploration Regulation 31; UNCLOS Article 204.

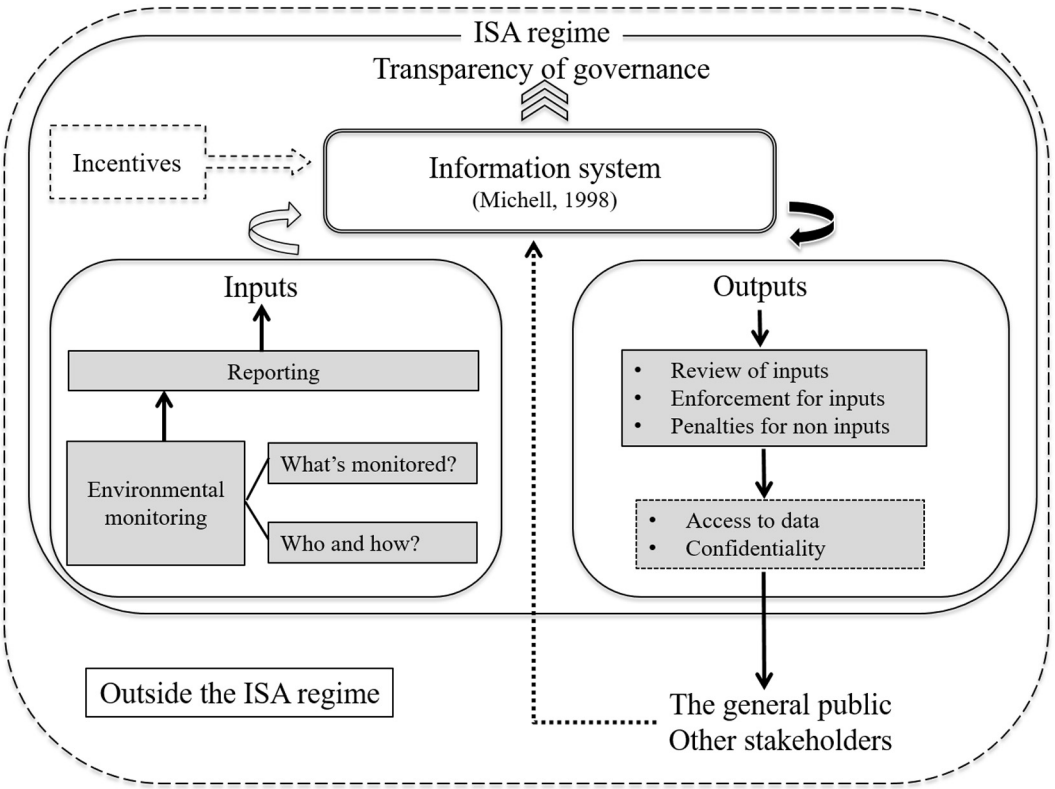

FIGURE 1 | Conceptual model of transparent information flow for ISA.

TABLE 1 | Transparency directions, to whom, and criteria of good monitoring elements.

Element	Information flow to the regime	Main actor	Transparency of governance to whom (direction)	Criteria expected for a good monitoring element
What's monitored	Input	Contractors	ISA (Up)	Clear and specific objectives and criteria for actions; clear rationales of assessed variables; measurement methods; reliable data with standardized methods
Reporting	Input	Contractors	ISA (Up)	Clear requirements and frequency (or other reporters)
Review	Input/Output	ISA	Contractors (Down)	Clear rules and criteria for assessments; external reviewers
Inspection	Input/Output	ISA	Contractors (Down)	Clear rules to distinguish non-compliance; Frequency and prompt processes; immediate reporting of inspections
Enforcement	Input/Output	ISA	Contractors (Down)	Clear triggers, timing and procedures
Penalties	Input/Output	ISA	Contractors (Down)	Clear criteria; severe enough beyond a contractor's business cost and proportionate with the breach of law
Access to data	Output	ISA	The public (In)	Clear criteria of the extent of accessible data; user-oriented data sharing platforms based on sharing rules
Confidentiality	Output	ISA	Contractors (Down), The public (In)	Clear decision-making rules to determine confidentiality

The information flow indicates an input or output of the information system (Mitchell, 1998) for the ISA regime. The transparency directions use the definitions of Heald (2006).

of contracted areas (Ramos et al., 2004). Contractors and the sponsoring States require transparency downwards (**Table 1**) from ISA to obtain the review results of their environmental monitoring. Transparency downwards is also the case for "*inspections*," "*enforcement*," and "*penalties*." Good review requires clear rules and criteria for assessments (Mitchell, 1998; Morrison-Saunders et al., 2007). External-sourced expert review processes should increase transparency (Lallier and Maes, 2016).

"*Inspections*" are to verify contractors' lawful activities (Banet, 2020). Frequency of inspections and prompt review are essential and immediate reporting of results can be efficient for further investigations to prevent harmful activities (Kasoulides, 1990). Simultaneously, the benefits of a regime's transparency from the inspection element can be traded off against costs and other regime goals (Mitchell, 1998). For deep sea minerals mining, Swaddling (2016) recommends that the triggers, timing and procedures for any "*enforcement*" must be clearly set out in the legislation and regulations. Swaddling also suggests that "*penalties*" should be sufficiently severe to exceed the contractor's cost of doing business and proportionate with the breach of law. The regime's rules in sanctioning procedures need to distinguish clearly between compliance or non-compliance (Mitchell, 1998).

Stakeholders such as scientists, environmental NGOs, the mining industry, and the general public need transparency inwards (**Table 1**) with respect to access to monitoring reports, reviews of results and synthesis of environmental data from ISA. The access to data element can improve the system's accountability (Ardron et al., 2018) and engagement between stakeholders to increase environmental performance (Gouldson, 2004). To ensure appropriate "*access*," the ISA monitoring regime should state the extent of accessible data and implement user-oriented data sharing platforms based on defined sharing rules (Ardron, 2016).

However, the need for "*access*" contrasts with the interests of contractors who prefer the maximum amount of confidentiality for proprietary information. We recognize this "*confidentiality*" and separate that element (how to determine confidentiality) from the "*access to data*" element. The assurance of confidentiality sometimes facilitates reporting of the States (Mitchell, 1998), while increased transparency may impose costs (Heald, 2006). Thus, the effectiveness remains unpredictable for confidentiality function (Heald, 2012). We emphasize that good monitoring should have clear decision-making rules of confidentiality to promote accountability among contractors and to the public (Swaddling, 2016; Ardron et al., 2018).

Research Variables to Be Evaluated in the ISA Regulations

As described in earlier sections, the better environmental monitoring elements should fulfill criteria (summarized in **Table 1**), but deep seabed mining has not yet started, and the current discussion of the regulations for environmental monitoring at ISA has many uncertainties with respect to standards, decision-making powers, the extent of data sharing, etc. These uncertainties may contribute to transparency problems within the regime and downgrade future monitoring outcomes. Therefore, this study examines the ISA regime's transparency issues in their regulatory governance and suggests possible policies that ISA could apply to improve the system's transparency or to influence contractors' behavior for the marine environmental protection.

In Sections "Potential Issues Identified in the ISA Monitoring Systems" and "Case Studies of Other Environmental Monitoring of the Deep Sea", we examine the monitoring elements, i.e., (1) what is monitored, by whom and how; (2) how results are reported; (3) how reports and data are reviewed; (4) enforcement of non-compliance with monitoring requirements; (5) penalties; (6) access to data; and (7) confidentiality of proprietary information. We explore if the element meets the criteria (**Table 1**) to constitute good monitoring to improve transparency. If not, we list such elements as having potential transparency issues in Section "Potential Issues Identified in the ISA Monitoring Systems."

We analyze in Section "Potential Issues Identified in the ISA Monitoring Systems" the ISA exploration and exploitation regulations, recommendations, reports of ISA's Council and Assembly, and workshop reports. The geographical focus is the CCZ region of the Central Pacific Ocean, for which ISA has developed regulations. "Exploration" contracts are permits given to contractors that provide non-exclusive (prospecting period) or exclusive (exploration period) rights to search for polymetallic nodules for 15 years, to conduct EIAs for commercial mining and submit an application for an exploitation contract. "Exploitation" contracts are permits that provide an exclusive right of commercial mining of polymetallic nodules for a maximum of 30 years. The current ISA contracts are all for the exploration period (as of 2020 March). The exploration regulations define detailed procedures of the contractor's application for exploitation.

Experience From Other Deep Sea Environmental Monitoring: Case Studies

The case studies in Section "Case Studies of Other Environmental Monitoring of the Deep Sea" employ three international and two national regimes of deep sea environmental monitoring systems on the impacts of resource development to illustrate alternative approaches: the Barcelona Convention and the Oslo Paris Convention (OSPAR) for offshore oil and gas development, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) for deep fisheries, the US government for offshore oil and gas drilling, and the PNG government for polymetallic sulfides development. We chose these cases with the criteria that each case should be: large in scale; having a deep sea component; representative of a large national or international system; designed for monitoring of extractive industry with environmental impacts; and having a relatively long history of practice. Thus, the case studies, from different regions for different management resources, will provide practice-based institutional features and potential options to compare and contrast with the current ISA system's transparency. Geopolitical and social settings of the cases are different, and a direct comparison among cases is not our goal. We seek examples of alternative practices to achieve transparency among regimes situated in similar conditions as ISA. In this sense, for example, ISA has a contracted-area based management system, which is different from other international cases, but national practices

of the US and PNG might be applicable. Due to the Deepwater Horizon accident within the Gulf of Mexico in 2010, the US government has revised the management regulations and institutional structure from which practical lessons can be drawn. PNG is the first nation to prepare EIAs and monitoring protocols for commercial mineral mining in the UNCLOS era, and its approach to establishing the best available sciences for environmental monitoring can be applied to the ISA monitoring system.

Linking Elements of Deep Sea Environmental Monitoring With Other Types of Transparency

In addition to the elements of transparency of governance listed above, the regime could allow for other types of transparency. For example, "transparency for governance" (Mitchell, 2011) is to alter contractors' harmful behavior through information disclosure and education policies. Then, ISA could adopt policies to increase transparency inwards where they publish contractors' reports to improve contractors' harmful activities. Or, the third party's review input might increase contractors' reporting. This paper asks if the current ISA regulations are transparent, and if not, to recommend potential policies that would improve transparency.

As we mentioned in the confidentiality element, incentives can be implemented to influence the effectiveness of transparency; for example, normative goals, public images, sanctions, and political rewards could change actors' behavior (Mitchell, 1998). In ISA, incentives could be confidential provisions to protect the economic value of mining contractors (Lodge et al., 2014). Ardron et al. (2018) report that ISA's incentives are not transparent because most reports and review results are available only to the ISA Secretariat and members of its advisory body, the Legal and Technical Commission (LTC). Only in 2018, did ISA finally publish two contractors' environmental impact statement reports for part of their exploration activities of Belgium and Germany (BGR, 2018; GSR, 2018).

POTENTIAL ISSUES IDENTIFIED IN THE ISA MONITORING SYSTEMS

This section points out potential transparency issues of the monitoring systems described in the ISA regulations for exploration and exploitation (**Tables 2**, **3** and **Supplementary Tables S1, S2** summarize the details).

Exploration Period

The ISA regulations for exploration (ISA, 2013b) contain the two pillars of environmental monitoring frameworks—a review cycle of "Plans of Work"[7] and annual environmental monitoring conducted by contractors. A Plan of Work is a full set of plans, submitted by potential contractors, of working, financial, and impact assessments and measures for exploration[8], required in order to commence exploration for a period of 15 years. Once the exploration starts, ISA has a legal obligation to monitor compliance based on the Plans of Work[9], and contractors and the Secretary-General (SG) jointly review the implementation of the Plans every 5 years[10].

During exploration, contractors conduct environmental baseline monitoring regularly and occasionally EIAs for test mining and submit annual reports to ensure effective protection for the marine environment from harmful effects[11]. Monitoring targets must include such measures[12] and ecosystems as described in the recommendations issued by the Council (ISA, 2013a, 2015) and the environmental management plan for the CCZ (ISA, 2011). These recommendations and plans are subject to development and recommendations by the Legal and Technical Commission (LTC)[13] to the Council.

Reporting and Review

In the Plan of Work framework, the initial application requires a review by the LTC[14]; however, a periodical review of results during exploration does not occur. This self-assessment is conducted by contractors and the SG[15]. Even for the initial review, Exploration Regulations do not require any external review committee other than the LTC. Its members are elected by the Council [Rule 10 (ISA, 2019)] and the LTC cannot be entirely independent of the sponsoring States who hire contractors.

The annual monitoring framework requires contractors to report environmental data annually to ISA; however, Exploration Regulations do not define the review bodies and process or compliance requirements[16] for the report except for the requirement of environmental data. We can only assume the LTC reviews the annual reports because the SG transmits reports to the Council, and the LTC is the review arm of the Council[11]. Having only one committee to evaluate the entire set of environmental data is insufficient especially without delineation of the standards to apply in the review (Section "What Is Monitored").

What Is Monitored

Because of "the substantial lack of data" (Levin et al., 2016) in the deep sea, baseline studies in the exploration period should be planned strategically to obtain data serving to detect a change from baseline. ISA categorizes annual reports' requirements of baseline monitoring into seven science fields by guidelines (ISA, 2013a, 2015), targeting potential impacts (18 in total) (Bräger et al., 2020), and recommends the standardized measurement methods in 2001 guidelines (ISA, 2001). However, ISA does not determine ecological indicators required for baseline studies

[7]ISA Exploration Regulation 10 and its Annex II.

[8]Ibid.

[9]UNCLOS, Annex III, Article 3.

[10]ISA Exploration Regulation 28.

[11]Ibid., 32.

[12]Ibid., 5 and its Annex IV.

[13]UNCLOS Article 165.

[14]ISA Exploration Regulations 20-22 and 28.

[15]Ibid., 20–22.

[16]Ibid., 6.

TABLE 2 | Potential issues of the ISA monitoring system for exploration.

Elements	Instruments	Issues
Review	Initial application and periodic reviews of a Plan of Work	No external committee other than the LTC is required for the initial review. No committee is required for the periodic reviews.
	Annual reports review (environmental data, measures)	Clear review bodies and processes are not articulated by the regulations. No external committee other than the LTC is required. The criteria and standards required to review environmental data are not established.
What is monitored/ Reporting	Reporting requirements on Annual reports (Baseline, EIA)	Standards to obtain and evaluate environmental data are not updated or established.
	Zones and protected areas (Environmental management plan for CCZ)	Collaborative monitoring in APEIs is not mandatory and not functioning.
Inspection	Onboard inspectors	The SG retains significant power. Inspections are never executed.
Enforcement	Suspension by the Council A settlement of disputes	Enforcement instruments are not well-articulated by the regulations. Need strong ISA's willingness to raise issues and execute.
Penalties	Fine for violation of a contract	Unclear process to determine the fine's amount. Never imposed.
Access to data	Environmental database	ISA has released datasets without information of the data extent, procedure standards, and sharing rules.
	Occasional release	A lack of information on the LTC's decision-making process to advise the Council.
Confidentiality	SG's responsibility	Only the SG has decision-making power to release the information.

to support EIAs (Clark et al., 2019). Nor has ISA updated the guidelines with the latest technologies developed since 2001, which is insufficient to achieve the use of best available technologies (ISA, 2013a).

The CCZ management plan established protected areas called "Areas of Particular Environmental Interests (APEIs)" (ISA, 2011), of which environments should be monitored by contractors collaboratively, but this monitoring is not a legal obligation for contractors.

Inspection, Enforcement, and Penalties

The Authority shall have the right to inspect all installations in the Area[5] and the Council shall establish appropriate mechanisms for directing and supervising a staff of inspectors[17], based on the recommendations of the LTC[18]. The SG can transmit the information from an onboard inspection report to contractors and the sponsoring States[19], and assess penalties as appropriate. Exploration Regulations allow the Council to impose monetary fines and terminate contracts to contractors for a willful violation of terms[20], although the regulations do not define the process and criteria to determine the fine (e.g., the phase "*seriousness of the violation*" is ambiguous). Contractors shall submit a written document to accept control by the Authority over obligations[21]: however, the regulations do not prescribe enforcement instruments for "non-compliance." Currently, non-compliant contractors do not seem to be punished or sanctioned, for example, no penalty was imposed in the non-compliance cases reported by an LTC Chair's report during the twenty-third Annual Meeting[22]. Settlement of disputes provisions in Exploration Regulations and UNCLOS exist to force contractors to take necessary actions[23]; however, this solution functions usually for bilateral problems (Brack, 2001). It requires greater willingness by ISA to enforce and than has so far been observed.

Access to Data

ISA claims it is establishing a database system (ISA, 2011), because UNCLOS binds ISA to exclude any marine environmental data from its confidential protection of proprietary information[24], and ISA, the States and contractors shall cooperate in sharing the environmental data[25]. In July 2019, ISA started publishing a GIS database "ISA Deep Data," which "*holds centralized data of public and private information on marine mineral resources acquired from various institutions worldwide*[26]." However, the database does not contain the geographic extent of coverage, content lists of data, data standards, or sharing rules, indicating that their quality has not improved since the evaluation of Ardron (2016). Such limited access to environmental data is an issue of transparency for the general public, which does not know if ISA has succeeded in opening all environmental data along with metadata concerning sampling methods, contact information, or reference papers or reports that explain the data.

[17] UNCLOS Article 162.

[18] ISA Draft Exploitation Regulation 95.

[19] Ibid., Annex IV as standard clauses.

[20] Ibid., Annex IV.

[21] ISA Exploration Regulation Annex II, Section "Concluding Remarks."

[22] ISA Council 2017 meeting report, ISBA/23/C/13, "Report of the Chair of the Legal and Technical Commission on the work of the Commission at its session;" ISA Council 2018 meeting report, ISBA/24/C/4, "Information relating to compliance by contractors with plans of work for Exploration, Report of the Secretary-General."

[23] ISA Exploration Regulation 40; UNCLOS Article 186-191.

[24] UNCLOS Annex III Article 14; ISA Draft Exploration Regulations 7 and 36.

[25] UNCLOS Article 200; ISA Exploitation Regulation 3.

[26] ISA website, https://www.isa.org.jm/central-data-repository.

TABLE 3 | Potential issues of the ISA monitoring system for ISA exploitation.

Elements	Instruments	Issues
Review	Initial application and periodic reviews of a Plan of Work	Public comments are considered only for the preliminary review of an application. No external committee other than the LTC is required for the initial review of an application. Advisory comments from an "independent competent person" are examined in the initial review, but the selection is unclear. No committee is required for the periodic reviews (a self-assessment by contractors and a check with the SG).
	Annual reports (environmental data, measures)	The regulations do not define review bodies and processes clearly.
	Periodical reviews of Environmental Assessment Performance reports	No external review committee other than the LTC is required. Environmental Performance Guarantee assessed based on the review results. No committee is required for the review of post-closure monitoring (a self-assessment by contractors and a check with the SG).
What is monitored/ Reporting	Reporting requirements for environmental plans (EIS, EMMP)	Ambiguity in the degree to monitor targets and environmental indicators.
	Mitigation measures	Measures require standards, which have not been established yet. Uncertainty in measures nationally and internationally.
	Protected areas (Strategic Regional Management Plan)	Under discussion (ISA Workshop No. 17).
Inspection	Onboard inspections Compliance notice	The SG retains significant power to determine "non-compliance" and issue/withdraw a compliance notice.
Enforcement	Suspension by the Council A settlement of disputes	The SG retains significant power to advise the Council to execute orders. Need strong ISA's willingness to raise issues and execute.
Penalties	Fine for violation of a contract	Criteria and process to define the fine amount are not established.
	Forfeiture of Environmental Performance Guarantee	Criteria and processes to define non-compliance and the forfeiture amount are not established.
Access to data	Data exchange cooperation Occasional release	Detailed and practical procedures to exchange information are not established. A lack of information on the decision-making process by the LTC and SG.
Confidentiality	SG's responsibility	Contractors can design the range of confidentiality with the SG.

A lack of information exists regarding decision-making processes by the LTC for occasional information release. The LTC has substantial power in the ISA system through requesting, examining, and reviewing of regulations, applications, and reports under the Council[13], but they release an insufficient amount of information. Summary reports by an LTC Chair have been provided to the Council [Rule 21 (ISA, 2019)], but these instances are rare, incomplete, and not mandatory according to Exploration Regulations. For example, in 2019, ISA released a brief report on the Plans of Work review for some contractors, namely, Japan, the United Kingdom, and Belgium (ISA, 2019e). Such management characteristics of LTC give the impression to the public that the system has unclear decision-making processes and lacks transparency (Wood, 1999; Jaeckel et al., 2016; Ardron et al., 2018).

Confidentiality

The data confidentiality has another transparency issue between ISA and contractors and the Sponsoring States. The confidentiality provisions of Exploration Regulations[27] can restrict any data other than those related to the protection and preservation of the marine environment. Although the provision is a necessary prerequisite for contractors, only the SG has the decision-making power to release the information upon a prospector's request, although the criteria to guide this process are not clearly stated. This could reduce accountability from contractors to ISA and reduce transparency to the public. So far only two contractors' environmental impact statements have been disclosed (BGR, 2018; GSR, 2018) and there are no annual reports.

Summary

The ISA exploration monitoring composes of two systems: one is the periodical compliance monitoring of contractors' activities, measures and achievement based on their Plan of Work, and the other is the annual environmental monitoring of baseline and test mining impacts. The *What's monitored element* is weak because the regulations suggest outdated standards for monitoring methods. The *Reporting element* lacks sufficient standards to assess environmental data and compliance requirements. The *Review element* shows a lack of clarity in review bodies and assessment criteria, especially for the periodical review of the Plan of Work based on a self-assessment between the SG and contractors – all of which degrades transparency. ISA can suspend non-compliant contractors and fine them; however, the regulations do not specify the processes and have not employed actual *inspections* and *penalties* for non-compliance issues. The *Access to data element* has improved due to the recently published

[27] ISA Exploration Regulations 8 and 36-37.

database, but its transparency is low because of a lack of information on the extent and quality of data. The sole power of the SG to determine the *confidentiality* of contractors' reporting and review results without clear criteria degrades transparency inwards from those outside the regime.

Exploitation Period

At present, ISA has drafted two sets of regulations for exploitation: one focuses on standard contract terms (hereafter, "Draft Exploitation Regulations") (ISA, 2019c) and the other focuses on environmental management (hereafter, "Draft Exploitation Environmental Regulations") (ISA, 2017a). The purpose of the initial application of Plans of Work[28], still conducted under the contractor's exploration contract, is to obtain a permit to conduct an EIA and the subsequent exploitation contract. The Plan of Work comprises a set of plans for mining operations, finance, security, training, and the environment which includes the Environmental Impact Statement (EIS), Environmental Management and Monitoring Plan (EMMP), and Closure Plan[29].

During commercial exploitation, ISA monitors the contractor's environmental management status with annual reports on the environmental data and measures, periodic reports based on the Plan of Work[30], and Environmental Performance Assessment reports based on the EMMP[31]. ISA's monitoring continues until the final assessment of post-closure monitoring[32] after the commercial production ends.

Reporting and Review

In the Plan of Work framework, the SG conducts the preliminary review[33] of the initial application from contractors. The SG makes proposed three environmental plans publicly available to gather comments on them from the Authority and stakeholders in light of the relevant guidelines[34], although the regulations do not specify the guidelines[35]. The contractors may examine the public comments in consultation with the SG[20] before the formal review. The LTC examines the revised Plans by taking into account any reports from the SG and advice from so-called "*independent competent persons,*"[36] but the criteria and selection process for the "*persons*" is unclear. Once a contract is issued, the Plan of Work is reviewed by the SG and contractors at intervals not exceeding 5 years[37]. The regulations allow the SG or a contractor to invite the sponsoring State to the review[37], but not the LTC, Council, or public. Thus, the review is closed.

Contractors submit annual reports to the SG on exploitation activities, measures and monitoring results, and data[38]; however, Draft Exploitation Regulations do not clearly specify the review body and processes as not done in Exploration Regulations.

Environmental Performance Assessments could be a robust monitoring instrument to evaluate the environmental management status; however, the LTC remains as the review body and is still not independent from ISA. Contractors periodically submit to ISA reports based on the self-assessment of the environmental effects caused by mining activities and the mitigation measures taken[39]. The regulations do not require explicit compliance-review committees, while the SG makes public the findings and recommendations from the LTC[40]. ISA determines monetary deposits called "*the Environmental Performance Guarantee*"[41] for when the contractor ceases operations. Taking into account the Performance review results, ISA assesses the deposits periodically and can require that they be forfeited where the contractor fails to comply with obligations during exploitation. The regulations do not define review processes for the post-closure mining phase and the final performance assessment, but the SG is supposed to ensure whether planned monitoring requirements are fulfilled based on the contractor's self-assessed performance report[42].

What Is Monitored

Draft Exploitation Regulations suggest basic monitoring targets (e.g., areas, effects, and categories) for the EIS and EMMP[43], but they are ambiguous regarding the degree to which they monitor the targets and environmental indicators[44], and a large part is entrusted to the contractor's judgment and interpretation, inferred from expressions such as "*impact analysis to predict the nature and extent of the environmental effects*"[45] and "*identification of directly and indirectly impacted areas.*"[46] The LTC makes recommendations regarding standards[47] but how ISA could process the exploitation application before they adopt necessary standards is questionable.

Another concern regards uncertainties of the mitigation measures for the marine environmental protection because ISA has not established environmental standards, despite this suggestion being made by many stakeholders (ISA, 2018a). Moreover, contractors shall implement all applicable measures following the sponsoring States' national regulatory framework[48],

[28]The initial process was to submit by contractors an Environmental Scoping Report on the EIA focus for pilot mining in the former Draft Regulations [36], which was omitted in the current draft [48].

[29]ISA Draft Exploitation Regulation 7.

[30]Ibid., 38.

[31]Ibid., 52.

[32]Ibid., 61.

[33]Ibid., 10.

[34]Ibid., 11.

[35]Ibid., 95.

[36]Ibid., 12.

[37]Ibid., 58.

[38]ISA Draft Exploitation Regulation 38; Draft Exploitation Environmental Regulation 77.

[39]ISA Draft Exploitation Regulation 52; Draft Exploitation Environmental Regulation 49.

[40]ISA Draft Exploitation Regulation 52.

[41]ISA Draft Exploitation Regulation 26; Draft Exploitation Environmental Regulation 44.

[42]ISA Draft Exploitation Regulation 61.

[43]Ibid., Annexes IV and VII.

[44]ISA Draft Exploitation Environmental Regulation 32.

[45]ISA Draft Exploitation Regulation 47.

[46]ISA Draft Exploitation Environmental Regulation 18.

[47]ISA Draft Exploitation Regulation 94.

[48]Ibid., 44.

and reports on the compliance status based on more explicit measures[49] are necessary for ISA and the sponsoring State.

Draft Exploitation Regulations do not specify the compliance requirements for contractors in environmental monitoring. The requirements described in Exploitation Regulation 51 are monitoring and annual reporting, implementation of measures, and maintenance of "*the currency and adequacy*" of EMMP, which is too broad to define non-compliance.

Inspection, Enforcement, and Penalties

More provisions exist to implement onsite ISA inspections[50] and monetary penalties against violation of terms[51] than to review non-compliance. When a report from onsite inspectors "*appears to the SG on the reasonable ground for non-compliance*," the SG shall issue a "compliance notice" to contractors, which constitutes a warning by the Authority[52]. When the issue is considered persistent, the Council may exercise enforcement power to take necessary actions[53] including suspension or termination of mining. Therefore, the system could allow the SG to retain significant power to boost inspection and enforcement.

A forfeiture of Environmental Performance Guarantee is another monetary penalty applied to contractors that do not fulfill their obligations (Section "What Is Monitored"), but the regulations do not specify the criteria for the failure.

Access to Data

Draft Exploitation Regulation 3 defines the duties of ISA, contractors, and sponsoring States to cooperate in exchanging information on protection and preservation of the marine environment, which is encouraged by Regulation 2. Still questionable is whether ISA will make all environmental data publicly available with the same reasons suggested in Section "Access to Data." The access also conflicts with the data's confidentiality, and some contractors' concern is that the confidentiality protection period is too short, for example, Japan Oil, Gas and Metals National Corporation (JOGMEC) (ISA, 2018a). Detailed and practical procedures to exchange information, stated as "*best endeavors*" in Regulation 3, should be discussed more and supplemented.

A lack of information regarding decision-making processes by the LTC and the SG persists as previously noted for Exploration Regulations.

Confidentiality

Similar to Exploration Regulations, other issues include the lack of clear criteria and procedures to define confidentiality. Draft Exploitation Regulations allow contractors to design the range of confidentiality in consultation with the SG[54] except for environmental information. Considering that the authority to determine what constitutes confidential information is given solely to the SG for a period of 10 years[55], the SG's power to control these matters is strong. The ISA regime can apply the limits of confidentiality to contractors without an assessment based on clear criteria, which would lower transparency downwards and decrease accountability. This would affect transparency inwards from the public as well.

Summary

The ISA exploitation monitoring comprises three systems: one is the initial application of Plans of Work and periodic review of contractors' activities, measures and achievement based on their Plan of Work, another is the annual environmental monitoring of baseline and test mining impacts, and the other is the periodic review of Environmental Performance Assessments. The elements of *What's monitored* and *Reporting* show many uncertainties because the regulations do not define the standards, indicators, mitigation measures and compliance requirements to report; instead, they leave to each contractor's discretion. The uncertainties make the *Review element* rather weak. Moreover, the most potent reviewer of the periodic review of the Plan of Work and environmental performance will be the SG, which has the freedom to invite other reviewers such as the sponsoring States and independent persons. The *Inspections and Enforcement elements* also turn to the SG to determine non-compliance. The *Penalties* element lacks clear criteria for how to determine the amount of fines. The deficiencies in the Exploration Regulations with respect to the *Access to data element* carry forward into the Draft Exploitation Regulations and is still questionable for transparency because of a lack of detailed procedures in data sharing. The sole power of the SG to determine confidentiality remains in the system.

CASE STUDIES OF OTHER ENVIRONMENTAL MONITORING OF THE DEEP SEA

This section examines how other environmental regimes for deep-sea resource management address environmental monitoring. **Table 4** summarizes the primary results, and **Supplementary Tables S3–S7** list the detailed results.

Offshore Oil and Gas Development Monitoring in the Barcelona Convention

The purpose of the Barcelona Convention, established in 1975, is the protection of the marine environment through a Mediterranean regional approach (UNEP MAP, 2018). The Convention adopts seven protocols, one of which, the so-called Offshore Protocol[56], constitutes the management of environmental impacts caused by offshore oil and gas development. According to Protocol Article 19, three monitoring frameworks are applied: compliance monitoring under the

[49] Ibid., 52.1.

[50] Ibid., 96-101.

[51] Ibid., 80, 103 and its Appendix III.

[52] Ibid., 103.

[53] Ibid., 99 and 103.

[54] Ibid., 89.

[55] Ibid., 9, 89, and 90.

[56] "The Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil," adopted in 1994, implemented in 2011.

TABLE 4 | Summary of the characteristics of monitoring systems in the case studies.

	What is monitored	Reporting	Review	Inspection	Enforcement	Penalties	Access to data	Confidentiality
Barcelona Convention	Effectiveness of measures, common regional indicators	Three-tiered reporting system	Multiple reviews by authority functions and observers	Each Party's effort	Recommendations; settlement of disputes procedure	Penalties discussed by Parties; sanctions by each Party	Online database, Meeting documents (compliance reports), disclosure requests can be refused by Parties	Confidentiality is not defined
OSPAR	Effectiveness of measures, common indicators	Self-reporting, common-reporting among States	Review by authority	Each Party's effort	Recommendations; settlement of disputes procedure	Penalties discussed by Parties	Online database, Meeting documents (compliance reports), disclosure upon Party's requests	Commercial information
CCAMLR	Compliance of conservation measures, unknown habitats, fishing vessels, gears, resource	The Secretariat's reporting based on Parties' self-reporting	Multiple reviews by authority functions	Onboard observers; port or at sea inspection	Recommendations; settlement of disputes procedure	Area closure; Discussed by the Contracting Parties	Online database (compliance reports), disclosure upon a Party's requests	Confidentiality is not defined
US	Standards usage, oil spills	Self-reporting	Review by the different authorities and public	Multiple authority functions	Government order of suspension and termination	Fine	Online database; detailed info on non-compliance	Commercial information
PNG	Environmental harm	Self-reporting	Review by the authority, public comments	Investigators appointed by the Director	Government order	Fine	No instruments	Any information could be confidential

*See **Supplementary Tables S3–S7** for details.*

Convention, monitoring within the Offshore Protocol, and an overarching monitoring project, the Integrated Monitoring and Assessment Programme (IMAP) (UNEP MAP, 2017c).

The Convention

The Convention accentuates compliance monitoring: Contracting Parties shall monitor the compliance and effectiveness of measures implemented for the Offshore Protocol[57]. As a unique feature, the Contracting Parties have adopted a three-tiered reporting system for compliance (UNEP MAP, 2017a): national reporting and reporting by any other entities and the Secretariat are assessed (*Reporting element*). This stricter multi-reporting system provides incentives to Parties for reporting correctly and to observers for participating. In the *Review*, the primary review is by the Contracting Parties every 2 years[58], but the Convention's advisory body, the Compliance Committee, also reviews, and observers can join to examine the review (UNEP MAP, 2017a). This innovative system was introduced in 2008. However, as an *Enforcement element* for non-compliance issues, the Convention refers only to recommendations from the Parties Meeting[59]. The Convention does not develop a *Penalties element* except for a Party's nationally prescribed sanctions[60]. Alternatively, a settlement of disputes provision exists and allows for an arbitration procedure[61]. With respect to the *Access to data element*, summary reports are provided online on the Parties' compliance status with non-compliant nations' names. The Convention does not define confidentiality of information and the public can request information disclosure from the Secretariat: however, the Contracting Party's confidentiality remains protected[62].

The Offshore Protocol

As a unique *what's monitored element*, the Offshore Protocol has mechanisms to develop standards and to implement monitoring methods by multiple committees and regionally. The primary purpose of this collective approach is to make it effective and transparent for monitoring of the high seas, which was initially not the Parties' strong interests (Katsanevakis et al., 2015). The Protocol develops the monitoring requirements such as the responsibility of each operator; the government's inspection of the information on offshore facilities, oil spills, and discharges; and the list of the harmful and noxious substances to be subject to a special permit[63] (UNEP MAP, 2017c). The Parties have sought a regional approach and adopted Offshore Action Plans (UNEP MAP, 2012, 2016a), which aim to establish regional goals such as common standards and develop a collaborative approach for environmental impact monitoring in addition to regular national monitoring. The Protocol applies a Party's self-reporting method, based on operators' self-monitoring and Parties' review results of the operators' reports (*Reporting and Review elements*). For reporting outputs to the public, Parties and the Secretariat have developed an online regional data system and publish a document every 2 years (UNEP MAP, 2016b) (*Access to data element*).

Integrated Monitoring and Assessment Programme (IMAP)

An instrument to integrate national-level monitoring onto an international scale is the IMAP. It facilitates the collaboration of Parties by establishing common indicators and reporting rules (*What's monitored and Reporting elements*). The common indicators describe the degree of threats or changes in marine ecosystems and can deliver valuable information to decisions (UNEP MAP, 2017c). Indicator 17[64], for example, is subject to a chemical contamination condition for offshore pollution. IMAP utilizes these standards to strengthen national monitoring with respect to the *Review element*: IMAP facilitates the review and implementation of national-level monitoring programs, where the review is carried out under the same scheme as the Offshore Protocol. Under the Action Plan and IMAP, the committees of the Offshore Oil and Gas Group and its subgroups make recommendations to Parties on the implementation of monitoring procedures (UNEP MAP, 2016a). The Group's first meeting on environmental impact was in 2017, where monitoring with IMAP indicators was proposed (UNEP MAP, 2017b).

Offshore Oil and Gas Development Monitoring in the OSPAR Convention

The purpose of the OSPAR Convention, adopted in 1992, is to manage marine pollution in the North Atlantic region, and its Annex III aims to prevent and eliminate pollution from offshore sources. The environmental monitoring is engaged through four frameworks: the Convention and Annex III, guidelines, the Joint Assessment and Monitoring Programme (JAMP), and the Coordinated Environmental Monitoring Program (CEMP).

The Convention

The overarching Convention system binds Contracting Parties to eliminate pollution from offshore sources and to report periodically to the OSPAR Commission (i.e., representatives of each of the Contracting Parties[65]) on the measures taken, the effectiveness of the measures, and problems with implementation of the measures[66] (*What's monitored element*). The *Reporting element* of the Convention comprises Parties' annual self-reporting through the Parties' efforts. The Convention's *Review element* may vary depending on the capacity of each Party. The Commission reviews the reports to assess the nation's compliance[67]. Annex III stipulates responsibilities of competent authorities of Parties, where they are required to regulate offshore-sourced substances and provide monitoring systems[68]. The elements of *Inspection, Enforcement and*

[57] Barcelona Convention, Articles 26 and 27.
[58] Ibid., 18.
[59] Ibid., 27.
[60] Offshore Protocol, Article 7.
[61] Barcelona Convention, Article 28.
[62] Ibid., 15.
[63] Offshore Protocol, Annexes I and II.
[64] Concentration of key harmful contaminants measured in the relevant matrix, IMAP (UNEP MAP, 2017c).
[65] OSPAR Convention, Article 10.
[66] Ibid., 5.
[67] Ibid., 22 and 23.
[68] Ibid., 4 and Annex III.

Penalties rely on Parties' self-effort. As *the Penalties element* for non-compliant Parties in the reporting, the Commission adopts recommendations voted on by Parties[69]; however, such recommendations have no binding force[70]. Alternatively, Contracting Parties may use the settlement of disputes provisions[71] (*Enforce element*). From the document archive of the OSPAR website, the Offshore Industry Committee periodically overviews the compliance status of measures of each Party and publishes a report (OSPAR, 2009) (*Access to data element*). Except for commercial confidentiality, Parties shall ensure their competent authorities make available the information on activities and measures upon a request within 2 months[72] (*Confidentiality element*).

The Guidelines

The *What's monitored element* focuses on improving the consistency of the monitoring system, the OSPAR Commission developed standards by establishing guidelines for monitoring the environmental impact of offshore activities in 2004 (hereafter, the Guidelines) (OSPAR, 2017). The Guidelines recommend monitoring standards, sampling targets and strategies, and quality assurance of monitoring data, referenced to JAMP (explained later) and the International Organization for Standardization (OSPAR, 2010, 2017). The establishment of the "OSPAR list," composed of the chemicals assumed to originate from drilling installations, is one of the outcomes of the consistent monitoring strategies. The Guidelines require public access to information through an online OSPAR database system regarding discharged water, spills, and emissions (*Access to data element*).

Joint Assessment and Monitoring Programme (JAMP) and Coordinated Environmental Monitoring Program (CEMP)

To achieve more science-based monitoring and collaboration among Parities, Joint Assessment and Monitoring Programme (JAMP) commenced in part under the EU Marine Strategy Framework Directive (OSPAR, 2014), which aims to achieve long-term benefits such as cost reductions in monitoring and products of higher-quality databases (*Access to data element*). For the *Reporting element*, JAMP requests that the Offshore Industry Committee implement such monitoring to report the more explicit outcomes that identify issues. Then, for the *Review element*, along with the Guidelines, the OSPAR Commission and the Offshore Industry Committee join the review of the annual reports in terms of specific targets to report to the OSPAR Secretariat.

OSPAR established the Coordinated Environmental Monitoring Program (CEMP) after JAMP, in order to encourage common and coherent data assessments among Parties to address specific questions raised by JAMP (OSPAR, 2016). The effort has sought for the coherence of *Reporting and Review elements*. The Contracting Parties implement specific CEMP monitoring and report annually, and the reports are reviewed by the Offshore Industry Committee and JAMP reports. The purpose of the CEMP stage is to establish a collaboration hub of data, and increased data compatibility and transferability are required for the data management system (*Access to data element*).

Vulnerable Marine Ecosystems' (VMEs') Monitoring in the CCAMLR Convention

CCAMLR, established in 1982, is a conservation organization that has an extensive history of conducting deep-sea fisheries monitoring in the Southern Oceans in order to manage fish and other living marine resources. In addition, it has attributes similar to a regional fisheries management organization (RFMO) (CCAMLR, 2002). Its ecosystem-based management approach protects the marine environment but does not exclude harvesting marine-resources.

Conservation Measures

Conservation measures constitute the CCAMLR's *What's monitored element*. The essential policy instruments include legally binding and non-binding conservation measures that determine the use of marine living resources in the Antarctic based on the best scientific evidence available[73]. A primary purpose of the measures is to manage and restrict the deep-sea bottom fishing and gears that would cause adverse impacts on the VMEs, for example, Conservation measure 22-6 (CCAMLR, 2017b). Environmental monitoring includes baseline surveys and EIAs to identify the areas where VMEs are likely to occur as well as to track the impacts caused by VME fishing. CCAMLR applies a compliance monitoring system to force all Parties to use authorized gear, carry at least one CCAMLR-designated science observer, and submit data along with the Data Collection Plans.

For the *Review element*, the member nations have an obligation to contribute to work of a decision-making body, "the Commission," a science-based advisory body, "Scientific Committee" to make recommendations to the Commission, and a subsidiary body, "Standing Committee of Implementation and Compliance," to assess compliance. The Commission reviews and updates conservation measures at regular meetings, especially in terms of the effectiveness of relevant measures to protect VMEs, which reflect the most current data and knowledge.

The *Review element* for compliance evaluation has clear procedures. A conservation evaluation procedure is adopted to review and evaluate Parties' compliance status with the measures[74]. In the procedure, a draft report prepared by the Secretariat from the Party's compliance information is circulated to and revised by the Party with additional data and finalized as a summary compliance report. Subsequently, at the annual meeting, the Standing Committee of Implementation and Compliance reviews the report and makes recommendations on remedial actions that should be taken by the Party and other responsive actions by the Commission. Finally, the Commission assesses and makes decisions on the response taken by the Party.

[69] Ibid., 23.
[70] Ibid., 13.
[71] Ibid., 32.
[72] Ibid., 9.
[73] CCAMLR Article 9.
[74] CCAMLR Conservation measure 10-10 (CCAMLR, 2017a).

The final compliance report is available online as part of the CCAMLR annual meeting report (CCAMLR, 2017d) (*Access to data element*).

For the *Enforcement element*, CCAMLR has a consultant and arbitration system to settle disputes between Parties[75]. As another enforcement method to combat non-compliance, the Food and Agriculture Organization (FAO) can require RFMOs to close the deep-sea bottom fishing area until the RFMO establishes appropriate conservation measures to prevent significant impacts on VMEs (FAO Guideline 66, UN General Assembly Resolution 61/105). Thus, CCAMLR has implemented control and surveillance systems to monitor fishing vessels' compliance through electronic and satellite-based vessel monitoring systems and onboard observers (*Inspections element*). According to the FAO's guidelines, any States—flag States, port States, importing and exporting States, and jurisdictional States—are required to establish and implement domestic policy for VME monitoring, which may include inspections at any ports. However, FAO has not established methods to enforce non-compliant Parties and impose penalties such as to prohibit the activities of the area.

In terms of *Confidentiality and Access to data elements*, the CCAMLR Convention does not contain confidential provisions. Confidentiality of monitored data is determined by the rules for access and use of CCAMLR data (CCAMLR, 2003) and conservation measures for each monitoring target. The Secretariat can release any monitoring data upon a Contracting Party's request; however, they require approval of the Commission, the Scientific Committee, CCAMLR officers, and data originators if the request does not follow the CCAMLR framework. CCAMLR regards a data provision of online open-access to the vessel data under Data Collection Plans as one of the Parties' most essential obligations. Based on the fishing vessel information, the Science Committee advises the Commission to create VME maps, and the Secretariat shares the list and risk areas of VMEs, for example, the VME Taxa Classification Guide 2009 (CCAMLR, 2009, 2017c).

The VME Monitoring

In another *What's monitored element* to facilitate monitoring new species of VMEs, the conservation measures 22-6 and 22-7 request Parties to report to the Secretariat whenever they encounter previously unknown VMEs or affect them incidentally, such as in by-catch, in the Convention area. This report is ultimately reviewed by the Working Group of the Ecosystem Monitoring and Management under the Science Committee (*Review element*).

The Ecosystem Monitoring Program

CCAMLR has been developing the Ecosystem Monitoring Program through international cooperation with Parties, RFMOs, and voluntary groups since 1989 (CCAMLR, 2014). The Program has established the *What's monitored element* – standards as critical life-history parameters of selected dependent species, which can detect long-term changes in the abundance of harvested species such as seals, petrels, and penguins. However, CCAMLR has not established similar life-history parameters for deep fishery species of VMEs and should develop such standards to observe VMEs.

Monitoring of EEZ Offshore Oil and Gas Drilling in the United States

The environmental management of US offshore mineral mining is characterized by a stringent permit process, which considers any related US regulations and standards, regular and unannounced inspections, and thematic monitoring programs.

Leasing Processes by BOEM

The Outer Continental Lands Act of 1978 constitutes the regulatory framework for leasing. The process employs a national 5-year program to schedule the potential lease size, timing, and location, based on which the Bureau of Ocean Energy Management (BOEM)[76] calls for lease sales. BOEM is required to coordinate meetings with stakeholders from federal agencies to interest groups to input comments and conditions for the new lease sales and to draft an EIS. For a *What's monitored element*, the draft EIS includes proposed actions, alternatives and mitigation measures. The *Review element* has the features of external and consistent assessments because the draft EIS must be reviewed publicly and for consistency with State plans under the US Coastal Zone Management Act. After the final notice of lease sale, BOEM makes information from the bidding process open to the public (Baur et al., 2015) (*Access to data element*).

Additional *Review elements* are required to start exploitation activities, i.e., lessees must obtain further approval of Exploration and Development Plans submitted by lessees to BOEM (BSEE, 2016a). BOEM reviews these plans for various criteria such as water and air quality, oil spill response, and compliance with other laws and regulations. This process is in cooperation with other regulatory mechanisms and agencies such as the Environmental Protection Agency and the National Marine Fisheries Service, and also in cooperation with affected States for a consistency review (Baur et al., 2015). As a *Reporting element*, the Plans must contain environmental information, biological monitoring reports, and bottom survey reports. The proposed activities must comply with any related requirements and regulations such as the National Environmental Policy Act, the Endangered Species Act, and the Marine Mammal Protection Act.

Operational Monitoring by BSEE

The Bureau of Safety and Environmental Enforcement (BSEE) conducts project-specific safety reviews to ensure the operator uses approved technologies and equipment, and the technologies must fulfill design criteria and performance-based standards (*What's monitored element*). This principle is from the Best

[75] CCAMLR Article 23 and Annex for an arbitral tribunal.

[76] After the Deep Water Horizon Oil Spill in 2010, new agencies were created under the US Department of Interior to avoid the management conflicts occurred in a single organization that owns both power for leasing and inspections (Baur et al., 2015). These are BOEM, which issues leases and manages the offshore resources in an environmentally and economically responsible manner; and the BSEE, which provides an inspection force to promote safety culture in offshore operations (BSEE, 2016a).

Available and Safest Technology principle of the Outer Continental Shelf Lands Act (BSEE, 2018a). The *Inspection element* is well defined: the BSEE is required to perform an annual inspection of the operators' safety equipment (to prevent, e.g., blowouts, fires, and spills) and random follow-up inspections. For *Enforcement and Penalties elements*, the BSEE may charge a violating operator a civil penalty (of up to USD 100 K/day) or a criminal penalty and suspension of the operation (Baur et al., 2015). The inspection includes environmental oversight to ensure the operators' compliance with environmental standards, which is managed by the Environmental Compliance Division of the BSEE (BSEE, 2018b). With respect to the *Penalties element*, scholars argue that the current firm's liability compensation cap is too small for the size of the large area and the liability mechanisms do not serve adequately as an incentive for those firms to increase self-regulation (Scovazzi, 2012; Hasson, 2013).

As another instrument to prevent oil spills in operations, the BSEE reviews and approves of oil spill response plans from operators and inspects oil spill contaminant and cleanup equipment (*Review and inspections elements*). For the discharged water from drilling rigs in the Gulf of Mexico, Alaska, and West Pacific regions, the Environmental Protection Agency issues water permits and is responsible for its monitoring, which is carried out by BSEE (2018c).

For the *Access to data element*, the websites of the Data Center of BOEM and the BSEE share access to various types of information on, for example, leases, operators, wells, production data, and plans. Detailed inspection reports, such as an operator's non-compliance status, are not available, but the BSEE publishes an annual report on the inspection results and the number of non-compliance incidents to evaluate performance (BSEE, 2016b). Non-planned discharges or releases of polluted water must be reported by operators or by any individual who notices the discharge to the National Response Center within the Coast Guard. This information is publicly available online (USCG, 2019).

Long-Term Monitoring

For monitoring during activities, BOEM has started long-term environmental monitoring of the big oil spill region in the Gulf of Mexico for restoration and recovery to complement other science-based environmental study programs (BOEM, 2017). Recently, the US has amended regulations to require operators to use remote real-time monitoring using satellites in their offshore operations (BSEE, 2016c), which may help clarify standardized methods of the *What's monitored element* and increase the frequency of the *Inspection element*.

Monitoring of EEZ Seabed Mineral Mining in PNG

Although the process to advance commercial mining is on hold and the contract company was delisted from a stock market in 2019 (Nautilus Minerals, 2019), we should examine PNG's practices because the EIA documents are available and the EIA development involved many world-wide scientists. PNG established the Mining Act 1992 (PNG, 1992), which governs the exploration, development, processing, and transportation of minerals, and the Environmental Act 2000 (hereafter EA2000) (PNG, 2014) to set regulatory management systems of environmentally impacting activities, which is required to conform to UNCLOS Article 208. For their main project named "Solwara 1," PNG issued a mining license for resource exploration to Nautilus in 1997 and a permit for commercial mining for 25 years in 2009. In the meantime, EIAs[77] were conducted.

EIS for Leasing

The Conservation and Environment Protection Authority (CEPA; renamed in 2015) administers the EA 2000 of PNG, and gives the Director of Environment its most functional position. The Director can issue any permits related to the Act, ensure that EIAs are carried out, undertake inspections, enforce provisions of the Act, take appropriate measures for environmental protection, and prepare and submit reports on issued permits to the Minister (PNG, 2000). An advisory body, the so-called "the Environment Council," is supposed to review the Director's decisions; however, the Director serves as the Council's Chairman, and the review is based on the request of the Director[78]. Based on the Director's assessment report and public opinion submissions, the Director accepts the EIS once the Environment Council approves it[79]. Thus, the *Review, Inspection and Enforcement elements* are highly weighted toward the centralized power of the Director without clear assessment criteria.

For the EIS, Nautilus had a wise strategy to collect data promptly in an unknown field by using scientists' interests and capacity (*What's monitored and reporting elements*). Nautilus assembled high-level observation data from these scientists as supporting materials and provided a full citation of the data and contributors to the EIS. Its open policy of the EIS highlights their *Access to data element*. Nautilus' assessment process comprises a baseline survey, international workshops with scientists and stakeholders, estimation of potential impact assessments (Nautilus-Coffey Natural Systems, 2008), and creation of mitigation strategies. Each part of the assessment incorporates international standards, domestic PNG requirements, and an estimation of residual impacts after mitigation. However, the number of their publications of environmental data and technical reports on the website decreased after their Environmental and Social Benchmarking Analysis report in 2015 (Nautilus-Earth Economics, 2015), and their financial condition became worse (Davidson and Doherty, 2017). The economic instability may have affected the *Access of data element*.

Environmental Management Plans

The environmental permit requires the operator to conduct a specified monitoring program at the cost of the permit holder[80]. Nautilus announced it has already submitted the environmental monitoring program plan in 2017 (Nautilus Minerals, 2018a), although this report is not publicly available. Nautilus mentioned in the published EIS that the monitoring program would include the compilation of baseline surveys, an

[77] PNG EA2000, Article 51.
[78] Ibid., 68.
[79] Ibid., 51 and 53–55.
[80] Ibid., 66.

intense short-term validation study of discharged water, and operations monitoring to ensure regulatory compliance and to identify unforeseen effects. With these limited facts, we cannot confirm the requirements for the *What's monitored and reporting elements*. The project has had to manage financial issues in developing collecting machines and operation ships (Nautilus Minerals, 2018b). When the project's mining activities will resume is unclear (Economist, 2018).

For the *Enforcement and Penalties elements*, the Director or a person appointed by the Director can audit and investigate the operator's activities, compliance reports, and management plans for the cause of environmental harm[81]. If the operator fails to comply with or provides false or misleading information, the operator is regarded as guilty of an offense, and the penalty, a fine, shall not exceed PNG Kina 100K (∼USD 30K as of Mar. 2020)[82].

Except for the review results of the EIS, the Environmental Act does not contain an information-sharing policy with stakeholders and the public (*Access to data element*). The Director can collect and store data related to the environment and asks the operators to provide such information; however, confidential information is excluded[83] (*Confidentiality element*). Aside from Nautilus, due to the minimal information available on the PNG government websites, an analysis of what and how PNG has made decisions on the environmental management and monitoring performed by Nautilus is difficult. This fact degrades the *Access of data element* as the PNG regime.

Conclusion of Case Studies

The cases (**Table 4**) suggest that international monitoring systems, such as the Barcelona Convention, OSPAR, and CCAMLR, have focused on implementing transparent *reporting* and *review* systems, e.g., third-Party reporting and reviews by multiple bodies, to eliminate uncertainties from the national self-reporting. In this sense, the compliance review system practiced by CCAMLR based on the Secretariat's reporting may be useful to avoid false statements but demands a specific high capacity for the Secretariat to consult the Parties. Examinations of *enforcement* and *penalties* based on these reports still have uncertainties in the requirements, which reduce the value of the cases with respect to transparency.

For *monitoring requirements*, the international regimes focus on enhancing the regional efforts to establish effective measures, monitor compliance status, and develop regional and thematic common indicators and rules to report. CCAMLR's monitoring system prioritizes the assessment of compliance with conservation measures. The OSPAR system introduces standards from the beginning stage and made each Party implement these standards, rather than expanding national-level monitoring standards to a regional level. This system also recognizes that a common database and collaborative monitoring efforts would be beneficial in terms of value and costs for all Parties.

By contrast, national monitoring cases of the US and PNG tend to rely on clear standards to assess permit applications before a lease is issued to a contractor, as in the US case. These systems seem not to depend on the operator's self-reporting efforts. The PNG system does not even have a critical review system for reports; instead, they depend more on the strict standards and the durable *enforcement* and *penalty* mechanisms prepared by the government. US offshore monitoring is managed by a stringent permit process that follows multiple regulations and by multiple *inspections* under "separated" agencies. PNG's seabed development is controlled by law enforcement under a single environmental agency, which provides centralized decision-making power to the Director of the authority. The *enforcement* power of the US and PNG can execute a government order to terminate the contractors' activities and impose monetary *penalties* to the operators for non-compliance.

Compared with the national cases, the international regimes do not establish many instruments for *inspection*, *enforcement*, and *penalties* except the CCAMLR's onboard inspection and observers. The systems seem to rely on each Party's national effort. Recommendations from the authority to non-compliant nations may not be effective, and settlement of disputes procedures require other Parties' approval.

Confidentiality of information is not defined well in the cases of the Barcelona Convention and CCAMLR, and any commercial information can be confidential in other cases. Decision-making power on the range of *confidentiality* is ambiguous in most cases. Instead, disclosure requests by Parties or the public are allowed in international cases, although Parties can refuse to disclose such as in the Barcelona Convention. For *access t*o all or a part of non-compliance information, it is open to the public except for the PNG case, and the regimes are facilitating the creation and publishing of online databases.

RECOMMENDATIONS

The International Seabed Authority (ISA) is in the process of negotiating its regulations for environmental monitoring of commercial exploitation. Based on our assessments provided above and collaborated by other studies, the current ISA regulations are compromised by a lack of clarity in terms of criteria for monitoring elements. Given the larger scale of exploitation activities compared with exploration, the commercial mining phase would produce greater disturbance in a vulnerable and incompletely understood environment. ISA needs to develop an adequate monitoring system, while performing a dual role in protecting the marine environment and allowing for benefits of mineral extraction. Without a high-quality and transparent monitoring system, a gap would increase between interest and concerns for the minerals extraction by ISA's stakeholders, science and environmental communities, and the public. The ISA monitoring elements have a mixed feature of both national and international types of monitoring assumed from our case studies of five different environmental monitoring regimes. The cases provide alternative approaches for how to achieve high-quality environmental monitoring and greater

[81] Ibid., 74.

[82] Ibid., 74 and 114.

[83] Ibid., 77.

transparency. The following recommendations address identified concerns about quality and transparency in the ISA regulations to monitor deep seabed mineral development in the CCZ, and outline potential ways to improve transparency and effectiveness of the regime's environmental monitoring.

What Is Monitored

The ISA system continues to have many ambiguities in its standards and compliance requirements, whereas the Barcelona Convention and OSPAR systems implement international standards and measures, and the US offshore system manages the operators with multiple critical standards and regulations with tight inspections and penalties.

Clear Common Standards and Measures Among Contractors as Clear Goals

ISA has not established standards and measures for deep seabed monitoring of exploitation except for some out-of-date baseline survey methods (ISA, 2001). This phenomenon raises many uncertainties for contractors, for example, Germany and the African group (ISA, 2018b). ISA should establish indicators to measure environmental impacts and conditions, e.g., the indicators set by the Barcelona Convention and OSPAR (Sections "Offshore Oil and Gas Development Monitoring in the Barcelona Convention" and "Offshore Oil and gas Development Monitoring in the OSPAR Convention"). ISA should revise those measures periodically based on the assessment of their effectiveness as is performed by CCAMLR (Section "Offshore Oil and gas Development Monitoring in the OSPAR Convention"). Science-based standards and measures are mandatory under UNCLOS[84]. Clear goals based on clear standards and measures could strengthen an environmental monitoring plan and lead to greater transparency.

Reporting System

Collective Reporting Through Collective Environmental Monitoring

Collective monitoring among contractors has been encouraged in recent ISA workshops and CCZ environmental management guidelines regarding exploitation and exploration (ISA, 2013a, 2017c). In keeping with that approach, this study recommends that collective integrated monitoring should follow each contracted area's baseline survey and cover common protected areas [APEIs (ISA, 2011)]. First, because it is time-efficient. From scientific perspectives, deep-sea baselines in the CCZ-contracted areas contain huge uncertainties (Van Dover et al., 2017), but the temporal and spatial scales of the data obtained by a single contractor are limited. There is little possibility to confirm the natural variations during the limited duration of the current Exploration contracts, i.e., a 15-year maximum. Second, collective monitoring facilitates the effort to establish standards and common methods, equipment, and environmental indicators. Both the Barcelona Convention and OSPAR regimes have implemented collective monitoring strategies to define common indicators to measure environmental impacts. Third, costs could be reduced. Currently, some nations have developed and deployed high-quality monitoring technologies, and with this new option, nations can share resources (e.g., joint use of a ship). This effort could promote technology transfer and capacity building too[85], which could lead to coherent outcomes of monitoring over various contractors. State cooperation on environmental protection is an inevitable spirit of the Common Heritage of Mankind (CHM)[86]. The CHM seeks benefit-sharing of mining as well as the preservation of natural resources and marine environments in a manner to ensure equity between developing and developed States (Jaeckel et al., 2017).

Reporting by Others on Compliance and Emergency Issues

In the Barcelona Convention system, the reports from other entities on activities of any State can be submitted at the compliance committee meeting. The US offshore system has a reporting and information provision system accessible to anyone who notices unplanned discharges and oil spills from offshore rigs. Their practice contrasts with the current ISA regulations that only allow annual reports, environmental performance reports and incident reports[87] based on a contractor's self-reporting. Given the vast scale of the contracted area in the CCZ, this self-reporting is not efficient and could not produce an adequate and timely response if an unexpected pollution event occurs and the contractor does not report it immediately. Any source, that detects an incident, should be allowed to report it and ISA should establish a process for prompt investigation. This type of reporting would also be beneficial as a boundary monitoring tool for detecting mining plumes beyond multiple contracted areas[88].

Autonomous Transmission of Compliance Data From Ships

For cost reduction and more transparency, ISA should promote autonomous electronic submission of compliance data. Data such as discharge water quality, equipment settings, and ship locations could be transmitted autonomously using current technologies. ISA regulations recommend the use of remote monitoring technology[89] as another onsite inspection method, but ISA should also examine the potential of real-time monitoring using satellite systems similar in function to those in operation for the US offshore EEZ and CCAMLR.

Review System

The centralized power and responsibilities of the SG and the LTC characterize the ISA system as different from other international monitoring. There are not clear standards for review of the contractors' reports on environmental baselines and impacts during exploration by the SG and LTC. The primary recommendation to ISA is that it should make the review system more transparent and increase the capacity to monitor the

[84] UNCLOS Articles 194 and 201.

[85] Ibid., 144.

[86] Ibid., 197 and 200.

[87] ISA Exploration Regulation 33.

[88] Expressed as a concern by the German government (ISA, 2018b).

[89] Note 36 (ISA, 2019b).

status of contractor compliance, which could provide evidence to enforce against non-compliance.

Independent Compliance Review Committees

Except for the review by the SG and the LTC, there is no review system to assess reports for compliance allowed in the current and draft regulations. Most regimes in the case studies have a compliance review committee, such as in the Barcelona Convention, OSPAR, and CCAMLR systems. ISA should have an independent compliance committee to review annual and environmental performance reports and discuss the effectiveness of national measures and consistency of those measures with ISA regulations. The compliance evaluation function is lacking in the current and draft regulations.

Independent Environmental Review Committees

The review process for annual reports and the roles of the LTC and the Council is unclear in the regulations. For the periodical environmental performance review, contractors prepare and submit their documents for review and the SG comments. This sort of internal review lacks transparency compared with other regimes. ISA should establish an independent environmental review committee. Ideally, this review committee would provide independent advice to the LTC and the Council and their advice should be available to stakeholders. Currently, the LTC is involved in most review processes such as contract applications, annual reports, and environmental performance review. However, this concentration of review processes in one body may lead to failure because of the burden of multiples reviews and the lack of sufficient expertise. An example of such a potential source of failure can be seen in having only one agency promoting lease sales and oil and gas production, monitoring environmental performance and enforcing compliance in the US offshore program prior to the Deepwater Horizon oil spill.

Centralized Analysis and Evaluation System for Contractor Data by an ISA Data Analysis Team

This recommendation proposes that contractors would send raw environmental data measured in the baseline and EIAs to an "ISA data analysis team." The team would analyze and evaluate such environmental data over the whole mining area of the CCZ. This approach is scientifically justified because it is highly likely that local impacts identified in the biodiversity of the CCZ give high impacts even on the larger-scale environment (Levin et al., 2016): larger-scale assessments would benefit from the ability to synthesize available data. The team would be composed of ISA-hired research experts and supported by an additional monitoring fee to be paid by contractors or sponsoring States. An advantage to this option is that the team can process data with standardized methodologies and criteria, which would lead to a comprehensive baseline. Integration of the analysis which each contractor is supposed to prepare could reduce total costs. For individual costs, presently, contractors usually hire environmental assessment companies to analyze their data and create a report[90]. Second, contractors' confidentiality can be retained within the regime even if the data contain sensitive information. Third, transparency and quality control of data can be more effectively managed compared with a system based on each contractor's self-reporting. Transparent outputs from such a centralized ISA team is vital to ensure that all States receive equal treatment, which can lower the risk of a loss reputation for the Secretariat (Dijkstra, 2017).

[90]E.g., Tonga's contractor hired an Australian company to prepare its exploration report (Tonga Offshore Mining Ltd-Golder Associates, 2012).

Inspection and Enforcement

ISA should develop the capacity to perform random inspections without prior notification as practiced in the US offshore monitoring practice. It should be designed to be fair because some leading stakeholders of mining companies and their sponsoring States are concerned about random inspections (e.g., Japanese government, Interoceanmetal Joint Organization, and Deep Ocean Resources Development) (ISA, 2018a). Concerns also exist regarding the inspection costs that may be imposed on contractors. Reducing costs is not easy; however, more explicit inspection requirements in the regulations should decrease the concerns. The concerns lead to the need for clear evidence for following enforcement actions and for a standardized penalty system, such as national practices of the US and PNG. Inspections and enforcement in the ISA system are complicated because the system is set up so that the mining contract is between the contractor and ISA, and the responsibilities and roles of the sponsoring States for non-compliance are ambiguous. International treaty arrangements such as OSPAR and CCAMLR define the Parties' responsibility for the contractors' non-compliance.

Inspections Based on Technical Standards

Inspections should prioritize the target requirements in advance so that contractors know what to expect and inspectors know what to investigate. One of the practical inspection targets should be whether the contractor is using the required technologies and equipment. Thus, it is incumbent on ISA to establish the list of technologies and equipment standards based on its stated commitment to use of best available science and technologies.

Penalties

Clear Criteria in Penalty Assessments

ISA should develop clear criteria of enforcement and penalties to be assessed for non-compliance. Currently, in Exploitation Regulations, the SG is supposed to determine and enforce a compliance notice to contractors and monetary fines such as the Environmental Performance Guarantee, but the standards are not clear and so far penalties have not been assessed where non-compliance has been detected (Section "Exploration Period").

Incentives to Increase Compliance by Contractors

ISA should examine incentives to reward good behavior in concert with the current penalty system. This could include a grace period to validate new regulations for good record contractors. Incentives are often more effective than monetary penalties if the contractors are wealthy and not strongly supportive of the regime's norms (Mitchell, 1998). Regime stability is critical for major investments. Contractors are

legitimately concerned that ISA could change the contract terms and conditions every time regulations are amended once mining starts (ISA, 2018b). Of course, providing all contractors with notice well in advance and justification of legal amendments is essential.

Access to Information

Access to ISA Workshops

ISA organizes workshops intended to assist in drafting monitoring guidelines. Stakeholders including observers, NGOs, and academic scholars have wanted to participate in the workshops; however, most workshops have been closed and subject to the Secretariat's unstated invitation system, which is neither open to the public nor provided on their website. In April 2019, the Secretariat published four criteria of experts to be selected for the workshop on CCZ biodiversity synthesis[91]. The criterion, "*Good experience in environmental management of seabed activities*" is very ambiguous and subject to bias. Another criterion, "*Experts with access to unpublished biodiversity data in CCZ*," is in practical terms restricted to mining contractors and their consultants. Thus, the opportunities remain limited for stakeholders and the public to make comments reflected in ISA regulations. This approach for selecting invitees is against ISA's policies for the CCZ area[92] and the spirit of the CHM. Using technologies such as a webinar conference system[93], ISA should be able to manage a broad audience and provide means for feedback and comments.

Compliance Status and Meeting Documents

The current ISA regulations do not require public access to information on compliance status. The case studies show that most international management regimes report information on the compliance status for each State. Although complete access might result in controversy in terms of contractors' performance, ISA should report non-compliant activities and the countermeasures being taken even if non-compliant companies' names are not publicly released. Additionally, more meeting documents such as those of the LTC meetings and regional session meetings should be made publicly available. Currently, the Chairman's report on the LTC is publicly available but presents a minimal amount of information. Availability of compliance status information should be effective to enhance transparency if ISA adopts an external rating system of contractors, for example, the System for Transparent Allocation of Resources implemented by the Global Environmental Facility (Global Environmental Facility, 2013) and the Environmental Performance Index by Yale University (Yale University, 2018).

Parallel Access to a Database

Whether the development of an ISA database has provisions to improve transparency is unclear. The database should not be merely a platform for data submitted by contractors without any guidelines. To collect new biological data in the deep sea, clear objectives to collect certain types of data and to provide parallel access to data by stakeholders, e.g., the CCAMLR system created for its VME database, would be effective. Such parallel access should allow contractors and others who can submit their research findings, as well as other Parties with a substantial interest in what is known, for example, observers and NGOs.

Real-Time or Quasi-Real-Time Publication and Streaming of Monitoring Data

Information provision should be as fast as possible. ISA should release production reports and pollution status reports quickly, as is the case for the US offshore oil and gas monitoring. Real-time monitoring of the environment by contractors is technically possible. Monitoring pictures and video from satellites should be streamed on ISA websites.

Confidentiality

In the ISA system, the information disclosure policy stipulated in the regulations remains ambiguous and the criteria owe to the SG's decision primarily. Other international cases do not clearly define the range of confidential information either; however, the CCAMLR case installed a procedure to discuss the confidentiality among multiple actors of data requesters, providers, and the authority committee and officers.

Decision Making by Anyone Other Than the SG for Confidentiality

The current regulations provide decision-making authority regarding data confidentiality to the SG upon consulting with contractors, which produces transparency issues (Ardron et al., 2018). It could also cause inequity among contractors, as many contractors have already expressed (ISA, 2018b). ISA should establish criteria for what constitutes proprietary data and should reconsider and promulgate powers to assess such confidentiality, including the establishment of a compliance committee on that.

CONCLUDING REMARKS

The International Seabed Authority (ISA) has managed deep seabed mineral exploration since its first establishment of regulations in 2000 and is currently drafting another set of regulations for commercial mining. This study focuses on exploration and exploitation for polymetallic nodule mining in the CCZ and examines the ISA's environmental monitoring governance system for seven monitoring elements that measure transparency of the ISA regime. The *Monitoring* and *Reporting* elements lack standards and compliance requirements, which may hinder contractors' information inputs to ISA. The *Review* element is

[91] ISA website, https://www.isa.org.jm/workshop/deep-ccz-biodiversity-synthesis-workshop.

[92] E.g., 2011 CCZ management guidelines (ISA, 2011), 35 h "*Facilitate cooperative research*."

[93] ISA has live streamed the Assembly and Council since 2018 without feedback functions, https://enb.iisd.org/vol25/enb25168e.html.

unclear with respect to criteria for reviewing environmental monitoring reports and impacts of activities by contractors. The effectiveness of *Inspections* and *Enforcement* elements depends heavily on the action and capacity of the ISA Secretary-General (SG). The elements of *Enforcement* and *Penalties* lack the procedures and criteria to define non-compliance as well as a fair penalty fee schedule. The *access to data* and *Confidentiality* elements have defects because of the lack of definition of the extent of its openness and the reliance on the SG as the sole decision-making authority. The overall ambiguities found in these elements result in a lack of transparency for stakeholders and the general public to facilitate the effectiveness of the environmental monitoring system.

Based on case analysis with other deep-sea monitoring, the current ISA system performs similar functions to the national practices such as the US offshore oil and gas drilling monitoring in the EEZ. However, international institutions such as the Barcelona Convention's offshore oil and gas development monitoring are now focusing on collective regional monitoring and transparent reporting. Their review systems achieve higher monitoring effectiveness collectively among member States, which represents a significant shift from the national level monitoring. The results raise a question—whether the ISA's monitoring approach is sufficiently "adaptive" (Ellis et al., 2017; ISA, 2017b; Durden et al., 2018) in managing unknown mining impacts on the deep-sea environment for a vast area under the principles of the CHM.

The policy recommendations proposed by this paper based on the case studies would allow ISA to improve the design of current monitoring systems to become more transparent. The key areas to improve are in detecting and enforcing non-compliance, improving the effectiveness of efforts to obtain environmental data, and achieving the balance between transparency and the contractors' confidentiality. In particular ISA should increase the regime's transparency downwards from ISA to the contractors by explicitly establishing clear rules and criteria to assess contractors' data and activities. This effort should help ISA to improve transparency inwards from the interested public. The recommendations emphasize the need to develop a collective monitoring approach comprising adjacent contractors or an independent team of experts to review and synthesize data collected. Such a team, tasked with combining the monitoring of separate contractors in the large contiguous area of claims, could contribute to consistent reporting environmental data, and may help improve the efficiency and effectiveness of the entire effort. Similar to other international regimes, ISA's weak enforcement system requires further development. Clarifying uncertainties in standards and compliance requirements should improve effectiveness.

Once Exploitation Regulations are approved and passed, it may be a challenge for ISA to engage with commercial mining enterprises to balance the interest in production with adequate monitoring protocols to ensure protection of the deep sea environment. ISA should take a sufficient amount of time to increase its capacities to examine and respond to concerns of stakeholders before the regulations are established. Commencement of mining can and indeed should wait until ISA completes its deliberations.

AUTHOR CONTRIBUTIONS

KK conceived the research theme, analyzed the research data, and wrote the draft. DF contributed to the Sections "Introduction," "Research Approach for Assessing Transparency of Deep Sea Environmental Monitoring," "Recommendations," and "Concluding Remarks" and to the overall organization.

ACKNOWLEDGMENTS

Our appreciation to John Delaney and Nives Dolsak from the University of Washington for their insightful advice on analysis of seabed mining and governance, respectively. Internship experience at the International Seabed Authority was helpful for the manuscript. We are grateful to dedicated reviewers of FMS.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fmars.2020.00247/full#supplementary-material

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Conflict of Interest: Here, we disclose the persons and organizations that could have potential competing interests with the draft article. First, KK is currently working for Amundsen Science in Canada since January 2019, whereas she declares her responsibilities are nothing related to this draft article and there is no financial help obtained from the affiliation for this article. Neither is for DF, who works for University of Washington in the United States.

Second, the present study is based on the KK's master thesis written under the supervision of her academic advisors DF, Professor John Delaney, and Professor Nives Dolsak, from Graduate School of Marine and Environmental Affairs of the University of Washington in 2016–2018.

Third, KK had an internship experience at the Secretariat of the International Seabed Authority in 2017, but did not receive any support from the organization for the draft article.

During her master's program, she interned for the Secretariat of the International Seabed Authority in Jamaica for three weeks in the summer of 2017. The internship was to become familiar with international organization systems: however, it was a voluntary internship without any stipends and salaries. Her responsibility for the internship was computational processing seawater property data. Thus, the Secretariat is not a sponsor of the present study. She did not obtain and utilize any data which are not publicly available and did not apply any confidential information that she knew during the internship.