SMALL-SCALE TESTING OF NODULE COLLECTOR COMPONENTS ON THE SEAFLOOR OF THE CLARION-CLIPPERTON FRACTURE ZONE AND ITS ENVIRONMENTAL IMPACT

GLOBAL SEA MINERAL RESOURCES (GSR)

ENVIRONMENTAL IMPACT STATEMENT (EIS) REVIEW

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1. INTRODUCTION

Global Sea Mineral Resources (GSR) has drawn up and published an Environmental Impact Statement on the small-scale testing of components of an installation for the collection of polymetallic nodules on the seabed, in the so-called Clarion-Clipperton Fracture Zone in the Pacific Ocean. In practice, the project, which is being conducted within the framework of the exploration phase of a potential future project for deep-sea mining, comprises the testing of a collector vehicle that is considered a pre-prototype for a future (larger) mobile installation for the collection of polymetallic nodules. The test project aims to test the vehicle's manoeuvrability, reliability and efficiency when collecting the nodules, under field conditions. In addition, the intention is to chart the potential environmental impacts of such an operation, by means of an extensive monitoring program. The test project will therefore be accompanied by an extensive scientific research program aimed at gaining a better picture of the environmental characteristics within the test zone, and of the way in which the project influences this. The information gathered will be used for the optimisation (both technical and environmental) of the operation, with a view to scaling up to a commercial level, and will help to expand the knowledge base for any subsequent environmental reports for these scaled-up operations.

This document is a review of the EIS document proposed by GSR, in terms of methodological approach, completeness and usability. This document also formulates recommendations with regard to the EIS document itself and its implications for the follow-up process.

2. REVIEW

2.1 Structure of the impact assessment

This document formulates comments and observations pertaining to the way in which the EIS was drawn up and developed, inter alia, from the standpoint of the general methodological aspects that apply to environmental impact assessments. On the basis of best practice and existing guidelines, it can be stated that a number of standard elements must be present in all good environmental impact assessments. Thus we also examine the extent to which these elements are, indeed, included in the general structure of the document and whether they are sufficiently elaborated on and substantiated.

Annex V to the "Draft Regulations on Exploitation of Mineral Resources in the Area" (ISBA 23/LTC/CRP.3*, August 2017) proposes a template that can be used as the basis for the structure of an Environmental Impact Statement, and the document from GSR is partially based on this. Furthermore, reference can also be made to document ISBA/19/LTC/8 ("Recommendations for the guidance of contractors for the assessment of the possible environmental impacts arising from exploration for marine minerals in the Area") which contains a list of the information that must as a minimum be submitted within the context of an environmental impact assessment for an exploration activity on the seabed.

Since the project is not yet in the exploitation phase, use of the template from ISBA 23/LTC/CRP.3 is not mandatory and not all elements of this are equally applicable to the present pilot project. Indeed, a comparison between the template and the document highlights a number of differences. For example, socio-economic aspects are not dealt with in the EIS, there is no information available on the decommissioning phase, the EIS does not contain a bona fide environmental management plan etc. The initiator justifies these differences by the fact that this is not a large-scale industrial operation but rather a test project that forms part of the exploration phase, which is limited in duration and in the area affected, and which does not comprise all the elements and components of a large-scale, commercial operation.

This justification is defensible, yet at the same time exposes the limitations of the environmental impact assessment for the pilot project: given the differences in scale between the pilot project and ultimate exploitation, and particularly given the fact that a number of the essential components of commercial exploitation (e.g. systems for bringing nodules to the surface, dewatering on board the ships, the discharge of wash- and transport water, and the processing of minerals etc.) are not part of the pilot project, no information will (can) be collected that enables the visualisation of the (potential) impacts of this. Thus the pilot project provides only information on some of the potential impacts that the commercial exploitation of polymetallic nodules from the deep sea might precipitate.

2.2 Scoping

"Scoping" is an exercise used to define the limits of an environmental impact assessment and, in particular, to determine what should and should not be investigated. The ISBA 23/LTC/CRP.3 document states that, in preparation for the submission of a work plan for exploitation of the seabed to the International Seabed Authority (ISA) and prior to the preparation of an environmental impact report, a so-called "environmental scoping report" must be submitted, according to the template included in Annex IV of the aforementioned ISBA document. Since the EIS referred to here is not intended to accompany a work plan for exploitation, there is also no obligation to prepare a scoping document, which has not, consequently, been created.

Notwithstanding this, it is good practice in any form of environmental impact report to provide a separate chapter or paragraphs specifically dedicated to scoping, i.e. to the structured ex-ante analysis of the project's various potential environmental impacts, including a substantiated selection of those impacts that may be potentially significant and should therefore be examined in the environmental impact report. Such a formal and well-developed scope exercise is missing from the report. The "risk register" in the appendix, however, does constitute a first step towards this.

A form of scoping can be found in a short paragraph at the beginning of the chapters that relate to the impacts on the physicochemical and biological environment respectively, under the heading "description of potential impact categories".

The following categories are distinguished for the impact on the biological environment for example:

- habitat/nodule removal,
- sediment disturbance and plume deposition,
- increased concentrations of plume particles in the water column directly above the seafloor,
- biogeochemical alterations of the sediment (i.e. change of habitat integrity),
- potential release of toxic sediments and/or substances into the lower water column,
- noise and light pollution

Essentially, this largely concerns the impacts on the physicochemical environment; thus the list is almost identical to that proposed for the physicochemical environment. Whilst these obviously have a knock-on effect on the biological receptors, such a logical step is not made under the heading "description of potential impact categories". The relationships between primary physical and derived biological impacts are sometimes discussed in more detail elsewhere in the text, yet not in a systematic way.

The listed impact categories pertaining to the consequences of collecting polymetallic nodules on the seabed are also detailed in the literature (please refer to, inter alia, Cuyvers et al., 2018; MIDAS, 2016). They also ensue logically from the nature of the operation, although, for example, the impacts higher in the water column and on the water surface (which, incidentally, are (briefly) covered in the impact assessment itself) do not appear in the list. As the scoping has not been conducted in the form of a systematic cause-and-effect analysis based on the nature of the operation and the equipment used by GSR, it cannot be determined with any certainty whether all potential impacts have been taken into consideration and whether it was decided not to investigate certain impacts and, if not, why not.

The document does indicate (briefly) elsewhere (under "1.4. This report") that the socio-economic aspects have not been examined and why.

2.3 Assessment and significance framework

The impacts are defined in the EIS according to a number of parameters, which can be considered as assessment criteria. Whilst these assessment criteria are not initially presented together in the form of an assessment framework, they can be derived from the impact description. No specific *significance framework* is linked to the assessment criteria. A significance framework comprises rules and standards that allow the distinction to be made impacts that are, for example, negligible, limited or significant. By defining a significance framework a priori, there is an objective basis for assessing the importance of a determined impact.

For example: the extent of sediment deposition resulting from the operations is in practice expressed in the EIS, inter alia, as the surface area of the zones in which sedimentation amounts to 1 mm (or more) and 0.1 mm (or more) respectively.

This is effectively a *description* of the impact. However, an *assessment* of its significance is not provided. In other words, no answer is given to the question of whether the fact that the area in which the sedimentation exceeds 0.1 mm can be as much as 9 km² is meaningful and potentially significant. From the fact that the document elsewhere states that the impact of the test phase is limited ("no serious harm will be caused to the marine environment"), due to the limited time and spatial scale of the operation, it can be deduced that implicit use is made of a significance framework that states that (inter alia) the spatial distribution and extent of the sedimentation are not significant; however, this implicit framework is not made explicit anywhere, thus it is not possible to verify its validity.

One could argue that it is difficult to link significance to the extent of a physical impact at all, since *ultimately* it is the knock-on effect on the biological environment that determines whether an impact is significant and potentially substantial. This knock-on effect is indeed (extensively) described, yet only in general terms and based on literature from previous research. Here too, no specific significance framework is employed that would allow us to determine whether the test phase's impact on biology is significant or not. As is also indicated in the report, it is not currently known, for example, which heights or rates of sediment deposition are tolerable or lethal for each of the various fauna groups present.

The reason that no concrete statements are made about the scale and significance of the test phase's impacts on the biological environment is that, as the document itself indicates, there is a significant knowledge gap, both in terms of the "baseline" (in particular with regard to ecological processes and functions) and with regard to the knock-on effect of the predicted physical impacts on the biological environment. Incidentally, this fact does not in itself prevent a generic significance framework from being drawn up, which could subsequently be elaborated on and applied as soon as the aforementioned knowledge gaps have been filled.

From the general description of the impacts that can be derived from, inter alia, previous observations (of the consequences of earlier pilot projects), it does indeed appear that the impacts on ecology could potentially be significant and long-term or even permanent (please refer to, inter alia, Cuyvers et al., 2018; MIDAS, 2016). This fact, combined with the (explicitly mentioned) knowledge gaps and the precautionary principle, which is fully applicable to exploitation of the seabed (please refer to International Tribunal for the Law of the Sea, 2011, cited in, inter alia, *Cuyvers et al*., *2018*), should in fact lead to the conclusion that a significant impact of the pilot project cannot be excluded.

The assertion in the EIS that the impact is limited is in that sense premature, and cannot be substantiated.

2.4 Description of the policy, legal and administrative context

This section is extremely brief and essentially limited to a reference to the UN Convention on the Law of the Sea. Reference is also made elsewhere in the document to, for example, the MARPOL convention. However, that is not included in this heading.

Reference is additionally made to "relevant appropriate national requirements by the sponsoring States", without specifying what is meant by this.

An overview of any (national or international) standards that shall or can be used to test the significance of certain impacts (for example, in terms of water quality) could be placed under this heading.

2.5 Project description

The EIS contains a clear and complete description of the technical and operational aspects of the pilot project, including the presence and spread of the polymetallic nodules in the area, the technical characteristics and dimensions of the test vehicle, Patania II, the technique used to collect the nodules and separate them from the sediment, and of the experimental design.

As already indicated, the experimental design relates to only some of the operations that would be required in a commercial setting, in particular the dispersion over the seabed and the collection and separation of the nodules. The scale, both of the test vehicle and of the operation, is also considerably smaller than that of a potential commercial phase.

The underlying project rationale (which (market) demand the project must help satisfy - why opt for the mining of polymetallic modules on the seabed, as opposed to other options?) is not discussed. This aspect should preferably be (briefly) expanded upon in the EIS.

2.6 Description of alternatives

The EIS does not contain a description of alternative techniques and methods for achieving the project's objectives. However, Patania II is the result of a long, prior process of research and optimisation, and it can be assumed that other solutions (e.g. with regard to the collection technique) have passed review, at least conceptually. It can also be assumed that the environmental impact was considered in the selection process, thus the present design additionally incorporates an optimisation from that perspective.

We believe that it would be useful (and befitting good EIS practice) to include in the EIS a brief overview of previously investigated solutions and the reasons why these were not ultimately selected. A comparative table summarising the advantages and disadvantages of each solution (both in technical terms and from an environmental point of view) would complete this overview. This information is detailed in technical appendix 12.1. for the hydraulic collection system and in terms of effectiveness. However, it would be good to summarise the essence of this in the main text and to expand upon it with information about the other components and the advantages and disadvantages in terms of environmental impact.

A comparison exercise, in terms of the expected environmental impact between various strategic options for (partially or fully) satisfying the demand for certain metals (onshore exploitation, recycling, exploitation of the seabed, etc.) would also prove interesting. However, this does, of course, fall outside of the initiator's responsibility. There is also a need for a strategic environmental impact assessment of the seabed exploitation activities on a regional scale.

2.7 Description of the existing situation (baseline)

In order to determine the project's impacts correctly, a reference is required with which the situation that arises upon project execution can be compared. In the pilot project, the existing situation within the zone that can or will be impacted by the project is used as the reference situation. A separate zone (the "control reference zone") is also defined and delineated. This zone is assumed to lie completely outside the influence of the pilot project and can therefore serve to visualise the natural evolution of

the initial situation, in a project-free situation. This reference zone is approximately 11 km from the project location. This distance was chosen because modelling with the hydrodynamic model (see below) indicated that the limit to where sedimentation has decreased to 0.1 mm, even in a worst case scenario, would be restricted to about 6 km. Given that the model has not been validated or calibrated on the basis of observations, or only to a very limited extent, and that the results are strongly influenced by assumptions pertaining to the current, we consider this 11 km distance too modest. According to the model results, the plume itself (concentration limit 0.1 mg/l) may extend to 12 km from the operation. Some impact on the water volume above the seabed can thereby not be excluded. It would be better to define a "control reference zone" at a greater distance from the project location. In the context of the monitoring plan, the option of defining additional reference sites is left open.

The document describes the *physical environment* in detail. The description largely relates to an area of approximately 200 km², within which the actual test zone (with an area of max. 0.1 km² (10 ha)) and reference zones are located. Thus, it can be assumed that this description is representative of the area to which the pilot project relates and also provides a picture of the variability within the area. Based on previous research, the document describes the existing (physical) situation in terms of, inter alia, topography, geomorphology, water quality, currents, turbidity, natural sedimentation and substrate properties. The description contains a significant amount of information and appears exhaustive; at most, one could question whether all the information presented is indeed relevant to the impact assessment and used effectively in the description and assessment of the impacts.

The situation pertaining to light and sound (biologically important parameters that can be influenced by the project) is also described, albeit very briefly and in general terms (not based on observations). This is motivated by the fact that compiling data on these parameters is not mandated by the recommendations in document ISBA/19/LTC/8.

The description of the biological environment is based on a number of measurement and observation campaigns in the period 2014-2017. It contains a lot of interesting information at the taxa and genera level. Information pertaining to the ecological relationship between the various groups and thus about the functioning of the ecosystem is currently rather limited, which, of course, gives rise to limitations when it comes to assessing the project's impact correctly. Furthermore, it is also the case that, whilst detailed and valuable in itself, the information relates to a rather limited number of sampling and observation points, and a limited time frame (a few years). This means that the observations do (or can) not provide a full picture of the actual baseline conditions, which is also admitted (elsewhere) in the report.

It can hereby be noted that the pilot project is intended, inter alia, to further improve the baseline inventory and to build up knowledge that should enable us to better assess the project's impacts on that baseline, which is certainly a good thing. At the same time, however, this implies that (too) little basic information is currently available and, thus, that it is actually not possible to assess the impacts of the test phase itself correctly (which is, inter alia, the object of the EIS).

2.8 Description of the impacts

The impact description is partly based on existing literature (taking into account the baseline conditions to the extent that they are known) and partly on the basis of models.

In the latter case, this mainly concerns a hydrodynamic model that is intended to estimate sediment dispersion and deposition; this model will be used during the research phase, inter alia, to determine a priori within which contours impact monitoring is useful.

However, in the absence of measurement data, the model has been scantily validated and has not

been calibrated with regards to the sediment transport aspect. The assessments obtained using this model, including sediment deposition, as reported in the EIS, must therefore be used extremely cautiously.

The report also recognises the need for further validation of the models via monitoring and for a better understanding of the relationship between (primary) impact and effects on the environment; it is in this context that extensive research will be conducted (by the Mining Impact 2 consortium) as an intrinsic part of the test phase. A substantial part of the knowledge required to assess the impacts of the test phase correctly will therefore be gathered only during the test phase itself. This leads to a sort of chicken-and-egg situation in which further research is needed to assess the impacts correctly (including the test phase), on the one hand, whilst that same research will be conducted only as part of the test phase, on the other. The EIS explicitly states that the authors refrain from providing detailed assessments or prognoses on the extent of the impacts. This is a somewhat strange statement in the context of an environmental impact assessment, which can be partly explained by the lack of basic data, for which the test phase that is the subject of the research seeks to help provide a solution. This statement is inconsistent with the statement in the "executive summary" that the impacts of the pilot project will be limited ("no serious harm will be caused").

With regard to the impact description in the EIS, the following can also be noted:

1. As far as the air pollution caused by the expedition ship is concerned, reference is made only to the MARPOL protocol and the fact that ships must comply with this. That fact does not, of course, guarantee that there will be no impacts, particularly as the ship will remain in the same environment for a considerable period of time. In contrast to the impacts that occur in the deep sea, this type of impact is easy to describe and assess. The above also applies to the treatment in the EIS of surface water pollution emanating from the ships
2. With regard to the ships' noise impact, reference is made to the potential impacts of ship noise on (inter alia) marine mammals. At the same time, however, it is stated that "no whales or larger sea mammals have been sighted (…) during any of the exploration cruises". The latter is, of course, only anecdotal information, which also has little significance in view of the large distances over which noise can travel under water.
3. It is stated that the removal of the nodules will lead to a "significant change in the habitat of the seabed". At the same time, it is stated that the removal of the nodules will have an insignificant impact "on a more regional scale". In the absence of a clear significance framework, it is not possible to explain what this reasoning is based on. Nor can it be deduced what is the maximum extraction area that would still allow for the impacts to be defined as non-significant.
4. When describing the impacts of disturbing the seabed and the ensuing formation of a sediment plume, it is (rightly) stated that too little is known about the cause-effect relationships to be able to make a statement about the consequences of this on the structure and function of the deep-sea ecosystem and that it is not known which sediment deposition will cause a problem for the various fauna groups. The fact that the sediment plume (at a threshold of 0.1 mg/l) can reach up to 12 km from the source and up to 140 m above the seabed does suggest that the impacts on ecology could be potentially significant here, particularly when taking into account the fact that natural turbidity and natural sedimentation in the project zone are extremely small. The document describes the available observations (on the basis of previous disturbance experiments) in detail and makes it clear that (it is possible that) a portion of these impacts, some of which are considerable and will still be observed decades after the operation, will also occur in the pilot project. This concerns impacts on the properties of the seabed, which also affects groups and species, and thus also the system's ecological function. Here too, reference is

made to the pilot project as a basis for collecting data and increasing knowledge, which should allow a clearer picture of the impacts' true significance.

5. Much attention is paid to the description of the dispersion plume and sediment deposition modelling, with numerous figures and graphs (including those in annexes) that display the calculation results, in various scenarios and assumptions. This multitude of (quantitative) information might give the impression that knowledge related to the pilot project's impacts on turbidity and sedimentation is currently more extensive, solid and substantiated than information on the other impacts, which in our opinion is not the case.

6. Of course, the fact that the impacts on the physical system are long-lasting also has naturally an effect on the ecology, as also indicated in the EIS. Regarding the impact on epifauna, which are highly dependent on the presence of hard substrate (in this case the nodules), reference is made to the small scale of the operation in order to suggest that the impact will likely be limited. However, it is elsewhere indicated that the impact may be permanent, with consequences for species diversity and thus potentially for the functioning of the ecosystem.

7. It appears that all of the potentially relevant impacts are at least mentioned and (sometimes briefly) described, based on what is known from the literature. However, this *description* does not always include an *assessment* (not even in qualitative terms) of its potential significance in the realisation of the pilot project. This can partly be attributed to the knowledge gaps.

In general terms, it can be stated that, within the limitations of the knowledge gaps, a good description of the pilot project's potential impacts is provided. The summary statement (in the "executive summary") that the impacts will be limited is not or insufficiently substantiated on the basis of the detailed description of the potential impacts. The knowledge gaps described present a limitation for determining the exact extent of the impacts and do not permit the assertion that the impacts are absent or of little significance.

2.9 Description of mitigating measures

The report does not have a separate chapter devoted to mitigating measures and they are not or scarcely discussed elsewhere in the text. The first steps in this regard are only broached in the "risk register" at the very end of the document (and are thus slightly obscured). This lacuna is obviously related to the statement from the EIS that, due to the small spatial extent and limited duration, the impacts are negligible. In such a case, mitigating measures would be superfluous. Nevertheless, measures to prevent, mitigate or control the impact on the marine environment fall under the information that must be provided by the initiator in the context of an environmental impact assessment (please refer to ISBA/19/LTC/8 regarding the environmental impact assessment of exploration activities).

Irrespective of the question as to whether this assessment is justified, it seems appropriate to us at this stage to reflect on any mitigating measures for the various potential impacts which, whilst not consistently assessed, are described in the document. The listing of (potential) mitigating measures, starting from knowledge of the operation and the suspected vulnerability of the environment, enables explicit research into the effectiveness, feasibility and side-effects of potentially eligible mitigation measures in the research program that forms part of the pilot project. This may also enable the creation of a "mitigation hierarchy" (i.e. a preferred order of mitigating measures that can be applied in large-scale commercial operations) and the definition of the Best Practicable Environmental Option (BPEO) for commercial exploitation. The latter implies that several operational variants should also be tested within the context of the research.

2.10 Description of the knowledge gaps

As indicated above, the occurrence of significant knowledge gaps is explicitly highlighted in several parts of the document, both in terms of the initial situation and in terms of the cause-and-effect relationships, which will also determine the significance of the (pilot) project's impacts. The existence of these gaps, and their significance in (not) assessing the operation's impacts, is also clearly stated in recent research literature (e.g. MIDAS, 2016).

These knowledge gaps are currently referred to in different places throughout the document; it would be preferable to provide a separate chapter in which everything is recapitulated. This would also make it easier to make the link to the necessary research (to be partially conducted within the framework of the pilot project) in order to highlight these gaps.

As a consequence of the knowledge gaps described, no statement can be made about the significance of the impacts; this is explicitly expressed in various parts of the document. Considering the vulnerability and uniqueness of the seabed ecosystem and the precautionary principle, this should in fact lead to the statement that significant impacts cannot be excluded. However, this reasoning is not applied to the report's conclusion as expressed in the "executive summary", where, on the contrary, on the basis of the limited area impacted, it is assumed that the impact will not be significant.

2.11 Environmental management and monitoring plan

The document contains an extensive chapter devoted to "environmental management, monitoring and reporting" and to what is specifically referred to as an "environmental management and monitoring plan".

In practice, environmental management is barely discussed, with the exception of a description of the organisational structure (including the responsibility for "pollution prevention") on board the expedition ship. The document does not contain a plan indicating what is being done to prevent environmental impacts and what actions are to be taken, should they occur. This obviously has to do with the fact that the very objective of the pilot project is to reveal any negative impacts. However, that does not alter the fact that a priori arrangements should be in place about what must happen should unexpected and/or significant impacts occur. This is moreover also specifically requested by document ISBA/19/LTC/8 pertaining to the environmental impact assessment of exploration activities.

The emphasis of this chapter is therefore on monitoring, both of the reference situation and the impacts. It is rightly stated that monitoring is essential for obtaining insight into the pilot project's impact. The information collected and knowledge acquired must also allow us to assess the impacts of a scaled-up (commercial) project and to optimise the collection technique with a view to reducing the environmental impact.

It is striking that the (ex post) monitoring (in this phase) applies only for a period of 2 years, whereas research shows that the impacts of earlier tests are sometimes clearly visible decades later (please refer to e.g. Cuyvers et al. , 2018; MIDAS, 2016). For commercial-scale exploitations, the impacts may be observed for even longer periods (MIDAS, 2016). Moreover, a sufficiently long period is also expected for the ex ante baseline determination; ISBA/19/LTC/8 states in this context that it is important to collect data over "as long a history as possible". MIDAS (2016) talks about a 10-year time series for the recording of baseline conditions.

The monitoring plan will also examine, inter alia, the impacts of recolonisation and restoration experiments. Other forms of mitigating measures (in terms of applied technology or operational aspects for example) do not appear to be the subject of the research.

The monitoring plan extensively describes the various research and analysis methods and techniques that will be applied, yet is less specific when it comes to describing where exactly will be measured and with what frequency. A concrete, operational monitoring plan must therefore be further elaborated upon. In this context ISBA/19/LTC/8 states, inter alia, that the monitoring must yield "statistically defensible data", thus the actual pilot set-up must take this into account. In particular, the (previously established) physical and ecological seabed variability must be considered when developing the research and monitoring plan.

The monitoring relates to the pre-impact phase, the project phase (with particular attention to the effects of the sediment plume and the impact on the physical and chemical soil properties, invariably with a subsequent translation to ecology) and on the post-impact phase.

It is not entirely clear whether the program will also be used for a thorough inventory of the biological baseline, in a larger area and/or at more stations than has been the case up to now. The pre-project inventory appears to focus predominantly on the areas in which impacts are expected, either directly or via the sediment plume.

Impact monitoring will be supplemented with in-situ and laboratory experiments. It is also the intention that the knowledge acquired will be used to support food web models.

There is no doubt that the proposed monitoring is of a high scientific standard and will contribute greatly to increasing knowledge. Due to the extensive focus on research methods, it is not always evident whether all the aspects of the proposed research additionally will result in knowledge and insights that will be useful in practice for impact assessments and for the development of mitigating measures.

The relationship between, on the one hand, the potential impacts described elsewhere in the document and the knowledge gaps identified in the process, and the proposed monitoring program, on the other hand, is not always immediately clear. A brief and simple portrayal of the relationship between the knowledge gaps identified in the context of the environmental impact assessment and the proposed monitoring would prove insightful at the beginning of the monitoring program's description. It could possibly in the form of a table or a diagram (the "risk register" appendix to the EIS constitutes a first (summary) step towards this). In other words, the relationship between the information requirements of the environmental impact assessment and the research and monitoring program needs to be clarified. This applies to both the baseline data and the impact data

Neither does the monitoring plan indicate which actions should be taken should intolerable negative impacts be identified. Since the plan is not only intended to collate scientific information but also to monitor effectively the pilot project's impacts, it is essential to be able to link the monitoring to tangible (mitigating) actions.

The monitoring relates to a test using an installation that will, during commercial exploitation, be of greater dimensions and capacity and will be used over a longer period and a larger area. The pilot project covers an area of 0.1 km², whilst one can assume an exploitation of some 200 km² per year (MIDAS, 2016) in an operational mining phase. The monitoring report should focus on the way in which the knowledge acquired can be extrapolated or scaled-up to allow ex ante statements to be made pertaining to the expected impacts at a commercial scale.

2.12 Non-technical summary

The non-technical summary ("executive summary") that is included at the beginning of the report is extremely brief. It does not contain information about the characteristics/vulnerability of the

environment. The results of sediment deposition modelling are described, yet their limitations are not made clear. Little or no attention is paid to the potential impacts on the biological environment and ecosystem, and the knowledge gaps, which currently make it impossible to assess those impacts accurately, are not made clear. The, to put it mildly, crude statement that there *shall be no serious impacts* ("no serious harm will be caused") does not ensue from the discussion in the main EIS text and, as such, does not occur in the main text. The summary therefore draws conclusions that are not made in the text itself. This is an important finding, as many readers will only peruse the "executive summary" and will thus not obtain an accurate picture of the problem.

Incidentally, there is a noticeable lack of summaries and conclusions formulated in the main text. The table of contents specified in Annex V to document ISBA/23/LTC/CRP.3* uses a system of "key messages" to summarise the key information per key chapter. In the EIS, however, this is only applied when describing the existing biological status. A general summary of the key findings and a conclusion regarding the potentially significant impacts of the pilot project (referring to the uncertainties) is also missing from the main text.

2.13 Structure and readability

The EIS is composed according to a logical structure (based on existing templates). It contains a lot of interesting and useful information and is easy to read, even for a non-specialist audience with a general scientific background.

The report contains a list of abbreviations and an extensive bibliography. The addition of an explanatory glossary would further enhance readability and comprehensibility.

The "Expert review" (Chapter 10) mentions 5 experts. However it is unclear what the expert review comprised, where it can be retrieved and what the role of the said experts was.

3. CONCLUSION AND RECOMMENDATIONS

3.1 Summary and conclusion

The "Environmental Impact Statement" drawn up by GSR is complete, easy to read and structured, and it contains a lot of useful information. The report describes the pilot project's potentially significant impacts. These are not always assessed (in other words, there is not always a statement about the impacts' gravity), which is largely due to the lack of knowledge necessary to perform this.

The occurrence of such knowledge gaps is mentioned in various parts of the document. The knowledge gaps are such that it is not in fact possible to make a substantiated statement on the environmental impacts of the test phase, which the main document text does not do. Yet the "executive summary" does state that there will be no significant impacts. This statement is, however, unsubstantiated and cannot be substantiated with the information available, particularly since there is no indication of what exactly should or should not be understood by a "significant impact".

Considering the vulnerability and uniqueness of the seabed ecosystem and the precautionary principle, this should in fact lead to the statement that significant impacts cannot be excluded.

The above means that in fact no statement can be made in the EIS regarding the pilot project's impact, which should be the very purpose of the document. This lacuna, however, does not ensue from the nature of the project or from the quality of the research conducted, but is intrinsic to the approach in which the pilot project itself aims to acquire the knowledge that should make it possible to map its impacts. Thus the impact assessment of this pilot project can only be conducted ex-post. In view of the importance of such pilot projects in enhancing knowledge and identifying the potential negative consequences of large-scale operations, this is acceptable, in so far as the monitoring plan additionally includes the necessary mechanisms for taking measures (which is currently not the case) in the event of impacts that are deemed intolerable.

3.2 Recommendations

Below we summarise the principal recommendations resulting from our analysis. We hereby make the distinction between recommendations that relate to the Environmental Impact Statement and recommendations that constitute areas of concern for the follow-up phases: setting up, implementing and interpreting the monitoring, and the knock-on effect of this on the assessment of any subsequent commercial phase.

Recommendations related to the EIS document:

1. A brief, yet more systematic scoping, starting from the operation and the applicable cause-and-effect relationships, would allow a better understanding of the reasons why certain impacts are investigated and (where appropriate) others not. This would be best documented under a separate paragraph or chapter.
2. It is important to state clearly and systematically in the EIS document that the impacts on the physical-chemical environment have a knock-on effect on the biological receptors, even if the precise relationships are not always known.
3. It is advisable to make an explicit distinction in the scoping between the impacts that are only relevant at this moment in time (given the specific scope of the test phase), and those impacts that will become relevant the moment that a large-scale commercial exploitation is rolled out. This will make it clear that the impacts described in the current EIS provide a picture of only some of the impacts that shall arise from any commercial exploitation.

4. It is important to develop a significance framework that makes it possible to determine whether an observed or predicted impact is significant and, where necessary, substantial. Since the aforementioned knowledge gaps do not allow us to conclude whether there will be any impacts on biology and how extensive these will be, this significance framework cannot currently be applied in practice in the EIS. It will, of course, be essential, as the actual extent of the primary impacts, and their impacts on ecology, can be better assessed based on, inter alia, the results of the pilot phase. The EIS should clearly state that such a comprehensive significance framework is not currently available, yet will be developed based on the results of the research.

5. The description of the policy, legal and administrative context should be further developed and better substantiated by, inter alia, including an overview of the standards frameworks that will or can be used to test the significance of certain impacts, by clarifying what is meant by "relevant appropriate national requirements by the sponsoring States", and by additionally including relevant references elsewhere in the text (e.g. to MARPOL) under this heading.

6. The underlying (economic and social) rationale behind the project should be expressed better. This could also briefly address any potential strategic alternatives to (partially or fully) satisfying the demand for certain metals, and the need for a strategic environmental impact assessment of seabed exploitation techniques on a regional scale.

7. We recommend furnishing the EIS with a brief overview of previously investigated (partial) solutions and the reasons that these were not ultimately selected. A comparative table summarising the advantages and disadvantages of each solution (both in technical terms and from an environmental point of view) could complete this overview.

8. It is recommended that an initial inventory of potential mitigating measures be included in the EIS. After all, it is not yet possible to state categorically that the pilot project has no impacts and that mitigating measures are not required. Moreover, mitigating measures will undoubtedly have to be addressed in a commercial phase. Listing (potential) mitigating measures now will allow explicit research into the effectiveness, feasibility and side-effects of mitigating measures that are potentially eligible.

9. It is recommended that the numerous knowledge gaps (which arise throughout the document) be recapitulated in a separate chapter, and that their consequences on the reliability of the conclusions that can currently be drawn be examined.

10. The environmental management and monitoring plan should indicate what is being done to prevent environmental impacts and what actions should be undertaken should intolerable negative impacts be identified during the pilot project.

11. A brief explanation of the relationship between, on the one hand, the potential impacts described and the knowledge gaps identified in the EIS and the proposed research and monitoring program, on the other hand, possibly in the form of a table or diagram, would prove insightful.

12. The report should be expanded with a summary (possibly for each chapter, in the form of "key messages") and a conclusion.

13. The non-technical summary (executive summary) should be expanded to include information pertaining to the existing situation, potential impacts and knowledge gaps. The conclusion in the summary must not deviate from that in the main text and must take into account all the information from the text.

14. The significance of the "expert review" mentioned in Chapter 10 should be clarified.

15. It is recommended that a glossary be added to the document.

Recommendations pertaining to the implementation of the pilot project, the research and monitoring program and the follow-up process:

1. The monitoring plan proposed in the EIS must be further substantiated and operationalised before it can be implemented.
2. The pilot phase and associated monitoring does not include all the components of a commercial operation and can therefore only help partially visualise the impact of such an operation. It will also be necessary to establish pilot projects, with accompanying monitoring programs, for the other project components (e.g. systems for bringing the nodules to the surface, dewatering on board the ships, the discharge of wash and transport water, the processing of the minerals etc.).
3. The proposed monitoring relates to a test using an installation that will in practice have a greater capacity and will be used over a (much) longer period and a (much) larger area. It is important to examine whether and how the knowledge acquired can be extrapolated or scaled-up in such a way that allows ex ante statements to be made about the expected impacts at a commercial scale, taking into account cumulative and synergistic aspects.
4. The proposed monitoring program has a lead time of 2 years. It seems appropriate to extend the monitoring efforts to a period of at least 10 years so as to reveal the impacts that also manifest themselves over a longer period.
5. The research and monitoring phase should focus on and result in a clear significance framework for assessing the various potentially significant impacts of a comparable mining project.
6. It must be determined and demonstrated within the framework of the research and monitoring program that the originally chosen reference zone will not, in fact, be influenced by the impacts of the pilot project. If it should transpire that this is indeed the case, one or more additional reference zones must be delimited at a greater distance from the project location than the currently established 11 km.
7. It is recommended that research into the effectiveness and side-effects of any potential mitigating measures be explicitly included as part of the research and monitoring program. This may also involve the investigation of operational variants (which is not currently anticipated), which could contribute to defining a “Best Practicable Environmental Option (BPEO)” for commercial exploitations.

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