MODULE 4, LESSON 4

BASELINE STUDIES: THE CORNERSTONE OF

ENVIRONMENTAL RESPONSIBILITY

LECTURE NOTES

Introduction

This lesson is designed to enhance general understanding of the collection of environmental baseline data in the international seabed area (Area), including the legal and policy requirements, the recommended types and quantity of such data, the techniques for collecting such data, and the storage and use of such data.

Why environmental baselines matter

ISA is required, under UNCLOS and the 1994 Agreement to promote and encourage the conduct of marine scientific research in the Area, as well as coordinate and disseminate the results of scientific research and analysis, when available[1].

However, whilst this is an added benefit, the main reason that environmental baseline data is collected is to enable the effective protection of the marine environment from harmful effects which may arise from activities in the Area[2]. The overall objective is to understand and be able to predict any changes in the environment that may occur as a result of human activity. To that end, the initial conditions that existed prior to that activity must be known.

Therefore, the **primary goal of the acquisition of baseline data** is to characterise the existing environment to enable an assessment of the possible impacts of exploration and exploitation activities on the marine environment prior to those activities taking place. Baseline data also define the methodologies and forms the basis for long-term monitoring of environmental impacts to make sure that those are in line with the environmental impact assessments and the environmental monitoring and management plan once exploitation commences.

The collection of environmental baseline data is explicitly mandated in the **exploration regulations**

[1] UNCLOS, art. 143
[2] UNCLOS art 145

for polymetallic nodules[3], polymetallic sulphides,[4] and cobalt rich-crusts[5].

According to UNCLOS, the 1994 Agreement and the exploration regulations three different groups each have a responsibility related to environmental baselines:

- The **Legal and Technical Commission** (LTC) shall develop and implement procedures for determining, based on best available scientific and technical information, whether proposed activities in the Area would have serious harmful effects on vulnerable marine ecosystems.
- **Contractors** are required to gather environmental baseline data to establish baselines against which to assess the likely effects of their programmes of activities.
- **Contractors and sponsoring states** are required to cooperate with ISA in implementing programmes for environmental monitoring and evaluation.

To support contractors and member states the LTC has developed a set of **recommendations for the guidance of contractors for the assessment of the possible environmental impacts arising from exploration for marine minerals in the Area**.[6] These recommendations are kept under constant review to reflect improved scientific knowledge and developments in Best Available Techniques. The most recent edition was published in 2023. The LTC is also drafting guidelines[7] to guide the collection of environmental baseline data during future exploitation activities.

What data should be collected?

Environmental baseline data should be multidisciplinary to allow for a complete assessment of environmental conditions and processes. Appropriate representation of the environment through sampling effort and replication is necessary to determine if any changes identified at a later date are associated with mining operations or represent spatial and temporal variability and trends that occur naturally or as a result of non-mining related anthropogenic activity. Without this knowledge, deviations from pre-mining conditions observed during mining operations could only be assigned to exploitation activities. As such a comprehensive understanding of the natural variability in baseline conditions needs to be determined before the beginning of the commercial mining phase.

Baseline data can be grouped into four types of information; physical oceanography, chemical oceanography and biogeochemistry, geological properties and biological communities.

Physical Oceanography - The main objectives for establishing a baseline of the physical oceanography of a contract area are to define the hydro physical and hydrodynamic conditions and structure of the water column and its variability. This information can then be used to understand

[3] ISBA/19/C/17,
[4] ISBA/16/A/12/Rev. 1
[5],ISBA/18/A/11
[6] ISBA/25/LTC/6/Rev.3
[7] ISBA_27_C_11-2117339E.pdf (isa.org.jm)

the habitats of marine organisms, define the detailed sampling strategy for other sampling measures, and assess the potential dispersion, and size and characteristics, of any operational and discharge plume. Parameters to be determined include the physical properties of the water masses (temperature, pressure and salinity), natural water movement (currents, tides and waves) and background physical parameters (noise and light).

Chemical Oceanography and Biogeochemistry - An understanding of the chemical environment of the water column and sediments (solid fraction and porewaters) is required to characterise baseline oceanographic and biogeochemical conditions in order to later assess both direct impacts of mining activities on the seafloor as well as indirect impacts from suspended sediment plumes that may be produced, including potential blanketing of the seafloor and impacting processes in the water column. A suite of pre-defined measurements should be taken to determine the chemical composition of the water and seabed.

Geological Properties - In combination with biogeochemical parameters, geological properties are collected to characterize the habitats and to determine the heterogeneity of the seafloor and subseafloor environment (bathymetry and geomorphology, geological setting, sediment and stratigraphy, diagenesis, weathering and remobilization, rock substrate geochemistry and mineralogy, mineral resource geochemistry and mineralogy). This will also assist in the placement of suitable sampling locations to characterise the distribution and composition of faunal communities. Measurements are taken to map large and small-scale morphologic features of the seabed and to characterise the sediment properties and habitat classification.

Biological Communities - When most people consider the impact of human activities on the environment, they are ultimately concerned with the impact on the biological communities. Biological communities include animals living on the seafloor, near the seafloor, and in the overlying water column all the way to the surface and are characterised to evaluate the effects of activities on the diversity, distribution, and behaviour of these animals. Parameters to be determined include community structure, connectivity and ecosystem functioning of all size classes, from bacteria to marine mammals such as whales.

How much data is needed?

The magnitude and spatiotemporal scales of variability will differ for different variables and between ecosystem components. Consequently, the replication and frequency needed to address variability will differ between components. To characterise the environment and to reduce the uncertainty of data, replicate observations should be obtained to detect changes as a result of time (seasons, interannual variability) and space (horizontal and vertical), and to differentiate between different regions. The exact number of samples to collect will depend on the local conditions. Also, the development of both the sampling methodology and mining technology will lead to a better understanding of the potential impact of human activity in the Area and will influence the number and samples that will be required and the suitable location of sampling.

Sampling strategies should build on the best available existing research and data. They should be regularly revised as more information becomes available to ensure it is fit for purpose and capturing the relevant spatial and temporal variability. The exact number of samples required can be determined using statistics and a combination of expert opinion to understand the variability of the parameter being investigated and the other parameters that may influence it. This expert opinion can be validated by statistics.

Random replicates should be obtained from each sample site, and the replication should be sufficient to cover the variability and discriminate between areas. The number of replicates required to characterise baseline conditions in a specific zone is determined on the basis of several factors, including the variable being considered, and is likely to differ among Contract Areas. Therefore, the number of replicates should be justified using appropriate statistics and consistent with the Draft guidelines for the establishment of baseline environmental data provide more detail on this[8].

Collaboration and consolidation of multiple datasets also provide context on larger scale patterns to facilitate the interpretation and use of baseline observations to enable a larger scale analysis to support regional environmental management plans whilst also reducing the burden on individual contractors.

If a sufficient number and spatial coverage of samples are not taken with the correct equipment and following Best Available Techniques and Good Industry Practice, then all the subsequent data and analyses may be flawed or compromised. Use of best practices will also ensure that sampling does not create unnecessary additional impacts on the environment.

There have been increasing efforts to collect environmental baseline data in areas where exploration activities have taken place over the past two decades. Around 140 cruises have been conducted by ISA contractors to fulfil their contractual obligations between 2001-2021, which also resulted in significant increases in the available of environmental data, particularly for deep-sea environment and biodiversity.

How should data be collected?

The environmental recommendations and guidelines issued by the LTC describe the procedures to be followed for acquiring baseline data to facilitate the reporting and archival of such data by contractors and to support collaboration.

Techniques and processes are subject to development over time and as such, to adequately characterise the environment, Best Available Techniques should be used. This will require independent feedback from relevant experts in the field to enable suitable adjustment as required. It is also essential that care is taken to make sure that data obtained with different approaches are consistent to allow for integrated assessments of all data obtained.

[8] ISBA/27/C/11

In some disciplines technological evolution is rapid, for example, molecular techniques were rarely used for biological studies when ISA was established and yet are now commonplace. ISA actually produced the first deep sea DNA barcoding manual back in 2015[9]. The ISA has also led the way in improving standardisation of techniques and biological classifications[10].

As mentioned above, it is essential to ensure enough samples are taken to characterise the environment and as such, the sampling programmes should be adaptable to respond to increased knowledge relating to the details of the technology that will be used for resource exploitation or where initial sampling indicate that the environment has more spatial and temporal variability than expected. However, changes in sampling strategy, especially where they involve discontinuation of observations at specific sites or seasons, should be done with caution so as not to miss episodic events or fail to resolve interannual variability or lead to inconsistencies that prevent temporal analysis.

One challenge for the collection of environmental data is the time it takes to collect and process. Some data can be collected in real-time with minimal processing. An example of this is large scale physical conditions such as measurements of temperature and salinity measured with satellites. Other information takes longer to obtain so must be planned well in advance of commercial exploitation. An example would be determining ecosystem functioning which requires sampling of biological organisms at sea that then need to be taken to laboratories for processing.

How is the data stored and used?

Environmental baseline data is stored in DeepData[11], a georeferenced online database created by ISA. In accordance with the regulations, some of the information is confidential and only accessible to the secretariat and the LTC but environmental information is open and free to the scientific community and general public. Environmental data are not confidential and can be accessed through DeepData. This enables regional assessments to be undertaken. The database has grown over the last few years and will continue to grow and be a resource both for the ISA and the wider deep sea community.

In addition to underpinning environmental impact assessment of proposed activities, one of the key considerations for using the data to monitor the marine environment and assess potential impacts effectively is that data should be comparable across the surveys by individual contractors to determine changes in the environment resulting from the activities but also between the various contractors for regional scale comparisons. This enables an understanding of cumulative impacts and the effectiveness of management measures, including establishing areas for environmental preservation. In this context, ISA has undertaken various activities to address standardisation of biological data, including the naming of species that are being discovered through its Sustainable

[9] https://isa.org.jm/files/files/documents/tstudy7.pdf
[10] Eg https://isa.org.jm/files/files/documents/techstudy13_web_27july.pdf
[11] https://www.isa.org.jm/deepdata

Seabed Knowledge Initiative (SSKI)[12].

Once data is standardised, it can be used to help fulfil ISA's mandates and responsibilities for the protection of the marine environment, including protection of the marine environment from harmful effects which may arise from activities in the Area; developing review regional environmental assessments and management plans; and ensuring public access to environmental information; developing robust monitoring programmes.

At the time of writing, DeepData hosts 137,179 records of occurrences of biological organisms. Since 2021, ISA has joined the International Oceanographic Data and Information Exchange (IODE) network of the Intergovernmental Oceanographic Commission (IOC) of UNESCO as an Associate Data Unit, which enabled ISA's biological data to be shared with IODE's Ocean Biodiversity Information System (OBIS). This promoted the interoperability among databases and use of environmental data collected by ISA contractors by the wider scientific community across the globe (Figure 3). Similar efforts are also being made to share the oceanographic data hosted in DeepData. The main consideration for sharing data across different databases is to ensure that the data adheres to FAIR principles, i.e. it is findable, accessible, interoperable and reusable, using common metadata standards and vocabularies.

Conclusions

A legal framework and technical guidelines are in place for building environmental baselines under ISA regulations. In this context, the primary goal of the acquisition of environmental baseline data is to characterise the existing environment to enable a robust assessment of the possible impacts of exploration and future exploitation of mineral resources on the marine environment. Building a solid baseline is key for ensuring the protection of the environment and the sustainability of mining operations, which is the mandate of ISA.

Environmental baseline data covers multiple disciplines, and the collection of such data requires sustained investment to ensure sufficient spatial and temporal coverage of samples. The amount of samples required to establish the environmental baseline varies for different variables and ecosystem components and is influenced by the sampling methodologies used and the technologies or activities subject to the environmental impact assessment. A sufficient number and spatial and temporal coverage of samples should be taken in accordance with Best Available Techniques and Good Industry Practice, and consistent with the legal framework.

When standardised datasets are available across a sub-regional or regional scale, environmental baseline data can also be used to inform other management or policy processes, such as regional environmental management planning and assessment of potential cumulative impacts from multiple activities. This is the rationale behind DeepData, which allows for the environmental baseline data in the Area to be centrally stored, updated and shared with the wider scientific community, with potential for comparative analysis and regional-scale assessments.

[12] Sustainable Seabed Knowledge Initiative - International Seabed Authority (isa.org.jm)