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Ecological safeguards for deep seabed mining

Final Report

For our Environment

Umwelt Bundesamt

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Federal Ministry for the
Environment, Nature Conservation
and Nuclear Safety

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Ecological safeguards for deep seabed mining

Final report

by

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On behalf of the German Environment Agency

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Kurzbeschreibung

Dieser Bericht ist ein Ergebnis des Forschungs- und Entwicklungsprojektes "Ökologische Leitplanken für den Tiefseebergbau", Oktober 2015 bis Dezember 2017, in Auftrag gegeben durch das Umweltbundesamt, UBA.

Aufgrund des in den letzten Jahren wiedererwachten Interesses für einen Abbau von Rohstoffen in der Tiefsee, und Anstrengungen, den notwendigen Rechtsrahmen in nationalen und internationalen Gewässern zu schaffen, wird jetzt dringend auch ein Konzept für den effektiven Schutz der Meeresumwelt vor den Folgen des Rohstoffabbaus erforderlich. Im sogenannten "Gebiet", dem Meeresboden jenseits nationaler Grenzen, hat die Internationale Meeresbodenbehörde, ISA, die Aufgabe, den Meeresboden und seine Rohstoffe im Namen von und zum Vorteil der gesamten Menschheit ('for the benefit of mankind as a whole') zu verwalten. Dazu gehört der Erlass von Regeln, Bestimmungen und Verfahren, welche die Auswirkungen der mit der Erkundung und dem Abbau von Rohstoffen im Gebiet zusammenhängenden Tätigkeiten in einem Rahmen hält, welcher die Vorgaben für den "effektiven Schutz der Meeresumwelt vor den Folgen der Tätigkeiten", wie im internationalen Seerecht gefordert, einhält.

Der vorliegende Text zeigt Möglichkeiten auf, wie die ISA mit dem Instrumentarium des modernen vorsorgenden und präventiven Umweltmanagements die regulatorische Kontrolle über die Umweltbelastungen durch Tätigkeiten im Gebiet ausüben kann. Angesichts der großen Wissenslücken über die potentiell betroffenen Tiefseeökosysteme und die möglicherweise eingesetzte Technik scheint es allerdings zur Zeit unmöglich, auch mit den besten Verfahren den Grad der zu erwartenden Umweltschäden einzuschätzen. Daher ist schon der Weg das Ziel, indem die ISA sich als moderne, umweltbewusste Organisation präsentiert, welche den Vorsorgeansatz und internationale Verpflichtungen zum Schutz der Meeresumwelt und zur nachhaltigen Entwicklung ernst nimmt und ihr Mandat unter Einbeziehung der derzeitigen und voraussichtlich zukünftigen Veränderungen der Meeresökosysteme bis in die Tiefsee ausübt.

Abstract

This report presents findings from the research and development project "Ecological Safeguards for Deep Seabed Mining" commissioned by the German Environment Agency (UBA) to the Institute for Advanced Sustainability Studies (IASS) (October 2015 - December 2017).

Interest in seabed mineral mining has renewed in recent years for various reasons and new offshore mining legislation is currently being developed for national and international waters. For this reason, agreement on the meaning of 'effective protection of the marine environment from adverse effects arising from activities' related to mining is needed. The International Seabed Authority (ISA) is mandated to manage access to and benefits from the seabed, subsoil and its mineral resources in the Area on behalf of mankind as a whole. This legal mandate comprises the development of rules, regulations and procedures for mining-related activities in the Area, which must prevent, reduce and control harm to the marine environment and ensure that such harm does not breach the standard of 'effective protection'.

The present text provides suggestions for how the ISA could effectively regulate the environmental effects of activities in the Area using a toolkit of modern, precautionary and preventive governance and management instruments and measures. However, due to large gaps in ecological knowledge and technical experience pertaining to the deep sea, it is currently impossible to predict with any certainty the degree of risk mining activities pose to deep sea ecosystems.

By developing such a toolkit, the ISA could spearhead a modern, comprehensive approach to precautionary governance of the Area in line with today's environmental challenges.

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List of Abbreviations

ABNJ	Areas beyond national jurisdiction
APEI	Areas of Particular Environmental Interest
BAT	Best available technology
BEP	Best environmental practices
CBD	Convention on Biological Diversity
CHM	Common Heritage of Mankind
CCZ	Clarion-Clipperton-Zone
COP	Conference of the Parties
CP	Closing Plan
DOSI	Deep Ocean Stewardship Initiative
EAM	Ecosystem Approach to the Management of Human Activities
EBSA	Ecologically or biologically significant marine area
EC	European Community
EIA	Environmental impact assessment
EMMP	Environmental Management and Monitoring Plan
EMP	Environmental management plan
EMP-CCZ	Environmental Management Plan for the Clarion-Clipperton-Zone
ERA	Ecological Risk Assessment
FAO	Food and Agricultural Organisation of the United Nations
FSA	Fish Stocks Agreement (Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks)
IA	Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea
IGC	Intergovernmental Conference
IRA	Impact Reference Area
IRZ	Impact Reference Zone
ISA	International Seabed Authority
ITLOS	International Tribunal for the Law of the Sea
IUCN	International Union for the Conservation of Nature
LOSC	Law of the Sea Convention, UNCLOS

LTC	Legal and Technical Commission
MAR	Mid Atlantic Ridge
MIDAS	Managing Impacts of Deep-seA reSource exploitation (research project)
MPA	Marine protected area
MSR	Marine scientific research
NGO	Non-governmental organisation
N2000	Natura 2000
OSPAR	Oslo and Paris Conventions
PRZ	Preservation Reference Zone
REMP	Regional Environmental Management Plan
REA	Regional Environmental Assessment
RFMO	Regional Fisheries Management Organisation
SIDS	Small Island Developing State
SEA	Strategic Environmental Assessment
SIDS	Small Island Developing States
SMS	Seafloor massive sulphides
UK	United Kingdom of Great Britain and Northern Ireland
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environment Programme
UNGA	United Nations General Assembly
US	United States of America
VME	Vulnerable Marine Ecosystem
WEF	World Economic Forum
WSSD	World Summit on Sustainable Development
WTO	World Trade Organisation
WWF	World Wide Fund for Nature

Zusammenfassung

Dieser Bericht ist ein Ergebnis des Forschungs- und Entwicklungsprojektes "Ökologische Leitplanken für den Tiefseebergbau", in Auftrag gegeben durch das Umweltbundesamt, UBA. Das kleine Projektteam des IASS (Institut für transformative Nachhaltigkeitsforschung, Potsdam) hat die Inhalte zwischen Oktober 2015 und Dezember 2017 erarbeitet.

Aufgrund des in den letzten Jahren wiedererwachten Interesses für einen Abbau von Rohstoffen in der Tiefsee, und Anstrengungen, den notwendigen Rechtsrahmen in nationalen und internationalen Gewässern zu schaffen, wird jetzt dringend auch ein Konzept für den effektiven Schutz der Meeresumwelt vor den Folgen des Rohstoffabbaus erforderlich. Im sogenannten "Gebiet", dem Meeresboden jenseits nationaler Grenzen, hat die Internationale Meeresbodenbehörde, ISA, die Aufgabe, den Meeresboden und seine Rohstoffe im Namen von und zum Vorteil der gesamten Menschheit (‘for the benefit of mankind as a whole‘) zu verwalten. Dazu gehört der Erlass von Regeln, Bestimmungen und Verfahren, welche die Auswirkungen der mit der Erkundung und dem Abbau von Rohstoffen im Gebiet zusammenhängenden Tätigkeiten in einem Rahmen hält, welcher die Vorgaben für den "effektiven Schutz der Meeresumwelt vor den Folgen der Tätigkeiten" wie im internationalen Seerecht gefordert einhält.

Um diesen effektiven Schutz sicherzustellen, bedarf es eines komplexen regulatorischen Rahmens der es ermöglicht, unabhängig und basierend auf den besten verfügbaren Kenntnissen zu ermitteln, ob mögliche oder voraussichtliche Umweltfolgen langfristig und klein- wie großräumig innerhalb eines vorab beschlossenen Zielrahmens für die Umweltqualität bleiben. Ein solcher regulatorischer Rahmen ist umso wichtiger, als weder der Abbau von Manganknollen von den Tiefseeebenen in 5000 m Tiefe, noch von Massivsulfiden an den Hydrothermalfeldern der Mittelozeanischen Rücken oder der in einigen Regionen an Seebergen angelagerten kobaltreichen Krusten bislang ein Vorbild hat. Es gibt also weder eine bekannte Technologie, Erfahrungen mit deren Anwendung noch mit den Auswirkungen auf die Meeresumwelt lokal wie regional. Allein Modellrechnungen und erste Prototypen für einzelne Geräte existieren, jedoch ohne bislang durch *in situ* Tests Erfahrungen gewonnen zu haben. Auf der anderen Seite haben wissenschaftliche Untersuchungen gezeigt, dass bereits kleinste Störungen im Rahmen wissenschaftlicher Experimente die betroffenen Lebensräume der Tiefseeebene, ebenso wie die Fischerei großflächig Seeberglebensräume, auf unbekannte Zeit auch funktional vollständig zerstören. Wie in anderen Ökosystemen, nur auf einer viel längeren Zeitskala, ist Biodiversitätsverlust unvermeidbar.

Abgesehen von den technischen Schwierigkeiten und Unwägbarkeiten, ist das größte Problem bei der Bemessung eines "effektiven Schutzes der Meeresumwelt" der durch die Unerreichbarkeit der Tiefsee bedingte geringe Grad an Kenntnissen über die Ökosysteme, deren Vernetzung und vor allem kritische Änderungen. Auch wenn der Überblick über die Arten des Benthos langsam zunimmt, stellt doch die Erkenntnis dass 90% oder sogar mehr in einer Probe identifizierte Taxa nur einmal gefunden werden die Wissenschaft vor große Probleme. Noch größere Probleme bereitet die Untersuchung von funktionalen Beziehungen oder gar Ursache-Wirkungszusammenhängen der Effekte von Bergbautätigkeiten wie erhöhter Trübung, Veränderungen des Sauerstoffhaushalts, erhöhte Toxizität. Diese Kenntnisse sind aber notwendig bevor beurteilt werden kann, ob Bergbautätigkeiten das Meer lokal oder großskalig und im Zusammenspiel mit anderen bereits wirkenden Faktoren wie den Folgen der globalen Erwärmung vorhersehbar verändern werden.

Zusätzlich bleibt auch das Internationale Seerechtsübereinkommen (UNCLOS), welches den Rechtsrahmen für Tätigkeiten im Gebiet bestimmt, in vielen umweltrelevanten Fragen vage oder weist Lücken auf. Diese betreffen beispielsweise eine nicht vorhandene genaue Definition, was unter den Tätigkeiten im Gebiet verstanden wird, mit entsprechenden Unklarheiten für die Regelungskompetenz der ISA und möglichen Überschneidungen mit Kompetenzen anderer Organisationen (Kapitel 4.1).

Auch die Kompetenzaufteilung zwischen ISA und befürwortendem Staat (‘Sponsoring State’) ist unklar (Kapitel 4.2). Wichtig für die Ermittlung von Umweltstandards und -grenzwerten wären obligate und gut überwachte *in situ* Tests, die jedoch nicht gefordert werden, und die falls sie stattfinden auch nur sehr unzureichend geregelt und ausgewertet werden (Kapitel 4.3).

Die Autoren dieses Berichtes sind der Überzeugung, dass es derzeit unverantwortlich wäre, eine neue Industrie in unbekannten Gewässern operieren zu lassen. Langfristig gesehen, ist die Entwicklung der Verfahren und Kriterien für die Ermittlung von Umweltfolgen und deren Beurteilung jedoch auch im Hinblick auf Entwicklungen in nationalen Gewässern wichtig. Um zukünftig ein voraussehendes, vorsorgendes Handeln der ISA möglich zu machen, empfiehlt dieser Bericht ein auf den ersten Blick komplexes System von Verfahren zur Umwelt- und Schadensbewertung und vor allem Abwägung von Interessen (Kapitel 3 und 4). Sollte entschieden werden, dass Rohstoffabbau im Gebiet genehmigungsfähig ist, dann sollen die vorgeschlagenen Verfahren ein schrittweises Vorgehen und die Anwendung größter Vorsicht in der Entscheidungsfindung erlauben, um unerwünschte und nicht erwartete Auswirkungen auf die Meeresumwelt zu vermeiden.

Als Hintergrund informiert Kapitel 2 über den Stand der Lizenzvergabe für die Exploration von mineralischen Rohstoffen in Meeresgebieten weltweit (Kapitel 2.1), die Entwicklung der globalen Agenda für den Biodiversitätsschutz und nachhaltige Entwicklung (Kapitel 2.2). Eine Bestands-aufnahme des Wissens über die von Bergbau betroffenen Ökosysteme, vor allem aber Wissenslücken werden versucht, in Kapitel 2.3. zusammenzufassen. Die verfügbaren Kenntnisse über die Verwundbarkeit der betroffenen Arten und Lebensräume werden in Kapitel 2.4 erörtert. Insbesondere werden in 2.3 und 2.4 auch die pelagischen Ökosysteme und Organismen berücksichtigt, ein weitgehend vernachlässigter Teil der Tiefsee. Hierzu befindet sich in Annex 8 auch ein Gutachten von Christiansen & Denda (2017).

Kapitel 2.1 schließt mit Empfehlungen möglicher Schritte zur Verbesserung des gegenwärtigen **Lizenzgenehmigungsverfahrens** hin zu einer effektiveren Berücksichtigung von Umweltwerten und möglichem Umweltschäden in den vorgeschlagenen Erkundungsgebieten.

2.1.10 Empfehlungen

Das Verfahren und die Kriterien welche die Sach- und Fachkommission, LTC, der ISA derzeit anwendet, um Anträge auf Genehmigung von Arbeitsplänen zur Erteilung von Erkundungsverträgen angewendet werden bedürfen einer Überarbeitung um sicherzustellen, dass die Vertragnehmer die Umwelt tatsächlich "effektiv schützen". Es wird empfohlen, dass

- Die LTC Kriterien entwickelt und anwendet, die es erlauben den erwarteten Umweltschaden zu beurteilen;
- Diese Kriterien beinhalten auch die Abfrage eventueller Qualifikation oder bereits erfolgter Ausweisung der Gebiete oder Teilen davon als EBSA, VME, Meeresschutzgebiet oder andere Schutzkategorie anderer internationaler Organisationen und kompetenter Instanzen.
- Bewerbern zukünftig mit dem Genehmigungsantrag eine Analyse vorlegen, die auf der Basis einer Lebensraumkartierung darlegt ob und wenn ja welche potentiell schützenswerten Arten und Lebensräume nach den Kriterien der CBD für EBSAs, der FAO für VMEs (angepasst für den Bergbaukontext) und anderer Organisationen vorhanden sind.
- Bewerber zukünftig mit dem Genehmigungsantrag eine Nutzeranalyse des beantragten Gebietes vorlegen, einschließlich einer Erörterung potentieller Nutzungskonflikte
- Die LTC Kriterien entwickelt für die Abschätzung und Bewertung von grenzüberschreitenden Auswirkungen von Tätigkeiten, e.g. zu Nachbarlizenzgebieten, zu Reservierten Gebieten, zur Hohen See und Gebieten in nationaler Verwaltung der Küstenstaaten.

- Die Transparenz der Entscheidungsgrundlagen für den Rat (‘Council’) erhöht wird, indem die LTC ihre Empfehlungen an den Rat mit detaillierter Sachinformation und Hintergründen für die Empfehlung hinterlegt.
- Jeder Antrag auf Genehmigung, der entweder die Kompetenz oder Ausweisungen anderer Organisationen betrifft, oder mit anderen sektoralen Nutzungen überlappt wird zusammen mit den Erwägungen der LTC veröffentlicht bevor der Rat entschieden hat.

Die Internationale Meeresbodenbehörde hat zwar ein einzigartiges Mandat, sollte jedoch keinesfalls isoliert von den sich seit den 1980er Jahren zunehmend mit immer größerer Dringlichkeit international verabschiedeten Zielen und Maßnahmen zum **Schutz der Biodiversität** agieren. Kapitel 2.2 greift diese Notwendigkeit auf, und fordert insbesondere eine Konkretisierung des Umweltmandats der ISA für einen ‘effektiven Schutz der Meeresumwelt’ im Kontext mit zum Beispiel der Biodiversitätsstrategie der CBD und der globalen Nachhaltigkeitsagenda, sowie dem angelaufenen Prozess zum Schutz der Biodiversität in der Hohen See.

2.2.6 Empfehlungen ISA Umweltmandat

- Die ISA sollte jetzt einen Prozess einleiten, um eine langfristige Vision und Ziele zu entwickeln, wie Rohstoffabbau im Gebiet mit dem Umweltschutzgebot in Artikel 145 UNCLOS, sowie den Biodiversitätszielen der CBD (‘kein Verlust an Biodiversität’), der globalen Nachhaltigkeitsagenda und den möglichen Vereinbarungen für die Hohe See vereinbart werden kann, bzw. einen Beitrag zu deren Umsetzung leisten kann.
- Die ISA sollte jetzt mit der Umsetzung der Anforderungen aus Artikel 145 in eine vorsorgende Regulierung beginnen.
- Die Regulierung der ISA sollte Entscheidungen und Empfehlungen anderer internationaler Organisationen mit in Betracht ziehen, beispielsweise bezüglich der Ausweisung von Schutz- oder besonders schützenswerter Gebiete und Lebensräume, sowie Umweltmanagementverfahren (z.B. OSPAR).
- Die ISA sollte Kommunikation und Zusammenarbeit mit anderen internationale Organisationen, z.B. der Internationalen Schifffahrtsorganisation IMO, regionalen Fischereimanagement Organisationen und Umweltkonventionen verstärken und Verfahren der Zusammenarbeit entwickeln. Das OSPAR Collective Arrangement könnte dafür ein Beispiel sein. Ziel ist die Ermöglichung regionaler, multisektoraler strategischer Umweltqualitäts-Bewertungen zur gemeinsamen Sicherung der besten Umweltqualität und der Minimierung von Nutzungskonflikten.

Der Schwerpunkt von Kapitel 2.3 ist es herauszuarbeiten, welche Dimensionen die **Wissenslücken** über Tiefsee- und Hochseeökosysteme haben und warum das die Vorhersagbarkeit von Umweltfolgen von Eingriffen durch Tiefseebergbau oder auch kleineren Eingriffen nahezu unmöglich macht. Zwar ist inzwischen gut untersucht, dass die lokalen Folgen nahezu irreversibel sind, es bleibt jedoch unklar auf welchen räumlichen, zeitlichen und funktionalen Skalen Änderungen der Ökosystemparameter zu erwarten sind. Falls Aktivitäten im Gebiet genehmigungsfähig werden sollen, müssen die Wissenslücken weiter geschlossen und vor allem wirksame und transparente Verfahren zur Kontrolle und Begrenzung der Umweltfolgen erarbeitet und angewendet werden.

2.3.5 Empfehlungen Forschung und Überwachung

Wissenslücken schließen

Alle Aspekte der Tiefseeökosystemforschung müssen weiter vertieft und insbesondere um die funktionalen Aspekte erweitert werden. Aufbauend auf Empfehlungen von Clark *et al.* (2012), Van

Dover (2014) und Weaver *et al.* (2017) erscheint die Bearbeitung der folgenden Wissensfelder als prioritär für die Beurteilung von Umweltfolgen durch Tiefseebergbauaktivitäten:

- Die zeitliche und räumliche Ausbreitung und Persistenz von **Sedimentwolken** am Boden und in der Wassersäule, die im Zuge von Abbautätigkeiten, sowie Rückleitung von Abwässern entstehen ist ein Forschungsgebiet welches noch großer methodischer Entwicklung bedarf. Das betrifft sowohl die Modellierung als auch in *situ* Messungen.

  a) Modellierungen der Abbauwolke 3D über lange Zeitskalen und unter Berücksichtigung des Verhaltens der feinsten Komponenten in der Wassersäule unter realistischen Abbauszenarien wären sehr hilfreich. Andere Modelle werden gebraucht, um eine optimale Einbringtiefe und -technik für die Prozessabwässer zu finden, welche die Ausbreitung minimieren.
  b) Die Korngrößenzusammensetzung, die Sinkgeschwindigkeit und Ausbreitungseigenschaften der Sedimentwolken, sowie deren toxische Komponenten und biologische Wirksamkeit müssen verstärkt im Kontext mit der potentiell betroffenen Fauna und ökologischen Prozessen *in situ* untersucht werden.

- Jedes potentielle Abbaugebiet muss vorab bezüglich seiner Biodiversität, Struktur der Arten- und Lebensräume, sowie trophischen Zusammenhängen, Rekrutierung und Populationsdynamik, möglichen besonderen Werten, sowie Beiträgen zu globalen Ökosystemdienstleistungen, natürlichen und anderen anthropogenen Störungen sowohl am Boden wie in der Wassersäule untersucht und beschrieben werden.
- Jedes potentielle Abbaugebiet muss vorab in seinem **regionalen Kontext** ökologisch evaluiert werden, um damit zu verhindern, dass einmalige und anderweitig geschützte/schützenswerte Lebensräume von der LTC unerkannt zu Erkundungs- und Abbaugebieten werden.
- Hochaufgelöste Lebensraumkartierungen und eine detaillierte Untersuchung und Abgrenzung der Lebensgemeinschaften sind essentiell um die Zusammenhänge mit Ökosystemdienstleistungen durch Tiefseeökosysteme besser zu verstehen (Zeppilli *et al.*, 2016).
- Alle Aspekte des **pelagischen Systems**, der Fauna der Wassersäule, bedürfen sowohl der Grundlagenforschung als auch Studien zu den möglichen Auswirkungen der feinen Sedimentkompartimente auf insbesondere die gelatinöse Fauna, von Licht und Lärm auf Vertebraten, Ökotoxizität (s.a. Kapitel 2.4.6).

ISA Strategie für Forschung und Erkundung

- ISA sollte proaktiv unabhängige Forschungsaktivitäten im Gebiet initiieren und unterstützen, welche ergänzend zu den Arbeiten der Explorationsvertragnehmer regional repräsentativ Grundlagenforschung, einschließlich zeitlicher und großräumiger Variabilität und Prozessstudien betreiben.
- ISA sollte die schon vorhandenen Bemühungen um taxonomische Daten- und Referenzsammlungen dauerhaft finanziell und substantiell unterstützen, und dafür sorgen, dass Daten, Proben und Informationen von Vertragnehmern, Wissenschaft und ISA möglichst vollständig und auf Dauer beigetragen werden.
- Die ISA sollte klären, ob und wenn ja welche Rechte und Pflichten die unabhängige Forschung in Explorationsvertragsgebieten hat.
- Die Rechte der Forschung in späteren Abbaugebieten sollte ebenfalls geklärt werden. Dies könnte auch durch eine Anfrage an die Seebodenkammer des Internationalen Seegerichtshofes geschehen.

Standard Minimalanforderungen an Basisuntersuchungen der Vertragsnehmer

- Die ISA Leitlinien für Explorations-Vertragnehmer (ISBA/19/LTC/8), sowie alle zukünftigen Anforderungen an Abbauvertragsnehmer, sollten ein Standarduntersuchungskonzept zugrunde legen, welches ein Gerüst an für alle Vertragnehmer gleichen Anforderungen an Grundlagenuntersuchungen und Monitoring vorgibt, um die Vergleichbarkeit zwischen Vertragnehmern zu ermöglichen. Das betrifft Probennahmestrategien, Indikatorparameter, Probenaufarbeitung und -auswertung, vertiefende Studien und die Entwicklung von Modellen. Die Arbeiten von Clark *et al*. (2016b) und Swaddling *et al*. (2016) geben dazu wertvolle Hinweise.
- Es sollte Belohnungen dafür geben, wenn Vertragnehmer über die Minimalanforderungen an Basisuntersuchungen hinausgehen, z.B. als Erlass von Abgaben.
- Für die Entwicklung von technischen und Verfahrensstandards (BAT und BEP) ist ein kontinuierlicher Austausch mit und zwischen den Entwicklern bezüglich der Umweltbewertung der eingesetzten Technologie erforderlich.

Standard Minimalanforderungen an das Monitoring von Störungen

- Höhere Risiken erfordern intensivere Untersuchungen und besseres Wissen (ITLOS, 2011): Daher sollte ein gestuftes Standarduntersuchungskonzept ausgearbeitet werden, welches aufbauend auf den Grundlagenuntersuchungen, höhere Anforderungen an das Monitoring und die anschließende Bewertung von Störungen durch Geräte- oder Systemtests, und später in der Abbauphase vorschreibt.
- Die zeitliche Skala für die Messungen und Bewertung von Umweltveränderungen durch Störungen reicht von einer hohen Messfrequenz unmittelbar nach erfolgter Störung, bis zur langfristigen Überwachung über mehrere Dekaden nach Abschluss.
- Die Abdeckung des Probennahmerasters sollte (a) repräsentativ die biotischen und abiotischen Eigenschaften des Erkundungs-/Erprobungs-/Abbaugebietes, einschließlich der Wassersäule beschreiben; (b) mindestens drei repräsentative Ort für maximale, mittlere und minimale Sedimentation von Abbau- und Abwassersedimentwolken am Boden und in der Wassersäule (IRZ), und (c) eine oder mehrere Referenzstationen außerhalb des Sedimentationsgebietes (PRZ) umfassen.
- Eine ausreichende Anzahl von Mehrfachproben an jeder Station ist für die statistische Absicherung der Ergebnisse erforderlich.

Entwicklung eines umfassenden Bewertungsverfahrens

- Für die Bewertung möglicher Umweltveränderungen müssen die Monitoringergebnisse mit der vorhandenen Grundlagenstudie und den Ergebnissen aus nicht beeinflussten Gebieten (PRZ) verglichen werden. Dies sollte im Zusammenhang mit der natürlichen räumlichen und zeitlichen Variabilität geschehen.
- Bewertungsmethoden und -kriterien, einschließlich der Grundannahmen von Modellstudien zur Abschätzung der durch natürliche Faktoren und durch Tätigkeiten im Gebiet verursachten Umweltfolgen, sollten durch eine Expertengruppe entwickelt und regelmäßig fortgeschrieben werden.

Transparenz und Beratung durch unabhängige Experten

- Umweltberichte müssen öffentlich verfügbar sein: Alle Grundlagenuntersuchungen, Monitoring von Geräte- und Systemtests bis zum kommerziell betriebenen Abbau sollten für die wissenschaftliche Arbeit und öffentlichen Kommentar zur Verfügung stehen.
- Die geplante ISA Datenbank sollte nicht nur Roh- und Metadaten der Vertragnehmer sondern auch die dazugehörigen Veröffentlichungen, Forschungsfahrtankündigungen und -berichte, sowie alle Monitoring und Bewertungsberichte und -ergebnisse zur Verfügung stellen.
- Die ISA (eines ihrer Organe) erstellt regelmäßig eine Synthese aller Daten der Vertragnehmer und mit den Ergebnissen unabhängiger Forschung eine Bewertung des Umweltzustands in Regionen welche als Ganzes in einem regionalen Umweltmanagementplan verwaltet werden (s. Clarion-Clipperton-Zone Regional Management Plan).
- Ein unabhängiges wissenschaftliches Beratungsorgan würde sowohl für mehr Transparenz als auch für die erforderliche sachliche Absicherung von Bewertungen und Entscheidungen sorgen.

Entscheidend für die Auswirkungen von Eingriffen auf die Meeresumwelt ist die art- und lebensraumspezifische **Verwundbarkeit** für die daraus entstehenden Belastungen (s. Kapitel 2.4). Generell sind insbesondere langlebige, langsam wachsende Organismen, welche typischerweise auch nur eine unregelmäßige und/oder geringe Fortpflanzung haben besonders verwundbar - also die typischen Organismen der Tiefsee. Wegen der besonderen Gefährdung von Tiefseeorganismen durch die Fischerei wird seit etwa 10 Jahren ein vorsorgendes Handlungskonzept zum Schutz verwundbarer Arten- und Lebensräume (VMEs) vor den Folgen von bodenberührender Tiefseefischerei weltweit in internationalen Gewässern angewendet. Tiefseebergbau zielt auf Rohstoffe in denselben Lebensräumen, welche nach jahrelangen globalen Verhandlungen vor Zerstörung durch Fischerei geschützt wurden. Daher ist es dringend notwendig, die Standards für die Unterschutzstellung dieser Lebensräume, sowie die allgemeinen vorsorgenden Managementregeln welche die ISA in den nächsten Jahren entwickeln wird, mit denen der Fischerei zu harmonisieren.

2.4.5 Empfehlungen VMEs

- Das Konzept der Verwundbarkeit mariner Ökosysteme (VME) sollte für die mit Tiefseebergbau zusammenhängenden Tätigkeiten in den betroffenen Ökosystemen weiterentwickelt werden.
- Zur praktischen Anwendbarkeit bedarf es Bewertungskriterien und Indikatoren welche bei der Entscheidung/Empfehlung über eine Genehmigung angewendet werden, z. B. von der LTC.
- Ein Gesamtkonzept ist erforderlich, um sicherzustellen, dass die durch Tiefseebergbau betroffenen Ökosysteme effektiv geschützt werden und spürbare schädliche Auswirkungen auf die nähere und weitere Umgebung verhindert werden. Eine obere Belastungsgrenze muss auf verschiedenen räumlichen Skalen definiert werden.
- Eine Expertengruppe könnte damit beauftragt werden Vorschläge für ein Konzept zu erarbeiten.
- Insbesondere das pelagische Ökosystem bedarf erheblicher weiterer Forschung, um den Grad der Verwundbarkeit der Organismen und funktionalen Zusammenhänge beurteilen zu können. Empfehlungen für weitere Forschung und Verbesserung der Anforderungen an Vertragnehmer in (ISBA/21/LTC/15 und ISBA/19/LTC/8) sind in Annex 8 zusammengestellt.

Kapitel 3 zeigt auf warum der **Ökosystemansatz**, zu dessen Anwendung alle Staaten einschließlich der ISA verpflichtet haben, den geeigneten Handlungsrahmen für das Management von Tiefseebergbauaktivitäten im Kontext mit bereits existierenden Meeresnutzungen und anderen großskaligen Veränderungen (e.g. durch die globale Erwärmung) bildet (Kapitel 3.1). Die Umsetzung des Ökosystemansatzes bedeutet frühzeitig und mit Beteiligung aller Akteure durch moderne Managementwerkzeuge wie die Strategische Bewertung ('strategic assessment') die voraussichtlichen Auswirkungen von z.B. anstehenden Politikentscheidungen oder neuer Gesetzgebung auf die Umwelt, Soziales und/oder die Wirtschaft zu ermitteln und mit vorab vereinbarten Umweltzielen abzustimmen. Eine strategische Bewertung sollte somit die Entwicklung des ISA Mining Code begleiten, mit dem Ergebnis einer ISA Umwelt-, Sozial- und Wirtschaftsstrategie, welche dann regional durch verbindliche Managementpläne umgesetzt wird.

3.1.3 Empfehlungen Ökosystemansatz

- Die ISA Vertragsparteien sollten die Internationale Meeresbodenbehörde durch angemessene institutionelle, prozessuale und finanzielle Rahmenbedingungen die Umsetzung des Ökosystemansatzes für den Tiefseebergbau im Gebiet ermöglichen.
- Der Ökosystemansatz sollte sich in allen Teilen der ISA Governance widerspiegeln, also im Regelwerk, in den Organen und in entsprechenden Prüfungsverfahren und Entscheidungsfindungsprozessen.
- Der ISA Rat könnte die Rechts- und Fachkommission LTC damit beauftragen, zu erarbeiten wie der Ökosystemansatz durch ISA anzuwenden wäre und welche Schritte dazu notwendig sind. Eine Beteiligung von Experten aus den Vertragsstaaten und von Beobachtern wäre sicher hilfreich.
- Als erster Schritt sollten die Umwelt-, Sozial- und Wirtschaftsauswirkungen der derzeit in Entwicklung befindlichen gesetzlichen Regelungen für den Abbau von Rohstoffen im Gebiet durch eine (öffentliche) **Strategische Bewertung** ermittelt und mögliche Alternativen diskutiert werden. Dies wird im Sinne des ESPOO Protokolls, Artikel 1 zu einem hohen Schutzniveau für die Umwelt beitragen, indem

  a) Sichergestellt wird, dass Umweltfragen in der Entwicklung von Plänen und Programmen berücksichtigt werden;
  b) Besondere Anliegen in die Dokumente einfließen;
  c) Klare, transparente und wirksame Verfahren für Strategische [Umwelt-]Bewertung eingerichtet werden;
  d) Eine Öffentlichkeitsbeteiligung stattfindet; und
  e) Durch Einbeziehung der Umweltbelange in Maßnahmen und Instrumente die nachhaltige Entwicklung gefördert wird.

Eine Strategische Bewertung der Entwürfe der Abbauverordnung umfasst einen Umweltbericht einschließlich der Erörterung von Alternativen, eine transparente Strategie zur Beteiligung der Öffentlichkeit, die Abstimmung mit anderen Instanzen mit Regelungskompetenz in internationalen Gewässern und ggf. Küstenstaaten, Beurteilung der Leistungen im Hinblick auf das Umweltmandat ('effective protection'), Kommunikation der Bewertung sowie Überwachung der Einhaltung der erwarteten Umweltfolgen.

Insbesondere eine **Umweltstrategie**, entweder unabhängig oder als Teil einer Gesamtstrategie, hat wichtige Funktionen (Kapitel 3.2): Eine Umweltstrategie sollte alle umweltrelevanten Fragen abdecken und die Grenzen für genehmigungsfähige Tätigkeiten im Gebiet festlegen. Sie ermöglicht damit die einheitliche Anwendung von Standards auf alle Vertragnehmer der ISA, unabhängig vom Rohstoff und Meeresgebiet.

3.2.3. Empfehlungen Umweltstrategie

Eine Umweltstrategie, z.B. als Unterthema in einer Gesamt ISA-Strategie, dient dazu, der Außenwelt zu kommunizieren, wie ISA seiner Verpflichtung zur einheitliche Anwendung der höchsten Standards zum Schutz der Umwelt, der sicheren Durchführung von Tätigkeiten und zum Schutz des 'Erbes der Menschheit' (ITLOS, 2011 §159) nachkommen wird. Daher wird die Strategie die Ausgestaltung aller relevanten Arbeitsbereiche festlegen. Notwendige Elemente der Umweltstrategie sind:

- Die Leitprinzipien (u. a. Vorsorgeprinzip, Gemeinsames Erbe);
- Die Vision, Ziele und Unterziele der ISA für den Erhalt der Umwelt in Abstimmung mit den globalen Umwelt- und Nachhaltigkeitszielen;
- Die Leitlinien für die Entscheidungsfindung, Zuständigkeiten und Öffentlichkeits- und Expertenbeteiligung. Dazu gehört eine grundsätzliche Festlegung der minimal notwendigen Informationen für eine Entscheidungsfindung z. B. über einen Arbeitsplan.
- Genehmigungsverfahren, welche auf einem hierarchischen Gefüge für die Umwelt[schadens]bewertung auf globaler, regionaler und lokaler Ebene beruhen;
- Verfahren und Kriterien für die vergleichende Bewertung von Umweltauswirkungen bzw. Nachhaltigkeit von [Anträgen auf] Tiefseebergbau und Alternativen (u.a. Landressourcen);
- Verfahren und Kriterien für eine ganzheitliche Bewertung der Kosten (Umwelt-, Sozial- und wirtschaftliche Kosten) und des Nutzens (Rohstoffe, Geld?) heute und für zukünftige Generationen;
- Die Sektor übergreifende Betrachtung der Auswirkungen des Tiefseebergbaus zusammen mit anderen legitimen Meeresnutzungen
- Konfliktlösung wo Tiefseebergbau die Interessen anderer Nutzer berührt, z.B. Fischerei, Seekabel, Biotechnologie);
- Adaptive Governance und Management
- Regelungen zur Schließung von Minen und Anforderungen an den Abbau von Infrastruktur
- Rechtsdurchsetzungs Mechanismen.

Während die Umweltstrategie auch ein übergreifendes politisches Grundsatzpapier sein kann, müssen die Rollen und Verantwortlichkeiten der Akteure, sowie einige Kernthemen s.o. und Umsetzungsverfahren verbindlich im Mining Code festgelegt werden.

Eines der Hauptdefizite des derzeitigen Regelwerks der ISA ist das Fehlen vereinbarter **Umweltziele** (Kapitel 3.3). Eine Ausnahme ist der regionale Umweltmanagementplan der Clarion-Clipperton-Zone, in dem eine Vision, Ziele und Unterziele für die Region benannt werden. Ohne vereinbarte und messbare Umweltziele wird es unmöglich sein, den Grad der Auswirkungen von Tiefseebergbau auf die Meeresumwelt an Erhaltungszielen zu messen und so Grenzüberschreitungen festzustellen - sollte das jemals im Tiefseekontext möglich sein. Durch alle Vertragsstaaten vereinbarte Umweltziele sind auch für allgemeine Managemententscheidungen erforderlich, beispielsweise ob noch weitere Abbaugenehmigungen erteilt werden dürfen, und stellen sicher, daß die ISA einen Beitrag zu den globalen Umwelt- und Nachhaltigkeitszielen leistet.

3.3.4 Empfehlungen Umweltziele

Die ISA sollte in naher Zukunft übergreifende strategische Ziele, einschließlich globaler Umweltziele mit messbaren Unterzielen und Indikatoren verabschieden. Diese Ziele sollten nicht nur die direkt umweltbezogenen Anforderungen aus dem Seerechtsübereinkommen aufnehmen, sondern auch die Grundideen des

- Prinzips des Gemeinsamen Erbes
- Vorsorgeprinzips,
- Verursacherprinzips und
- anderer Pflichten und Verpflichtungen der ISA und seiner Vertragsstaaten unter internationalen Abkommen, Konventionen und UN Resolutionen

umsetzen. Der Prozess der Erarbeitung von ISA Umweltzielen sollte transparent und inklusiv sein, also möglichst viele Vertragsstaaten und Beobachter einbeziehen. Eine technische Arbeitsgruppe der Versammlung (‘Assembly’) oder des Rats (‘Council’) könnte einen von einer Expertengruppe erarbeiteten ersten Entwurf anpassen.

Hier ein Vorschlag für **übergreifende Umweltziele**, welche die ISA sich setzen könnte:

- Das Gebiet ist von großem Wert für diese und zukünftige Generationen. Der Wert besteht nicht nur im Wert der geförderten Rohstoffe, sondern auch im Wert der Rohstoffe *in situ*, seine biologischen Werte, Ökosysteme und Funktionen im globalen Kohlenstoffzyklus.
- Der Abbau von Rohstoffen im Gebiet wird nur erwogen, wenn Folgen für die Umwelt abgeschätzt und eingegrenzt werden können, ein gesellschaftlicher Bedarf für die Minerale besteht, es keine Alternativen gibt und erhebliche finanzielle und andere Vorteile daraus für die Menschheit entstehen.
- Die Förderung von Rohstoffen aus der Tiefsee wird zum Erreichen der globalen Nachhaltigkeitsziele als Ganzes beitragen, die Kreislaufwirtschaft fördern und nicht durch Beibehalten alter Wirtschaftsmuster schwächen.
- Die Förderung von Rohstoffen aus der Tiefsee wird dazu beitragen, das globale Paris Abkommen zum Klimaschutz, sowie die Aichi Ziele der Biodiversitätskonvention, einschließlich des Ziels weiteren Verlust an Biodiversität zu verhindern.
- Die Integrität der benthischen und pelagischen Ökosysteme, Lebensräumen und Artengemeinschaften in den von Tiefseebergbau betroffenen Gebieten bleibt erhalten.
- Die Umsetzung des Vorsorgeprinzips in alle Bewertungs- und Entscheidungsprozesse sorgt für ein in höchstem Maße vorsichtiges Vorgehen, welches den großen Unsicherheiten und Risiken Rechnung trägt.
- Die Anwendung von bester verfügbarer Technik (BAT) und bester Umweltpraxis (BEP) wird durch kontinuierliche Fortschreibung dazu beitragen Umweltschäden zu minimieren.
- Die Zusammenarbeit der ISA mit Vertragnehmern und unabhängigen Forschungsprogrammen wird dazu führen, daß Entscheidungen auf der besten möglichen Wissensbasis getroffen werden.

Jedes übergeordnete Ziel muss mit konkreten und messbaren (SMART) Zielvorgaben überprüfbar gemacht werden.

Neben den Umweltzielen müssen eine Reihe von **Prinzipien** der zweiten Säule für die Implementierung des Ökosystemansatzes in wirksame prozessuale, institutionelle und regulatorische Instrumente (Kapitel 3.4)umgesetzt werden. Da Tiefseebergbau als neue Industrie bislang keine Vorbilder hat und in einem sehr wenig bekannten, und technologisch sehr anspruchsvollem

Ökosystem zur Anwendung kommen wird ist das **Vorsorgeprinzip** (Vorsorgeansatz, s. Kapitel 3.4.1) von größter Bedeutung.

3.4.1.8 Empfehlungen Vorsorgeansatz

- Maßnahmen zum Schutz der Umwelt sollten integraler Bestandteil des Entscheidungsfindungsprozesses der ISA sein. Das heißt, daß beispielsweise festgelegt sein sollte, daß die in regionalen Managementpläne ermittelte und fortgeschriebene Umweltqualität die verbindliche Grundlage für die kumulative Bewertung der Zulässigkeit von projektspezifischen Anträgen auf Rohstoffabbau ist und keine Genehmigungen ohne regionale Umweltmanagementpläne erteilt werden können.
- Zur Umsetzung des Vorsorgeprinzips gehört daß Maßnahmen zum Schutz der Umwelt *rechtzeitig*, d.h. *vor* dem Beginn von Rohstoffförderung in Kraft treten. Das schließt die Verabschiedung von regionalen Umweltmanagementplänen ein welche regional schützenswerte und besonders verwundbare Arten und Lebensräume identifizieren, klare Schutzziele definieren, sowie die technischen Anforderungen an Umweltverträglichkeitsprüfungen einzelner Projekte vorgeben. Deutschland könnte diese zeitlichen Erfordernisse im Rat der ISA hervorheben.
- Die sachlichen Überlegungen einschließlich aller Unsicherheiten welche die Empfehlungen der Rechts- und Fachkommission, LTC, bzw. die Entscheidungen des Rates begründen sollten mit veröffentlicht werden. Dazu gehören wissenschaftliche, technische Überlegungen sowie Abwägungen von Werten. Dies wird zu größerer Transparenz führen und den Staaten im Rat ermöglichen Entscheidungen auf der besten möglichen Sachgrundlage zu treffen.
- Das derzeitige Bewertungsverfahren von Arbeitsplänen durch die LTC bezüglich des ‘*wirksamen Schutzes und des Erhalts der Meeresumwelt einschließlich aber nicht nur bezüglich der Auswirkungen auf die biologische Vielfalt’* ist unklar und sollte durch Bewertungskriterien nachvollziehbar gemacht werden, welche in einem inklusiven Verfahren erarbeitet und durch den Rat angenommen werden.
- Das Vorsorgeprinzip erfordert, daß auch alle Anträge bzw. deren Bestandteile für die Genehmigung von Arbeitsplänen alle Unsicherheiten benennen, welche im Projektdesign, den Bewertungen etc. enthalten sind, und wie damit umgegangen wurde.
- Ohne eine Aufstockung der institutionellen Kapazität der ISA, zum Beispiel durch Einrichtung einer Bergbaudirektion (‘Mining Inspectorate’), wird es unmöglich sein Umweltrisiken zu bewerten und zu minimieren, sowie Tätigkeiten im Gebiet zu überwachen. Dies wird zusätzliche operative Kosten verursachen, für die die Vertragsstaaten einen Mechanismus schaffen müssen.

Das Gebiet mit den dort vorhandenen Bodenschätzen wurde durch das Seerechtsübereinkommen als ‘**Gemeinsames Erbe der Menschheit**’ ausgewiesen, welches durch die Internationale Meeresbodenbehörde zum Vorteil (‘benefit‘) der Menschheit verwaltet wird (Kapitel 3.4.2). Die im Seerechtsübereinkommen mit diesem Prinzip verknüpften Erwartungen und Auflagen müssen in den von der ISA beschlossenen Regeln, Vorschriften und Verfahren zum Ausdruck kommen. Allerdings gibt es einigen Interpretationsspielraum für die praktische Umsetzung, beispielsweise in der Definition was genau zum Vorteil der Menschheit ist, wie zukünftige Generationen mit einbezogen werden müssen, und in welcher Form ggf. wirtschaftliche und finanzielle Vorteile mit der Menschheit geteilt werden sollten.

3.4.2.7 Empfehlungen Gemeinsames Erbe der Menschheit

- Das Prinzip des 'Gemeinsamen Erbes der Menschheit', CHM, erfordert die Bewahrung von mineralischen Rohstoffen für zukünftige Generationen. Das könnte unter anderem die Reservierung von Gebieten, welche für die Rohstoffförderung interessant sind für die Nutzung in der Zukunft umfassen.
- Die Ausgestaltung dessen, was das Prinzip des 'Gemeinsamen Erbes der Menschheit' für alle ISA Mitgliedsstaaten bedeutet und wie es umgesetzt werden soll, muss weiter ausgearbeitet werden. Der Prozess dazu kann im Rahmen der Entwicklung der Abbauverordnungen durch jede Partei in der ISA Versammlung ('Assembly') eingeleitet werden.
- Um aus dem CHM Prinzip erwachsenen Anforderungen an die Vorsorge und Nachhaltigkeit im Umgang mit den Werten des Gebiets, sowie der öffentlichen Rechenschaftspflicht Rechnung zu tragen sollten u.a. folgende Maßnahmen getroffen werden:

  f) Finanzierung der wissenschaftlichen Forschung zur Schaffung einer besseren Wissensgrundlage über die marine Umwelt,
  g) Beteiligung der Öffentlichkeit an der Entwicklung des Mining Code,
  h) Bedarfsermittlung für Minerale aus Tiefseebergbau gegenüber Alternativen wie der Bewahrung für zukünftige Generationen.

Adaptive Governance und adaptives Management sind in bestimmten Fällen eine Möglichkeit, neue oder im Kontext neue Tätigkeiten zu genehmigen, deren Umwelt-, Sozial- und Wirtschaftsauswirkungen im Ganzen nicht vorhersehbar sind (Kapitel 3.4.3). Allerdings erfordert das, daß bestimmte Maßnahmen innerhalb eines relativ kurzen Zeitraums messbare Auswirkungen in der Umwelt zeigen, die zur weiteren Justierung von Maßnahmen, gemessen an vorab festgelegten Umweltzielen, verwendet werden. Im Tiefseekontext erscheint es allerdings weitgehend unwahrscheinlich, aussagekräftige Indikatoren für kurzzeitige Anpassungen an veränderte Maßnahmen zu identifizieren.

3.4.3.9 Empfehlungen Adaptives Management

- Die Umsetzung eines adaptiven Managements des Tiefseebergbaus ist nur möglich, wenn es der ISA möglich ist auch für laufende Verträge die Mindestumweltstandards kontinuierlich, bzw. die Arbeitspläne periodisch anzupassen.
- Adaptives Management erfordert Infrastruktur und Kapazitäten, um fortlaufend und unabhängig von den Vertragsnehmern die Umweltauswirkungen genehmigten Tätigkeiten zu überprüfen.

Die Internationale Meeresbodenbehörde, ISA, hat das Mandat, das Gebiet für 'die Menschheit' zu verwalten. Das bedeutet einerseits, daß alle Mitgliedsstaaten an der Entscheidungsfindung beteiligt sein müssen, andererseits aber auch nicht-staatliche Beobachterorganisationen, Vertreter der Zivilgesellschaft und Privatpersonen betroffen sein können und beteiligt werden sollten (Kapitel 3.4.4). Derzeit fehlen wichtige **Transparenz**elemente in den Verfahren der ISA, wie beispielsweise eine Strategie, wie die Öffentlichkeit informiert und beteiligt wird, wie Eingaben aus der Öffentlichkeit und der Wissenschaft berücksichtigt werden, sowie ein Forum, wo alle Umweltbelange öffentlich diskutiert und entschieden werden können.

3.4.4.7 Empfehlungen Transparenz

- Eine ISA Informations- und Datenrichtlinie ist erforderlich, um die Rechenschaftspflicht umzusetzen. Es sollte grundsätzlich gelten, daß alle Informationen im Zusammenhang mit der Regulierung der Tätigkeiten, Arbeitsschutz und der Meeresumwelt im weitesten Sinne öffentlich verfügbar sein sollten. Ausnahmen werden gesondert begründet.
- Eine aktive Beteiligung der interessierten Öffentlichkeit sollte gefördert werden. In Umsetzung des Prinzips des Gemeinsamen Erbes der Menschheit sollte eine breite Beteiligung insbesondere auch bei Richtungsentscheidungen über die Verwaltung des Gebiets ermöglichen.
- Die ISA braucht ein neues beratendes Organ für die transparente Behandlung aller mit dem Schutz der Umwelt vor Auswirkungen durch Tiefseebergbau zusammenhängenden Angelegenheiten. Über dieses Organ könnte auch unabhängige wissenschaftliche Beratung erfolgen.

Eines der wichtigsten Prinzipien modernen Umweltmanagements ist es **vorbeugend tätig** zu **werden**, und so bereits zu einem frühen Zeitpunkt mögliche Umweltschäden zu erkennen und ggf. zu verhindern (Kapitel 3.4.5). Zu den Voraussetzungen gehören unter anderem nationale oder internationale Schutzziele, sowie Mechanismen, um geplante Politik- und Gesetzesentwicklungen, sowie Projekte während ihrer Entwicklung bzw. vorab auf mögliche und wahrscheinliche Umweltauswirkungen zu untersuchen und mit gültigen Schutz- und Umweltzielen abzugleichen. Eine *à priori* Festlegung von Tätigkeiten, welche geprüft werden müssen ist erforderlich. Die wichtigsten Prüfinstrumente für die genehmigende Behörde sind die Strategische Bewertung (‘strategic assessment’) welches anstehende Politikentscheidungen, Großprojekte und neue Regulierungen begleitend u.a. mit einer umfassenden Risikoanalyse daraufhin untersucht, ob ggf. negative Umweltauswirkungen entstehen, welche nicht mit anderen Verpflichtungen zu vereinbaren sind, zu Nutzerkonflikten führen oder besser über Alternativen gelöst werden können. Strategische Bewertung kann auch zur Abschätzung der kumulativen Umweltbelastung eingesetzt werden, um das Potential für weitere Aktivitäten abzuschätzen - wie es einige Länder in Europa für ihre offshore Sektoren getan haben. Umweltverträglichkeitsuntersuchungen untersuchen die voraussichtlichen Belastungen von Einzelprojekten im Kontext mit den regulatorischen Rahmenbedingungen im entsprechenden Seegebiet.

3.4.5.8 Empfehlungen Vorbeugung

- Eine strategische Bewertung der möglichen sozialen, wirtschaftlichen und Umweltauswirkungen der derzeit in Entwicklung befindlichen ISA Abbauregularien ist vor Abschluß der Verhandlungen erforderlich. Ein strategisches Bewertungsverfahren stellt eine angemessene Öffentlichkeitsbeteiligung sicher welche angesichts der strategischen Bedeutung der Regularien für das Gemeinsame Erbe sehr bedeutsam ist.

  i) Eine strategische Bewertung des Verordnungsentwurfs sollte erfolgen bevor die Vertragsparteien die Verhandlungen aufnehmen.
  j) Die Staaten sollten im Rat und in der Versammlung das Verfahren initiieren und steuern, unter Beteiligung von Beobachterorganisationen und ggf. der Öffentlichkeit.
  k) Zur Durchführung ist institutionelle Kapazität erforderlich, insbesondere ein technisches Beratungsorgan mit der notwendigen Umwelt- und Managementkompetenz.

l) Der Aufbau guter Arbeitsbeziehungen zu anderen internationalen Organisationen und Behörden mit Zuständigkeit für Gebiete jenseits nationaler Grenzen sollte so schnell wie möglich erfolgen.

- Eine Gesamtrisikoabschätzung ist Teil der strategischen Bewertung und wird periodisch aktualisiert, um u.a. additive, kumulative und synergistische Auswirkungen aus verschiedenen Quellen gegen die zu erwartenden Vorteils durch den Abbau von Rohstoffen abzuwägen.
- Die ISA sollte intern anwendbare Empfehlungen entwickeln, wie im gesamten Genehmigungsverfahren mit Unsicherheiten umgegangen werden soll, beispielsweise ob dadurch weitere gezielte Forschung initiiert wird, und ab wann ein Verfahren/ein Antrag abgelehnt wird.
- Der derzeitig in den Empfehlungen für Erkundungs-Vertragnehmer (ISBA/19/LTC/8) vorgesehene Umweltprüfungsprozess für bestimmte Tätigkeiten (genannt Environmental Impact Assessment, EIA) ist unzureichend und bedarf weiterer Ausarbeitung zu einem wirksamen Instrument zur Weiterentwicklung von Umweltstandards. Nicht nur Vertragnehmer, sondern auch Staaten und Beobachter müssen an der Weiterentwicklung beteiligt werden.

Strategische Bewertung und Umweltverträglichkeitsprüfungen können nur aussagekräftig eingesetzt werden, wenn Anträge von Betreibern im Kontext mit gültigen Umwelt- und Schutzzielen, sowie **Grenzwerten** für Umweltbelastungen evaluiert werden (Kapitel 3.4.6). UNCLOS Artikel 145 fordert von der ISA und den Staaten ganz allgemein den ‘*wirksamen Schutz der Meeresumwelt vor schädlichen Auswirkungen*’ durch Tätigkeiten im Gebiet, während für besonders restriktive Maßnahmen ‘erheblicher Schaden’ möglich oder wahrscheinlich sein muss. Die Schwelle für das Einleiten einer Umweltverträglichkeitsprüfung liegt bei der Vermutung, daß ‘signifikante und schädliche Veränderungen der Meeresumwelt wahrscheinlich sind (Artikel 206). All diese Schwellen müssen operationalisiert werden, d.h. konkretisiert durch Indikatoren und Grenzwerte. Das ist eine ungeheure Aufgabe, insbesondere angesichts der Unsicherheiten über den Grundzustand und das Funktionieren der Tiefseeökosysteme, aber auch der zur Anwendung kommenden Technik.

3.4.6.5 Empfehlungen Grenzwerte

- Abbaugenehmigungen sollten nicht erteilt werden bevor

  a) ISA Umwelt- und Schutzziele, Alternativen und der Grad der politisch akzeptablen Umweltveränderungen durch Tiefseebergbau verabschiedet wurden und
  b) Aus der Strategischen Bewertung der Abbauregularien eine Strategie und Managementpläne für das zukünftige Vorgehen der ISA hervorgehen, welche sicherstellen, daß keine unkontrollierten, kumulativen, u.a. Umweltveränderungen stattfinden, welche über das vereinbarte Maß hinausgehen.
  c) Aussagekräftige und wissenschaftlich fundierte regionale Umweltbeschreibungen vorliegen
  d) Indikatoren und Grenzwerte für den Umweltzustand und -veränderungen vereinbart sind
  e) Standard Monitoring und Bewertungsverfahren festgelegt und umgesetzt wurden.

- Abbau- und Gerätetests sollten erst stattfinden, nachdem

  a) die von den Vertragnehmern vorgelegte Grundlagenuntersuchung des Vertragsgebietes evaluiert und für gut befunden wurde;

b) Kriterien und Leitlinien für die Ausweisung von 'preservation reference zones', PRZ, und 'impact reference zones', IRZ verabschiedet und durch die Vertragnehmer umgesetzt wurden;
c) Andere nach Kriterien anderer Organisationen geschützte, besonders empfindliche oder verwundbare Lebensräume und Arten ausgewiesen wurden.
d) Standardmonitoringverfahren entwickelt und durch die Vertragnehmer angewendet werden können;

- Wie im regionalen Managementplan der Clarion-Clipperton-Zone gefordert müssen periodisch regionale Umweltqualitätsberichte erstellt werden, welche die Grundlage für die Beurteilung vorhandener und zukünftiger Belastungen der Meeresumwelt sind. Deutschland könnte hier mit seiner vorhandenen umfangreichen eigenen Forschungsexpertise einen Beitrag leisten.
- Wissenschaftliche Arbeitsgruppen sind am besten geeignet, um

a) Methoden zur Überwachung und Bemessung von Umweltgesundheit und -veränderungen, sowie die Feststellung der Einhaltung/das Übertreten von vereinbarten Grenzwerten im Rahmen natürlicher Dynamik,
b) Kriterien für 'wirksamen Schutz der Meeresumwelt' aufzustellen, und Vorschläge für Maßnahmen zur Umsetzung unter Berücksichtigung von Vorsorge- und Gemeinsames Erbe Prinzip zu machen.

- Für diese Art externen Expertenbeirat müssen die institutionellen Strukturen und ein Mandat geschaffen werden (s.a. Kapitel 3.4.4).
- Die Ergebnisse dieser Arbeitsgruppe[n] müssten durch ISA Organe unter Öffentlichkeitsbeteiligung überprüft werden und in die Beurteilungskriterien bei Genehmigungsverfahren durch LTC eingehen.
- Deutschland könnte sich mit gleichgesinnten Staaten für veränderte Arbeitsweisen in der ISA einsetzen, beispielsweise technische Arbeitsgruppen im Rat. Die Umsetzung von Artikel 145 in die ISA Praxis erfordert einen breiten Konsens über die damit verbundenen Ziele, Kompromisse und Methoden über die parallel zur Weiterentwicklung der Abbauverordnung Klarheit geschaffen werden sollte.

Kapitel 4 analysiert das Seerechtsübereinkommen (UNCLOS) bezüglich Tiefseebergbauaktivitäten und des Schutzes der Meeresumwelt. Der Rechtsbegriff **'Tätigkeiten im Gebiet'** ('activities in the Area') ist die Grundlage für die Definition der Befugnisse und der Funktionen der ISA bei Maßnahmen zum Umweltschutz (Kapitel 4.1). Wenn das Gutachten der Meeresbodenkammer des Internationalen Seegerichtshofes (ITLOS, 2011) mit herangezogen wird, ist es nicht eindeutig, ob und zu welchem Grad die in UNCLOS genannten Aspekte des Transports und der Verarbeitung zu den 'Tätigkeiten im Gebiet' zählen. Möglicherweise spiegelt die derzeitige Regulierung nicht wider, wie die 'Tätigkeiten im Gebiet' ablaufen werden, wenn die späteren kommerziell eingesetzten Technologien und Systeme entwickelt sein werden. Daraus können sich Lücken und Schwächen für den Schutz der Umwelt ergeben. Die endgültige Abbauverordnung sollte sicherstellen, daß sämtliche Schritte der Prozesskette durch den Begriff 'Tätigkeiten im Gebiet' erfasst sind.

4.1.7 Empfehlungen 'Tätigkeiten im Gebiet'

- Die ISA muss verbindlich festlegen, welche technische Ausrüstung und welche Tätigkeiten zu 'Vorbehandlung an Bord' ('shipboard processing'), Vorverarbeitung ('preliminary processing') und Gewinnung ('recovery') gehören, sowie mit welchen Kriterien 'unmittelbar über dem Abbaugebiet' ('immediately above a mine site') festgestellt wird, damit eine kohärente und einheitliche Anwendung des Begriffs 'Tätigkeiten im Gebiet' möglich wird.
- Die Feststellung von Lücken und Überschneidungen zwischen dem Regime für Tiefseebergbau und anderen Managementregimen, sowie den allgemeinen internationalen Verpflichtungen zum Schutz der Meeresumwelt ist erforderlich, wie beispielsweise durch die Wissenschaftliche Arbeitsgruppe der London Konvention/London Protokoll vorgeschlagen.
- ISA und die Internationale Schifffahrtsorganisation, IMO, sollten eine Absichtserklärung unterzeichnen, welche die genauen Zuständigkeits- und Verantwortungsbereiche für Schiffe und Anlagen festlegt, welche Teil von Tiefseebergbautätigkeiten sind. Besonderes Augenmerk sollte der Vorbehandlung an Bord und der Vorverarbeitung gelten. Auch die Zuständigkeiten von Flaggenstaaten und Befürwortenden Staaten müssen festgelegt werden.
- Die ISA und ihre Mitgliedsstaaten könnten bei vorhandenem politischem Willen auch über andere internationale Abkommen wie die Konferenz der Vertragsparteien der IMO und der Biodiversitätskonvention auf eine Verbesserung des Umweltschutzes durch die ISA hinwirken. Auch wenn derzeit kein Interesse erkennbar ist, wäre es theoretisch möglich unter beiden Instrumenten sogar Moratorien für Teile der technischen Prozesskette zu erwirken. Dies könnte auch als Teil der geforderten Sorgfaltspflicht von Befürwortenden Staaten angesehen werden.

Erarbeitung der Abbauverordnung:

- Die Abbauverordnung muss eine rechtlich verbindliche Definition von 'Tätigkeiten im Gebiet' und damit zusammenhängenden Begriffen enthalten, um die Konsistenz mit UNCLOS und des Gutachtens der Meeresbodenkammer (ITLOS, 2011) herzustellen.
- Die detaillierte Regulierung der einzelnen Schritte der technischen Prozesskette muss die rechtliche Grundlage, sowie Mechanismen und Verantwortlichkeiten festlegen, falls bestimmte Tätigkeiten teilweise oder ganz außerhalb des ISA Mandats stattfinden.

Die **Kompetenzaufteilung zwischen ISA und befürwortenden Staaten** ('Sponsoring States') für den Schutz der Umwelt vor schädlichen Auswirkungen der Tätigkeiten im Gebiet ist dynamisch und nicht eindeutig (Kapitel 4.2). Die Interpretation der Kompetenzen der ISA in Bezug auf 'Tätigkeiten im Gebiet' bestimmen direkt welche Verantwortlichkeiten die befürwortenden Staaten haben, und welche gemeinsam übernommen werden müssen. Der evolutionäre Ansatz bei der Weiterentwicklung der Regulierung Tätigkeiten und der Institutionen der ISA, sowie die Vermeidung von übermäßig normativer Regulierung könnte im Endeffekt zu einem Defizit an Umweltschutz führen. Staaten, die 'Hüter' des Völkerrechts, müssen ggf. in allen Bereichen, die nicht ausreichend durch die ISA reguliert werden unter Anwendung von Teil XII des Seerechtsübereinkommens und anderen Verpflichtungen zum Umweltschutz einspringen. Wirksamer Umweltschutz erfordert sowohl umfassende und gut geschriebene Regularien, als auch ausreichende Kapazität sowohl bei der ISA als auch bei den befürwortenden Staaten zur Umsetzung. Von besonderer Wichtigkeit für die Durchsetzung der ISA Regularien wäre die Einrichtung des Bergbaudirektorats, ohne dessen Überwachung der Schutz der Umwelt während der Erkundungsphase gefährdet sein kann.

4.2.12 Empfehlungen Kompetenzaufteilung

- Eine klare Aufteilung der Verantwortlichkeiten der verschiedenen Akteure ist erforderlich. Alle Tätigkeiten, für die ISA und befürwortende Staaten gemeinsame oder geteilte Verantwortung haben müssen identifiziert werden. Formale Verfahren für eine wirksame Zusammenarbeit müssen verabschiedet werden.
- Die ISA sollte ihre institutionellen Schwächen für bestimmte Verpflichtungen angehen, einschließlich der nicht vorhandenen Bergbaudirektion und eines Umweltorgans. Eine Absichtserklärung der ISA und der IMO sollte sicherstellen, daß Inspektionen auf allen Schiffen möglich sind, die Teil der Tätigkeiten im Gebiet sind (und nicht beschränkt auf 'Installationen im Gebiet').
- Ein formales Verfahren für eine Benachrichtigung der ISA durch befürwortende Staaten sollte entwickelt werden. Das sollte dazu dienen daß Staaten im Rahmen ihrer Sorgfaltspflichten mitteilen wenn sie vermuten, daß ihr Rechtssystem und institutionelle Kapazität nicht ausreichend sind um ihren Verpflichtungen, einen minimalen Umweltstandard aufrechtzuerhalten, nachzukommen.
- Ein ISA Programm zur Unterrichtung von Vertragnehmern und befürwortenden Staaten über die regulatorischen und institutionellen Pflichten im Zusammenhang mit der Übernahme einer Befürwortung für Erkundung/Abbau im Gebiet.
- Transparenz und Öffentlichkeitsbeteiligung sollten als Teil der Sorgfaltspflichten und Mechanismen für den Aufbau von Kompetenz verstanden werden.

Erarbeitung der Abbauverordnung:

- Die Abbauverordnung muss die Aufteilung der Verantwortlichkeiten zwischen ISA, befürwortendem Staat und Vertragnehmer klar definieren. Formale Verfahren und Kriterien sind notwendig im Fall gemeinsamer oder geteilter Verantwortung.
- Die Abbauverordnung muss die Verantwortung der ISA für die Überprüfung/Inspektion der genehmigten Tätigkeiten festlegen, statt dies wie bislang in das Ermessen der Inspektoren zu stellen. Inspektionen müssen auf allen mit Tätigkeiten im Gebiet befassten Schiffen und Installationen durchgeführt werden.
- Mechanismen der gegenseitigen Kontrolle müssen Teil der Abbauverordnung werden, um eine interne Kontrolle der Gewaltenteilung zwischen den Organen zu ermöglichen und die Rechenschaftspflicht zu verstärken.
- Die Abbauverordnung muss festlegen, daß Versagen beim Schutz und Erhalt der Meeresumwelt ein spezifischer Grund für eine Verwarnung ('compliance notice') und ggf. der Aufhebung und Beendigung eines Abbauvertrags ist.
- Transparenz, Öffentlichkeitsbeteiligung und Zugang zu Information müssen verankert werden, um der Rechenschaftspflicht nachzukommen und ein wirksames Handeln zu demonstrieren.
- Die Qualifikation von Staaten um als befürwortender Staat für Abbauvertragsnehmer zu bürgen sollte durch spezielle Kriterien abgefragt werden, welche auch einbeziehen wie anderen internationale Umweltverpflichtungen nachgekommen wird.

In situ **Tests** jeder Art sind im derzeitigen Regelwerk nur sehr **unzureichend geregelt** und bedürfen dringend verbesserter Bestimmungen da die ersten Gerätetests bereits 2018 durchgeführt werden. Es kann nicht davon ausgegangen werden, daß Abbautests grundsätzlich nur geringe Umweltauswirkungen haben. Außerdem gibt es Hinweise darauf, daß der derzeitige Regulierungsansatz nicht der schrittweisen Weiterentwicklung und dem UNCLOS Ansatz des vom Kleinen-zu-Großen-entwickeln gerecht wird.

4.3.6 Empfehlungen Abbau- und Gerätetests

- Es müssen objektiv messbare Kriterien und Verfahren für die umwelt-relevante Kategorie (‘scale’) von Geräte- und Systemtests werden, um die in UNCLOS geforderte Herangehensweise an die technologische Entwicklung umzusetzen.
- Spezifische Bewertungsverfahren für Geräte- und Systemtests während der Erkundungsphase werden benötigt, welche mit dem Grad der von den Tests ausgehenden Umweltrisiken korrespondieren.
- Es muss sichergestellt werden, daß die Ergebnisse von Tests für eine Umweltrisikoanalyse und eine Bewertung der technischen und ökonomischen Machbarkeit bei einem Antrag auf Abbaugenehmigung zur Verfügung stehen.
- Die Kontrollverpflichtung der Befürwortenden Staaten für alle Arten von Tests muss klar geregelt sein und schließt eine vorherige Umweltverträglichkeitsprüfung der Tests ein.
- Die Empfehlungen für Erkundungs-Vertragnehmer (ISBA/19/LTC/8) sollten dahingehend überarbeitet werden, daß alle Arten von Tests durchgängig und vollständig behandelt werden.

Erarbeitung der Abbauverordnung:

- Die Abbauverordnung muss festlegen, daß bei Antragstellung auf Abbaugenehmigung, spätestens vor Beginn der kommerziellen Produktion, Testergebnisse für alle Komponenten, das integrierte Abbausystem, sowie die Produktionsprozesse aus dem entsprechenden Gebiet vorgelegt werden müssen. Es sollte von kleinskaligen zu großskaligen Tests verfahren werden.
- Die bei Antragstellung auf Abbau durchgeführte Umweltverträglichkeitsprüfung sollte u.a. die Ergebnisse der Tests berücksichtigen. Diese Ergebnisse müssen als Umweltinformation öffentlich verfügbar sein.
- Die Abbauverordnung sollte einen Mechanismus festlegen der sicherstellt, daß die ISA ausreichende Informationen über Tests zur Verfügung gestellt bekommt, um eine wirksame Kontrolle über die Entwicklung der Abbautechnologien und der entsprechenden Umweltauswirkungen ausüben zu können.
- Die Abbauverordnung sollte die Vertragnehmer verpflichten, die beste verfügbare Technik (BAT) einzusetzen, und entsprechend die Entwicklung eines ISA Verfahrens zur Bestimmung und periodischen Überarbeitung der BAT Standards, einschließlich externer Überprüfung, einleiten.

Je näher die Realisierung von Tiefseebergbau rückt, desto wichtiger wird die Behandlung der Unzulänglichkeiten der derzeitigen Regulierungen im Hinblick darauf, wirksamen Umweltschutz umzusetzen, die technologische Entwicklung zu begleiten und ggf. einzuschränken. Die Aufteilung der Verantwortlichkeiten zwischen den Akteuren erfordert noch viel Arbeit, ebenso die Identifikation und Behandlung der bestehenden Lücken beim Umweltschutz, sowie Konzepte, um in UNCLOS nicht vorgesehene technische Entwicklungen in die Regulierung mit einzubeziehen. Die Analyse in Kapitel 4 zeigt, daß sowohl die Umsetzung der bestehenden Erkundungsregularien als auch die in Entwicklung befindliche Abbauverordnung noch großer Verbesserungen hinsichtlich der Realisierung eines möglichst umweltgerechten Tiefseebergbaus bedürfen. Die Aufmerksamkeit galt auch einigen Themen, welche sonst vielleicht bei der Erarbeitung der Abbauverordnung nicht so ausführlich diskutiert worden wären. Hoffentlich ist das ein Impuls für die Behandlung dieser Fragen.

Abschließend kann hier festgestellt werden, daß die Internationale Meeresbodenbehörde die Chance hat, sich als moderne, umweltbewußte Organisation darzustellen, welche den Vorsorgeansatz und internationale Verpflichtungen zum Schutz der Meeresumwelt und zur nachhaltigen Entwicklung ernst nimmt und ihr Mandat unter Einbeziehung der derzeitigen und voraussichtlich zukünftigen

Veränderungen der Meeresökosysteme bis in die Tiefsee ausübt. Dazu gehört, daß sich die ISA eine 'Governance' und ein rechtliches Regelwerk gibt, welches sicherstellt, daß 'Tätigkeiten im Gebiet' nur genehmigungsfähig sind wenn diese die Meeresumwelt nicht in unvorhersehbarer, unbekannter und nicht rückgängig zu machender Weise beeinträchtigen. Die Schaffung eines solchen Regelungsrahmens ist arbeits- und zeitaufwändig und erfordert den politischen Willen und die institutionellen Möglichkeiten, die drei Säulen der Nachhaltigkeit bei der Verwaltung des Gemeinsamen Erbes langfristig und nachhaltig in Einklang zu bringen.

Summary

This report reflects findings from the Research and Development project "Ecological Safeguards for Deep Seabed Mining" commissioned by the German Environment Agency (UBA) to a small team of scientists from the Institute for Advanced Sustainability Studies (IASS) from October 2015 to December 2017.

With renewed interest in mining the minerals of the deep seabed minerals in recent years and the development of new offshore mining legislation for national and international waters, concepts for the effective protection of the marine environment from the adverse effects of mining are urgently needed. The International Seabed Authority (ISA) is mandated to manage access to and benefits from the seabed, its subsoil and mineral resources in areas beyond the limits of national jurisdiction, referred to legally as ‘the Area’. The ISA is mandated to act as a trustee for the benefit of mankind as a whole. Its legal mandate comprises the development of rules, regulations and procedures for mining-related activities in the Area, which must prevent, reduce and control adverse impacts on the marine environment which exceed the standard of effective protection.

A complex framework of environmental policy decisions and measures is needed to ensure that only those activities be allowed where scientific knowledge confirms that the impacts on the marine environment will be acceptable over the long-term. The mining of minerals from the deep sea, whether manganese nodules from the abyssal plains at 5000 m depth, massive sulfide deposits at hydrothermal vents on the mid-ocean ridges, or cobalt-rich crusts on the seamounts of some regions at intermediate depths, will be a novel and unprecedented activity. There is no prior experience with the technologies that may potentially be employed and there is virtually no scientific knowledge of their effects on the environment. So far. Modelling studies have been conducted and only rudimentary equipment prototypes exist. However, it has recently been shown that disturbances in the deep sea caused by mere scientific research persist after the initial impact for a currently unknown, but likely extremely long, time scale. Permanent and irreparable ecosystem changes and biodiversity loss have been observed, as well as other ecosystem successions.

Compounding this situation, scientific uncertainty in the deep ocean is magnitudes higher than in other ecosystems. Most deep-sea taxa have only been identified once in samples and such singletons make up more than 90% of the communities studied. More knowledge of the ecological structures and ecosystem functions of the deep sea are required to even begin contemplating the effects of mining activities on recipient ecosystems. This is even more the case at larger scales when considered in conjunction with other impacts on ocean ecosystems, including climate change.

Although the United Nations Convention on the Law of the Sea (UNCLOS) sets out the legal framework for the development of the Area and its resources, it does so in broad terms and leaves substantial gaps. These gaps include the scope of ‘activities in the Area’ and the interrelationship of legal obligations under UNCLOS and legal obligations under other international agreements, the coordination of the mandates of other international organisations with relevance to ‘activities in the Area’ (Chapter 4.1); the division of responsibilities between the ISA and sponsoring states (Chapter 4.2), and the regulation of mining system and equipment tests *in situ* (Chapter 4.3).

This report therefore recommends establishing a complex framework of checks and balances for mining activities, should this reflect how States wish to proceed (Chapters 3 and 4). This framework should realise utmost precaution as activities in the Area proceed and ensure that adverse effects on the marine are prevented to the greatest extent possible. To this end, the first chapters in Section 2 set out the current state of licensing for the exploration of seabed mineral mining in national waters and in the Area (Chapter 2.1.), investigate the interaction of global biodiversity protection obligations and the sustainability agenda with the seabed mining regime (Chapter 2.2), elaborate on current scientific

uncertainties – the knowns, unknowns and unknowable's, (Chapter 2.3), as well as the vulnerabilities of the recipient ecosystems and pelagic communities (Chapter 2.4).

Chapter 2.1 concludes with recommendations for a number of possible steps to improve the current **licensing process** towards a more effective examination of environmental values and possible environmental damage in the proposed exploration areas.

2.1.10 Recommendations Licensing Process

The procedures and criteria used by the ISA's Legal and Technical Commission (LTC) to review applicants' plans of work for exploration contracts needs revision in order to ensure the "effective protection" of the marine environment. It is recommended that

- The LTC develop and apply criteria to assess the environmental impacts of the proposed work;
- The LTC develop and apply criteria to cross-check for eventual environmental protection designations made by other international organisations and competent authorities in adjacent areas such as EBSAs, VMEs, and MPAs;
- Applicants are required to provide an analysis, based on habitat mapping, of potential areas, habitats and species which would qualify as ecologically significant (according to CBD criteria), vulnerable (for example, according to FAO criteria adapted to mining) or otherwise in need of protection.
- Applicants are required to provide information on potential conflicts with other sectoral uses of the area in question.
- The LTC develop and apply criteria to assess the eventual transboundary effects of activities (whether in neighbouring license areas, reserved sites, the high seas or areas within the limits of national jurisdiction);
- Transparency is increased. In addition to current practice, LTC reports to the Council should detail the methodologies, criteria and uncertainties used by the LTC when making recommendations concerning applicants' plans of work.
- In the event of an overlap with the environmental designations of other organisations or with other sectoral uses, the application in question, as well as the LTC's deliberations, should be made publicly available prior to the Council's decision.

Chapter 2.2. addresses the need for the International Seabed Authority to make its **environmental protection mandate,** as provided in Article 145 UNCLOS, more concrete. ISA measures should be harmonised with other international organistions' goals and mechanisms for protecting marine biodiversity.

2.2.6 Recommendations Biodiversity Protection

- The ISA should start a transparent process now to develop its vision for how deep seabed mining can be harmonised with the overarching obligation to protect the marine environment, the CBD biodiversity targets, the global sustainability agenda and, in particular, with a new legally binding instrument for marine biodiversity in ABNJ;
- The ISA should develop a comprehensive set of mechanisms to translate the obligations contained in Article 145 into precautionary regulatory action;
- The ISA's regulations and institutional processes must take the regulations and decisions of other international organisations into account, such as those concerning marine protected areas, VMEs and EBSAs in order to contribute to achieving the global biodiversity and sustainability targets;

- The ISA needs to develop its approach to communication and collaboration with other international management authorities such as the International Maritime Organisation and regional fisheries management organisations. The aim should be to enable regional, cross-sectoral strategic environmental assessments of human activities to ensure optimal environmental conservation and to minimise conflicting uses.

Chapter 2.3 examines the '**The Known, the Unknown, the Unknowable**' of deep sea biology. The main intention of the chapter is to highlight the dimensions of the unknown and the unknowable of deep sea and open ocean ecosystems, and how this impedes the prediction of the environmental effects of deep seabed mining or smaller-scale activities. Recent research has demonstrated the near- to irreversible local changes caused by activities. Considering that the spatial, temporal and functional scales of potentially adverse ecosystem changes remain unclear, the recommendations focus on how to address the most crucial knowledge gaps, how to optimise research planning, how to improve the provision of baseline data from contractors to enable region-wide assessments, and enhance transparency, expert input and access to information.

2.3.5 Recommendations Addressing Knowledge Gaps

Addressing knowledge gaps

All aspects of the deep sea require further scientific study, as detailed above. In order to address knowledge gaps concerning the potential impacts of mining, the following points should be taken into account (see also the recommendations of Clark *et al.*, 2012; Van Dover, 2014; Weaver *et al.*, 2017):

- The temporal and spatial nature as well as the extent of excavation and sediment plumes in the water column and as footprints on the seafloor remain a major unknown here, detailed three-dimensional modelling of excavation plume development over long time scales under assumed realistic mining conditions will be helpful. Other models will need to determine optimal discharge techniques and depths for minimising the spatial extent of plumes.
- The *in situ* grain composition, buoyancy, toxicity and dispersal characteristics of excavation and sediment plumes must be studied in relation to ambient fauna and ecological processes.
- Each potential mine site must be studied in its biogeographic context, biodiversity, community and trophic structure, connectivity, ecosystem services, disturbance regimes and community dynamics, etc., and including its pelagic components.
- A comprehensive ecological assessment of each mine site in its regional context should be conducted to ensure that no unique sites will be mined, such as active hydrothermal vents on the Mid-Atlantic Ridge.
- In particular, all aspects of the pelagic system require baseline research as well as studies concerning the potential effects of light, noise and turbidity (see also Chapter 2.4.6).
- High-resolution habitat mapping and a detailed analysis of species distribution at habitat scale are crucial for improving the management of goods and services delivered by deep sea ecosystems (Zeppilli *et al.*, 2016b).

ISA Strategy Science and Exploration

- The ISA could proactively initiate independent research activities in the Area, which complement contractors' work with regard to regional-scale natural variability and baselines, surveys of designated APEIs and in-depth process studies.
- The ISA should initiate regional taxonomic reference collections and related bar-coding databases, with contributions from contractors and science.

- The ISA should clarify the status of science in ISA exploration areas and address the issue whether the freedom of scientific research applies.
- The rights of the scientific community to conduct research in eventual exploitation areas also needs clarification. This question could be addressed to the Seabed Disputes Chamber of the International Tribunal for the Law of the Sea.

Standard minimum requirements of contractor baseline investigations

- The ISA guidelines for contractors during exploration (ISBA/19/LTC/8, currently under review) and any future requirements for contractors during exploitation should determine (after public consultation) a standard baseline and monitoring investigation kit, including both large-scale (license area) and small-scale (future mining area, PRZ, IRZ) sampling grids, minimum sampling requirements (sample density, fauna/gear), sample treatment and storage, and need for in-depth studies, modelling etc. Clark *et al.* (2016b) and Swaddling *et al.* (2016) will be helpful in this respect.
- Incentives should be developed to reward contractors for providing more extensive baseline research and monitoring. A reduction in annual fees, for example, could encourage contractors to operate more comprehensive investigation programmes.
- The elaboration of environmental standards will require a continuous exchange of experiences among contractors to ensure the application of best available techniques and environmental practices, as well as their backward compatibility.

Standard minimum requirements for monitoring studies of disturbance events

- Noting that the degree of risk should determine the stringency of investigation, a standard investigation concept is required which incrementally builds on standard baseline investigations and augments requirements for the environmental monitoring of disturbances, ranging from small- to large-scale testing and commercial-scale exploitation.
- The temporal scale for monitoring observations should encompass the period of time from immediately after the disturbance, until several decades after the event. Continuously operating measuring platforms will be extremely helpful to detect the dynamics of at least the abiotic changes.
- The sampling grid should be designed to represent (a) the main abiotic and biotic features of the mining site, including the water column. (b) At least three locations representing maximum, medium and minimum sedimentation from operational and discharge plumes on the seafloor and the water column (IRZ), and (c) one or more reference stations outside the area affected (PRZ).
- A sufficient number of replicates at each station are necessary for robust statistical analyses.

Develop a comprehensive assessment framework

- Observations from monitoring must be assessed against an environmental baseline study of the mine or test site and allow for determination of natural spatial and temporal variability.

- Assessment methodologies and criteria, including the framing of models for projecting potential environmental consequences of natural and human-derived impacts, must be developed and regularly updated by a group of experts.

Transparency and expert input

- Transparent reporting lines: All environmental baseline studies, monitoring of equipment or system tests, and commercial mining must be made available for scientific review and public comment.
- The ISA should maintain not only a public database for data but also include publications, information from research cruises and all relevant assessments and reports.
- The ISA should synthesise the standardised data coming in from contractors and scientists to determine and regularly update regional quality status reports (as foreseen in the CCZ Environmental Management Plan).
- Independent scientific expert advice will increase transparency, accountability and trust in the ISA's judgements and in the overall environmental decision-making process

The concept of **vulnerability** (chapter 2.4) has been most extensively developed in regard to deepwater fisheries in order to prevent the further destruction of habitats and species which are particularly vulnerable to the impacts of fishing. Deep seabed mining risks destroying the same deepwater habitats and species which have been safeguarded from fishing impacts through a lengthy global negotiation process. Standards for protection and, in particular, precautionary measures to address the problem should be harmonised across sectors.

2.4.5 Recommendations VMEs

- The concept of vulnerable marine ecosystems (VMEs) should be adapted for the purpose of indicating sites with communities and habitats which are particularly vulnerable to the impacts of seabed mining for all three resources in the Area;
- The concept should be made operational by setting criteria for the LTC to consider when evaluating a future plan of work for exploration or exploitation.
- An overarching approach is required for determining how to ensure effective protection and prevent significant adverse effects on the ecosystems targeted by mining and the broader surroundings. This should include the option that mining will cause an unacceptable degree of damage and should therefore not be authorised.
- A practical way forward will be to set up a working group of experts mandated by the LTC to assist with finding solutions in this context.
- In particular, further research should be conducted on pelagic fauna and ecosystems, including establishing the baselines in contractor areas. Recommendations for research and for amending the ISA Guidance for contractors (ISBA/21/LTC/15 and ISBA/19/LTC/8) can be found in Annex 8.

Chapter 3 demonstrates why the **ecosystem approach** to the management of human activities – a commitment made by the ISA as an organisation and by all its member States – is the appropriate conceptual framework for the management of deep seabed mining (Chapter 3.1). This chapter further examines how the ecosystem approach can be implemented using modern environmental management tools such as strategic assessment of the environmental, social and economic effects of the policies, rules and regulations under development. The assessment should result in agreed environmental, social and economic strategies of the International Seabed Authority (Chapter 3.2).

Management plans developed to implement the strategies, if possible for ecologically coherent regions, will serve as a reference for day-to-day management decisions.

3.1.3 Recommendations Ecosystem Approach to Management

All States and international organisations of which they are members are committed to implementing the ecosystem approach to the management of human activities (EAM), including the ISA. Therefore,

- ISA member States should enable the Authority to implement EAM in the Area using appropriate institutional, procedural and financial arrangements.
- The EAM needs to be fully reflected in the ISA's institutional, procedural and regulatory framework, including the steps necessary for implementing EAM;
- The Council could ask the LTC to develop and recommend an implementation scheme for EAM to be considered by the Council and observers (and, if possible, in consultation with experts and stakeholders).
- Until a full-scale process for implementing an ecosystem approach and a management strategy (see 3.1.2. and box above) have been designed, the draft regulations and further revisions should be subject to a strategic assessment of the potential environmental consequences of the legislation, including the discussion of alternatives (see e.g. ESPOO Protocol on Strategic Environmental Assessment, 2003). This will contribute to a "high level of protection" of the marine environment by

  c) *'Ensuring that environmental, including health, considerations are taken thoroughly into account in the development of plans and programmes;*
  d) *Contributing to the consideration of environmental, including health, concerns in the preparation of policies and legislation;*
  e) *Establishing clear, transparent and effective procedures for strategic environmental assessment;*
  f) *Providing for public participation in strategic environmental assessment; and*
  g) *Integrating by these means environmental, including health, concerns into measures and instruments designed to further sustainable development'* (Article 1, ESPOO SEA Protocol).

A strategic environmental assessment of the draft regulations will entail an environmental report including the consideration of alternatives; a transparent public participation mechanism; consultation with other authorities; decision-making concerning the performance of the regulations with respect to the ISA's environmental obligations ('effective protection'); and, after approval, monitoring and communication of the results to the public and other authorities.

In particular, an **environmental strategy** -- whether as a stand-alone document or as part of an overall strategy -- is instrumental in setting the boundary conditions for permissible activities in the Area (Chapter 3.2). As such, the environmental strategy will cover all globally relevant questions and enable the uniform application of standards to all contractors, irrespective of the resource being targeted.

3.2.3. Recommendations Environmental Strategy

An environmental strategy, as a subset of an overall ISA strategy, will serve to communicate to the outside world how the ISA intends to implement the '*uniform application of the highest standards of protection of the marine environment, the safe development of activities in the Area and protection of the common heritage of mankind*' as specified in the ITLOS Advisory Opinion (ITLOS, 2011, § 159). Accordingly, it will also be instrumental in organising the related work streams. Essential elements of the strategy are:

- The overarching principles (including the precautionary principle and the principle of the common heritage of mankind);
- The ISA-specific environmental vision, goals and objectives, and their integration with global conservation targets;
- The decision-making processes, including division and sharing of responsibilities as well as public and expert participation. This also includes criteria for minimum information required for informed decision-making.
- The hierarchical framework for assessment and decision-making (global/regional assessment and strategy, regional environmental assessment and management plans, local EIAs);
- The procedures and criteria for the evaluation of the acceptability and sustainability of seabed mining in light of the alternatives;
- The evaluation of benefits and costs for present and future generations;
- The cross-sectoral integration of ISA environmental management with other legitimate uses;
- The resolution of conflicts with other uses (e.g. fishery, laying of submarine cables, use of marine genetic resources), and between different mining projects;
- Adaptive Management;
- Mine closure and decommissioning requirements; and
- Enforcement mechanisms.

While the environmental strategy can be a policy framework, the roles and responsibilities of actors, as well as the core elements and their procedural linkages need to be part of the binding regulatory framework.

A major deficit of the current framework for ISA decision-making is **the lack of an agreed environmental vision, goals and objectives**, except those laid down in the Clarion-Clipperton-Zone regional environmental management plan (Chapter 3.3). Without such objectives, it will be impossible to determine the acceptable limits of environmental deterioration, i.e. in the case of an application for exploitation. Environmental objectives agreed by all member States of the ISA will also be instrumental for harmonising the ISA's management directions in light of globally agreed conservation goals and commitments such as those under Agenda 2030 – the Sustainable Development Goals.

3.3.4 Recommendations Environmental Objectives

The ISA should be supported in developing **overarching strategic objectives**, including an environmental vision, goals and objectives.

- ISA environmental objectives should not only reflect the obligations set by UNCLOS, but operationalise the substance of
  - the principle of the common heritage of mankind;
  - the precautionary principle;
  - the polluter-pays principle;
  - other obligations and commitments of the ISA and States under international agreements, conventions and UN resolutions;

- The definition and agreement of the strategic objectives could best be done by Parties and observers to ISA. A dedicated Council or Assembly working group might be a tool to ensure broad debate and transparency.

As a starting point, the following **high level environmental goals** are proposed for consideration:

- The Area is a place of value for present and future generations. This value comes not only from mineral resources, but from its natural resources, ecosystems and functions in the global carbon cycle.
- The exploitation of minerals in the Area will only be considered if there is a clear societal need for the minerals, there are no alternative sources, any significant financial and other benefits accrued from mining are shared, and environmental damage is minimised.
- The exploitation of minerals in the Area shall contribute to and not counteract the achievement of the sustainable development goals, the WSSD targets, the Aichi Targets and the Paris Agreement, including to halt the loss of biodiversity.
- The integrity and health of benthic and pelagic systems, species and habitats affected by mineral mining shall be maintained.
- The integration of the precautionary principle into the regulations and the ecosystem approach to management ensures careful decision-making in the face of high risks and uncertainties.
- An ongoing process will ensure the continuous assessment and implementation of the best available techniques and environmental practices.
- Collaboration and cooperation between the ISA, contractors and independent researchers through international research programmes will maximise knowledge of ecosystems and the environmental effects of technologies, thereby reducing risks and uncertainties;

Each goal will need to be substantiated with a set of SMART targets and objectives.

The other pillar of an ecosystem approach, in addition to an agreed environmental vision, goals and objectives, is the translation of a number of **principles** into a meaningful procedural, institutional and regulatory framework for action (Chapter 3.4). Given that deep seabed mining is an emerging industry which will operate in a scarcely known and technologically challenging environment, the **precautionary approach** to all related decisions is of utmost importance (Chapter 3.4.1).

3.4.1.8 Recommendations Precautionary Approach

- Measures to protect the environment should be procedurally integrated into the ISA's decision-making process. It should be clearly specified that REMPs set required environmental and management baselines against which the overall effects as established in project-specific EIAs are assessed, and that mining contracts cannot be granted without them.
- Because precaution requires *timely* action, protective measures should be taken *before* any mining occurs. This includes establishing REMPs, deciding on the protection of VMEs, establishing clear conservation objectives, clearly defining the content and procedure of EIAs, and ensuring baseline data is sufficient. Germany could highlight this point in the ISA Council.
- The Mining Code should require the LTC and Council to specify which scientific, technical, and value considerations as well as uncertainties inform a particular decision. This will lead to much greater transparency, including about the reasons why the LTC recommends approval of a certain application, and shift power to the States represented in the Council.
- Establish criteria for the LTC to evaluate whether an application for an exploration contract provides for 'effective protection and preservation of the marine environment including, but

not restricted to, the impact on biodiversity'. At present, it is unclear how this evaluation is made.

- In line with the precautionary principle, applicants should be required to identify the uncertainties inherent in their project design and assessments and to demonstrate how these are addressed in their plans of work.
- The ISA requires the institutional capacity to assess and manage environmental risks and monitor compliance, for example through a Mining Inspectorate. To enable this capacity, States will have to be willing to finance these operational costs.

The principle of the Area and its mineral resources being the '**Common Heritage of Mankind'**, to be administered by the International Seabed Authority for the benefit of mankind, is laid down in UNCLOS (Chapter 3.4.2). It is therefore mandatory that the rules, regulations and procedures developed by the ISA give particular expression to the aspirations of UNCLOS. Yet, UNCLOS provides only limited guidance as to what constitutes a benefit, how any financial and economic benefits are to be shared, and what a particular consideration of the needs of developing countries and future generations would entail.

3.4.2.7 Recommendations Common Heritage of Mankind

- The CHM principle requires preserving natural resources for future generations. As such, some mineable areas might be reserved for future generations.
- The ISA has yet to develop the common heritage of humankind (CHM) principle and specifically discuss how it intends to give effect to it. Such a discussion could be initiated by a State party in the ISA Assembly, in the context of developing the exploitation regulations.
- Options to give effect to the CHM principle include establishing preconditions for deep seabed mining, such as
  (a) funding marine scientific research to increase knowledge of the deep sea for all of humankind,
  (b) ensuring that the Mining Code is developed with participation of the public,
  (c) determining whether there is a current need for the minerals from deep seabed mining as opposed to conserving them for future generations.

Adaptive governance and management can be an option to ensure incremental progression towards an activity, of which the environmental, social and economic effects are not fully foreseeable (Chapter 3.4.3). However, the methodology requires that management measures relate to measurable effects within a short to medium time period for enabling the effectiveness of the measure. This is unlikely to be the case in the deep sea context. Furthermore, considerable institutional and regulatory powers are required to implement periodic adjustments to mining plans of work, for example.

3.4.3.9 Recommendations Adaptive Management

- To enable adaptive management, the ISA will need to reserve the power to require adjustments to environmental standards for mining operations on a continuous basis.
- Adaptive management would require the capacity and infrastructure to continuously monitor environmental impacts. Independent monitoring will be necessary to ensure reliability of the observations.

The International Seabed Authority is mandated to act on behalf of mankind, which on the one hand means that all member States must have a say in its decision-making, but on the other hand calls for the involvement of observer organisations and, where appropriate, public consultation (Chapter 3.4.4). Today, the ISA lacks important **transparency** elements and mechanisms, such as a dedicated stakeholder involvement strategy, a strategy for consideration of external advice and a forum where all environmental matters can be discussed and decided openly.

3.4.4.7 Recommendations Transparency

- Adopt an open information and data policy to maximise accountability. The ISA should implement a presumption of public accessibility of all information relating to the regulation of deep seabed mining and the protection of the marine environment and safety.
- Ensure the active involvement of all interested stakeholders. The ISA should develop a mechanism that enables the engagement with and participation of stakeholders in decision-making, consistent with the principle of the Common Heritage of Mankind.
- Establish an environmental advisory body. The ISA should establish a new organ to provide comprehensive advice on matters of the environment.

One of the most important principles of modern environmental governance is the principle of **preventive action** (Chapter 3.4.5). It sets out that human activities are screened and evaluated for their potential environmental effects prior to their authorization. The existence of international and/or national conservation objectives and appropriate mechanisms for standardised assessment of possible impacts on various scales is, therefore, a precondition. Also, prior determination of those activities which require permission is needed. The most important tools for preventive action by the regulator are strategic assessment and environmental impact assessment (EIA). Strategic assessment, including a comprehensive risk assessment, is a tool to indicate at an early stage, whether new policies or regulations are at risk to increase the environmental impact beyond pre-agreed levels. Strategic assessment can also be used for comprehensively collecting information on relevant pressures to indicate remaining potential for further activities, as the UK and Ireland have done for their offshore sectors. EIAs are needed for the assessment of individual projects, in context with a broader strategic assessment of developments in a particular marine area.

3.4.5.8 Recommendations Preventive Action

- A strategic assessment process would be a suitable tool for conducting prior evaluation of the environmental consequences of the draft exploitation regulations for the Area (ISA Mining Code, Exploitation Regulations) in a participatory and transparent way.

  h) The strategic assessment should be initiated as soon as a final draft of the regulations is available.
  i) ISA member States should lead the process, but allow for full participation by observers and civil society.
  j) Institutional capacity building is likely required. In particular, a technical advisory body next to or under the guidance of the LTC will be helpful for providing necessary environmental and management expertise.
  k) The ISA should begin strengthening its working relationships with competent authorities and organisations in the high seas as soon as possible.

- Regulatory risk assessment should be conducted as part of the initial strategic assessment and periodically thereafter, *i.a.* to address additive, cumulative or synergistic effects from different sources, and to guide the evaluation of risks against benefits to be expected from mining.

- The ISA may need to develop internal guidance for how its decision-making will address uncertainty due to lack of scientific knowledge and information on *i.a.* baseline environmental conditions and cause-effect relationships.
- The current provisions for environmental impact assessment of exploration and testing activities (ISBA/19/LTC/8) need revision to establish an assessment process of environmental effects which can guide the later elaboration of environmental threshold levels. In addition to contractors, States and observers should be asked to provide comments.

Strategic assessments and environmental impact assessments can only be useful tools for guiding environmental management if the evaluation of operator applications can be guided by pre-agreed environmental objectives and **thresholds of harm** (Chapter 3.4.6). UNCLOS names the goal of "effective protection of the marine environment from harmful effects" (Article 145), while for the triggering of certain measures, "serious harm" needs to be likely. The threshold for EIAs is again different and relates to "significant and harmful changes of the marine environment"(Article 206 UNCLOS). All these terms need to be supplemented with appropriate indicators and threshold levels of change in order to be operationalised. This is an enormous task in view of the profound unknowns of deep sea ecology but also of the technology involved in deep seabed mining activities.

3.4.6.5 Recommendations Thresholds of Harm

- No exploitation contracts should be concluded until:
  - ISA environmental goals and objectives, alternatives, as well as limits to politically acceptable mining impacts have been negotiated and agreed in a global strategic assessment and regional environmental assessments and management plans;
  - there are adequate regional environmental baselines;
  - the indicators and thresholds for environmental status and change have been determined; and
  - Monitoring and assessment methodologies have been developed and implemented.
- Prior to test mining, standardised baseline investigations and monitoring protocols should be performed by contractors, including criteria and guidelines for the selection of preservation reference zones, impact areas, and how to take account of other protected, ecologically important and/or vulnerable habitats and sites.
- A state-of-the-art knowledge report could be produced, for example, for the Clarion-Clipperton-Zone. Germany could be instrumental in this, given its extensive scientific expertise.
- In a second step, a mandated scientific working group could elaborate proposals for how best to operationalise the monitoring and assessment of ecosystem changes and classification as ‘within natural limits’, ‘reversible harm’ or ‘irreversible harm/significant adverse/serious harm’.
- The proposed thresholds will have to be reviewed by the LTC and the Council, including comments from observers and the public, and transformed into a detailed set of criteria for the LTC’s evaluation of plans of work for exploitation in conjunction with the objectives and limits set by strategic assessment and regional environmental management plans.
- Measures to ensure ‘effective protection from harmful effects’ (ITLOS, 2011), taking into account the precautionary and the common heritage principle, must be developed.
- The ISA needs institutional improvement to accommodate independent scientific advice and a specialist forum for environmental management (e.g. Environment Commission, see Chapter 3.4.4).

- Germany could gather a like-minded group of States to lobby for a new mode of technical work in the ISA, e.g. via technical working groups in the Council. The working group could discuss the implementation of an ecosystem approach to management in fulfilment of obligations arising from Article 145 UNCLOS in the current work of ISA, including the regulations for exploitation (under development).

Chapter 4 analyses international law relating to deep seabed mining and protection of the marine environment. The term "**activities in the Area**" is the basis for defining the powers and functions of the ISA to regulate environmental protection (Chapter 4.1). There are a number of ambiguities concerning the activities falling under the term "activities in the Area" following the ITLOS Advisory Opinion, particularly concerning processing and transportation. The current regulation of "activities in the Area" may not reflect how activities are eventually carried out when commercial-scale technologies and systems have been developed, which could lead to gaps and weaknesses in environmental protection. The final version of the Exploitation Regulations must ensure that the term "activities in the Area" addresses all elements of the technical process chain.

4.1.7 Recommendations Activities in the Area

- Develop and formally adopt authoritative ISA Guidelines to clarify exactly which technical equipment and activities are involved in "shipboard processing", "preliminary processing" and "recovery", as well as objective criteria for determining the spatial scope of "immediately above a mine site" in order to ensure that the term "activities in the Area" is consistently and uniformly applied.
- Request a study by the LTC of gaps between the DSM regime and broader international legal obligations concerning the protection of the marine environment as already proposed by the Scientific Group of the LC/LP.
- Conclude a Memorandum of Understanding between the ISA and the IMO to demarcate exact areas of responsibility over different vessels and installations involved in deep seabed mining with particular regard for the activities representing preliminary processing. Particular clarification is necessary in regard to the intersections between the responsibilities of flag States and sponsoring States.
- Consider action in the Conferences of the Parties to the London Convention/Protocol and the Convention on Biodiversity to augment environmental protection measures developed by the ISA. Although political will does not currently exist in this regard in either treaty body, measures as far reaching as moratoria for at least part of the technical process chain are theoretically possible under both instruments. Such action to address fundamental environmental issues through additional fora arguably reflects due diligence required of sponsoring States.

Developing the exploitation regulations:

- Include a legal definition of "activities in the Area" and related terms in the final version of the Mining Code to ensure its consistency with UNCLOS and the 2011 ITLOS Advisory Opinion.
- Develop more detailed regulation of the individual steps making up the technical process chain, identifying the legal basis for regulating each step and clearly designating responsibilities and mechanisms for coordination when specific activities fall partially or fully outside the ISA mandate.

The **division of responsibilities between the ISA and sponsoring States** for the protection of the marine environment from the effects of deep seabed mining is dynamic and not clear-cut (Chapter

4.2). How the ISA's competences are ultimately defined in light of the interpretation of "activities in the Area" directly determines which responsibilities fall under the purview of sponsoring States and which are jointly held. The ISA's 'evolutionary approach' to developing specialized regulation for deep seabed mining and its avoidance of being 'over-prescriptive' could lead to an under-regulation of environmental matters. States, as the 'guardians' of international environmental law, are required to fill gaps in all areas that are not sufficiently regulated by the ISA using other sources of environmental protection obligations including Part XII UNCLOS. Effective environmental protection requires both well-drafted, comprehensive regulation, as well as sufficient capacity on the part of the ISA and sponsoring States to implement the corresponding obligations. The lack of a functioning inspectorate endangers environmental protection under the Exploration Regulations.

4.2.12 Recommendations Division of Responsibilities

- Clearly define the division of responsibilities between all actors and identify all activities where the ISA and sponsoring States have shared or joint responsibilities. Establish formal procedures and criteria to ensure effective cooperation.
- Address institutional weaknesses within the ISA for upholding specific obligations, including the lack of an existing inspectorate or environmental organ. Develop a memorandum of understanding with the IMO to ensure that inspections may be conducted on all vessels engaged in activities in the Area and are not restricted to "installations in the Area".
- Develop a formal procedure for sponsoring States as part of their due diligence obligations to notify the ISA of areas where their legal systems and institutional capacity for upholding their obligations may fail to uphold the minimum standard.
- Develop ISA capacity-building programs not just for contractors but also for sponsoring States to ensure that they have the regulatory and institutional capacity to uphold the obligations connected with sponsorship.
- Understand transparency and public participation as mechanisms for enhancing capacity and due diligence.

Developing the exploitation regulations:

- Ensure that the division of responsibilities between the ISA, sponsoring States and contractors are clearly defined and ensure that formal procedures and criteria for cooperation have been created in areas of joint responsibility.
- Ensure that the Draft Exploitation Regulations clearly establish the ISA's responsibility to conduct inspections and not just the discretionary rights of its inspectors ("may"). Also ensure that inspections are not spatially restricted to "installations in the Area" but may be conducted on all vessels involved in activities in the Area.
- Ensure that checks and balances are built into the Draft Exploitation Regulations to provide internal controls over the exercise of powers by the organs of the ISA and increase accountability.
- Ensure that failure to protect and preserve the marine environment is specifically named as grounds for compliance notices, as well as the suspension and termination of contracts.
- Clarify mechanisms for transparency, public participation and access to information in order to create external mechanisms for ensuring the accountability and effective operations of the ISA.
- Establish criteria for States to fulfill in order to qualify as sponsors, emphasizing their gatekeeper function at the application stage as well as their on-going environmental obligations also derived from other international legal instruments.

An analysis of the legal and regulatory framework for mining tests reveals that **testing of any kind is currently poorly regulated** and require urgent attention as equipment tests are scheduled to begin in 2018. Assumptions that mining tests will have little environmental impact must be challenged. There are indications that the current regulatory approach to testing does not reflect the multi-phase development and gradual scaling-up of technology originally foreseen in UNCLOS.

4.3.6 Recommendations Mining Test Regulation

- Develop objective criteria and procedures for determining "scale" in order to correctly implement the technological development approach set out in UNCLOS.
- Establish specific assessment requirements for mining tests taking place under the Exploration Regulations which correspond to the scale of the equipment and mining systems to be tested.
- Ensure that the results of mining tests are used for both environmental risk management and assessment of commercial and technical feasibility in the application process for exploitation licenses.
- Establish clear control obligations for sponsoring States over all testing activities irrespective of their scale, including prior EIA requirements for tests.
- Update the LTC recommendations to contractors applicable to test mining to ensure that all potential testing activities are consistently and comprehensively addressed.
- Developing the exploitation regulations:
- Ensure that contractors are required to conduct mining tests on all components, integrated systems and production processes at gradually increasing scales prior to beginning commercial production.
- Define specific requirements in the EIA process for integrating the results of mining tests and ensure that this information is considered environmental information for the purpose of transparency and participation.
- Incorporate a mechanism into the Draft Exploitation Regulations to ensure that the ISA receives sufficient information about tests in order to exercise effective control over the development of mining technologies and their environmental impacts.
- Include an obligation for contractors to use Best Available Techniques (BAT) in the Draft Exploitation Regulations and a corresponding obligation for the ISA to establish procedures for determining and revising BAT standards including an external review mechanism.

As deep seabed mining becomes an increasingly realistic proposition, it is of profound importance that the inadequacies of existing regulation are resolved so that effective environmental protection can be implemented and the technological development process can still be guided, and where necessary, restrained. Much remains to be done to clarify the division of responsibilities among the various actors, address potential gaps in the coverage of environmental protection measures and develop regulatory approaches for technology development which were left unaddressed during the drafting of UNCLOS. This section has considered three areas where considerable work is necessary, both in regard to the implementation of existing rules and regulations and the development of new rules and regulations in order to draw attention to issues that might not otherwise be discussed in more detail as the Draft Exploitation Regulations take shape. It is hoped that these findings have drawn attention to some relevant issues in this process and provide impulses toward resolving them.

In conclusion, the ISA has the chance to spearhead a modern, comprehensive approach to precautionary governance of the Area in line with the goals of other international agreements and conventions concluded after UNCLOS in 1982, and more in line with today's environmental challenges. The development of a governance framework to ensure that activities in the Area do not adversely interfere with ocean ecology in ways and at scales that are unpredictable, uncertain and irreversible is an extremely complex endeavor. Only with considerable expertise, time, political will and appropriate institutional arrangements can the ISA demonstrate how the common heritage of mankind can be administered in a long-term, sustainable manner.

1 Introduction

Deep seabed minerals exploitation targets non-renewable mineral resources associated with highly sensible deep-sea ecosystems. Any a mining operation is likely to have substantial ecological impacts that are and will remain to some extent unknown, and will likely be irreversible on human time scales (e.g. Van Dover *et al.*, 2017; Glover and Smith, 2003; Gollner *et al.*, 2017; Jones *et al.*, 2017; Ramirez-Llodra *et al.* 2011*)*. In particular, this new activity will extend the human footprint to the so far least affected regions of the planet.

All available scientific ecological knowledge points to the particular sensitivity and vulnerability of habitats and species of the deep ocean (Ramirez-Llodra *et al.,* 2010). Therefore, it is likely that seabed mining may inevitably add to the already ongoing loss of marine species, habitats and ecosystem services (Mengerink *et al.*, 2014; Ramirez-Llodra *et al.*, 2011; WWF, 2014; Van Dover *et al.*, 2017; Niner *et al.* 2018), and will impair the chances for reaching the globally agreed biodiversity, sustainable development and climate targets (Convention on Biological Diversity, 2012a; UN Framework Convention on Climate Change, 2015; UN General Assembly, 2015).

The task of this project was to investigate how to determine ecologically meaningful limits for impacts arising from activities related with the mining of seabed minerals in the Area, and to analyse whether the existing and developing legal frameworks are appropriate.

1.1 Deep seabed mining - development of a new industry in sensitive ecosystems

Mineral raw materials are indispensable drivers of economic and industrial development. Under the premise of necessary continuous growth to safeguard the nutrition and supply of a growing world population, especially in emerging and developing countries, the view of previously unused raw materials from the sea seems obvious. On the one hand, there is hope that this will increase the supply of raw materials as well as reduce the dependence of commodity-importing countries on existing suppliers. However, it is disputed whether the raw materials from the deep sea are actually necessary to facilitate the further development towards, for example, regenerative energy consumption (Teske *et al*., 2016), or whether deep seabed mining generally leads to any recognizable benefit for mankind (Kim, 2017).

In addition, the further expansion of potentially damaging industrial activities on and in the oceans is forseeably in conflict with the globally agreed protection of marine ecosystems, as well as with the economic, social and environmental sustainability of human uses for present and future generations (UNGA resolution 66/288 (2012), see further chapter 2.2). An effective implementation of the ecosystem approach and precautionary principle should therefore '*protect and, if necessary, restore the health, productivity and resilience of the seas and marine ecosystems*' (UNGA resolution 66/288 (2012)). The 2015 UN Sustainable Development Summit decided on the 2030 Sustainable Development Agenda, which includes an inclusive and universal set of 17 sustainability goals, including a standalone Marine Objective (Goal 14), which calls, among others, to avoid significant adverse impacts on the marine environment (UN General Assembly, 2015).

This environmental quality objective is derived from the resolutions of the UN General Assembly (UNGA, 2006, and *et seq.*) for sustainable fishing in the high seas, particularly in the deep sea, and the Food and Agricultural Organisation of the UN (FAO, 2009). It sets the framework for the implementation of the precautionary principle and the polluter-pays principle by requiring flag states and regional fisheries management organizations to assess bottom fishing activities for significant adverse effects on so-called 'vulnerable species' (e.g. particularly long-lived fish) and 'vulnerable marine ecosystems' (VMEs), such as hydrothermal vents, seamounts or coral reefs. Such effects should be avoided, for example by closure of VME-designated areas for further fisheries. The definitions, standards and precautionary procedures for the prevention and evaluation of environmental damage developed for deep-sea fishing provide a good basis for developing ecological safeguards for deep seabed mining (see further chapter 2.4).

These environmental quality objectives should therefore set the framework for independently formulated environmental and protection goals for all legal areas of the sea, including the seabed beyond national jurisdiction, the Area (the seabed, subsoil and its mineral resources). However, in contrast to the extraction of mineral resources from the Area enshrined in the Law of the Sea, there is currently no comprehensive legal framework for taking measures to protect marine ecosystems in these areas, either in the water column (high seas) or on the seabed. After a multi-year preparatory process, the UN decided to start negotiations on a legally binding Implementation Agreement on the Law of the Sea to regulate the protection and sustainable use of marine biodiversity in 2018. Among the agreed subjects for the negotiations are marine genetic resources, including questions on the sharing of benefits, measures such as area-based management tools, including marine protected areas, environmental impact assessments, as well as capacity building and technology transfer (UNGA, 2018). A major challenge will be the creation of an integrated ecosystem-based approach, covering the different sectors of use, such as deep seabed mining, shipping and fisheries and the protection of biodiversity (see further chapter 3).

So, while the broader legal foundations for environmental protection in areas beyond national jurisdiction are not yet clear, progress is being made towards developing the legal framework for enabling the exploitation of mineral resources in the Area.

1.2 The environment of deep seabed mineral resources

In the deep oceans beyond the continental shelves, basically three different types of metallic deposits have been created over millions of years, which today could potentially be utilized as mineral resources:

Iron and manganese-rich nodules (commonly named manganese nodules) lie in high densities on the surface of deep-sea abyssal plains in some parts of the subtropical oceans at 4000 - 6000 m depth. The manganese nodules are distributed in different densities over very large areas. Deposits of so-called massive sulphides, including highly concentrated copper, zinc, gold, and silver, which precipitate out of the hot hydrothermal waters that rapidly cool in the seawater, are found on today's active and ancient hydrothermal vents on the mid-ocean ridges and in the relatively shallow ponds of the Pacific "fire ring". Cobalt-rich iron-manganese crusts are formed over millions of years by deposition of metals dissolved in the seawater on all exposed rocks in the ocean, but especially on the flanks of seamounts at 800-2500 m depth.

All three types of deposits are located in ecologically sensitive zones of the deep ocean, which have so far been insufficiently explored ecologically because of their difficult accessibility, the high costs associated with research, and the large dimension of the areas (Ramirez-Llodra et al., 2010, 2011, see further chapter 2.3). Scientists have long since suggested that the degradation of the seafloor mineral deposits will have unpredictable and potentially irreversible consequences (Glover and Smith, 2003, ICES, 2015, Ramirez-Llodra et al., 2011, Van Dover et al., 2017; Vanreusel et al., 2016). The effects, although in varying degrees, include both immediate habitat destruction by the mining machinery and associated large-scale environmental change caused by suspended and re-settled sediment, associated smothering of fauna, release of toxic effluents, noise and light pollution (e.g. SPC, 2013a, b, c; see further chapters 2.4 and 3.4.5.4). Large-scale disturbances of biological carbon transport, through, for example, altered food webs, could have additional repercussions on the course of climate change (Reid *et al*., 2009). Scientists have repeatedly called for States to take responsibility for the conservation of deep-sea ecosystems (Barbier et al., 2014, Halfar and Fujita, 2002, Mengerink et al., 2014, Van Dover, 2011) and ensure adequate protection of ecosystems before the start of resource extraction (Wedding et al., 2015). To support this concern, an international network of scientists has formed in recent years to advise the competent authorities in this regard (INDEEP-DOSI).

Also, the Secretary-General of the International Seabed Authority (ISA) summarized in his 2011 Annual Report (ISBA/17/A /2) that the current understanding of deep-sea ecology is insufficient to make clear risk assessments of the consequences of large-scale resource extraction. He saw the role of his agency as complementary to global efforts to protect the marine environment in areas outside national jurisdiction.

1.3 The legal framework

The prospection, exploration and exploitation of mineral resources in the Area is governed by the United Nations Convention on the Law of the Sea (UNCLOS, 1982, Part XI) and the related Implementing Agreement of 1994. The Area and its mineral resources have been collectively declared the 'Common Heritage of Mankind', which is administered by the ISA on behalf of and for the benefit of all present and future generations. This includes a fair distribution of any financial and economic benefits arising from 'activities in the Area', specifically extraction of mineral resources.

At the same time, Article 145 of the Convention, and more generally Article 209 of the Convention, oblige States and the ISA to ensure '*effective protection for the marine environment from harmful effects which may arise*' from activities related to the extraction of mineral resources in the Area. This requires a proactive set of rules and the application of the precautionary principle (ITLOS, 2011). The ISA is required to establish the appropriate mining licensing requirements, to control access to the area and to monitor compliance with the regulations.

1.3.1 The Common Heritage of Mankind

Article 136 of the Convention (UNCLOS) defines the Area and its mineral resources as the 'Common Heritage of Mankind'. Historically, the idea of looking at the sea as a commons can be traced far back. In the Convention, this is limited to the seabed outside areas under national jurisdiction by coastal states and includes only the mineral resources *in situ* (resources) as *res communis*. Owner is mankind as a whole. In contrast, the living resources fall under the *res nullius* principle of the high seas and its freedoms, which can be used by everyone. Although undefined in detail, UNCLOS sees u.a. the following elements of the implementation of the principle of the 'Common Heritage':

The International Seabed Authority, ISA, is thus the body responsible for implementing the 'effective protection' of the marine environment, as enshrined in Part XI (Art. 145 UNCLOS) and XII. In combination with other legally and/or customarily anchored environmental protection principles such as the precautionary principle/precautionary approach, the polluter-pays principle, the proportionality principle as well as the political will to sustainability, various new aspects arise for contents of the 'Common Heritage' principle:

- The overarching goal for ISA actions should be the long-term conservation and use of the Area of its resources across generations.
- There is a requirement for risk avoidance and risk management - this includes all individual risks and cumulative risks.
- Users (private or state companies, the sponsoring states and the Enterprise) have a responsibility to humanity beyond the return of parts of the explored areas.
- Other mining options, including non-use, must also be weighed against the sustainability goals
- Potential conflicts with other legitimate users of the sea are to be considered.
- Involvement of civil society is required.

However, not only have new mineral resources been discovered since the adoption of the UNCLOS and its Implementing Agreement, but also the need for environmental, climate and social justice has become internationally recognized, and has recently been confirmed as a top priority by high-level international agreements. This suggests that the framework developed in the 1960s and 1980s for the implementation of the principle of the 'Common Heritage' and set out in UNCLOS should be considered in the light of the environmental, economic and social sustainability demanded in the 2030 Agenda (see chapter 3.4.2).

1.3.2 Development of the Mining Code

Deep seabed mining has not yet taken place on a commercial scale so far, neither in the Area nor in national waters of coastal States. However, there has been a rapid development of national laws on deep seabed mining in recent years, especially in the South Pacific Island States (see also chapter 2.1).

The existence of an international authority, the ISA, with exclusive competences in the Area to establish a binding set of rules, regulations and procedures prior to the first commercial exploitation of mineral resources, is a great opportunity for the application of modern principles and techniques to ensure adequate protection for marine ecosystems. International regulations for the protection of the environment set the standard of protection also in national waters (*inter alia* Article 208-210 UNCLOS).

The recent increase in international interest in extracting mineral resources from the deep sea, both within and outside the national legal areas defined by the UNCLOS, has acted as an accelerator for the development of a regulatory framework for the extraction of mineral resources in the Area by the ISA. Between 2000 and 2012, the regulations for the exploration of manganese nodules (2000, updated 2013), massive sulphides (2010) and ferromanganese crusts (2012) were adopted. By end 2017, a total of 29 exploration contracts were signed with public or private, state-sponsored, entities, covering all three mineral resources in all oceans (ISBA/23/C/7, see further Chapter 2.1).

Since 2013, the development of regulations covering the exploitation of minerals from the Area and all related issues has entered the publicly visible stage. A technical study (International Seabed Authority, 2013, see also ISBA/19/C/5) sets the stage and suggests *i.a*. a multi-stage process and pilot trials prior to awarding the final mining permits to future licensees. The report focuses on the direct relationship between the ISA and the contractors, as well as some institutional issues such as a mining inspectorate, but excludes wider issues related to the protection of the environment, the integration of Regional Environmental Management Plans or the status of 'Common Heritage'.

The first public consultations in 2014 and 2015 identified a broad picture of the structure, elements and priorities for designing the mining code (Mining Code), which is (not in a specific way) included in a first contract scheme and priority list (International Seabed Authority, 2015a) and its revised version of July 2015. The priorities highlighted by the ISA in 2015 for the further development of the Regulations include *i.a*. the development of the Environmental Impact Assessment and Strategic Environmental Assessment processes, as well as the operationalization of 'adaptive management' and the term 'serious harm' (ISBA/21/C/16).

On this basis, two large-scale international workshops on the development of environmental aspects in a future mining code took place, 2016 in Australia (International Seabed Authority, 2017c) and 2017 in Berlin (International Seabed Authority, 2017e), hosted by Umweltbundesamt (UBA) and Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), supported by the Institute for Advanced Sustainability Studies(IASS). The workshop in Berlin explicitly referred to the hitherto publicly available versions of the Mining Code, the so-called 'Zero Draft' (International Seabed Authority, 2016b), as well as a 'Discussion Paper', with first proposals for the formulation of the regulations for the protection of the Environment (International Seabed Authority, 2017a). Various proposals have been made to concretise and improve the present documents, which are detailed in the workshop reports cited above.

While in the above drafts of the Mining Code the aim was to build the exploitation regulation out of three modules (contract terms, environment, monitoring) and to only adopt it when all three parts are accepted ('nothing is agreed until everything is agreed'), a new comprehensive draft has been put up for public comment in August 2017. A discussion in the ISA Council has revealed a number of weaknesses, in particular in relation to environmental protection and the Common Heritage of Mankind principle which are not adequately reflected in the draft regulations. As the draft regulations are currently formulated, all relevant environmental management aspects other than the naming of several principles will not be covered by the legal text. It is intended to develop such parts after adoption of a set of rules which may guide contractors in assessing their obligations and risks when proceeding towards exploitation, however without naming clear environmental obligations. These shall be added in the form of Annexes or guidelines, with unclear legal liability.

Yet, as the report below shows, there is a huge scope for ISA to develop and implement a truly precautionary policy and legal framework for deep seabed mining in the Area. In addition, there are crucial legal gaps to fill prior to the adoption of exploitation regulations.

2 The Knowledge Base for Developing Ambitious Environmental Standards

2.1 Development towards Deep Seabed Mineral Mining[1]

2.1.1 Introduction

So far, no commercial scale mineral mining has been carried out beyond the shallow territorial waters of coastal states. However, deep seabed mining is currently evolving from a more academic option and scientific interest into a new marine industry, ready to operate in national waters as well as in the Area. In particular, the first-ever actual mining lease obtained by a small Canadian mining company to mine a field of hydrothermal vents off Papua New Guinea in 2011, has demonstrated the potential feasibility of a new industry and kicked off expressions of interest by a number of actors including:

- National interests: in industrial countries, volatile prices and perceived increasing competition for and uncertainty of secure and long-term supply of home industries with raw minerals raise calls for government investments into alternative supply from the deep ocean. Developing countries, like the Small Island Developing States, SIDS, hope to set up a new source of income to heal their state budgets;
- Industry interests: marine technology companies, shipping and increasingly the big steel producers aim to develop this as a new market;
- Science interests: as deep-sea research is extremely expensive and national budgets get cut, institutes increasingly have to seek co-funding from industry. A developing deep-sea mining industry will inject a lot of money into research.

So collectively, these actors have pushed governments and institutions such as the International Seabed Authority and the European Union to develop policies and strategies, and provide funding for a major effort to overcome the technical and management hurdles prior to the first mineral resource extraction operations in the deep sea. Exploration work in all oceans is progressing rapidly. Table 5 in Annex 2 provides an overview of contemporary exploration licenses issued in national waters.

2.1.2 South West Pacific

In the southwest Pacific, hydrothermal vent fields are known from six national Exclusive Economic Zones, EEZs (**Fiji, New Zealand, Papua New Guinea, Solomon Islands, Tonga** and **Vanuatu**). At least 81 active vent fields are located in areas with granted or pending applications for mineral prospecting and exploration. This corresponds to 62% of all known vents in these EEZ and 34 % of the known arc and back-arc vents in the region (Beaulieu *et al.*, 2013). In addition, substantial fields of polymetallic nodules have been explored in waters under the jurisdiction of the Cook Islands (Cronan and Hodkinson, 1989; Kingan, 1998). In 2015, the government of the **Cook Island**s has tendered for applications for exploration licences for manganese nodules offshore within a designated area of the Cook Islands Exclusive Economic Zone[2]. No applications were received[3].

[1] this chapter has been written in December 2015, and updated as far as possible in July 2017 and February 2018. Some of the facts may be outdated.

[2] http://www.seabedmineralsauthority.gov.ck/cook-islands-seabed-minerals-tender-2015

[3] http://cookislandsnews.com/national/local/item/56633-no-bids-for-deep-sea-mineral-tender/56633-no-bids-for-deep-sea-mineral-tender

Several private exploration companies are currently active in the region in order to explore and mine SMS deposits (Ecorys, 2014)[4], as a rule at active hydrothermal vents:

2.1.2.1 Nautilus Minerals Inc.

As of December 2014, Nautilus Minerals Inc. has held approximately 423,000 km² of exploration tenements (granted and under application) in the territorial waters and Exclusive Economic Zones (EEZs) of Papua New Guinea, Tonga, Solomon Islands, Fiji (15 licenses until 2017), Vanuatu, New Zealand and in the Area (Nautilus Minerals Inc., 2014, 2015). In 2015, Nautilus conducted an exploration program on its 100% owned Solomon Islands licenses with the aim of identifying SMS targets for follow up seafloor target testing. For a more flexible exploration drilling, Nautilus purchased a second-hand drill rigg in 2015 (Nautilus Minerals Inc., 2015).

Nautilus has identified 12 potentially commercially viable Seafloor Massive Sulphide ('SMS') deposits in the Manus Basin, Papua New Guinea. For the first site, Solwara 1, a mining lease was granted in 2011, with mining expected to commence in early 2018 (Nautilus Minerals Inc., 2014, 2015), with a mine life of less than 3 years. However, due to financial problems the company underwent a substantial restructuring in 2016, which will at best allow to commence the initial deployment and testing operations at the Solwara 1 Project to the end of Q1 2019[5], though even this is unlikely[6].

Development of the Solwara mine site

Based on international scientific exploration in the Bismarck Sea, Nautilus Minerals applied for and was granted a commercial exploration license 1196 in November 1997. Commercial exploration started in 2005. Concurrent to the mineral and geological investigations, biological studies were carried out for a period of 1-3 years prior to submitting to the PNG authorities an Environmental Inception Report in 2007 and an Environmental Impact Statement in 2008.

The Solwara project has been subdivided in two separate phases, of which only Phase 1 (recovery of the ore and transport to a holding facility on land) has been subject to Environmental Impact Assessment and permit (Coffey Natural Systems, 2008).

In December 2009, Nautilus received the final Environmental Permit for the development of the Solwara 1 Project from the Department of Environment and Conservation (DEC) of Papua New Guinea for a term of 25 years, expiring in 2035. An Environmental Management Plan is required 6 months before mining starts.

In January 2011, a mining lease was granted with the State exercising its legal right to take a 30% contributing interest. In April 2014, the government of Papua New Guinea and Nautilus Minerals Inc. came to a new agreement on the terms of their cooperation with a.o. an initial 15% equity investment by the state of PNG via its subsidiary Petromin PNG Holdings Limited (Petromin).

In early 2016, the three Seafloor Production Tools, SPTs, the Auxiliary Cutter, the Bulk Cutter and the Collecting Machine were delivered, and shipped to Oman for and extensive submerged testing of the fully assembled system. Umbilical winches and cables are also available, as well as an assembled riser and lifter system, pumps and other equipment. The production support vessel, owned and built in

[4] For more details on the contractors see the list of exploration contracts in the Annex

[5] http://www.nautilusminerals.com/irm/PDF/1818/NautilusobtainsbridgefinancingandrestructuresSolwar

[6] http://www.deepseaminingoutofourdepth.org/nautilus-agm-solwara-1-deep-sea-mining-venture-remains-a-speculative-pipe-dream/

China by a marine solutions company based in Dubai, will later be chartered by Nautilus Inc. It is being built, keel laying occurred in June 2016[7].

In February 2018, Nautilus Minerals has announced the results of a preliminary economic assessment of the Solwara 1 project[8]. An 'Environmental and Social Benchmarking Analysis of the Nautilus Minerals Inc. Solwara 1 Project' was published in 2015 (Batker and Schmidt, 2015), which 'provides a preliminary framework that examines the ecosystem goods and services that may be enhanced, degraded, or consumed by the Solwara 1 project in Papua New Guinea'. The study was heavily criticised for failing to meet the well accepted requirements of a cost-benefit analysis (CBA), as well as other errors (Rosenbaum and Grey, 2015).

Polymetallic nodule Project

In 2012, Nautilus (through its 100% owned subsidiary TOML), signed an exploration contract with the ISA covering an area of 75,000 km^2 in the Clarion-Clipperton-Zone, Central Pacific. A first resource estimate was published in 2013, a 96 day exploration cruise took place in 2016, with updated resource estimates and environmental data published in 2016 (AMC Consultants, 2016). No further exploration activity is known[9]

2.1.2.2 Bluewater Metals South Pacific Ltd.,

A former subsidiary of Neptune Minerals (US) and since 2009, a subsidiary of SMM Project LLC (US), which is a subsidiary of Odyssey Marine Exploration Inc. (the company driving the mining of phosphate sands in the EEZ of Mexico). Bluewater Metals is based in Australia[10] and holds 46 exploration licenses for about 150,000 km^2 of ocean floor in **PNG, Solomon Islands, Tonga and Vanuatu**[11] and since 2013 also in **Fiji** waters. In 2015, Bluewater Minerals (SI) Ltd was seeking to explore a total of 81 tenements in the Solomon´s waters, all within Temotu province.[12] No more recent information is known.

2.1.2.3 Bismarck Mining Corporation,

Part of the Neptune Minerals Group (US), is based in **Vanuatu** and owns exploration licences for 10 000 km^2 in Vanuatu waters with a good potential for mineable SMS deposits[13].

2.1.2.4 Neptune Minerals, Inc.,

Holds applications for or granted prospection tenements in seven countries in the Western Pacific – **Japan, Papua New Guinea, Solomon Islands, Vanuatu, Fiji, Tonga** and **New Zealand**, covering 175,000 km^2 [14]. The company emphasizes to target non-active hydrothermal deposits. Applications for SMS exploration licenses are ongoing in Micronesia and Palau (Ecorys, 2014, not mentionned on website).

[7] http://www.nautilusminerals.com/irm/content/status-of-the-equipment.aspx?RID=424

[8] https://www.juniorminingnetwork.com/junior-miner-news/press-releases/505-tsx/nus/42865-nautilus-announces-preliminary-economic-assessment-for-its-solwara-1-project.html

[9] http://www.nautilusminerals.com/IRM/Company/ShowPage.aspx?CategoryId=190&CPID=1553&EID=99064433

[10] https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=81598262

[11] http://shipwreck.net/pr193.php

[12] https://ramumine.wordpress.com/tag/bluewater-minerals/

[13] http://www.radionz.co.nz/international/pacific-news/257002/seabed-miner-looking-at-vanuatu-operation

[14] http://www.neptuneminerals.com/our-business/tenements/

2.1.2.5 Korea Ocean Research and Development Institute

The state-sponsored Korea Ocean Research and Development Institute (KORDI, now KIOST) has been exploring in **Tonga** and **Fiji**. After more precise resource definition in the Tongan sites, KIOST has envisaged to carry out an Environment Impact Assessment (EIA) end of 2013 to be followed by an application for a mining license in 2014 (unknown status of this!). This will be followed by preparation for commercial mining including the construction of mining equipment and facilities between 2014 and 2016, with commercial mining to commence in 2017.

In Fiji, KIOST has acquired a 6-year exclusive license for exploring SMS deposits in the EEZ in 2011. SMS deposits were verified 2014-2015 and KIOST announced to appraise the resources potential for commercial extraction in 2016-2017. Korea is carrying out equipment tests such as of a nodule crusher (Sung *et al.*, 2014), and pilot tests of the subsea mining robot Minaero to collect ore from the seafloor and to send it up to a buffer system installed about 500 meters below the surface of the water. There, the collected ore is pumped through 8-inch vertical pipes, called yangguang riser pipes, up to the ship[15].

Other commercial companies interested in cooperating with a Pacific Island state on seabed mining are *Lockheed Martin* (Fiji)[16], *G-Tec Sea Mineral Resources* NV (Cook Islands) and others. Both are actively involved in creating the necessary national legal environment to be able to start their activities in national waters and under sponsorship in the Area.

In **New Zealand**, several applications for the exploitation of seabed minerals (iron sand, phosphates) in territorial waters, and in the EEZ, respectively, were initially rejected, because the planned environmental protection and monitoring was incompatible with the applicable law (Kim and Anton, 2014). In particular, the court

> *'as required, favoured caution and environmental protection. In doing so, we have also considered the extent to which imposing conditions ... might avoid, remedy or mitigate the adverse effects of the activity' (Trans-Tasman Resources Ltd Marine Consent Decision, section 59(2)(j))* [17]*).*

A permit for shallow-water extraction of iron sand was given in 2017, which is being appealed[18].

The EEZ around the Kermadec Islands to the north of the North Island is subject of the Kermadec Ocean Sanctuary Bill which aims to designate the area as a large fully protected nature reserve[19],[20]. In 2007, *Nautilus Minerals* applied for a prospecting license for SMS deposits on the ridge between the north island and the Kermadec islands. Nautilus originally applied for a huge area of 180,000 square kilometres long New Zealand's Kermadec Arc – but has reduced this to 48,200 km^2. The status of the negotiations is unknown. *Neptune Minerals* held a prospection license of 8,000 km^2 until 2002-2010, and has applied for an exploration licence in 2011 partly coinciding with the Benthic Protection Area

[15] http://www.korea.net/NewsFocus/Sci-Tech/view?articleId=131977

[16] http://fpif.org/sopac_expedites_new_seabed_mining_legislation_for_lockheed_martin/
http://www.abc.net.au/news/2013-03-14/sopac-role-in-lockheed-seabed-mineral-bid-queried/4574058

[17] http://www.epa.govt.nz/eez/EEZ000006/EEZ000006_CRP%20Final%20Version%20of%20Decision.pdf ;
http://www.epa.govt.nz/EEZ/EEZ000004/Trans_Tasman_Resources_decision_17June2014.pdf

[18] https://www.stuff.co.nz/business/industries/95546761/ttr-ironsand-mining-decision-approved

[19] https://mfe.govt.nz/marine/kermadec-ocean-sanctuary/question-answers-kermadec-ocean-sanctuary

[20] https://www.mfe.govt.nz/sites/default/files/media/Marine/Kermadec%20Ocean%20Sanctuary%20Cabinet%20Paper_0.pdf

to the southwest of Kermadec in the EEZ of mainland New Zealand. First exploration drilling took place 2005[21].

Since 2010, French agencies and research institutions carry out exploration for deep seabed minerals (in particular manganese nodules and the search for hydrothermal vent sites) in the waters of **Wallis-and-Futuna**. The economic potential for manganese nodules is considered limited and exploitation not feasible within the coming 15-20 years. SMS deposits bear more potential, yet exploration is in the early stages[22].

Exploration for cobalt-rich crust is an option in the waters of French Polynesia, off the Tuamotu and Marquesas atolls. This exploration is sensible because of conflicts over maritime boundaries and the wish for decolonisation of the islands[23].

2.1.3 South East Pacific

The Galapagos Rift (Ecuador EEZ) is of potential interest for SMS deposits. Currently there is scientific exploration (Szamałek *et al.*, 2011). Manganese nodule fields are known from the Peru Basin, however no commercial exploration is known.

2.1.4 North Pacific

In the **US**, the Pacific EEZ Minerals Study investigates the minerals potential in the US EEZ[24]. In addition, there is an exploration and research campaign, CAPSTONE 2015-2017, which will investigate the ferromanganese crust deposits at seamounts in the Hawaiian archipelago and the Johnston Atoll EEZ[25].

Japan is part of the 'Pacific Ring of Fire' and therefore has numerous active and inactive hydrothermal vent fields in its waters. The EEZ of Japan is explored by the state-funded Japan Oil, Gas & Metals National Corporation (JOGMEC) based on a 10-year plan of the Ministry of Economy, Trade & Industry (Masuda et al., 2014). There are two regions of interest for seafloor massive sulfides, the Okinawa Trough and the Izu-Bonin back-arc basin to the southwest and south of Japans main islands. Discoveries include ore bodies hidden under 30 m of sediment. In both regions also Neptune Minerals has lodged in total 405 applications for prospection, which had not been decided upon in 2014 (Allsopp et al., 2006; Ecorys, 2014). Japan is actively developing and testing seafloor mining tools and processing of SMS. The proposed mining system is described by (Ishiguro et al., 2013).

In the **China** seas, it has been considered unlikely that deep-sea deposits will have much commercial significance, due to several natural factors that raise the costs of exploration, development, and production (Hoagland *et al.*, 1992). Therefore, China focusses its efforts on the exploration and exploitation of the mineral resources of the Pacific Ocean in international waters.[26]

2.1.5 Indian Ocean

Further to its exploration programme for polymetallic nodules in the Area (see below), **India** is researching the mineral potential at hydrothermal vents on Carlsberg Ridge, Central Indian Ridge, and the Andaman Backarc Spreading Center (Sharma, 2010). Cobalt-rich manganese crusts are

[21] http://www.mining-technology.com/projects/kermadec-neptune/

[22] http://www.senat.fr/rap/r13-430/r13-4303.html (4 December 2015)

[23] http://www.radionz.co.nz/international/pacific-news/288392/france-asked-to-cede-tahiti-exploration-rights

[24] http://walrus.wr.usgs.gov/research/projects/pac_eez_minerals.html

[25] http://oceanexplorer.noaa.gov/okeanos/explorations/ex1504/background/crusts/welcome.html

[26] http://www.lib.noaa.gov/retiredsites/china/programs.htm

investigated at the Afanasiy Nikitin seamount. In cooperation with the Seychelles, India has explored the Seychelles Exclusive Economic Zone for the occurrence of polymetallic nodules in 1984, and carried out similar surveys in the Mascarene Basin off Mauritius in 1987 (Sharma, 2010).

The newly discovered hydrothermal vents on the mid-ocean ridges of the Indian Ocean, situated in the Area, are being explored scientifically with increasing intensity, and more and more mineral exploration areas are being contracted by the ISA (see below). For example, in 2013-2014, an extensive survey in the Central Indian and South West Indian Ridges (in the Area) served to map areas for the exploration of polymetallic sulphide deposits. In September 2016, India signed a 15 year exploration contract with near Rodrigues Triple Junction (RTJ) – a junction in the Southern Indian Ocean near Mauritius where three tectonic plates meet[27].

2.1.6 North-East Atlantic

In the North-East Atlantic, fields of manganese nodules are known to exist, however they are currently of no commercial exploratory interest. With exceptions, also the polymetallic crust thickness and coverage of seamounts in the North East Atlantic is not sufficient for minerals mining (Koschinsky et al., 1995). However, in recent years, the mineral potential of crusts in Portuguese waters has newly come into the focus of research (Muin˜os *et al.*, 2013; Rozemeijer *et al.*, 2018). Of most interest is the potential for seafloor massive sulphide deposits on the Mid Atlantic Ridge, in particular south of the Azores Islands and in the northern North Atlantic ridges.

Seabed minerals are known to be present in deep parts of the **Norwegian Sea**. Black smokers were discovered more than a decade ago, and sulphide deposits have been identified. Norway's continental shelf areas are expected to contain manganese crusts in parts of the deep Norwegian Sea and around the Yermak Plateau in the Arctic Ocean and Bouvet Island in the South Atlantic[28]. In 2012, the Norwegian University of Science and Technology (NTNU), *Statoil* and *Nordic Ocean Resources AS* (NORA) entered into a joint cooperation project regarding seabed mineral resources[29]. The project is targeting knowledge increase within marine mineral resources and will focus on current knowledge and future areas for research. NORA has launched an application for exploring SMS on the Mid Atlantic Ridge (Ecorys, 2014). As part of its Strategic Research Areas 2014-2023, the Norwegian University of Science and Technology, NTNU, runs extensive scientific research programmes to address the range of challenges of potential future deep seabed exploration and mining projects[30], including developing technology solutions. In 2015, the Research Council of Norway has granted support for a research and industry exploration project, MarMine, on the marine mineral resources potential on the Norwegian continental shelf. In focus are SMS deposits on the Mid Atlantic Ridge[31.] The project is expected to deliver a concept for mining and exploitation of the studied deposits. It will also conduct an ecological baseline study and eco-toxicological tests to assess environmental impact of the mining to support guidelines and best available practices. A first Master thesis was made available in 2016 (Thon, 2016). A report with a first consideration of environmental impacts to be expected from mining indicated substantial gaps in knowledge and assessment procedural gaps (Olsen *et al.*, 2016) In May 2017,

27 https://blogs.timesofindia.indiatimes.com/tracking-indian-communities/india-dives-deep-on-way-to-mining-gold-from-sea/

28 http://www.npd.no/en/Publications/Norwegian-Continental-Shelf/No-1-2017/Minerals/

29 http://www.nordicmining.com/nordic-ocean-resources/category326.html ;

30 https://www.ntnu.edu/documents/919518/1266689199/84670_Deep+Sea+Mining_2016.pdf/97c5e008-1857-4d09-838e-994df5454784; https://www.ntnu.edu/oceans/deep-sea-mining

31 http://subseaworldnews.com/2015/06/26/norway-backs-marmine-seabed-minerals-research/

Norway has launched a consultation a new act on mineral recovery on the Norwegian Continental Shelf.

In 2008, a first request for a prospection licence for approx. 6,000 km^2 of the Mid Atlantic Ridge, MAR, south of the **Azores** was submitted by the Canadian company *Nautilus Minerals Inc*.[32]. Here, the hydrothermal vent fields are closely spaced, and at least six seafloor massive sulphide (SMS) deposits are recorded in the ISA database. The proposed exploration areas extend from near one of the main fishing grounds of Azorean fishers, the Princess Alice Bank to the south of the Rainbow vent field on the extended continental shelf (as submitted), but circumventing the areas of the Natura 2000 sites (and OSPAR MPAs) Menez Gwen, Lucky Strike and Rainbow. These MPAs are subject to conservation as part of the Azores Marine Park (2010a; Calado *et al.*, 2009). The Azores adopted specific deep seabed mining legislation in 2012[33], which was subsequently ruled unconstitutional by the national constitutional court in 2014[34]. As a consequence, Portugal implemented a framework directive and a new decree-law, limiting the regional competences for the mineral resources in areas beyond the 200 nm Exclusive Economic Zone[35], yet the Azores kept unlimited competence for environmental protection. In 2015, the legal framework was established '*for the exploration and exploitation of geological resources in the national territory, including those located in the national maritime space. This law lacks any concern about the environmental protection before, during or after the proposed activities that may be taking place. For license grant purposes, both the regional and national governments must be signatories.'* **After the approval of this law, the regional government reacted, approving the expansion of the Azores Marine Park, created in 2011, and included the areas submitted by Nautilus Minerals Inc. for license applications for exploration, keeping the prohibition of mining within the park's protected areas.**[36]

The national government has resumed the negotiations with *Nautilus Minerals* in 2015, however the status is unknown.

2.1.7 Mediterranean Sea

In the Mediterranean, *Neptune Minerals* has applied for an exploration licence in **Italy** to investigate the SMS resource potential in the Tyrrhenian Sea (Ecorys, 2014).

2.1.8 European Union

In the European Union, in particular under the Blue Growth funding stream, substantial funding is provided for environmental (e.g. FP7 project MIDAS, until 2016) and technical research and development (Horizon 2020 projects Blue Mining[37] and Blue Nodules[38]); calls in priority area 'Technologies for primary and secondary raw materials' production of the European Innovation Partnership (EIP) on Raw Materials for proposals to '*facilitate the market uptake of solutions developed through industrially- driven multidisciplinary consortia*' in deep mining on continent and in seabed. The expected impact is to 'push the EU to the forefront in the areas of sustainable exploration, mining and

[32] Due to a legal dispute over the competences for seafloor minerals mining between the autonomous region of the Azores and Portugal, this request was suspended for some time.

[33] Decreto Legislativo Regional n.o 21/2012/A. http://www.azores.gov.pt/Gra/SRMCT-MAR/conteudos/legislacoes/2012/Maio/DLR+21_2012_A.htm?lang=pt&area=ct

[34] Acórdão do Tribunal Constitucional n.º 315/2014. https://dre.pt/web/guest/pesquisa/-/search/25343679/details/maximized?p_p_auth=MEf0NZGo

[35] https://dre.pt/application/file/67552586 (accessed 1 March 2018)

[36] this text quotes: **http://oceanolivre.org/en/o-caso-dos-acores** (accessed 1 March 2018)

[37] http://www.bluemining.eu/ (accessed 1 March 2018)

[38] http://www.blue-nodules.eu/ (accessed 1 March 2018)

processing technologies and solutions’. Among others, a pilot mining project[39] was proposed to develop mining technology to the stage where it can be sold.

A European consortium of 26 research partners funded by their national governments cooperate in the project ‘Ecological Aspects of Deep-Sea mining, MiningImpact’, a EU coordinated action, to investigate the long-term ecological impacts of commercial scale mineral mining and develop the scientific methodology for monitoring and assessment of impacts.[40] A first phase of this action terminated in December 2017, a second phase will commence in August 2018, to accompany a commercial equipment test in the German manganese nodules licence area in the Clarion-Clipperton-Zone, Pacific, in 2019. For a complete list of relevant research projects see Rademaekers et al. (2015).

Despite substantial funding going into developing science and technology for a possible future deep seabed mining industry, in January 2018, the European Parliament adopted a resolution (European Parliament, 2018) in which it

> *‘19. Calls on the Commission to encourage Member States to cease subsidising licences for mining prospecting and extraction in areas beyond national jurisdiction and issuing permits for mining of their continental shelves; and*
>
> *22. ... calls on the Member States and the Commission to work through the ISA in order to ensure transparency in its working methods and its effective capacity to assess environmental impacts, as well as ensuring the effective protection of the marine environment from harmful effects and the protection and preservation of the marine environment, ...’.*

This is not binding to EU member States, however; each member State is bound by the European legislative framework, in particular the European Treaty (2007; European Union, 2012), which obliges States to implement the precautionary principle and preventive action where threats to biodiversity or human health are likely, and to ‘preserving, protecting and improving the quality of the environment’ (Art 191).

2.1.9 The Area

The prospection, exploration and exploitation of seabed minerals in the Area (seabed beyond national jurisdiction) are activities covered by the UN Law of the Sea Convention (1982 and Implementing Agreement 1994) and subject to regulation by the International Seabed Authority. Regulations for the prospection and exploration of polymetallic nodules are in force since 2000 (revised 2013), for the exploration of seafloor massive sulfides (SMS) and polymetallic crusts since 2010 and 2012, respectively[41]. Regulations for the exploitation of marine minerals in the Area are currently being developed[42].

As at June 2017, 27 contracts for exploration with states or state-sponsored entities had entered into force (17 for exploration for polymetallic nodules, 6 for exploration for polymetallic sulphides, SMS, and 4 for exploration for cobalt-rich ferromanganese crusts, see Table 6 in Annex 2) (ISBA/23/C/7).

[39] https://ec.europa.eu/growth/tools-databases/eip-raw-materials/en/content/innovative-mining-marine-mineral-resources-%E2%80%93-european-pilot-mining-test-atlantic-tools (accessed 1 March 2018)

[40] https://jpio-miningimpact.geomar.de/de (accessed 1 March 2018)

[41] https://www.isa.org.jm/mining-code/Regulations (accessed 1 March 2018)

[42] https://www.isa.org.jm/legal-instruments/ongoing-development-regulations-exploitation-mineral-resources-area (accessed 1 March 2018)

The licenses cover areas in the North (16 nodule licenses) and West Pacific (4 crust licenses), Indian Ocean (1 nodule, 4 SMS licenses) and Atlantic Ocean (2 SMS licenses and 1 crust license). One more contract is to be signed before end 2017, one application is up for approval during the 2017 Annual Session.

So far, all applications for exploration licenses have been recommended by the Legal and Technical Commission, LTC and approved by the Council - at least it has not become public should the LTC have had any concerns with respect to the effective protection of the environment in the respective areas pursuant to the Exploration Regulations (Reg. 23(4 b)[43]). All three exploration regulations require the LTC to

'develop and implement procedures for determining, ..., whether proposed exploration activities in the Area would have serious harmful effects on vulnerable marine ecosystems,

in particular hydrothermal vents (Reg. 33 (4), ISBA/16/A/12/Rev.1),

in particular those associated with seamounts and cold water corals (Reg. 33 (4), ISBA/18/A/11),

and ensure that, if it is determined that certain proposed exploration activities would have serious harmful effects on vulnerable marine ecosystems, those activities are managed to prevent such effects or not authorized to proceed.' (Regulation 31(4), ISBA/19/C/17).

A Plan of Work by an applicant can be disapproved ... 'in cases where substantial evidence indicates the risk of serious harm to the marine environment'[44]. Currently, neither a guidance exists on what 'substantial evidence' nor 'serious harm[45]' entails in terms of criteria, indicators and threshold values.

However, hydrothermal vents and seamounts have been generally classified as vulnerable marine ecosystems, VMEs, which are to be protected from significant adverse impacts from Deepwater fishing beyond and partly within national jurisdiction by a range of precautionary measures (FAO, 2009; UNGA, 2006). While these resolutions and guidelines are not legally binding, their implementation in national and regional law has made the provisions compulsory for a wide range of actors globally. The currently six contracts for exploration of SMS deposits in the Atlantic and Indian Ocean, as well as the four contracts for exploration of cobalt-rich manganese crust in the south Atlantic and western Pacific Ocean therefore target ecosystems which are under precautionary management by another sector.

[43] Regulation 23 (4): The Commission shall, in accordance with the requirements set forth in these Regulations and its procedures, determine whether the proposed plan of work for exploration will:

(b) Provide for effective protection and preservation of the marine environment including, but not restricted to, the impact on biodiversity;

[44] ISBA/16/A/12/Rev.1 , Reg. 23 (6): The Commission shall, not recommend approval of the plan of work for exploration if part or all of the area covered by the proposed plan of work for exploration is included in:

(c) An area disapproved for exploitation by the Council in cases where substantial evidence indicates the risk of serious harm to the marine environment.

[45] Regulaton 1(f) "Serious harm to the marine environment" means any effect from activities in the Area on the marine environment which represents a significant adverse change in the marine environment determined according to the rules, regulations and procedures adopted by the Authority on the basis of internationally recognized standards and practices.

In addition, a number of contract areas overlap with designated 'Ecologically or biologically significant marine areas', EBSAs"[46] or other protection areas:

- Central Indian Basin - Central Indian Ocean Basin EBSA seabirds
- Southwest Indian Ocean Ridge - Benthic Protection Zones (SIODFA, 2016) Atlantis and Coral seamount EBSAs, Agulhas Front EBSA
- Clarion-Clipperton-Zone - Clipperton Fracture Zone Petrel Foraging Area
- Mid Atlantic Ridge - Hydrothermal vent EBSA (see box below).

In particular, the exploration areas on the Mid Atlantic Ridge (see box below and Figure 1) give rise to concern that mineral exploration and later exploitation will entail a risk of significant adverse impacts for the ecosystems associated with the active and inactive hydrothermal vent fields (Convention on Biological Diversity, 2014b). As a minimum, the described features should be excluded from the Plans of Work of contractors (see also (Van Dover *et al.*, 2018). However, in August 2017, the Plan of Work for exploration of polymetallic sulphides along the Mid-Atlantic Ridge south of the Azores was adopted (ISBA/23/C/19/Rev.1) based on a recommendation of the Legal and Technical Committee, LTC, of the International Seabed Authority, which does not consider any environmental issues (ISBA/23/C/11).

Also on the mid and southwest Indian Ocean Ridge, there seems to be an overlap of SMS exploration contract areas with areas proposed for spatial protection measures: the Southern Indian Ocean Deepsea Fishers' Association, SIODFA, has designated several benthic protection areas as a voluntary measure (SIODFA, 2016). Some of these may coincide with the SMS exploration areas of Korea (Mid Indian Ridge), China (Coral, Bridle) and possibly India (Atlantis Bank). The seamounts Coral and Atlantis are also designated as EBSA.

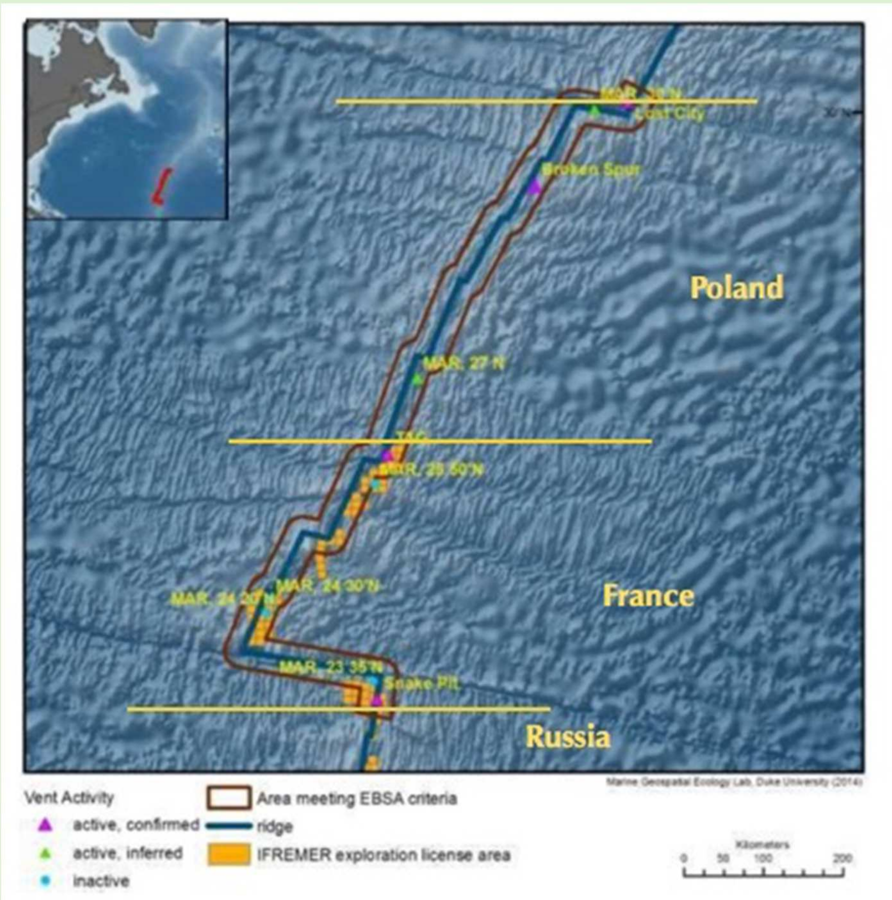
Mineral exploration will therefore take place in areas of particular biological or ecological importance. Acknowledging the fact that biological scientific investigations lag far behind the effort and coverage of geological and mineral scientific investigations and exploration, it is very likely that many more sites, regions or features would deserve to be designated as an EBSA. LTC, when scrutinising the Plans of Work of applicants, should place special emphasis on the effective protection of the respective marine environments, and include the details of its considerations in its report to the Council.

[46] https://www.cbd.int/ebsa/. The designation of EBSAs within and beyond beyond national jurisdiction according to scientific criteria shall aid the implementation of the global goal to halt the loss/decline of biodiversity and is therefore the first step towards protecting thesee ocean areas.

SMS Exploration areas in designated EBSA

All the hydrothermal vent fields on the Mid Atlantic Ridge south of the Exclusive Economic Zone of the Azores/Portugal and north of 14.7° N have been designated a 'Ecologically and biologically significant area, EBSA' by the contracting parties of the Convention on Biodiversity (Convention on Biological Diversity, 2014a, b). The EBSA extends from the Rainbow vent field at 36° N to the Logachev vent fields at 14.7 N. All of the vent fields on this section of the Mid Atlantic Ridge, except Rainbow (which is on the extended continental shelf as submitted by Portugal), are subject to exploration contracts (or applications) concluded by International Seabed Authority with Russia (2012), France (2014) and Poland (application ISBA/23/LTC/3 in 2017, see ISBA/23/C/7 for status of contracts). The exploration area of Russia extends from approx. 12-20° N and includes the active Logachev vent field and a number of inactive fields covered by the EBSA, as well as further active sites south of the EBSA. The French exploration area extends covers the southern portion of the EBSA south of the TAG vent field. An application by Poland for exploration of the MAR north of the French contract area (26°09´ - 32°50´N) will include the vent fields TAG, Broken Spur and Lost City. The Lost City vent field was also nominated for protection under the World Heritage Convention (Freestone *et al.*, 2016).

Figure 1 The coverage of the Hydrothermal vent EBSA on the Mid Atlantic Ridge by exploration contract areas of Russia, France and Poland (application 2017). Composite map based on Fig. 8 and 9 of Convention on Biological Diversity, 2014a, proposed Area No. 7, pp. 107-122).



The first seven exploration licenses with IOM, Russia, China, Japan, Korea, France and India expired in 2016 and spring 2017, respectively. In 2016, applications for a five-year extension of the work plans covering the expired exploration contract were received (ISBA/22/C/11-16) and granted (ISBA/22/C/21-26). In 2017, an application for extension of its present contract from India was granted as well. However, the criteria for consideration of applications for contract extensions have not been disclosed (ISBA/21/C/WP.1), and if they existed, then they were not pre-agreed in Council and made publicly available. Such criteria should include a quality measure and qualitative or quantitative threshold for contractors' environmental work in pursuit of the '*Guidelines for Contractors*' as set out by the LTC (ISBA/19/LTC/8). Currently, contractors are only obliged to provide an inventory of their environmental work, and to submit as yet missing data. In addition, an argument not related to the performance of the contractors may have been sufficient for granting the extensions: '*If the prevailing economic circumstances (such as those encountered in the global markets and low metal prices) did not justify proceeding to the exploitation stage, then it was to recommend the approval of the applications*' (ISBA/22/C/17, para 13).

In effect, the six contract extensions were granted without anyone outside the LTC knowing their state of exploration, of environmental work, and reasons for not being able to complete exploration within the 15 years of contract duration. The LTC report to the Council (ISBA/22/C/17 and ISBA/23/C/13) merely summarises its efforts in considering the applications and do not provide for a firm basis for the recommendations given or the decision by the Council.

There is no information on the type or status of work programmes of contractors for exploration licenses in the Area. These Plans of Work have to be submitted for approval of the exploration contract by LTC, and then annually for assessment of progress made and data delivery. None of this is accessible for non-LTC members (see also chapter 3.4.4). The 5-year review is done only between the contractor and the General Secretary, who recently invited the LTC to share the work (ISBA/22/LTC/14). Some more details on the exploration projects is given in (Ecorys, 2014).

Since 2013, the ISA has worked towards developing regulations for the next stage of mineral mining: the exploitation of manganese nodules[42]. However, as much of the rules in the regulation will also apply to the exploitation of seafloor massive sulphides and cobalt crust, once this first regulation has been agreed, it will be followed by the others soon after. It is as yet unclear whether there will be a framework regulation for all three types of minerals with specific annexes, or whether the procedure will be as with the exploration regulations: a distinct regulation for each mineral type. In particular, the extent to which the regulations will cover the conduct of the activities and the regulatory control is under debate.

The process of developing the regulations is designed as circuit of drafting by external contractors/consultants under guidance of the ISA secretariat - discussion in LTC - public consultation - modification based on public consultation - discussion and recommendation for further procedure in LTC - decision by the Council for revision - and back to the consultants. The participation from contracting parties and observers in the public consultation was substantial, yet it is unclear whether and/or how the LTC deals with suggestions and comments. What is clearly lacking is a more direct involvement of the parties of the Council in providing directions for the work of the LTC and for debating the settings of the overall legal framework for exploitation.

The first stakeholder survey was launched in March 2014 and focussed on four areas: Financial terms and obligations; Environmental management terms and obligations; Health and safety and maritime security and General considerations – stakeholder communication and transparency, as set out in document (International Seabed Authority, 2014) in the form of a questionnaire. LTC drafted a framework for the regulation of exploitation considering the suggestions of the survey in report (International Seabed Authority, 2015a). In addition, a discussion paper on a possible payment mechanism (International Seabed Authority, 2015b) was set out for public consultation. In 2016, a third round of public consultations took place, now requesting opinions on contents and structure of the first working draft of the Regulations and Standard Contract Terms on Exploitation for Mineral Resources in the Area, as issued by the LTC (International Seabed Authority, 2016b). Prior to working out the stakeholder opinions on the first working draft, a discussion paper on the development and drafting of Regulations on Exploitation for Mineral Resources in the Area (Environmental Matters) was published in early 2017. Substantial criticism, suggestions and ideas on possible environmental regulations were put forward in a workshop in Berlin 'Towards an Environmental Strategy for the Area', March 2017 (International Seabed Authority, 2017e). During the Annual Session 2017, a new document with draft exploitation regulations (International Seabed Authority, 2017b) was published by the ISA Secretariat and subsequently opened for public comments. A meeting of the Council in March 2018 will discuss the further strategy for the elaboration of the exploitation regulations.

It can be anticipated that the process of elaboration and adoption of the regulations, in particular if they are to provide sufficient clarity and detail on the environmental framework and conditions, is likely to take much longer than the suggested period until July 2020, indicated by the ISA Council in 2017 (ISBA/23/C/13, Annex).

2.1.10 Recommendations

Recommendations

The procedures and criteria used by the ISA's Legal and Technical Commission (LTC) to review applicants' plans of work for exploration contracts needs revision in order to ensure the "effective protection" of the marine environment. It is recommended that

- The LTC develop and apply criteria to assess the environmental impacts of the proposed work;
- The LTC develop and apply criteria to cross-check for eventual environmental protection designations made by other international organisations and competent authorities in adjacent areas such as EBSAs, VMEs, and MPAs;
- Applicants are required to provide an analysis, based on habitat mapping, of potential areas, habitats and species which would qualify as ecologically significant (according to CBD criteria), vulnerable (for example, according to FAO criteria adapted to mining) or otherwise in need of protection.
- Applicants are required to provide information on potential conflicts with other sectoral uses of the area in question.
- The LTC develop and apply criteria to assess the eventual transboundary effects of activities (whether in neighbouring license areas, reserved sites, the high seas or areas within the limits of national jurisdiction);
- Transparency is increased. In addition to current practice, LTC reports to the Council should detail the methodologies used by the LTC when making recommendations concerning applicants' plans of work of.
- In the event of an overlap with the environmental designations of other organisations or with other sectoral uses, the application in question, as well as the LTC's deliberations, should be made publicly available prior to the Council's decision.

2.2 Progress towards the Protection of Marine Biodiversity in Areas beyond National Jurisdiction

2.2.1 Introduction

Biological diversity is an umbrella term which encompasses the variability among living organisms from all ecosystems and ecological complexes, including diversity within species, between species and of ecosystems.[47]

Biodiversity loss increasingly occurs on a global scale, due to growing human pressures on the environment. As a result, 60% of the ecosystem services supporting life on earth are considered to be degraded or used unsustainably (Millennium Ecosystem Assessment, 2005). Also the condition and trends of biodiversity in deepwater habitats give rise to increasing concern (EEA, 2015; Secretariat of the Convention on Biological Diversity, 2014), mainly because of the expansion of fisheries to previously inaccessible ecosystems, such as continental slopes and seamounts. Despite the deteriorating state, the oceans are increasingly seen as an underexploited treasure trove of resources and opportunities which should be exploited for the benefit of a growing world population.

However, marine ecosystems are subject to a range of interacting and cumulative impacts, eventually acting synergistically at all ecosystem levels (Halpern *et al.*, 2008). In particular, rising global atmospheric temperatures and CO_2 levels contribute to the warming, acidifying and deoxygenating of the ocean, which put the deep ocean ecosystems under stress (Levin and Le Bris, 2015), and will lead to largely unpredictable changes in ecosystem structures and functions. A recent modelling study predicts that a climate change-induced reduction of the flux of particulate organic matter to the abyssal seafloor will lead to an overall loss of biomass and diversity of macrobenthic fauna, and change faunal communities and their role in ecosystem long-term (Sweetman *et al.*, 2017), ultimately reducing the carbon sequestration capacity of the deep sea (Thurber *et al.*, 2014). Carbon biogeochemical cycling in the ocean, in balance with the planet systems, crucially depends on the ecological long-term of the deep sea (Sweetman *et al.*, 2017).

Deep-water ecosystems are considered especially vulnerable to human impacts, because of the temporal stability of the ecosystems resulting from slow growth rates, longevity and limited reproduction of deep ocean species, which limits their tolerance to change, their ability to adapt and results in a long time lag between pressure change and detectable ecosystem change (Smith *et al.*, 2008a). In addition, the general level of knowledge about life histories, physiological adaptation, spatial and temporal scales of species diversity and ecosystem functioning is extremely limited and unlikely to be sufficient for knowledge-based management of human activities at any one time. In particular, we understand little about the long-term impacts of human interventions and have near to no abilities to predicting change (see Chapter 2.3).

Open oceans are one of the least protected, least studied and most inadequately managed ecosystems on Earth (Ban *et al.*, 2014). Therefore, the effective procedural, institutional and regulatory implementation of the precautionary approach (International Seabed Authority, 2017d) is crucial to preventing the degradation of marine ecosystems due to an unsustainable scale or type of human uses, including deep seabed mining (Van Dover *et al.*, 2017, see Chapter 3.4).

This chapter aims to describe the political progress towards developing an ecologically sustainable use of the oceans beyond national jurisdiction.

[47] Convention on Biological Diversity, 1992, Article 2

2.2.2 The challenge of effective biodiversity conservation

The UN Convention on the Law of the Sea, UNCLOS, is directly binding on states parties and the ISA. It specifically requires the prevention of damage to marine flora and fauna (UNCLOS, Part XII)[48]. Importantly, Part XI, Article 145, provides for the protection of all flora and fauna, irrespective of whether they occur on the seabed (the Area) or in the water column (high seas), from adverse effects of seabed mining (see also Annex III art. 17(1) and 1994 Implementing Agreement, annex section 1(5)(g)). Moreover, UNCLOS goes beyond the avoidance of harm and requires the active preservation of the marine environment, which includes the requirement to take active measures to enhance the state of the marine environment (Nordquist et al., 1991). Thus, Part XII introduces a proactive element requiring both states and international organisations to regulate and manage human activities before serious harm occurs (Birnie *et al.*, 2009).

In addition to the preservation of ecosystems, UNCLOS obligates states to prevent pollution. Article 194 requires states to take '*all measures consistent with this Convention that are necessary to prevent, reduce and control pollution of the marine environment from any source*', including from seabed mining operations (art. 194(3)(c), 196, 208, 209) but also from vessels, dumping, land-based activities, and atmospheric pollution (art. 194(3), 207, 210-212). This obligation applies to all maritime areas, including the international seabed.

Already Principle 4 of the 1992 Rio Declaration (1992) requests that '*in order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it.*' Consequently, the 2030 Agenda for Sustainable Development (UN General Assembly, 2015) calls on States to reduce and eliminate unsustainable patterns of production and consumption and promote appropriate demographic policies (Goal 8) and '*achieve, by 2030 the sustainable management and efficient use of natural resources*' (Goal 12, (UN General Assembly, 2015))(Goal 12, UN General Assembly, 2015). Goal 14, '*Conserve and sustainably use the oceans, seas and marine resources for sustainable development*' aims to regain healthy and productive oceans by preventing and reducing marine pollution (14.1), and by avoiding significant adverse impacts on marine and coastal ecosystems, by strengthening the resilience, and by taking action for restoration (Goal 14.2).

With respect to areas beyond national jurisdiction (ABNJ), the obligations set out in the Convention on Biodiversity, CBD, must be implemented by states through organisations with competences over ABNJ, such as the ISA (Ardron *et al.*, 2014b). An example is the aim of conserving 10 percent of marine spaces through protected areas, set out in the Aichi Biodiversity Targets adopted by the CBD in 2010. This aim can only be achieved if states parties push for these targets nationally or within sectoral regimes, such as the ISA.

Similarly, while the CBD identified numerous ecologically or biologically significant areas (EBSA) also beyond national jurisdiction[49], these can only be protected if organisations such as the ISA adopt sectoral conservation and management measures for EBSAs. Furthermore, the goals agreed at Rio+20 (Convention on Biological Diversity, 2012a) and in the 2030 Agenda for Sustainable Development (UN General Assembly, 2015) require implementation by states, directly and through their participation in organisations that regulate potentially harmful activities. In other words, the protection of biodiversity can only be achieved if it is being integrated into regimes that regulate activities, which are potentially harmful to biodiversity, such as deep seabed mining.

[48] see also Table 7 in Annex 3

[49] see https://www.cbd.int/ebsa/

The implementation of the above goals, as well as the ambitious goals of the new Paris Agreement on climate change (UN Framework Convention on Climate Change, 2015), requires a transformation in production, consumption, and management patterns. The UN Secretary-General described the direction of this transformation as follows:

> *'To respect our planetary boundaries we need to equitably address climate change, halt biodiversity loss (...). We must protect our oceans, seas, rivers and atmosphere as our global heritage, and achieve climate justice. We must (...) decouple economic growth from environmental degradation, advance sustainable industrialisation (...); ensure sustainable consumption and production; and achieve sustainable management of marine and terrestrial ecosystems and land use' (UN Secretary General, 2014).*

However, marine governance in waters beyond national jurisdiction is highly fragmented and inadequate to the need for transformation and effective biodiversity conservation (Ban *et al.*, 2014). In addition, the different legal regimes for managing biodiversity conservation and sustainable use in the water column (high seas, UNCLOS, Part VII), and on the seabed, the Area (UNCLOS, Part XI), prevent a coherent approach (e.g., Warner, 2014).

With regard to the conservation of high seas biodiversity Durussel (2015) identified the main institutional challenges are (e.g., Ardron *et al.*, 2014b; Durussel, 2015; Gjerde *et al.*, 2013):

- The fragmented and sector-based management of the oceans;
- The lack of a comprehensive legal framework for the high seas encompassing all biodiversity components;
- The lack of cooperation and coordination between States and between institutions with a mandate to work on the high seas; and
- The lack of implementation and enforcement of existing legal instruments and measures.

It is further noted that the current institutional regulatory regime in place for the high seas is sector-based and focuses on activities such as fishing, shipping or deep seabed mining. Not all activities taking place on the high seas are covered by this regime and it only covers some activities in a fragmented and geographically selective manner at the regional and global levels. There is currently:

- No institution specifically working on high seas biodiversity related issues;
- No coordinating institution amongst global and regional bodies for high seas related matters;
- No institution to oversee the application of conservation principles and management tools, the effective compliance and enforcement of rules and regulations, or to assess the degree of cumulative impacts of present and future ocean uses.

The management of high seas biodiversity occurs indirectly through a scattered network of laws and institutions. In particular, the sector-based institutional regulatory framework in place has been described as inadequate to take into account the cumulative impacts of all human activities currently taking place and that may take place in the future on the high seas and in the deep seas.

2.2.3 The way forward for the High Seas

In 2015, the UN resolved to negotiate a new implementing agreement for comprehensively addressing the need for conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction. Since 2015, a Preparatory Committee has met biannually to make substantive recommendations to the General Assembly on elements of a draft text of an international legally-binding instrument under the UN Convention on the Law of the Sea. The currently proposed elements include (UN GA Res. A/69/780) the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction, in particular together and as a whole, marine genetic resources, including questions on the sharing of benefits; area-based management tools, incl. marine protected areas; environmental impact assessments; and capacity building and the transfer of marine technology. In 2017, a recommendation to the United Nations General Assembly was agreed to advance an Intergovernmental Conference (IGC) to negotiate a potential Open Ocean Treaty for the protection of biodiversity and ecosystems beyond national jurisdiction[50].

2.2.4 Contribution of the ISA

Mining the mineral resources of the Area is an activity which has been included in the UN Law of the Sea (UNCLOS, Dec. 10, 1982), with a dedicated set of rules adopted in Part XI, and the related Implementing Agreement adopted in 1994. Since then, a number of international conventions and agreements have been developed and agreed, which complement and extend the UNCLOS framework with regards to the protection of the marine environment (Warner, 2014), which are also relevant for the scope of the rules, regulations and procedures to be agreed and implemented by the ISA and its member states.

In the Area, the International Seabed Authority (ISA) already has the competences for sectoral regulation and the use of tools such as marine protected areas or prior environmental impact assessments (Lodge, 2011). Although not directly responsible for the protection of biodiversity in the Area, the UN Convention on the Law of the Sea (UNCLOS) nevertheless requires the ISA to ensure that the activities related to prospection, exploration, exploitation and processing of seabed minerals at sea do not interfere with its obligation to 'ensure effective protection for the marine environment from harmful effects' (Art. 145) by adopting rules and regulations for:

- The prevention, reduction and control of pollution and other hazards;
- The prevention, reduction and control of interference with the ecological balance of the marine environment;
- The protection and conservation of the natural resources of the Area; and
- The prevention of damage to the flora and fauna of the marine environment (Jaeckel, 2015a).

The above obligations of ISA complement the legal duties of all states individually to '*protect and preserve the marine environment*' (Art. 192) and to '*protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life*' (Art. 194(5)). In formulating international rules and standards, states must take into account '*characteristic regional features*' of marine environments (Art. 197), which in the deep ocean context includes unique, slow-growing and largely unchartered ecosystems.

So far, ISA has not yet formulated an overarching conservation vision which could guide the evaluation of seabed mining-related environmental impacts. However, the Environmental Management Plan for the Clarion-Clipperton-Zone (EMP, International Seabed Authority, 2011) is a first document in which the ISA sets out a regional conservation vision, goals and objectives with respect to the impacts of deep seabed mining on biodiversity (see further Chapter 3.3.1). The environmental aspirations expressed clearly aim to strike a balance between the facilitation of mining while seeking to conserve biodiversity as far as possible. One of the goals of the EMP is a contribution to the targets agreed by the Plan of Implementation of the World Summit on Sustainable Development (WSSD, 2002) including

- To halt the loss of biodiversity
- To establish ecosystem approaches to management
- To develop marine protected areas, including representative networks by 2012.

[50] http://www.un.org/depts/los/biodiversity/prepcom_files/Procedural_report_of_BBNJ_PrepCom.pdf

Most crucial is the term '*minimising as far as practically possible the impacts*', and '*reduce impact on the biota of the marine environment*', which implies that technical and economic criteria may in the end determine the level of ecosystem damage. In addition, the Environmental Management Plan currently has no legal implications for contractors, see Jaeckel (2015a) and Chapter **3.4.3** on adaptive management.

In addition to these low ambition objectives for the region, the current practice of approval of Plans of Work submitted by applicants for the exploration of minerals in the Area for approval by ISA (the Legal and Technical Commission) is ineffective as long as

- It is undefined what effective environmental protection means;
- No criteria exist to assess the environmental performance of the proposed work;
- Ecologically significant (CBD EBSAs), particularly vulnerable (FAO VMEs) or designated marine protected areas by other international organisations (e.g. OSPAR or CCAMLR MPAs) need not be considered or even mentioned in a PoW (see Chapter 2.1.9);
- There is no detailed and transparent environmental impact assessment for the proposed work; and
- The information on how the proposed work aims to protect the marine environment is not available (International Seabed Authority, 2017d).

As long as there are no agreed global, regional and/or site-specific conservation objectives in relation to a prospective deep seabed mining regime in the Area, it is unclear what 'effective protection of the marine environment' entails in detail. However, (Gjerde and Jaeckel, 2017) make clear, that the '*achievement of this aim will entail a comprehensive approach that integrates environmental protection into all mining-related activities by the Authority, Member States, Sponsoring States and contractors, with expert input from scientists and participation from civil society*'.

With respect to 'Vulnerable Marine Ecosystems, VMEs' (FAO, 2009; UNGA, 2006), protected from deepwater bottom trawling, the LTC is required to determine whether proposed exploration activities in the Area would have serious adverse effects on '*in particular those associated with seamounts and cold-water corals*' as well as hydrothermal vents[51]. It is the task of the LTC to ensure that if serious harmful effects can be expected 'those activities are managed to prevent such effects or not authorized to proceed.' However, despite repeated calls for action from the UN General Assembly[52] the ISA has not yet acted upon this obligation (see further Chapter 2.1.9).

Overall, a contribution of ISA to the WSSD and CBD targets seems a bit dubious. ISA is the institution which aims to facilitate the expansion of the human footprint to hitherto near-pristine, and extremely vulnerable ecosystems at great depths. Any measures such as 'Areas of particular Environmental Interest', APEIs, merely protect against any future activities of the mining sector in areas outside the core interest of manganese nodule miners - and even those are not cast in stone (Jaeckel, 2017). Given the insufficient knowledge of ecological processes (see Chapter 2.3) and the technological effects on the environment, a particularly low threshold of probability for harm and ecological risk is needed to trigger precautionary action by the ISA and Sponsoring States as part of their due diligence (ITLOS, 2011, para 110).

[51] Nodules Exploration Regulations, regulation 31(4); Sulphides and Crusts Exploration Regulations, regulation 33(4).

[52] UN Doc A/Res/67/78 (11 December 2012), paragraphs 190-191; UN Doc A/RES/68/70 (9 December 2013), paragraphs 206-207; UN Doc A/RES/69/245 (29 December 2014), paragraphs 221-222.

2.2.5 Outlook

So far, the ISA is the only institution which has the competences to implement measures for the effective protection of the marine environment from impacts arising from human activities in areas beyond national jurisdiction. Therefore, it is not a question of the availability of the powers to do so, but of the structures and processes to effectively implement it. However, this is a sectoral response strategy rather than a proactive preservation action as the UN Implementing Agreement may seek to address. Only when proactive measures are possible to protect the environment for its own good, for its crucial ecosystem services, or in response to particular vulnerabilities, then potentially unsustainable sectoral activities such as deep seabed mining should be considered to be allowed.

While the new UN agreement is in the making, one step forward to achieve a more comprehensive impact and management vision for ocean areas potentially subject to minerals mining would be the development of working relations with other global and regional management organisations and regional environmental conventions, where they exist. For example, the Memorandum of Understanding of ISA with OSPAR (ISBA/18/C/10) has not yet led to any measures by ISA in the marine protected areas designated in the OSPAR area in ABNJ. OSPAR also has a comprehensive set of principles, tools and guidelines to be instrumental to environmental protection which could usefully be contributed to ISAs sectoral development of environmental practices.

The drafting of the future regulations for the exploitation of marine minerals in the Area provides the opportunity to initiate a discussion process together with stakeholders on how to implement '*effective protection for the marine environment from harmful effects which may arise from such activities*' (Art. 145). This requires the adoption of conservation goals to determine management direction and thresholds, if possible as part of an Environmental Strategy agreed with stakeholders, the better integration of external scientific advice, and the setting up of a regulatory framework which enables the effective control of activities and allows for adjustments of the environmental framework to be binding also after contracts have been granted (International Seabed Authority, 2017d).

In addition, a global debate should be led on whether the cumulative impacts to be expected from seabed mining are compatible with the marine environmental protection goals, and about the implications of the Common Heritage status of the Area and its resources (see Chapter 3.4.2).

2.2.6 Recommendations

Recommendations
▸ The ISA should start a transparent process now to develop its vision for how deep seabed mining can be harmonised with the overarching obligation to protect the marine environment, the CBD biodiversity targets, the global sustainability agenda and, in particular, with a new legally binding instrument for marine biodiversity in ABNJ; ▸ The ISA should develop a comprehensive set of mechanisms to translate the obligations contained in Article 145 into precautionary regulatory action; ▸ The ISA's regulations and institutional processes must take the regulations and decisions of other international organisations into account, such as those concerning marine protected areas, VMEs and EBSAs in order to contribute to achieving the global biodiversity and sustainability targets; ▸ The ISA needs to develop its approach to communication and collaboration with other international management authorities such as the International Maritime Organisation and regional fisheries management organisations. The aim should be to enable regional, cross-

sectoral strategic environmental assessments of human activities to ensure optimal environmental conservation and to minimise conflicting uses.

2.3 The known, the unknown, and the unknowable about the deep ocean ecology

2.3.1 Introduction

The deep sea (waters beyond 200 m depth or the continental shelf, Gage and Tyler, 1991) is a realm of near-total darkness, cold temperatures (0-10° C), great depth (on average 3.7 km) and related high pressure. The volume of ocean water acts as a main buffering system to the effects of global warming at the price of acidification, rising temperatures, increasing stratification and oxygen minimum zones, changing patterns of production and biogeochemical flux (Reid *et al.*, 2009), which all influence ecosystem functioning and ecosystem service provisioning (Sweetman *et al.*, 2017; Thurber *et al.*, 2014).

Most heterotrophic life in the deep ocean depends on export of organic material from the photic zone, which is effectively recycled in the water column (Mayor *et al.*, 2014) before it reaches the seafloor (only 1 % of the surface production is finally buried). In addition, chemoautotrophic biomass production and carbon fixation occurs locally at, for example, hydrothermal vents and cold seeps, but also everywhere by benthic archaea (Danovaro *et al.*, 2014) and by water column protists (Arìstegui *et al.*, 2009).

Recent research has challenged a number of paradigms of ocean research, starting from the discovery of chemoautotrophic production at submarine hydrothermal vents and seeps (Baker *et al.*, 2010), the unpuzzling of oligotrophic ecosystems (Hagström *et al.*, 1988; Kletou and Hall-Spencer, 2012) to the acknowledgement of the important role of water column and seafloor microbes (Jørgensen and Boetius, 2007; Zinger *et al.*, 2011) and archaea (Karner *et al.*, 2001). Although much about the dynamics and processes in the ocean interior are still unknown, recent assessments suggest that integrated respiration of organisms below the epipelagic zone is comparable to that in the epipelagic zone, and that the dark ocean is a site of paramount importance for material cycling in the biosphere (Arìstegui *et al.*, 2009).

Not only new species of microscopic size are continuously being discovered, but even large metazoans like new species of fish (e.g., Pietsch and Sutton, 2015) and mammals (Wada *et al.*, 2003). Furthermore, new scientific investigation techniques such as those allowing for visual inspection of habitats and organisms, tagging of individuals, and modern acoustic mapping very slowly open up the window to study marine animal behaviour.

A widely accepted paradigm in ecology is the general link between biodiversity (loss) and the functioning of ecosystems, as summarised in six scientific consensus statements (Cardinale *et al.*, 2012):

- Biodiversity loss reduces the efficiency by which ecological communities capture biologically essential resources, produce biomass, decompose and recycle biologically essential nutrients.
- Biodiversity increases the stability of ecosystem functions through time.
- The impact of biodiversity on any single ecosystem process is nonlinear and saturating, such that change accelerates as biodiversity loss increases.
- Both the identity and the diversity of organisms jointly control the functioning of ecosystems.
- Loss of diversity across trophic levels has the potential to influence ecosystem functions even more strongly than diversity loss within trophic levels.
- Functional traits of organisms have large impacts on the expression of ecosystem functions, so loss of different organisms/functional traits result in different changes of ecosystem function.

The researchers (Cardinale *et al.*, 2012) suggest that the impact of biodiversity loss on ecological processes is overall of the same magnitude as that 'of other global drivers'. Moreover, they suggest that the impact is growing stronger with time and that as a result of biodiversity loss ecosystems processes will become less complex.

Presently, there are interests in exploiting three types of mineral concretions in the deep sea of the Area: the manganese nodule fields in some regions of the abyssal plain, the seafloor massive sulphide concretions created by hydrothermal vents, and the cobalt-rich crust on the flanks and summits of some types of seamounts. The exploitation of these resources is likely to have substantial ecological impacts that are and will remain to some extent unknown, and will likely be irreversible on the conventionally used time scale (e.g., Glover and Smith, 2003; Ramirez-Llodra *et al.*, 2011; Van Dover *et al.*, 2017). In particular, this new activity will extend the human footprint to the so far least affected oceanic regions at great depth.

All available scientific ecological knowledge points to the particular sensitivity and vulnerability of habitats and species of the deep ocean (Ramirez-Llodra *et al.*, 2010). Therefore, it is likely that decades of seabed mining will add to the ongoing loss of marine species, habitats and ecosystem services (Gollner *et al.*, 2017; Mengerink *et al.*, 2014; Niner *et al.*, 2018; Ramirez-Llodra *et al.*, 2010; Vanreusel *et al.*, 2016), and will impair the chances for reaching the globally agreed biodiversity, sustainable development and climate targets (Convention on Biological Diversity, 2012b; UN Framework Convention on Climate Change, 2015; UN General Assembly, 2015).

2.3.2 The Known

2.3.2.1 Abyssal Plains

General Characteristics

The abyssal landscape, at depths between 4,000 and 6,000 m below the sea surface, essentially consists of vast sedimentary plains and rolling hills, punctured by seamounts, and subdivided by mid-ocean ridges, island arcs and ocean trenches (Glover *et al.*, 2016; Smith *et al.*, 2008a). Due to latitudinal, longitudinal and ocean-scale differences in surface production and sedimentation patterns, the abyssal faunal composition, biomass and ecological processes differ from ocean to ocean and often from ocean basin to ocean basin, as e.g. in the North Atlantic (Christiansen and Thiel, 1992; Thurston *et al.*, 1995; Thurston *et al.*, 1994; Thurston *et al.*, 1998) and Pacific (Glover *et al.*, 2010; Ruhl *et al.*, 2008; Smith *et al.*, 1997; Smith *et al.*, 2008a).

General ecological characteristics of abyssal benthic habitats

Summary modified after Smith *et al.* (2008b):

- Waters are well-oxygenated, temperatures are -0.5-3°C and the current velocity is usually too low to cause sediment erosion;
- The seafloor sediments are usually very fine (medium sands to clay), and oxygenated to the depth of bioturbation, with intermediate regions of (semi-buried) hard substrate provided by manganese nodules or man-made debris such as clinker;
- The habitat structure is exclusively biogenic, bioturbation ensuring the oxygenation of the upper sediment;
- There is no primary production, except locally by hydrothermal vents and cold seeps where they occur;
- Therefore, the dependence on food flux from the upper water layers causes the system to be food/energy limitated. The arrival of digestible carbon depends on the quantity and quality of surface production, as well as the re-working of material in the pelagic systems on the way down.

Ecosystem stability

The abyssal ecosystems are probably the least disturbed ecosystems on earth, with certainly the most stable physical environmental conditions. Nonetheless, due to their dependence on the surface production, the deep-sea ecosystems are subject to seasonally, interannually and aperiodically varying food input (Lampitt, 1985; Lampitt *et al.*, 2001; Thiel *et al.*, 1988/89) and occasional food falls (e.g., Smith *et al.*, 2015), and they are thus intricately linked to the changes in large scale climate oscillations (Ruhl and Smith, 2004; Smith Jr *et al.*, 2009) and quantitative trends in organic matter production and flux (Jones *et al.*, 2013; Sweetman *et al.*, 2017). The links consist likely in the modulation of the plankton community; for example, high North Atlantic Oscillation (NAO) patterns are possibly related to increased scalp abundance, whose fast sinking faecal pellets directly couple surface processes with the abyssal sediment dwelling benthic fauna such as holothurians (reviewed by Ruhl and Smith, 2004; Smith *et al.*, 2008a; Smith Jr. *et al.*, 2014). In addition, ephemeral events such as eddies may speed up bottom currents and turbulence (MIDAS Consortium, 2016; Palacios *et al.*, 2006), and eventually fertilise and enhance deep ocean productivity (Company *et al.*, 2008).

In effect, the fundamental properties of ecosystem structure and function in the abyss are likely to be highly sensitive to climate-driven changes in the upper ocean (Glover *et al.*, 2010; Smith *et al.*, 2008a). In addition, climate-change related alterations of the ocean temperature, stratification patterns and carbonate balance will act synergistically with other pressures on the ecosystem structures and functions (Levin and Le Bris, 2015; Smith *et al.*, 2008a; Smith Jr *et al.*, 2009; Sweetman *et al.*, 2017).

For example, in the equatorial Pacific, such as in the Clarion-Clipperton-Zone (CCZ) region, the surface productivity and therefore the amount of organic carbon reaching the seafloor is generally very low (Rex *et al.*, 2006), with some increase towards the equatorial upwelling and from west to east (Glover *et al.*, 2002; Smith *et al.*, 1997; Veillette *et al.*, 2007); however, an overall decreasing trend due to the effects of global warming can be anticipated (Behrenfeld *et al.*, 2006). Accordingly, the overall faunal density in the region is very low and might decrease further. At a smaller scale, the density of manganese nodules affects the density of mobile epifauna, which ranged between 4-15 ind/100 m^2 in nodule areas and 1-3 ind/100 m^2 in areas without nodules (Vanreusel *et al.*, 2016). Sessile epifauna densities likewise reach 14-30 ind/100 m^2 and less than 8 ind/100 m^2, respectively, in areas with or without nodules (Vanreusel *et al.*, 2016). However, the spatial variability is high as shown by (Amon *et al.*, 2016). Estimates of metazoan megafaunal abundance varied between contract areas within the CCZ and were found to be higher in the UK-1 area than elsewhere. In comparison with other abyssal habitats, the overall metazoan megafaunal abundance estimated from camera observations in the UK-1 contract area of the CCZ (0.83 ind /m^2) was found to be lower than at station M in the central North Pacific, but higher by at least one order of magnitude than at the DISCOL site in the Peru Basin and on the Porcupine Abyssal Plain in the North Atlantic (Amon *et al.*, 2016).

The relative stability or predictability of the environmental conditions in the deep sea obviously favours the long-term evolution of a particular benthic community dominated by K-strategic species (Grassle and Sanders, 1973), characterised by slow growth, late maturity, low reproductive output and longevity. Many deep-sea organisms are physiologically adapted to sporadic food uptake (e.g., Smith *et al.*, 2008a), being able to adapt their metabolism. Food and substrate availability are the limiting factors shaping the prevailing benthic communities (Ruhl *et al.*, 2008), but a disturbance, such as an artificial substrate or organic enrichment (e.g. a whale fall) at abyssal depth, reveals the full community potential, with otherwise rare species then rapidly colonising the new habitat and dominating the community structure there (Smith *et al.*, 2015). Hence, as in shallow water, the deepwater fauna adapts to disturbance with a change in community structure and function (reviewed by Levin and Gooday, 2003; Snelgrove and Smith, 2002), but at different time scales.

Biodiversity

Contrary to earlier perceptions, the abyssal seafloor exhibits a habitat heterogeneity comparable to shallower areas (Ebbe *et al.*, 2010). One important factor adding significantly to the abiotic heterogeneity of the seafloor is bioturbation, which may crucially increase the community diversity (Loreau, 2008). The high local and micro-scale habitat heterogeneity, in conjunction with the evolutionary age of the habitat, is driving the enormous species diversity of benthic fauna in the abyss generally, and in the nodule-rich areas in particular (Amon *et al.*, 2016; Mullineaux, 1987; Snelgrove and Smith, 2002; Vanreusel *et al.*, 2010). Here, the habitat richness not only relates to the additional availability of hard substratum for settlement of the abyssal megafauna and macrofauna on the outside of the nodules (Veillette *et al.*, 2007), but also to the large inner surface of the nodules, which provides room for endemic meiofaunal and bacterial communities (Blöthe *et al.*, 2015; Bussau *et al.*, 1995; Thiel *et al.*, 1993).

Distinct seafloor morphologies are characterized by highly distinct, diverse faunal assemblages, whereas areas sharing similar seabed morphologies host similar assemblages (Zeppilli *et al.*, 2016b). In the case of the manganese nodule fields in the Clarion-Clipperton-Zone, the substrate provided by the nodules creates a specific habitat with a typical associated fauna (Smet *et al.*, 2017; Vanreusel *et al.*, 2016; Veillette *et al.*, 2007). One particular group are giant protists, Xenophyophores, often sessile on the nodules and creating secondary habitats, which are exceptionally diverse in the region (Gooday *et al.*, 2017). The total species richness of sediment-dwelling foraminiferans, nematodes and polychaetes (a subset of the total fauna) at a single site in the CCZ was estimated to easily exceed 1,000 species (Smith *et al.*, 2008b). Regionally, the community structure of the foraminiferans and polychaetes differ substantially over scales of 1,000–3,000 km (Smith *et al.*, 2008b).

Occasional stones and pebbles give substrate to sea anemones and sea pens which are the most commonly found members of the sessile megafauna in otherwise sedimentary areas. Sponges, sea cucumbers and crinoids also frequently appear on bottom photographs, whereas crustaceans, gastropods, cephalopods, sipunculids and madreporarians are rarely observed.

Part of the fauna of manganese nodules is a typical hard substratum community of the deep sea, with faunal diversity increasing with the number of microhabitats (Veillette *et al.*, 2007). The average coverage of nodules by eucaryotic fauna is 10 %, consisting commonly of suspension-feeding metazoans and rhizopod protozoans (Mullineaux, 1987). But manganese nodules provide the habitat also for a distinctive nodule fauna settling on or encrusting the substrate (Mullineaux, 1987, 1989), in the crevices (Thiel *et al.*, 1993), and within the nodule (Blöthe *et al.*, 2015; Wu *et al.*, 2013). One major element of the nodule fauna are mat- or net-like foraminifera (Mullineaux, 1987; Veillette *et al.*, 2007). The crevices within the nodules are populated with up to 170 individuals per nodule of nematodes, copepods and other small taxa (Thiel *et al.*, 1993). It is likely that biomineralisation, particularly by bacteria and foraminifera, is an important component of nodule formation, as reviewed in Mullineaux (1987) and Wang and Müller (2009).

Metazoans mostly dwell on the largest nodules, which may be related to the higher current flow necessary for suspension feeding (Veillette *et al.*, 2007). Sponges, actinians, octocorals, gorgonian and anthipatharian corals and crinoids are the main epifauna of manganese nodules, and are themselves colonised by a large variety of mostly suspension feeding organisms (Beaulieu, 2001; Bluhm, 1994; Tilot, 2006). In nodule sites in the Southeast Pacific, almost every manganese nodule is colonized by epifauna (Bluhm, 1994).

Ecosystem functions and food web

Using nematode diversity as a proxy for functional diversity of the whole benthic community (Smith *et al.*, 2008a), we can conclude on the functional capacity of the ecosystem (Danovaro *et al.*, 2008). Each habitat hosts certain nematode genera that are usually rare in 'typical' bathyal and abyssal sediments. Therefore, the abyss acts as a species pool, preserving taxa that are usually rare in soft sediments (Vanreusel *et al.*, 2010).

2.3.2.2 Hydrothermal vents

General Characteristics

Hydrothermal vents are geologically and biologically unique features on earth. They are found at ocean ridges, where the tectonic plates move apart and magma rises to the sub-surface and erupts at the seafloor. Due to the rock deformation, seawater penetrates through cracks in the ocean floor to great depth, where it is heated to 350-400 °C, and rises as acidified solution back to the surface, enriched with large amounts of dissolved material, especially hydrogen sulfide (H_2S), various sulfide minerals, metals, carbon dioxide (CO_2) and methane. Depending on the pressure of ejection and the ambient temperature (depth), crystallisation of the sulfide minerals forms chimneys known as 'black' or 'white smokers' for their colour (see e.g. OSPAR Commission, 2010a). Hydrothermal processes control the transfer of energy and matter from the interior of earth to its crust, hydrosphere and biosphere. They provide lessons to be learned with regard to their influence on ocean temperature, circulation patterns, chemistry and biology, the early genesis of earth and the possible development of life on earth.

Since their first discovery in 1977, vent fields have been found in all oceans (Beaulieu *et al.*, 2013; Rona *et al.*, 2010), and they are expected to occur approximately 100 km apart from each other (Cherkashov *et al.*, 2010). Still very little is known about most of the 50,000 km of ocean ridges. The Mid Atlantic and Central Indian Ridges are slow-spreading, the South-West Indian Ocean and Arctic ultra-slow-spreading ridges (MAR 2.5 cm, and SWIO 14 mm per year, respectively), compared with more active ridges such as the East Pacific Rise (approx. 6 cm per year), both types display a high site-specific variability due to different host rocks, depth and heat sources (Rona *et al.*, 2010). Faunal provinces develop depending on biogeographic history and present day environment in the different ocean basins (Moalic *et al.*, 2012).

Hydrothermal vents support some of the most unusual animal communities on earth, which depend, by contrast to the 'normal' deep-sea fauna, on chemolitho-autotrophic bacteria as the basis of the food web, using hydrogen sulfide to fuel the production of organic carbon. In the Pacific, the dominant vent fauna, e.g. the tube worm *Riftia pachyptila* and the clam *Calyptogena magnifica,* derive their energy from endosymbiontic bacteria in their gills, whereas in the Atlantic, in addition to clams (e.g., *Bathymodiolus azoricus*) associated with endosymbiontic bacteria, for example the shrimps *Rimicaris exoculata* appear to depend on ectosymbionts living in their digestive tracts.

Ecosystem stability

On geological time scales, the taxonomic composition of vent communities has changed considerably through time, and most modern vent animal groups arose only relatively recently from shallower sources after a major extinction event in the late Mesooic/early Tertiary (Little and Vrijenhoek, 2003). So rather than providing a shelter for species survival in times of change, there is no support for the earlier hypothesis that these deep-sea chemosynthetic environments are immune from global extinction events which affect diversity in the photic zone (Little and Vrijenhoek, 2003).

Depending on the geological setting (seafloor spreading rate, thickness of crust), hydrothermal vents are subject to periodic or infrequent volcanic eruptions (Rubin *et al.*, 2012). The variability in hydrothermal discharges from the short-term to decadal time scale causes temporal and spatial evolution of the animal communities associated with the vents, the lifetime of individual vents ranging from decades to centuries. On slow spreading ridges such as the Mid-Atlantic Ridge, the hydrothermal activity is spatially more focused and stable over the long-term (Copley *et al.*, 2007), even if the lifetime of an individual vent site is similar to that on fast spreading ridges (Comtet & Desbruyères, 1998 in OSPAR Commission, 2010a). Vent fields can persist for up to 120,000 years, as in the case of the off-axis vent field Lost City with 60 m high chimneys (Denny *et al.*, 2016). And SMS deposits accumulated over time extend over much larger areas in stable vent fields than on fast spreading ridges. For example, intermittent pattern of venting over the past 50,000 years have created the TAG hydrothermal mound at 26°N on the Mid Atlantic Ridge, which is one of the largest known submarine hydrothermal deposits, comprising a mound 200 m in diameter and 60 m high principally composed of massive sulphides (Copley *et al.*, 2007). Its current activity is thought to have started about 60 years ago after 4,000 years of quiescence (Lalou et al., 1993 in Copley *et al.*, 2007).

The fundamental drivers of vent faunal community structure therefore vary with the geological setting (host rock, spreading type of ridge), the composition and variability of the resulting vent fluid chemistry, differences in depth, life history strategies of individual species, and the geographic distance separating vent sites (Beedessee *et al.*, 2013; Desbruyères *et al.*, 2000; Van Dover *et al.*, 2002). Vent associated invertebrates display life-history characters of opportunistic species, *i.e.* those adapted to disturbance events, which suggests that infrequent and unpredictable disturbance events influence population development (Van Dover, 2014).

Therefore, the hydrothermal vent communities on the mid ocean ridges are comparatively adapted to disturbance, quite to the contrary of the 'normal' deep-sea environment which occupies the opposite end of the disturbance-resilience spectrum (Van Dover, 2014). However, recruitment patterns and larval connectivity between sites is hitherto one of the great unknowns of hydrothermal vent communities (Hilário *et al.*, 2015; Metaxas, 2011). At least for some species, such as for example the vent mussel *Bathymodiolus azoricus*, the larval release is triggered by the seasonal peak in primary production and resultant organic flux to the seafloor (Dixon *et al.*, 2006).

It has been suggested that the deepest vent fields (>3,000 m) on the Mid Atlantic Ridge are geologically stable systems, while the shallower vent fields, in particular Rainbow and Menez Gwen, display some signs of venting instability in time and space (Desbruyères *et al.*, 2000). Nonetheless, the vent communities south of the Azores have not displayed any ecological changes since their discovery and this is taken as an indication for spatially and temporally stable communities (OSPAR Commission, 2010a).

Biodiversity

The vent associated organisms are adapted to locally very steep temperature gradients, transient extremes reaching up to 113° C, low oxygen and potentially toxic concentrations of sulphur, heavy metals and radionuclides in the water. The fauna thus thrives in patchy, transient and highly fractured places with distinct environmental features and cues (temperature, presence of sulphide and CH4, hard ground, particle flux; (Vanreusel *et al.*, 2009). The species-specific dispersal relies on larval dispersal, which depends on larval duration, current transport, settling conditions and more (Gollner *et al.*, 2017 and literature quoted).

Overall, more than 700 species from 373 genera have been recorded at hydrothermal vents, of which 71 % are endemic to vents, 5 % are also known from cold seeps or whale falls, and 9 % also occur in the surrounding non-vent habitats (Wolff, 2005). The prevailing groups are molluscs, arthropods and polychaetes (Wolff, 2005).

Mid Atlantic Ridge

Overall, the Mid-Atlantic Ridge, MAR, fauna has a community composition unlike any other global vent province (Bachraty *et al.*, 2009). More than 225 macrofaunal species have been recognized on the Mid Atlantic Ridge (Kelley and Shank, 2010), whereas, Mid-Atlantic vent sites typically host between ~35 (e.g., Rainbow and Lost City) and 80 (e.g., Menez Gwen and Snake Pit) (Cherkashov *et al.*, 2010) macrofaunal species; the highest diversity was described at Lucky Strike with 110 species. As regards the background fauna, sponge and anemone species were found to be most diverse at the shallowest site, Menez Gwen, while echinoderms and nematodes were more diverse at the deeper Atlantic sites. With the exception of a few ubiquitous species, most of the invertebrate vent species have been found only in one or two of the vent fields between Menez Gwen at 37° N and Ashadse at 12° N on the MAR (Kelley and Shank, 2010), resulting in species communities differing considerably between sites. While in the northern and shallower vent fields on the MAR, such as Lucky Strike and Menez Gwen, the mussel *Bathymodiolus azoricus* is the dominant species, the southern and deeper vent fields, namely TAG, Broken Spur and Snake Pit, are dominated by the bresiliid shrimp *Rimicaris exoculata* (Gebruk *et al.*, 1997). Rainbow is part of the continuum between the *Bathymodiolus* (mussel)-dominated and *Rimicaris* (shrimp)-dominated assemblages, with elements from both extremes (Desbruyères *et al.*, 2000; Desbruyères *et al.*, 2001). These differences cannot be explained by bathymetric zonation or geographic distance, but are more likely caused by the metallic content of the fluids.

The fauna of the vent fields further south, in the ISA contract area of Russia, is described by Gebruk (pers. comm.) in the box below.

Contract area of the Russion Federation on the Mid Atlantic Ridge

The sector of the Mid-Atlantic Ridge claimed by the Russian Federation for sulphide exploration/prospecting extends approximately from 12̊ N to 20̊ N. There are ten hydrothermal vent areas in this sector, three active and seven inactive. Active areas include Logatchev at 14°45́ (year of discovery 1994), Ashadze, 12°58́ (2003) and Semyenov, 13°31́ (2007). Inactive areas are Puy des Folles 20̊ 31′ (1996), Krasnov 16°38́ (2004), Zenit-Victoriya 20°08́ (2008), Peterburgskoe 19°52́ (2010), Irinovskoe, 13°19́ (2011), Jubilee, 20°09 (2012) and Surprise, 20°45 (2012). Further vent and ore fields have been discovered (Molodtsova *et al.*, 2017).

The Logatchev region includes two active vent areas known as Logatchev-1 and -2 and three relict hydrothermal fields, Logactchev-3, -4 and -5. The Logatchev-1, depth 2900-3050 m, formerly known as '14-45', is the largest and the most active in the region. Logatchev-1 is characterized by a wide range of hot vent habitats, including chimney complexes at different stage of activity, 'smoking craters' and warm flows through the soft sediment. The number of species recorded at Logatchev-1 is close to 40. Among them 70% are obligate to hydrothermal vents and 14% are endemic to the area. The main biological peculiarity of Logatchev-1 is the population of vesicomyid clams co-occurring with mussels *Bathymodiolus puteoserpentis* and thyasirids *Thyasira* (*Parathyasira*) sp. at the site Anya's Garden. This is the only known live population of vesicomyids north of the equator on the MAR. The record biomass for hydrothermal vents on the MAR was registered at Logatchev-1: over 70 kg m^{-2} (wet weight with shells) in the 0.3 m thick layer was reported for the population of mussels at the site Irina-2.

Ashadze lying at 4080 m depth is the deepest hot vent area on the MAR. The number of species known from this area is 45. At least 11% of species are endemic to Ashadze (very conservative estimate). The hot vent community structure at Ashadze is unusual: it is the only deep-sea hot vent community dominated by non-symbiotrophic species: the anemone *Maractis rimicarivora* and the chaetopterid polychaete *Phyllochaetopterus pollus*. Symbiotrophs in this area are represented by single individuals of the shrimp *Rimicaris exoculata*.

Data on the biota of Semyenov are very preliminary. Of special interest is the record in this area of the shrimp *Opaepele susannae*. This species has been described from two locations on the MAR south of equator: Lilliput (9°32’S, 1500 m) and Sisters Peak (4°48’S, 2986 m). Various aspects of regional biodiversity related to sulphide exploration will be discussed.

Text: Gebruk, A., 2013. Biological peculiarities of hydrothermal vent areas in the MAR sector claimed by Russian Federation for sulphide exploration. Text of poster submitted to 5th Symposium on Chemosynthesis-based Ecosystems, 18-23 August 2013, Vancouver, Canada.

Obligatory hydrothermal vent benthic species are dependent on hydrothermally active or other habitats providing energy-rich compounds (e.g. whale falls, some cold seeps) for propagation. Therefore, the pelagic larvae of benthic species either have to settle within the vent field of birth, or be able to endure prolonged drift until they reach a suitable site for settlement (reviewed by Hilário *et al.*, 2015; Van Dover, 2014). The predominant migration pathway is along-ridge transport following the prehistoric plate tectonics (Tunnicliffe and Fowler, 1996). Therefore, the distribution range of larvae originating from species in isolated chemosynthetic habitats is likely not only species- dependent, but is driven also by the regional setting and plate-tectonic processes on an evolutionary time scale (Van Dover *et al.*, 2002). Short and long-distance settlement patterns likely act in concert to maintain local populations and facilitate gene flow.

The fish fauna so far recorded at active hydrothermal vents in the Atlantic consists of members of 4 families (Synaphobranchidae, Gadidae, Zoarcidae, Bythitidae), comprising many undescribed species (Biscoito *et al.*, 2002). The highest number of species per site was three. A literature review revealed 43 species of the families Macrouridae, Ophidiidae, Squalidae, Moridae and Synaphobranchidae in the vicinity of vents in the Atlantic (Biscoito *et al.*, 2002).

<u>Indian Ocean Ridge</u>

It is not even 20 years ago that the first communities associated with hydrothermal vents in the Indian Ocean were discovered (Hashimoto *et al.*, 2001; Van Dover *et al.*, 2001), and further vent sites and communities, as well as new types of symbioses have been met with almost every scientific expedition. New discoveries include, a.o., a hydrothermal megaplume and microbes with unique tolerances, which may hold some potential for biotechnological development[53]. On the basis of DNA-sequencing, the dominant fauna of the Indian Ocean vent communities resembles partly those of the Atlantic (e.g. the shrimp *Rimicaris* spp) and partly those of the Pacific (e.g. alvinellid polychaetes) which suggests a connection between ocean basins on evolutionary time scales (Van Dover *et al.*, 2001). A substantial faunal connectivity seems to exist also along the ridge (Beedessee *et al.*, 2013; Gollner *et al.*, 2016).

Ecosystem functions and food web

Hydrothermal vent systems have an ecological footprint which is far larger than the actual vent field (Levin *et al.*, 2016a): Further to modification of global biogeochemical and elemental cycles through heat, minerals and particulates ejected from the vents, also the biotic environment is being modified on large scale by providing the basis for a vent-based food web, establishing biotic connectivity through horizontal and vertical propagation.

Although the hydrothermal venting and associated fauna are linked to the seafloor, most sedentary fauna release meroplanktonic larvae into the water column for dispersal, in order to maintain the population, colonize new vents, and recolonize disturbed vents (e.g., Adams *et al.*, 2012). Further away

[53] http://news.nationalgeographic.com/news/2005/12/1212_051212_megaplume_2.html; https://www.ncbi.nlm.nih.gov/pubmed/17480169; http://m-biotech.biol.uoa.gr/MATHIMATAPMS/ANALYSEIS/M1/BOURBOULI(YD).pdf

from the emission of vent fluids, the normal deep-sea fauna prevails on the seafloor and in the water column. The interactions between both ecological compartments are barely known.

Within the hydrothermal communities of the MAR deeper than 800 m, usually three trophic levels are recognised (Gebruk *et al.*, 1997): building on primary production of symbiontic or free-living bacteria, the first level of consumers (annelids, clams, shrimps) produces the bulk of biomass and feeds the scavengers (e.g. amphipods) and carnivorous vent fishes (e.g. eelput, Zoarcidae) as well as other fish species roaming in the periphery (Biscoito *et al.*, 2002). At shallow (<800 m) vent sites on the northern MAR, bacterial mats develop, and the 'normal' background elements dominate the faunal communities.

Contrary to early beliefs, the hydrothermal vent communities are not fully autochthonous, but may depend also on organic material from the surface production, which, for example, triggers the reproduction of a vent mussel species at least at the shallow vent site Menez Gwen (Dixon *et al.*, 2006).

2.3.2.3 Seamounts

General characteristics

Seamounts, commonly defined as isolated elevations from the seabed taller than 100 m (Staudigel *et al.*, 2010), are widespread features on the seafloor of the world ocean. Only a few of them have been mapped bathymetrically, but data based on satellite bathymetry predict that there are more than 100,000 large seamounts >1 km in height on the ocean floor (Wessel *et al.*, 2010). On the one hand the abrupt topography of these undersea mountains provides varying benthic habitats from soft bottom to hard substrata, such as basaltic outcrop and cobalt-rich crusts, often resulting in high biodiversity of benthic fauna, by contrast to the vast sedimentary deep-sea plains. On the other hand, seamounts present obstacles for the ocean currents, and thus also influence density and distribution patterns of the pelagic fauna.

Hydrodynamic processes in the water column above and around seamounts created by current-topography interactions, such as seamount-associated eddies (Richardson, 1980, 1981), Taylor caps/columns, or tidal resonance and seamount-trapped waves (e.g., Dower *et al.*, 1992; Genin and Boehlert, 1985; Lavelle and Mohn, 2010), may feature local aggregations within the pelagic communities. For example, high biomass concentrations of pelagic and benthopelagic fishes have been reported for several seamounts especially in the Pacific (Koslow, 1997; Koslow *et al.*, 2000; Parin *et al.*, 1997). Seamounts may attract and accumulate usually dispersed oceanic fishes and other top predators, probably due to an enhanced food supply, and also provide suitable water depths and habitats for typical shelf species and may act as resting or breeding points (e.g., Morato *et al.*, 2010a).

The interest in contract areas for the exploration of cobalt-rich ferromanganese crust on seamounts primarily focusses on the western and central Pacific Ocean. Here, some 4,000 underwater features (seamounts, guyots, banks etc.) have been identified among which some 2200 are located within the EEZs of Pacific Island States (Allain *et al.*, 2008).

Biodiversity

The generally high **benthic** species richness at seamounts is determined by local environmental variables (O'Hara and Tittensor, 2010; O´Hara, 2007) and depends particularly on the variability of available substrates. The earlier hypothesis of high levels of endemism on seamounts is no more generally supported (Rowden *et al.*, 2010) as sampling effort is generally too low, resulting in poor knowledge of distributional ranges to distinguish species new to science from endemics.

Corals are among the most abundant benthic invertebrates in seamount communities (Samadi *et al.*, 2007) and are considered to be of special ecological importance for deep-sea ecosystems (Rogers *et al.*, 2007). Coral species (scleractinians, anthipatharians, black corals) occurring on seamounts in the

SW Pacific show different degrees of regional connectivity patterns, most of them being genetically homogeneous, but three species showed genetic subdivision across oceanic distances (Miller *et al.*, 2010).

Cobalt-rich ferromanganese crusts form a more or less thick coating on seamounts, which provides a porous, micro-structured hard-substrate for sessile megafauna in regions of the seamount flanks and tops where current flow is maximal. Thus, the presence of the crusts was expected to have an influence on the structure of benthic assemblages (Grigg *et al.*, 1987; Pratt, 1963), recently confirmed by an analysis of underwater videos taken on the Hawaiian seamount chain (Schlacher *et al.*, 2014). These authors found that the benthic fauna of seamounts inside the cobalt-rich crust region of the Central Pacific differed significantly in terms of species composition and relative abundance from sites outside this region. However, there were no indications of differences in species richness. Rather, most species occurred inside and outside the region of cobalt crust seamounts with abundances of the same species being higher in shallow than in deeper waters for seamounts inside the cobalt crust region. On the other hand, Morgan *et al.* (2015) found discontinuous and heterogenous megafaunal communities along the targeted cobalt-rich mining region of the Necker Ridge in the Pacific, depending on, a.o., oxygen, sediment cover and latitude. This points to a suite of environmental factors driving the actual expression of the benthic communities on cobalt-rich seamounts.

Seamounts are hotspots of **pelagic biodiversity** as revealed, for example, by a study investigating the coincidence of pelagic species captured by longline fisheries in relation to distance to seamounts in the west and central Pacific (Morato *et al.*, 2010a). Seamounts were found to have higher species diversity of fishes in the vicinity of the summits. Higher probability of capture and higher number of fish caught were detected at seamounts for 15 taxa of shark, billfish, tuna, and other teleosts (Morato *et al.*, 2010a). Yellowfin- bigeye- and yellowfin tuna are attracted by some seamounts, with those in the FS Micronesia, Papua New Guinea, Solomon Island and Kribati being the most important (Morato *et al.*, 2010b). Seamounts also have an aggregating effect on some seabird species (Yen *et al.*, 2004), and may serve as orientation points during sea turtle and whale migrations (Garrigue *et al.*, 2010; Morato *et al.*, 2008).

Ecosystem functions and food web

Functionally, seamounts can act as stepping stones for the dispersal of benthic species, as oases of abundance and biomass, and hotspots of species richness. Food webs at seamounts are largely based on photoautotrophic production by phytoplankton in the euphotic zone, although benthic macro- and microalgae may add to the production at shallow seamounts reaching into the euphotic zone, and chemosynthetically derived production may occur at active volcanoes. Increased fluxes of suspended organic material due to amplified bottom flows over abrupt topographies could sustain high local densities of benthic organisms, zooplankton and fish, and the large-scale entrapment of water by topographically rectified currents could increase the downward flux of high-quality particulate organic matter to benthic communities over the centre of a seamount (Kiriakoulakis *et al.*, 2009 and references therein). The uplift of deeper nutrient-rich water and a stabilization of the water column are suggested to enhance primary production, but the high variability of vertical nutrient fluxes and retention processes makes a persistent maintenance of autochthonous high productivity, resulting in enhanced transfer to higher trophic levels and export to deeper regions, generally unlikely (Genin and Dower, 2007).

2.3.2.4 Pelagos

The deep-water pelagic communities are even less comprehensively understood and investigated than those of the seafloor (Robison, 2004). Until recently, the commonly used net sampling and acoustic detection have barely been able to describe the patterns of zooplankton and micronekton biogeographic and vertical distributions, missing the entire fraction of soft-bodied and otherwise fragile organisms. Robison (2004) states that '*more than a century after the return of the Challenger Expedition, the ocean's deep interior remains an unexplored frontier*'. He expects '*a million undescribed species, with biological adaptations and ecological mechanisms that we cannot yet imagine*'.

Pelagic communities vary at local and regional scales among others with the water mass and flow patterns, turnover and production patterns, oxygen, nutrient and light levels. Daily, seasonal and ontogenetic vertical migrations are common among pelagic communities, as are extensive horizontal migrations in oceanic nekton, for example between foraging and nursery areas.

Most of the deep-water pelagic communities rely on photoautotrophic production in the epipelagic layer of the ocean. The remains of surface production, for example algal cells, fecal pellets, carcasses, exosceletons, larvacean houses or salp remains, are exported into deeper layers in the form of small particles, as floccular or aggregate 'marine snow', but also large food falls. Most of the sinking organic detritus is repackaged during sinking and undergoes changes facilitated by coagulation and disaggregation, combined with bacterial and zooplankton consumption and remineralization, and reaches the seafloor at abyssal depths about 1-4 months after its original production in surface waters (Smith Jr. *et al.*, 2008 and references therein). New research indicates that by disintegration of these aggregates, zooplankton may in fact do 'microbial gardening' in the water column (Mayor *et al.*, 2014). Stomach content analyses, but also direct observations with modern visual techniques, have documented more and more 'large food falls', *i.e.* carcasses of pelagic organisms such as whales, cephalopods, crustaceans or jellyfish (Christiansen and Boetius, 2000; Martin and Christiansen, 1997; Smith *et al.*, 2015; Sweetman *et al.*, 2014). A species-rich community of highly mobile scavenging crustaceans and fish re-distributes these point sources of organic material (e.g., Smith *et al.*, 2015; Yeh and Drazen, 2009) and makes them available to other fauna.

Whereas the density of particulate organic matter generally decreases with depth, the near-bottom water layer up to 100 m above the seafloor is enriched, caused by the bottom flow resuspending the very fine material, and sometimes significantly enhanced by aperiodic, so-called 'benthic storms' (Harris, 2014). Coinciding with the food availability, the plankton density and biomass decrease exponentially with depth in the upper bathypelagic zone, to have weak gradients in the lower bathyal zone, but eventually increase near the seafloor, as do nekton and micronecton (reviewed by Christiansen *et al.*, 1999). Mirroring the surface productivity, there is also considerable variability in near-bottom zooplankton abundance between ocean basins (Christiansen *et al.*, 1999).

The pelagic and benthopelagic communities at bathyal and abyssal depths play an essential role in ecosystem integrity and can be considered as the largest reservoir of animal diversity on earth (Robison, 2009). The benthopelagic community (the pelagic community in close vicinity of the seafloor) is distinctly different from the pelagic communities higher up in the water column (Christiansen *et al.*, 2010; Robison *et al.*, 2010; Wishner, 1980) and probably represents a vital trophic link between the pelagic and demersal faunas of deep-sea ecosystems (Mauchline and Gordon, 1991). As Robison *et al.* (2010) describe from video dives, this specific community '*includes animals that feed only above the seafloor, such as lobate ctenophores, trachymedusae, diphyid and physonect siphonophores, larvaceans, and mysids; and those which feed both on and above the benthic interface, including the medusa* Benthocodon *sp., the polychaete* Flota vitjasi*, the isopod* Munneurycope*, the macrourid* Coryphaenoides acrolepis*, liparid fishes, and cydippid ctenophores*'. Overall, gelatinous animals dominated the observed fauna, a group which is not adequately reflected in traditional net samples. On the other hand, smaller-sized zooplankton is usually not properly assessed with visual observations: calanoid copepods were found to be generally the most numerous members of the near-bottom metazoan zooplankton as sampled with nets, making up about 50-75 % of the zooplankton (Christiansen *et al.*, 2010; Gowing and Wishner, 1986; Wishner, 1980), but copepods of the order Misophrioida may constitute a substantial part of the copepod community in the immediate vicinity (about 1 m) of the bottom (Christiansen *et al.*, 2010). Deep-sea populations of calanoid copepods in the benthic boundary layer are characterized by the dominance of a few families, which are considered to be mostly detritivores or carnivores, showing a high diversity comparable to many pelagic habitats (Renz and Markhaseva, 2015). Pump samples in the benthic boundary layer of the Clarion Clipperton suggest that meroplanktonic larvae may be an important group in near-bottom communities (Kersten *et al.*, 2017). Generally, the pelagic communities within meters of the seafloor are particularly little investigated (Christiansen *et al.*, 2010), as are the under-sampled conspicuous filter feeders such as larvaceans, salps and the predatory siphonophores, ctenophores and medusae (Robison, 2004).

The benthopelagic nekton consists of fishes, crustaceans and holothurians, most of which are believed to feed on the bottom and spend the majority of their time swimming or suspended above it (Robison, 2004), but mid-water feeding was also observed in benthopelagic fishes (Haedrich and Henderson, 1974; Mauchline and Gordon, 1991). The deepwater benthopelagic fish fauna of the Atlantic has been particularly well studied (Haedrich and Merrett, 1988; Merrett *et al.*, 1991) with assemblages differing with latitude/production patterns in the pelagial (Merrett and Haedrich, 1997). At abyssal depths, macrourids and synaphobranchids are particularly wide spread, but other families such as ophidiids appear to contribute increasingly to the benthopelagic fish community towards low latitudes (Christiansen and Martin, 2000; Vieira *et al.*, 2016).

The largest pelagic organisms in the deep ocean include deep diving marine mammals, some sharks, bathypelagic squids, but also large gelatinous species which themselves provide substrate for other species (Robison, 2004). For all these groups and species, the detection of even single-species distribution and migration patterns as well as population dynamics is extremely difficult.

2.3.3 The Known Unknown

The 'knowns' about the deep-sea ecosystems as summarised above, are clearly just revealing some spotlights of diversity and ecosystem functioning in the deep-sea realm. However, as emphasised by Rogers *et al.* (2015), '*understanding how deep-sea ecosystems function is vital if we are to assess and monitor the cumulative effects of natural and anthropogenic pressures and impacts*'. So far, we are far from understanding the ecosystem structures and processes at the scales which are affected by human impacts. This holds particularly true for the deep ocean. As impressively demonstrated by the Census of Marine Life Project (COML, 2010), even today almost every single sample taken in the deep sea reveals hitherto unknown sites, species, communities and/or functions (Danovaro *et al.*, 2014). Even for the best known marine taxa, such as for fishes, regional inventories remain incomplete (Mora *et al.*, 2008). The deep pelagic ocean, by volume and area the largest ecosystem on earth (Angel, 1993), is the least sampled and the least known of all realms (Webb *et al.*, 2010).

2.3.3.1 Scale

One of the main problems with reducing the unknowns in the deep sea relates to scale in many ways:

- The enormous size of the abyssal plains/nodule areas prevents intensive sampling throughout the region(s) potentially affected by human activities.
- Though apparently quite uniform, the deep seafloor and water column provide numerous microhabitats which are difficult to identify at the scale of human interventions and to describe due to methodological constraints.
- The natural disturbance regime is a key factor controlling the spatial species distribution and ecological processes. Multidisciplinary time series are required (Harris, 2014).
- The high benthic and pelagic species diversity in combination with extremely low biomass and abundance require a high number and a high volume of samples per unit area and time. For example, in the Clarion-Clipperton-Zone, more than 30 replicate samples are needed to

approximately sample the local macrofauna species pool (Paterson 2014[54])(Paterson *et al.*, 1998).

- Particularly in deep-sea regions overlain by oligotrophic waters, 'life stands still' (Levin and Le Bris, 2015) - therefore the temporal variability has to be assessed at very long (climate) time scales.
- Contrary to earlier perceptions, Sutton (2013) found that at least for fishes 'vertical connectivity among fishes across classical depth zones is prevalent, suggesting that a whole-water column approach is warranted for deep-ocean conservation and management'.

2.3.3.2 Sampling and Identification

There is no sampling gear which can sample all species groups, and even the successful deployment of all available gear would not provide a full inventory of species at that particular place. Especially pelagic organisms are very often highly fragile and sometimes do not even leave traces in nets. Although this can be overcome to some extent by optical tools, optical sampling screens only very small water volumes compared with large plankton nets and therefore misses non-abundant organisms. Similarly, benthic nanofauna cannot be retrieved by sieving sediment. Each sampling gear is specifically designed for a certain size range of organisms, all others are excluded. As a result, the fauna sampled by instruments with different sampling bias cannot be compared, the differences potentially being even augmented by non-standardised after-sampling treatments.

Once caught, the identification problems start with a lack of taxonomic identification keys: many species cannot be systematically identified, and new species coherently described, because the identification keys do not exist yet. This also means that newly described species with preliminary names may be described and named several times unnoticed. This uncertainty, the lack of taxonomic expertise and the time required for a new species description, all prevent a high output in species identifications.

Most deep-sea species are only known from one recognizable life stage; often identifications are based solely on adults. For example, pelagic crustaceans have numerous life stages and change appearance completely from juvenile to adult. Single lifestages can be differentiated only from the most abundant species, so that the life history of the overwhelming majority remains unknown. This holds true also for deep-sea fish species.

Another necessary tool of taxonomists are up-to-date and accessible collections of reference species. For example, a common species collection for the Clarion-Clipperton-Zone would certainly help to standardise the taxonomic identification results among the contractors. However, although preserved specimens could be compared at a later date, when reference material is available, the varying results on abundance and community composition derived from non-standardised sampling will ultimately prevent the establishment of a regional baseline.

The most recent scientific tool to investigate the diversity and eventually dispersal of various taxa groups is a reverse taxonomy approach based on DNA barcoding (Glover *et al.*, 2016; Janssen *et al.*, 2015). This technique is most useful if the distinguished gene sequences can be related to taxonomically identified specimens in a reference database. If the vast majority of species is either undescribed or so rare that they are not recorded sufficiently often, then the gene sequencing will not allow for conclusions on the functioning of the ecosystem (Janssen *et al.*, 2015). Therefore, a long-term

[54] Paterson, 2014. 'The known unknowns...' Preliminary results of a gap analysis of biogeographic data. Results from EU MIDAS project. Presentation given at ISA-KIOST Macrofauna Workshop, Korea.

iterative building of taxonomic knowledge based on traditional taxonomy and DNA barcoding is required (Glover *et al.*, 2016).

2.3.3.3 Diversity

Over the past century, considerable sampling efforts in the deep sea, mostly the deep-sea floor, have improved the knowledge of deep-sea communities in various regions; however, only a few areas have been studied in some detail (Ebbe *et al.*, 2010; MIDAS Consortium, 2016). Therefore, not even the site- and time-specific static community analyses can be based on a sufficiently complete dataset:

- Genetic diversity: the intra-species diversity, the gene pool, which is the fundament for a population's adaptability to environmental changes, remains obscure as long as not even species can be identified.
- Species diversity: Most benthic and pelagic taxa cannot be readily identified at species level, but require high-level taxonomic expertise and time-consuming examination. Thus, often only a few more common organisms are distinguished, and rare and undescribed species usually pass unnoticed. Genetic screening provides a new tool to enumerate at least the number of different taxa and compare samples for similarities (Glover *et al.*, 2016; Janssen *et al.*, 2015).
- Community diversity: Due to taxonomic and sampling problems wide-ranging species are overrepresented in community descriptions (Higgs and Attrill, 2015). Molecular analysis confirmed that, for example, the high local and regional benthic macrofauna diversity in the Clarion-Clipperton-Zone is based primarily on large numbers of singletons in the samples (Janssen *et al.*, 2015), and these locally or regionally rare species may be functionally the most important ones (Mouillot *et al.*, 2013).

Deep pelagic communities cannot be described with any completeness (Robison, 2004), due to the sampling bias immanent in any gear, the patchy distribution and particularly the low densities of deep-sea pelagic fauna. Many of the organisms are fragile, and some not even leave traces in conventional samplers. Although some of these fragile components may be made visible with modern camera systems, taxonomic identification only from pictures is usually impossible, and only small water volumes can be investigated. The integration of results from different sampling gears still needs to be accomplished. Also the overwhelming diversity and abundance of microbes (protists, bacteria, archaea) in the oceans has only recently been discovered and shown that the rare is common (Sogin *et al.*, 2006).

The pelagic nekton communities belonging to certain ocean regions are also only incompletely understood. For methodological reasons, these studies are often focussed on single groups, for example species that are attracted to bait, and are not representative for the whole nekton community. Furthermore, due to the low abundance of most deep-sea nekton species, usually only single or a few specimens are caught and rare species are collected only by mere chance. So even though it is known that the dynamics of the pelagic system is related to the natural variability of physically driven environmental parameters (Angel, 1997), the species interaction and community dynamics remain only incompletely understood.

With some exceptions, cephalopods are notoriously difficult to catch and assess for abundance and population dynamics (Clarke, 2006). Cephalopods respond highly sensitive to environmental change (Pierce *et al.*, 2008) and some species are deep-sea dwellers, such as those of the genus *Grimpotheuthis*, which includes a high number of as yet undescribed species (Collins *et al.*, 2001).

2.3.3.4 Distributional ranges

The knowledge on distributional ranges of deep-sea benthic and pelagic species, taxa, or communities is generally poor due to undersampling and limitations in identification. Yet there are indications that, although different water masses and topography can act as effective barriers to dispersal, high numbers of cosmopolitan species exist across all habitats (McClain and Hardy, 2010). However, the distributional range of less abundant, infrequent or rare species, which may also be broadly distributed, will be difficult or impossible to assess because only a tiny fraction of the total deep ocean can ever be sampled.

The connectivity of fragmented populations over larger spatial scales, which depends on their dispersal capabilities, is crucial for the colonisation or re-colonisation of a habitat (Hilário *et al.*, 2015). It is the essential component to enable a prediction of the long-term impacts of, for example, deep seafloor minerals mining. This requires the knowledge of (see Menot, 2014[55]):

- Life history traits, dispersal capabilities, settlement and recruitment dynamics,
- Scales of heterogeneities,
- Biological interactions.

However, the planktonic larval duration and exact requirements for larval settlement are not even known for many common shallow-water benthic species (Hilário *et al.*, 2015; Metaxas and Saunders, 2009). Of all deep-sea species, the planktonic larval duration, allowing for an estimation of dispersal range, has been approached for only 21 species from various habitats based on limited data (Hilário *et al.*, 2015). In particular, information on dispersal depth, swimming speed, egg buoyancy, direction of swimming, and physiological tolerances is missing.

With some exceptions, deep-sea animals cannot be cultured and raised in the laboratory to observe growth and development. On the other hand, modelling of connectivity not only requires the understanding of biological traits, but also a small-scale resolution of the three-dimensional physical environment, which is extremely difficult to measure, even in shallow water. This only leaves *in situ* observations, such as stationary monitoring boxes, which may deliver more knowledge on deep-sea species biology in the future. This knowledge is needed to replace with facts from deep-water environments what is now based on assumptions inferred from shallow water, in order to enable realistic modelling of dispersal and eventually resilience of deep-sea biota.

2.3.3.5 Lifecycles

There is only rudimentary knowledge of species life cycles, reproduction triggers, frequencies, locations and recruitment. Rogers *et al.* (2015) emphasize that '*We do not understand the complete life cycle of any deep-sea species (either invertebrate or fish) and fundamental processes of larval supply, settlement and recruitment are virtually unknown*'. One example for the possible complexity of life cycles is the association of a deep-sea octopod with sponge stalks on manganese nodules for placing and brooding its eggs (Purser *et al.*, 2016).

2.3.3.6 Communication

Bioluminescence and olfactory are, among other senses, important means of communication in the lightless depths. Only recently, new camera systems enabled the detection and enumeration of bioluminescence all through the water column to bathypelagic depths (e.g., Heger *et al.*, 2008). Although bioluminescence could be investigated in detail in only a few species, it is clear that the light production serves very different strategies (Robison, 2004), including mate finding, camouflage, prey attraction and fending off predators. Sound, olfactory and electromagnetic fields also appear to be common in deep pelagic organisms, but little is known about their functions, and there is need for

[55] Menot, L., 2014. 'The ecological context for the study of biodiversity of the macrofauna of the CCZ'. Presentation given at ISA-KIOST Macrofauna Workshop, Korea.

more studies (Robison, 2004), in particular should deep seabed mining occur. The long-term impact of disturbance from noise, light and chemical pollution on the communication in deep-sea species will be near to impossible to investigate, although, for example, behavioural effects of artificial lights on a few deep-sea organisms have been observed (e.g., Raymond and Widder, 2007).

2.3.3.7 Food web

Whereas stomach content analyses and direct feeding observations exist mainly from a few more common deep-sea fishes and some invertebrate scavengers (e.g., Bailey *et al.*, 2007; Britton and Morton, 1994; Drazen and Sutton, 2017; Martin and Christiansen, 1997), the use of biomarkers such as stable isotopes and fatty acids has given insight into trophic levels and trophic relationships for a greater part of the deep-water communities, but only at a few locations and usually not including the obligate benthopelagic zooplankton (e.g., Bühring and Christiansen, 2001; Denda and Christiansen, 2011; Denda *et al.*, 2017a; Denda *et al.*, 2017b). The knowledge of feeding types in this group and possible ontogenetic changes is extremely poor. Food (organic matter) availability to deep-sea organisms is the controlling agent for raising the metabolism and stimulating growth and reproduction (Danovaro *et al.*, 2014). Yet, it remains poorly understood which fractions of the sedimentary organic material are accessible to microbial degradation and on what timescale these fractions are digested, oxidized and assimilated (Jørgensen and Boetius, 2007).

For benthic filter feeders, lateral and vertical advection of particles is relevant - the impact of sediment plumes therefore needs to be considered with respect to seafloor currents and sediment roughness. Also, biological activity and interactions, such as through bioturbation of deposit feeding echinoderms, determine the environmental conditions for the abyssal benthic community and need consideration when assessing habitat quality and its deterioration or restoration.

The benthic-pelagic coupling in the deep-sea boundary layer is certainly least understood: Only little is known about feeding interactions between benthic and (bentho)pelagic organisms at bathyal and abyssal depths. Some benthopelagic fishes feed, at least facultatively, on benthic infauna or epifauna (Denda *et al.*, 2017b; Drazen and Sutton, 2017; Martin and Christiansen, 1997). Also, sloppy feeding in scavengers and faeces production will provide modified organic material to other consumers. However, the trophic transfer of the scavenged and preyed material, and processes associated with this transfer, such as carbon cycling, distribution and sequestration in the oceans, are still poorly understood (King *et al.*, 2007 and references therein; Priede *et al.*, 1991).

No information is available about possible feeding links, in either direction, between benthic fauna and benthopelagic zooplankton, except for deep-water corals that presumably feed on zooplankton (Carlier *et al.*, 2009; Tsounis *et al.*, 2010). In particular the fate of temporally pelagic larvae of benthic species (meroplankton), with respect to larval release time and trigger, the duration of the planktonic stage and the propagation potential remains to be understood. McClain and Hardy (2010 and references therein) emphasise that the larval modes of most deep-sea invertebrates are unknown, and a ‘typical’ deep-sea strategy does not appear to exist.

Micronekton act as critical link between lower trophic levels and top predators in the pelagic food web. Crustaceans, small fishes and cephalopods span a wide range of feeding modes, from herbivory to omnivory and zooplanktivory to piscivory. Micronekton are the main prey of most epi- and mesopelagic predators, such as large fishes, sharks, marine mammals and seabirds, but are prey also of bathypelagic and accordingly benthopelagic fishes. As many micronekton species undergo DVM, they play a key role in linking epi-, meso- and bathypelagic food webs, but their effect on bottom-up and top-down control of deep-sea food webs is not fully understood. The trophodynamics of micronekton are one of the most critically unknown components of pelagic food webs (Choy *et al.*, 2016; Young *et al.*, 2015).

The overall role of gelatinous organisms, such as Cnidaria (medusae), Ctenophora and Thaliacea (appendicularians and salps), in the food web is poorly known. Thus, quantifying the contribution of gelatinous organism to the pelagic food webs, and particularly their role in the bathypelagic realm, is increasingly important and needs further exploration, as well as their effect on the energy transfer throughout food webs and finally on the ecology of marine top predators (Sutton, 2013; Young *et al.*, 2015).

2.3.3.8 Natural and human-driven dynamics and variability

The knowledge of the dynamics of deep-sea ecosystems is extremely poor. Time series observations exist from only a very few locations (e.g., Kuhnz *et al.*, 2014; Smith Jr *et al.*, 2001) and are short in relation to many drivers of variability in the deep sea. Some important issues:

- Variability can be from rapid to decadal (Kuhnz *et al.*, 2014).
- Long time series are required which investigate the spatial and temporal qualitative and quantitative variability in organic flux and its relation to deep ocean population dynamics (Ruhl and Smith, 2004).
- The temporal variability of near-bottom oceanic plankton is practically unknown (Christiansen *et al.*, 2010).
- Food-related variability: Community diversity, e.g. of megafauna, shifts with changing food supply, reflecting the different food preferences or niches of the individual species (Ruhl and Smith, 2004). This implies that communities have to be observed over longer (climatic oscillation) timescales to identify their natural range of composition.
- Climate change effects: long-term change due to global warming will be superimposed on the natural cycles and lead to regional ocean acidification, the strengthening of oxygen minimum zones and changes in sedimentation patterns (Levin and Le Bris, 2015). The synergistic effects may result in the Clarion-Clipperton-Zone to become a zone even more impoverished in surface production and sedimentation of organic material to the deep seafloor (Levin and Le Bris, 2015; Smith *et al.*, 2008a; Sweetman *et al.*, 2017).

2.3.3.9 Resilience

Gollner *et al.* (2017) conclude that current knowledge is insufficient to predict the extent of resilience in deep-sea communities to the effects of mining. Overall, as expected, the recovery potential is linked to the stability of the ecosystem, mobility and isolation. Vent communities at fast-spreading ridges have the highest recovery potential, and information on those from slow- or ultra-slow spreading ridges, and inactive vents is lacking (Gollner, 2017). Recovery from bottom trawling at seamounts has not yet been observed (Althaus *et al.*, 2009; Williams *et al.*, 2010), while decades after a small-scale disturbance of nodule fields, the original species community was not re-established (Jones *et al.*, 2017).

The cumulative impact of natural and man-made changes of the marine environment on the respective communities will likely never be entangled in detail. Even in well-researched and monitored coastal waters, causal relationships can hardly ever be established. More so in the vast deep sea near to unknown ecosystem structures and functions. In addition, the recent findings of hydrothermal vents on oceanic ridges are the fruit of exploratory effort for minerals in environmentally poorly described regions.

2.3.3.10 Carbon flux

The dark ocean is the largest reservoir of 'active', mostly dissolved, organic carbon in the biosphere, derived from biological processes that take place in the upper ocean, and it is therefore a site of paramount importance for material cycling in the biosphere (Arìstegui *et al.*, 2009). The vertical flux from settling of organic particles, active transport by migrating plankton, and physical DOC transport mechanisms drive the deep food web. However, the actual rates and processes of energy transfer to the deep ocean at several temporal and spatial scales are not clear so far. A mismatch between carbon inputs and carbon demand of deep-sea communities (e.g., Christiansen *et al.*, 2001; Smith Jr *et al.*, 1987) not only points to possible sampling biases, but may also indicate a greater role of export pathways of organic matter additional to sinking detritus, for example migrant metazoans, large food falls, or an as yet unaccounted role of dissolved organic carbon. Also the contribution of autotrophic prokaryotic production in the dark ocean may be greater than so far assumed (reviewed by Arìstegui *et al.*, 2009). Large aggregates of natural particles such as abandoned larvacean houses are likely to play a significant role in the particle flux to the deep ocean (Silver *et al.*, 1998; Smith Jr. *et al.*, 2014). Such large aggregates are usually fragile and occur infrequently, and neither their abundance nor the related fauna are therefore well known.

Variation in carbon flux is the primary driver of patterns in biomass, abundance, and biodiversity in the deep sea (McClain *et al.*, 2012). Overall, the knowledge of the energetics in the deep ocean is 'meager', which is developing into a pressing problem, because changes can be expected at different scales of biological organisation and ecosystem functioning when the accelerating climate change effects reach the deep sea (McClain *et al.*, 2012). For the deep ocean benthic biomass, Jones *et al.* (2013) modelled the decadal to century-scale changes in carbon export associated with climate change and estimated a 5.2% decrease in future (2091–2100) compared with today's conditions (2006-2015).

2.3.3.11 Evolution

Last - not least - the deep sea may be a refuge of fauna during major climatic change events, though Danovaro *et al.* (2014) name the untangling of the conflicting evidences for marine species faunal origins to be one of the grand challenges in deep-sea biology.

2.3.4 The unknowable

The long-term ecological consequences of commercial-scale mining of deep ocean minerals have to be looked at as synergistic and cumulative impacts together with those arising from other human activities (fishing, shipping, hydrocarbon exploitation, waste disposal, eventually artificial fertilisation) and from human-related change of CO_2 levels, global temperature and its effect on oxygen minimum zones etc). This seems an impossible task based on the available knowledge.

Science can simulate the impacts from seabed mining activities to some extent, e.g. as experiments on a scientific or even larger scale (e.g. the DISCOL disturbance) experiment. However, the full extent of environmental change caused by these activities will only be known after a commercial scale mining test is carried out and monitored for a long period afterwards. But even then, the cumulative impacts accumulating over the 20-year lifetime of a mining operation, eventually coinciding with impacts from adjacent mining or other sector´s activities can likely only be modelled to a limited extent: Modelling results will depend on the temporal and spatial quality of the input data on, *inter alia,* the

- Baseline of environmental status, ecosystem processes and resilience to human pressure.
- Recolonisation potential of species at disturbed sites. This depends on the type of disturbance, the type and quality of the habitat and the colonisation capabilities of the species.
- Spatial and temporal sediment accumulation and the effects of enhanced sedimentation rates on benthic fauna.
- Effects of the disturbed sediment oxygen profiles on metal release and toxic impacts on cumulative toxic concentrations.
- Effects of high loads of un-palatable particles on benthic filter feeders, zooplankton and fish.
- Effects of physical and chemical disturbance regimes on olfactory communication.
- Effects of artificial light on the ecological functions of bioluminescence.

- Effects of noise on marine biota, including mammals.

In particular, the technical and biological data are missing so far, but also physical and chemical data are hardly available. While the technical specifications of machinery are likely to develop within the next few years, most knowledge gaps in biological and ecosystem understanding cannot be expected to be filled in the next decades. This leads to the question on the required minimum of knowledge necessary for evaluating whether commercial mining operations can be environmentally responsible and overall sustainable. Given the knowns of the vulnerability of deep-sea species and habitats, and the many unknowns of ecosystem structure and processes, an approach to new destructive activities in the abyss should be one of utmost precaution.

2.3.5 Recommendations

Recommendations

Deep seabed mining will inevitably lead to biodiversity-loss (Niner *et al.*, 2018). Yet, if this does not stop the development of a new industry, the known has to be much better managed and the unknown needs to be reduced. This requires not only research, but in particular effective regulatory processes and procedures to control and limit the associated environmental damage.

Addressing knowledge gaps

All aspects of the deep sea require further scientific study, as detailed above. In order to address knowledge gaps concerning the potential impacts of mining, the following points should be taken into account (see also recommendations of Clark *et al.*, 2012; Van Dover, 2014; Weaver *et al.*, 2017):

- The temporal and spatial nature as well as the extent of excavation and sediment plumes in the water column and as footprints on the seafloor remain a major unknown here, detailed three-dimensional modelling of excavation plume development over long time scales under assumed realistic mining conditions will be helpful. Other models will be needed to determine optimal discharge techniques and depths for minimising the spatial extent of plumes.
- The *in situ* grain composition, buoyancy, toxicity and dispersal characteristics of excavation and sediment plumes must be studied in relation to ambient fauna and ecological processes.
- Each potential mine site must be studied in its biogeographic context, biodiversity, community and trophic structure, connectivity, ecosystem services, disturbance regimes and community dynamics, etc., and including its pelagic components.
- A comprehensive ecological assessment of each mine site in its regional context should be conducted to ensure that no unique sites will be mined, such as active hydrothermal vents on the Mid-Atlantic Ridge.
- In particular, all aspects of the pelagic system require baseline research as well as studies concerning the potential effects of light, noise and turbidity (see also Chapter 2.4.6).
- High-resolution habitat mapping and a detailed analysis of species distribution at habitat scale are crucial for improving the management of goods and services delivered by deep sea ecosystems (Zeppilli *et al.*, 2016a)

ISA Strategy Science and Exploration

- The ISA could proactively initiate independent research activities in the Area, which complement contractors’ work with regard to regional-scale natural variability and baselines, surveys of designated APEIs and in-depth process studies.
- The ISA should initiate regional taxonomic reference collections and related bar-coding databases, with contributions from contractors and science.
- The ISA should clarify the status of science in ISA exploration areas and address the issue whether the freedom of scientific research applies.
- The rights of the scientific community to conduct research in eventual exploitation areas also needs clarification. This question could be addressed to the Seabed Disputes Chamber of the International Tribunal for the Law of the Sea.

Standard minimum requirements for contractor baseline investigations

- The ISA guidelines for contractors during exploration (ISBA/19/LTC/8, currently under review) and any future requirements for contractors during exploitation should determine (after public consultation) a standard baseline and monitoring investigation kit, including both large-scale (license area) and small-scale (future mining area, PRZ, IRZ) sampling grids, minimum sampling requirements (sample density, fauna/gear), sample treatment and storage, and need for in-depth studies, modelling etc. Clark *et al.* (2016b) and Swaddling *et al.* (2016) will be helpful in this respect.
- Incentives should be developed to reward contractors for providing more extensive baseline research and monitoring. A reduction in annual fees, for example, could encourage contractors to operate more comprehensive investigation programmes.
- The elaboration of environmental standards will require a continuous exchange of experiences among contractors to ensure the application of best available techniques and environmental practices, as well as their backward compatibility.
- All contractors should be obliged to follow this procedure throughout exploration, eventual testing and exploitation. Higher risks require more intensive study (ITLOS, 2011).

Standard minimum requirements for monitoring studies of disturbance events

- Noting that the degree of risk should determine the stringency of investigation, a standard investigation concept is required which incrementally builds on standard baseline investigations and augments requirements for the environmental monitoring of disturbances, ranging from small- to large-scale testing and commercial-scale exploitation.
- The temporal scale for monitoring observations should encompass the period of time from immediately after the disturbance, until several decades after the event. Continuously operating measuring platforms will be extremely helpful to detect the dynamics of at least the abiotic changes.
- The sampling grid should be designed to represent (a) the main abiotic and biotic features of the mining site, including the water column. (b) at least three locations representing maximum, medium and minimum sedimentation from operational and discharge plumes on the seafloor and the water column (IRZ), and (c) one or more reference stations outside the area affected (PRZ).
- A sufficient number of replicates at each station are necessary for robust statistical analyses.

Develop a comprehensive assessment framework

- Observations from monitoring must be assessed against an environmental baseline study of the mine or test site and allow for determination of natural spatial and temporal variability.

- Assessment methodologies and criteria, including the framing of models for projecting potential environmental consequences of natural and human-derived impacts, must be developed and regularly updated by a group of experts.

Transparency and expert input

- Transparent reporting lines: All environmental baseline studies, monitoring of equipment or system tests, and commercial mining must be made available for scientific review and public comment.
- The ISA should maintain not only a public database for data but also include publications, information from research cruises and all relevant assessments and reports.
- The ISA should synthesise the standardised data coming in from contractors and scientists to determine and regularly update regional quality status reports (as foreseen in the CCZ Environmental Management Plan).
- Independent scientific expert advice will increase transparency, accountability and trust in the ISA's judgements and in the overall environmental decision-making process.

2.4 Vulnerability of deep-sea ecosystems to the effects of deep seabed minerals mining

2.4.1 Introduction

The ecological sustainability of deep seabed mining is one of the key concerns in relation to the regulation of this future activity. The identification of the vulnerability of the recipient environments in relation to the activities related to seabed mining can be the crucial tool to prevent 'significant adverse impacts' on such ecosystems.

The vulnerability of an ecosystem is related to the likelihood that one or more components (*i.e.* populations, communities, or habitats) will experience substantial alteration resulting from short-term or chronic disturbance, and to the likelihood and time scales of recovery. '*The most vulnerable ecosystems are those that are both easily disturbed and very slow to recover, or may never recover*' (FAO, 2009). Subsequent to a UN resolution on sustainable fishing in areas beyond national jurisdiction in 2006 (UNGA 61/1052006), which committed States to manage bottom contact fisheries to '*prevent significant adverse impacts on such ecosystems consistent with the Guidelines or close such areas to bottom fishing*', International Guidelines were agreed under the auspices of FAO, and endorsed by UN Resolution 64/72 (2010b).

Not all deep-water ecosystems are equally vulnerable to disturbance. Whereas the species of the abyssal plain communities are little resilient to disturbance, yet are possibly widely distributed, hydrothermal vent communities may be locally unique, but adapted to the natural disturbances of their habitat (Van Dover, 2014). Therefore, the vulnerability will differ with respect to the type, scale and frequency of disturbance, and with the type of habitat affected. Apart from the here mentioned benthic ecosystems, the interacting benthopelagic and pelagic ecosystem components have to be considered as well.

Vulnerability can be measured in relation to the spatial scale of threats, their frequency, functional impact, resistance, recovery time and certainty (Halpern *et al.*, 2007). Rather than seeking to define the thresholds of ecosystem states with respect to external impacts, a functional approach is recommended which considers the process-defined capacity of systems to maintain ecosystem structure and deliver ecosystem services (FAO, 2009).

In the box below, the key terms in the discussion of 'vulnerable marine ecosystems', VMEs, are explained as used by the European Commission (EC 734/2008, based on FAO, 2009).

Vulnerable marine ecosystems (VMEs)

Vulnerable marine ecosystems (VMEs) are defined as (EC 734/2008, based on FAO, 2009):

- Any marine ecosystem whose integrity (*i.e.* ecosystem structure or function) is, according to the best scientific information available and to the principle of precaution, threatened by significant adverse impacts resulting from physical contact with bottom gears in the normal course of fishing operations, including, *inter alia*, reefs, seamounts, hydrothermal vents, cold water corals or cold water sponge beds. The most vulnerable ecosystems are those that are easily disturbed and in addition are very slow to recover, or may never recover.

Significant adverse impacts means:

- Impacts (evaluated individually, in combination or cumulatively) which compromise ecosystem integrity (*i.e.* ecosystem structure or function) in a manner that impairs the ability of affected populations to replace themselves, that degrades the long-term natural productivity of habitats, or causes on more than a temporary basis significant loss of species richness, habitat or community types.

Precautionary approach:

- Where site-specific information is lacking, other information that is relevant to inferring the likely presence of vulnerable populations, communities and habitats could be used to guide the identification of areas where the vulnerable habitat is likely to occur.

Scale refers to:

- The **intensity** or severity of the impact at the specific site being affected;
- The **spatial extent** of the impact relative to the availability of the habitat type affected;
- The **sensitivity/vulnerability** of the ecosystem to the impact; the ability of an ecosystem to **recover** from harm, and the rate of such recovery;
- The extent to which ecosystem **functions may be altered** by the impact; and
- The **timing and duration** of the impact relative to the period in which a species needs the habitat during one or more of its life- history stages.

The **criteria** agreed for identifying 'vulnerable marine ecosystems' highlight the importance of

- **Uniqueness or rarity** - an area or ecosystem that is unique or that contains rare species whose loss could not be compensated for by similar areas or ecosystems. These includes:
  - habitats that contain endemic species;
  - habitats of rare, threatened or endangered species that occur only in discrete areas; - nurseries or discrete feeding, breeding or spawning areas.
- **Functional significance** of the habitat - discrete areas or habitats that are necessary for the survival, function, spawning/reproduction or recovery of fish stocks, particular life-history stages (e.g. nursery grounds), or of rare, threatened or endangered marine species.
- **Fragility** - an ecosystem that is highly susceptible to degradation by anthropogenic activities.
- **Life-history traits** of component species that make recovery difficult: ecosystems that are characterised by populations or assemblages of species with one or more of the following characteristics:
  - slow growth rates;
  - long-lived and late age of maturity;
  - low or unpredictable recruitment.
- **Structural complexity** - an ecosystem that is characterised by complex physical structures created by significant concentrations of biotic and abiotic features. In these ecosystems, ecological processes are usually highly dependent on these structured systems. Further, such ecosystems often have high diversity, which is dependent on the structuring organisms.

With respect to the impacts of bottom fishing activities, FAO (2009) provides examples of vulnerable species groups, communities and habitats (certain cold-water corals and hydroids, other structure-forming epifauna, seep and vent communities), as well as abiotic features that potentially support them as indicators for the presence of 'vulnerable marine ecosystems' (VMEs). Examples for VMEs include:

- The summits and flanks of **seamounts**, guyots, banks, knolls, and hills (e.g. corals, sponges, xenophyophores);
- Hydrothermal **vents** (e.g. endemic microbial communities and invertebrates).

Seamounts are particularly vulnerable to the impacts of bottom trawling within fishing depths down to 2000 m (Clark *et al.*, 2016a; Watling and Auster, 2017) and in addition will eventually be subject to seabed mining where cobalt-rich crusts occur. For regulatory justice, it is important to evaluate and, where necessary, limit different activities along the same criteria and regulatory concepts. Possible cumulative or synergistic effects need to be identified and considered.

2.4.2 Vulnerability concept in context with deep seabed mining

UNCLOS requires states to implement measures 'to protect and preserve rare or fragile ecosystems as well as the habitats of depleted, threatened or endangered species and other forms of marine life' (Article 194.5). Prior to the approval of the first application for exploitation, the International Seabed Authority has to adopt '*rules, regulations and procedures incorporating applicable standards for the protection and preservation of the marine environment*'[56], including the prevention of interferences with the ecological balance (Article 145). Therefore, the VME concept is also relevant to managing the impacts of deep seabed minerals mining in the most precautionary way (Watling and Auster, 2017).

As the vulnerability of populations, communities, or habitats is always related to an actual threat or impact, the criteria for defining vulnerability need to be adapted to the context of deep seabed mining. Depending on the type and location of the deposits of polymetallic nodules on the abyssal plain, seafloor massive sulphides at or near hydrothermal vents and cobalt-rich ferromanganese crust on seamount slopes, the respective faunas and ecosystems, including those in the water column and the benthic boundary layer, will need to be tested for their vulnerability to the direct and indirect effects of mining activities.

In addition to the VMEs already approved, the populations, communities and habitats of the **abyssal plains** with or without manganese nodule substrate, **would equally qualify** as vulnerable marine ecosystems in relation to minerals mining, based on

- The life history traits of abyssal organisms and overall adaptation of deep-sea communities to low energy, low disturbance environments (see further 2.3.2.1, abyssal plain ecosystem).
- The fragility of the ecosystem
- The lack of recovery potential
- The apparent very high diversity per unit area,
- The functional significance of the nodules for associated fauna

Whereas the impact of minerals mining on the flanks and tops of **seamounts** and on **hydrothermal vents** will likely affect the whole or most of the ecosystem specific for that location, the significance of impact to the abyssal plain ecosystems may have to be assessed against the small-scale variability of biodiversity, the extent and variability of similar types of abyssal plain ecosystems (compare first

[56] 1994 Agreement, Annex, Section 1, para 5 (g)

approximation by ISA 2008). This however is barely known; the abyssal plains are most certainly among the least investigated places on earth.

So far the VME concept has not been applied to any **water column** habitats, communities or other pelagic organisational category. In relation to the pressures from mining seabed minerals, this will have to be initiated with respect to sound (all water column), light (near sea floor), toxicity and sediment load (within impact zone of excavation and return water plumes).

The spatial and temporal factors of mining activities are particularly important for evaluating the vulnerability of the concerned deep-water habitats. Commercial ventures will have to operate for project life times of at least 20 years in order to be profitable (see e.g. Kuhn *et al.*, 2011). During this time, new exploitation areas will be continuously sought, either within one contiguous area such as the nodule license areas, or at adjacent sites as for SMS or seamount crust mining. This will lead to a continuously growing footprint, and a long-term cumulative impact on the ecosystems.

The concept of VME indicator taxa may not be applicable in the DSM context: this industry will not move at random over the seafloor, but systematically remove structure in determined locations over a long time. In the case of the abyssal plains, too little is known of the actual large- and small-scale community composition to be able to identify indicators of representative habitats and associated communities.

As a first step towards defining VMEs in context with the ecosystems where the deep seabed mining will occur, vulnerability has to be investigated in terms of potential for recovery, which is determined by the life history traits of the organisms and defines the susceptibility to perpetual degradation by human activities. In the following, the vulnerability and recovery potential of the three main mineral resource types are discussed with respect to the benthic fauna. A further chapter addresses the vulnerability of pelagic fauna in context with deep seabed mining. Since, by contrast to benthic communities, pelagic fauna are rarely considered in studies of deep seabed mining impacts, we will also include a more detailed review of potential impacts of mining operations on the pelagic biota.

2.4.3 Recovery potential of abyssal plain ecosystems

The vulnerability of the abyssal fauna to the direct effects of nodule mining relates to the complete loss of habitat for hard substrate fauna (Bluhm *et al.*, 1995) for geological time spans, associated changes in species and habitat diversity (Glover *et al.*, 2010; Vanreusel *et al.*, 2010; Vanreusel *et al.*, 2016) and functional changes (Danovaro *et al.*, 2008), and a thorough disturbance of the physical, chemical and biological properties of the surface sediments, all resulting in very limited recovery potential (Van Dover *et al.*, 2017). Kaiser *et al.* (2017) conclude that the extraction of deep seabed minerals will alter the structure and functioning of the targeted ecosystems.

Particularly in deep-sea environments, the recovery potential of hard and soft bottom fauna is expected to be limited due to the temperature- and food-related low turnover rates, slow growth, high longevity, intermittent reproduction and eventually wide-range distribution, but low abundance, (e.g. review by Clark *et al.*, 2016a). Therefore, the removal of this fauna can be estimated to require recovery periods which may span centuries to millennia, and even much longer or not at all for the nodule fauna.

In line with these expectations, investigations into the recovery of abyssal fauna from small scale experimental nodule mining in several locations in the Pacific up to 26 years after the disturbance revealed only very limited recovery, with none of the sites returning to baseline or control conditions (Gollner *et al.*, 2017; Jones *et al.*, 2017). Whereas some recovery of meiofaunal density was observed, the overall species diversity and community composition remained depauperated, and the nodule-associated fauna in areas of nodule removal had, of course, not at all recovered (Jones *et al.*, 2017). The authors suggest that recolonization of vast areas of seafloor impacted repeatedly by sediment plumes will require even much greater time scales for recovery than the relatively small experimental disturbances analysed.

Another study confirmed these results for sessile epifauna in manganese nodule fields, analysing a time series of observations over up to 37 years (Vanreusel *et al.*, 2016). Loss of the reactive sediment surface layer by mining was observed to reduce microbial activity, change microbial community structure and function and consequently restrict their function as a basis for faunal recovery decades after the disturbance (Vonnahme *et al.*, 2016).

Particularly in the Pacific nodule zones, the natural sedimentation rates are minimal, e.g. less than 20 mm per thousand years in the CCZ (Petersen *et al.*, 2016). Any nodule mining will substantially increase sedimentation rates in a large area and for a long time. A minimum impact zone cannot yet be determined, and is likely species-dependent. Resuspended sediments are no new organic food sources, but comprise mainly inorganic or refractory organic particles accumulated over millions of years of sedimentation. Thus, this will not mean a new food pulse, but rather lead to competition with organic food particles and to smothering of benthic fauna, even if the sediment sheet is less than 0.1 mm (presently considered as lower threshold in sedimentation models, MIDAS Consortium, 2016), which is still 50-100 times the natural annual sedimentation rate. The extent of ecosystem changes due to sediment plumes outside the mining area itself cannot yet be determined (Gollner *et al.*, 2017). Levin *et al.* (2016b) consider extensive resuspension and deposition of sediments over large spatial scales a significant adverse change to the deep-sea environment.

Critical factors to abyssal plain fauna recovery after mining

- Hard substrate habitat will be removed, therefore loss of obligate nodule fauna (Mullineaux, 1987);
- Since nodule substrate will not recover, recolonisation by specific nodule fauna is impossible, resulting in permanently altered communities (Jumars, 1981; Rodrigues *et al.*, 2001; Thiel *et al.*, 2005);
- Mechanical disturbance will alter the biogeochemical properties and structure of sediments, which could prevent the original fauna from re-settling, even if larvae are present (Nath *et al.*, 2012);
- Recolonisation of sediments by nematode or other infauna was found to take more than three decades even after small-scale experimental disturbance (Miljutin *et al.*, 2011; Van Dover *et al.*, 2017);
- Abyssal pelagic and benthic filter feeders are not adapted to elevated levels of suspended sediments (Ozturgut *et al.*, 1981; Robison, 2009);
- Diversity patterns (spatial scales) and key drivers (depth, substrate, connectivity, energy flux) and particularly reproductive strategies are poorly understood;
- Spatial and temporal scales of expected impacts from mining nodules are beyond any experiences on the impacts of human activities on marine ecosystems, even in shallow water (except for the devastating effects of bottom fishing and large-scale dredging);
- Lack of knowledge of even the basic functioning of deep-sea food webs;
- Very high and often localised species diversity with up to 90 % of species found in samples being rare (Glover *et al.*, 2002; Grassle and Maciolek, 1992; Levin *et al.*, 2001; Smith *et al.*, 2008b);
- Additional stress from climate change on abyssal ecosystem can be expected (Smith *et al.*, 2008a; Smith Jr *et al.*, 2009; Sweetman *et al.*, 2017).

2.4.4 Recovery potential of hydrothermal vent ecosystems

In the case of hydrothermal vents, the question of vulnerability to human activities has to address three issues:

- Vulnerability of the vent fauna *s.s.*
- Vulnerability of the non-vent fauna in the vicinity of hydrothermal vents, impacted by mining activities
- Vulnerability of the fauna at inactive vent sites

2.4.4.1 Vulnerability of the vent fauna *s.s.*

The obligate vent-associated species have a life cycle characterized by rapid growth rates, early maturation, large reproductive output, and well-developed dispersal capabilities (Grassle, 1986), which is typical of opportunistic, disturbance-adapted communities. So they are adapted to the fluctuations and disturbances occurring in their natural habitat (Van Dover, 2014).

Nonetheless, considerable **interferences** of several decades **of marine research and exploration** with vent ecosystems can be documented, indicating that impacts from mineral exploitation can be expected to exceed natural perturbations at the local scale (Van Dover, 2014) and be effective in addition to the natural changes (Van Dover, 2011). Mining of vent ecosystems leads to the loss of local populations associated with the removed habitat. Due to their local restriction and a very large proportion of rare, poorly known, and typically undescribed species, these populations may be particularly susceptible to a complete removal of all individuals and their habitat (Van Dover, 2011).

High levels of faunal connectivity and short lifetimes of vents, *i.e.* a high frequency of naturally occurring catastrophic events, would be good preconditions for a relatively fast and complete **recovery** of the associated fauna if venting remains active. Unfortunately, these factors are unknown in most cases (Van Dover, 2011). There are also considerable uncertainties in relation to the reproduction of vent species, in particular to the pelagic larval phase, the understanding of which is essential for being able to assess the natural recolonisation potential at a mine site (reviewed by Van Dover, 2014)). Therefore, the recovery potential is species-specific and may vary substantially within the same community (reviewed by Boschen *et al.*, 2013)).

There is some evidence that at least for some hydrothermal vent systems, invertebrate populations are maintained by local larval supply and retention during periods of habitat stability (Adams and Mullineaux, 2008, and Metaxas, 2004, 2011, quoted by Van Dover, 2014). Van Dover (2014) suggests that the relative impact of mining or similarly-scaled human activity on a vent ecosystem then depends

- On the size of the remaining local breeding stock,
- On the degree of isolation of the site relative to larval dispersal capabilities,
- On the degree of change in the geochemical and geophysical setting, and
- On the patterns of succession of the vent community.

Two observations of recovery after destructive venting events at fast-spreading ridge sites indicate a relatively short-term recolonisation and approximation to the regional species pool (Shank *et al.*, 1998; Tunnicliffe *et al.*, 1997), however, the ultimate community may also be very different (Mullineaux *et al.*, 2010). At the Solwara 1 site in PNG, rapid regrowth of the chimney structures was observed (Coffey Natural Systems, 2008), however the faunal recovery is yet unknown. Van Dover (2011) expects a recovery of dominant hydrothermal species and biomass within 5 years of a mining event, but the recovery of rare species may take decades or more, with a species-specific risk of decreasing genetic diversity.

In other regions, such as at hydrothermal vents on seamounts along the Mariana and Kermadec Arcs, any recolonisation may occur only slowly due to low connectivity of patchily distributed and spatially constrained populations with high local recruitment but low potential for colonisation of new locations (Metaxas, 2011). The effects of mining such sites may therefore be very long-lasting. The loss of multiple and/or critical habitats can be considered to constitute a significant adverse change for vent ecosystems (Levin *et al.*, 2016b).

2.4.4.2 Vulnerability of the non-vent fauna

At hydrothermal vents, both lava flows and sea floor mineral deposition result in the creation of hard substrate that rises above the surrounding sea floor. Once the venting stops, these substrates can be colonised by normal deep-sea fauna. In the vicinity of active vent sites, these communities may also benefit from enhanced organic production there (Erickson *et al.*, 2009) and may become rich suspension-feeding assemblages dominated by corals and echinoids not normally found on the deep-sea floor (SPC, 2013c).

Similar to the vent-obligate fauna, also this non-vent fauna may tolerate high levels of toxic compounds (e.g., heavy metals) emitted in vent fluids and accumulated in diet items through trophic magnification (Erickson *et al.*, 2009). However, it is unlikely that the suspension feeding fauna will be tolerant to increased sedimentation as a consequence of removal of unconsolidated sediments and cutting the rock (see e.g. reviews by Glover and Smith, 2003; Van Dover, 2014). Mining will locally destroy the communities, impact on those further away, but will likely not interfere with the establishment of new communities, provided that new vent sites of similar characteristics emerge.

2.4.4.3 Vulnerability of the fauna at inactive vent sites

After ceasing of vent activity, the rocky outcrops, and later on the covering sediments will be populated with 'normal' bathyal fauna, their abundances depending on the vertical flux of prey in a food limited environment. The recovery at inactive vent sites will therefore be at the time scales of the surrounding abyss and thus will be very difficult to monitor and assess. A loss of species is considered probable (Van Dover, 2011).

However, to date the fauna and food web at inactive hydrothermal deposits are virtually unknown (Van Dover, 2011). The inactive sites gradually become buried under sediments. Therefore, the mining of mineral accretions at inactive vent sites will in most cases involve the removal and re-deposition of a substantial overburden of sediments, accompanied by substantial sediment plumes.

Critical factors to hydrothermal vent fauna recovery

Summary after Van Dover (2011) and Van Dover (2014):

The most critical point in SMS mining in a region is the spatial scale and the duration of several years of one such SMS mining operation - a scale in nothing comparable to the natural disturbance events observed at some hydrothermally active sites. The mining-induced loss of habitat will be additive to the natural disturbance with potential for cumulative impacts on the abundance and distribution of vent species. Therefore, the relevant factors are

- The spatial scale of impacts, which exceed natural disturbance scales;
- The cumulative impacts, which extend over the lifetime of mining operation and afterwards;
- There may be cumulative and additive impacts of more than one mining site in the region;
- The unknown patterns of local species maintenance and reproduction;
- The unknown population characteristics of rare species;
- The unknown species-specific local and regional connectivity and the nearest neighbour species pool.

The site-specific recovery potential depends on the natural frequency of venting and distance between sites: at slow-spreading ridges and deep vent sites a re-establishment of communities is more unlikely. Rare species are largely unknown and will likely lost be (Van Dover, 2014).

2.4.5 Vulnerability of seamount ecosystems

Seamount ecosystems have been identified as 'vulnerable marine ecosystems, VME' (see Chapter 2.4.1) according to the guidelines of FAO (FAO, 2009), because the benthic as well as part of the pelagic fauna living on or associated with seamounts typically include organisms that are slow-growing, long-lived and sensitive to mechanical disturbance and/or overfishing (Althaus *et al.*, 2009). These faunal traits make seamount ecosystems highly susceptible to anthropogenic impacts (Clark *et al.*, 2010; Koslow *et al.*, 2001). For example, seamount megabenthic assemblages which usually feature long-lived and slow-growing corals as major constituents, fail to recover from trawling impacts (Althaus *et al.*, 2009; Williams *et al.*, 2010).

Schlacher *et al.* (2014) found that the benthic megafaunal taxa occurring inside and outside seamount regions with environmental conditions permissive of the building of thick cobalt-rich crusts were principally the same, but the assemblage structures differed due to varying relative abundances of taxa. However, the taxonomic resolution was coarse, as it was based on video transects. If the resolution was higher and macrofaunal specis were included, eventually a differentiated picture of seamount clusters or along-ridge systems with highly localized species distributions and apparent speciation between groups or ridge systems would emerge, as indicated by the results of Richer de Forges *et al.* (2000), who also showed that neighbouring seamounts of the same environmental conditions do not necessarily have a similar benthic fauna.

There is a high likelihood that crust mining at seamounts in the Pacific will interfere with local fishing patterns, both with bottom trawls and pelagic longlines. Depending on summit depth and accessibility, as well as associated fish fauna, seamounts have a varying risk of being subject to bottom trawling. Generally, the optimum crust formation for mining is found on accessible seamounts at the same intermediate depths as those suited for bottom trawling. Crust formation, filter-feeder megafaunal growth and fish aggregation sites, all work best at moderate flanks and on flat tops flushed by high current speeds.

Any exploration and marine mineral mining comes along with significant airgun and machine noise, vessel traffic, pollution and sediment plumes - in addition to the actual destruction on the seafloor. Given the high importance of seamounts for pelagic species diversity (Morato *et al.*, 2010a), for migrating turtles (Santos *et al.*, 2007) and whales (Garrigue *et al.*, 2015; Morato *et al.*, 2016), and not least for tuna catches (Morato *et al.*, 2010b), any mining operations at seamounts can be expected to significantly interfere unsustainably not only with the benthic fauna but also with the pelagic ecosystem in a very wide circumference, in particular downstream.

Critical factors to seamount faunal recovery

- The global status of seamount benthic communities unknown (Richer de Forges *et al.*, 2000); however, it is known that, for example, megafaunal communities on cobalt-rich seamounts are highly heterogenous on various scales (Morgan *et al.*, 2015) and depend on small-scale hydrographic conditions (Mullineaux and Butman, 1990).
- Even adjacent and ecologically similar seamounts display distinct fish composition and abundance, possible as consequence also of different benthic habitats (Tracey *et al.*, 2012).
- Recolonisation is uncertain if not unlikely, as the substrate will be destroyed and the production environment altered (Boschen *et al.*, 2015; Mullineaux and Butman, 1990; Schlacher *et al.*, 2014).
- High vulnerability due to longevity, low reproductivity and fragility of benthic invertebrate and fish species (e.g., Carreiro-Silva *et al.*, 2013; Clark *et al.*, 2016a; Morato *et al.*, 2006)
- Unknown population dynamics, reproduction and settlement characteristics of even the best known species call for utmost precaution.
- Species-specific patterns of propagation abilities, genetic connectivity between and within seamounts (reviewed by Gollner *et al.*, 2016).
- Limited recruitment between seamounts (Richer de Forges *et al.*, 2000)
- Long-term disturbance to aggregating fish fauna, demersal as well as pelagic (Clark *et al.*, 2016a; Morato *et al.*, 2010a).
- Long-term disturbance to turtle and whale migration (Garrigue *et al.*, 2015; Yen *et al.*, 2004).
- Unknown settling behavior of the sediment plumes on and away from the mined seamounts, but potential for large-scale vertical and downstream extent (Mohn and White, 2010).

Schlacher *et al.* (2014) propose the following measures to aid the conservation of seamount faunal communities should cobalt crust exploitation take place:

- The conservation of seamounts outside the cobalt-rich crust region is unlikely to capture the full range of ecological features found inside the region;
- Conservation areas need to encompass a broad bathymetric gradient;
- The small-scale heterogeneity on individual seamounts is very high and therefore ideally, mining blocks on individual seamounts should not exceed 2 km in length.
- The 'downstream' effects of sediment plumes or other hazards (e.g. toxins created by mining operations and carried in the plumes) have to be considered.

The authors conclude that overall, the life history characteristics and morphological traits of the deep-water invertebrate fauna typical of seamounts in the region imply that any recovery from mechanical impacts is likely to be limited and very slow. Crust mining operations are expected to cause much greater physical impacts to the seafloor habitats than bottom trawling has already done. The observed lack of recovery of the fauna after trawling (Althaus *et al.*, 2009; Williams *et al.*, 2010) is predicted to be more protracted for mine-sites at seamounts.

In addition, Schlacher *et al.* (2014) strongly stress that more quantitative data (encompassing more seamounts and depths) on the density of deep-sea fauna on seamounts in the region are needed to make definitive statements about whether benthic fauna occurs at greater or lesser density in the cobalt-rich crust region; this will also need to encompass data on the chemical composition of the seafloor, which closely match the faunal records spatially.

2.4.6 Threats to and vulnerability of the pelagic fauna[57]

The deep-sea pelagic fauna has rarely been considered in studies of the consequences of deep seabed mining, although mining operations at all three types of concretions will affect not only the benthic, but also the pelagic components of the ecosystem. Building on a brief review of the pelagic fauna and ecosystems (see Annex 8), this part will compile possible effects of activities in conjunction with deep seabed mining on pelagic and benthopelagic organisms and evaluate the vulnerability of the pelagic ecosystem compartment. Normal at-sea operations of support vessels and the usual hazards of shipping will not be considered here. No full-scale pilot mining has been performed to date, and not all mining effects descibed are based on direct scientific evidence; some can be inferred from small-scale disturbances or shallow water processes, and others remain speculative. Because the knowledge of deep-water communities and ecosystem functioning is extremely poor and the extent of disturbances from future industrial-scale mining activities is difficult to predict, we cannot make quantitative assessments of the mining impacts, and an overall evaluation whether these will cause serious and persistent harm to the ecosystem is currently not possible.

2.4.6.1 Potential impacts of deep seabed mining on pelagic fauna

The main primary and secondary processes of deep seabed mining activities which can potentially affect the pelagic environment are:

- Removal of substrate
- Deposition of material
- Pre-processing of ore at the sea floor
- Removal of ambient water
- Generation of noise and light
- Compacting of bottom substrate
- Generation of operational sediment plumes
- Generation of discharge sediment plumes
- Alteration of habitat through substrate removal, sedimentation, deposition, compacting
- Destruction of benthic communities
- Alteration of near-bottom flow characteristics and turbulence
- Release of toxic compounds during extraction or in discharge plumes
- Acidification
- Release of nutrients
- Oxygen depletion
- Injection of water with different than ambient temperature

In the following, we will present a short description of each of these processes and assess whether and how they may impact pelagic communities. We will not consider effects on deep-sea microzooplankton and pelagic microbial communities, for which hardly any information exists.

Removal of substrate

The exploitation of all deep-sea mineral deposit types involves the removal of large amounts of substrate. The technology is still in the conceptual phase; prototypes exist for SMS and nodule deposits.

[57] Part 2.4.6 is extracted from Christiansen, B., Denda, A., 2017. Pelagic communities of the open ocean and deep sea - risks from seabed mining. Report to IASS. Universität Hamburg, p. 61. Part II, Executive Summary included in Annex 8.

Potential impacts

Water jets for loosening material and suction devices for nodules may take up, together with ore, sediment and water, smaller benthopelagic fauna and planktonic larvae which are not capable of avoiding the associated water flow. Overall, direct effects of cutting, scraping and raking are probably negligible for pelagic and benthopelagic fauna. The operation and movement of the collectors will, however, induce various indirect effects as shown below.

Deposition of material

Mining of SMS will be associated with large amounts of unconsolidated surface sediment and waste rock, which will be deposited in the vicinity of the mining pits and may amount to more than 200,000 t per mining site (Gena, 2013).

Potential impacts

Direct effects of deposing sediment, waste rock and ore on the seafloor are probably negligible for mobile pelagic and benthopelagic fauna, although some smothering of less mobile animals living close to the sea floor, for example jellyfish, cannot be excluded. Sediment plumes will be generated, and toxic material may be released (see below).

Pre-processing of ore at the seafloor

Currently, pre-processing of ore at the seafloor is supposed to be restricted to separation of sediment from nodules and to crushing or grinding material for hydraulic transport to the support vessel.

Potential impacts

No direct effects on pelagic/benthopelagic fauna are expected, but the process may generate sediment plumes, produce sound and release toxic compounds (see below).

Removal of ambient water

Most mining scenarios currently involve a closed riser system, which uses large amounts of ambient water for diluting the (grinded or crushed) ore and pumping the slurry to the surface, although the use of a continuous line bucket system is another option for transporting the extracted ore to a support vessel. Ambient water may also be used for water jets and suction devices during excavation and pre-processing. Estimates of water removal per single mining operation/collector range from >40,000 m^{-3} d^{-1} in SMS deposits (Jak *et al.*, 2014) to >50,000 m^{-3} d^{-1} in FeMn nodule fields (Oebius *et al.*, 2001).

Potential impacts

- Most of the water will likely be taken up in the layer within less than 10 m off the sea floor. This is the habitat of a specific benthopelagic fauna, including fishes, larger invertebrates, and zooplankton, which is substantially different from the overlying water column (e.g., Christiansen *et al.*, 2010). Results from the Clarion-Clipperton-Zone also indicate an accumulation or retention of meroplanktonic larvae of benthic invertebrates (Kersten *et al.*, 2017). The amount of hydraulic entrainment will depend on the inlet diameter and flow velocity of the suction device and vary with the size and mobility of the species.
- Part of the larger, more mobile fauna may avoid the inlet flow, but information is not available. Evidence from shallow water hydraulic dredging suggests that larger fishes are rarely entrained, but larvae and eggs are frequently sucked up (Wenger *et al.*, 2017). It is, however, questionable whether these results can be transferred to the deep sea, where fishes often appear rather sluggish (Koslow, 1996) and may have a lower ability to avoid disturbances than surface-dwelling fishes which live in a naturally turbulent environment.

- Zooplankton including meroplanktonic larvae will generally be sucked up with the water and subsequently killed, as can be inferred from a study by Mullineaux *et al.* (2005) who sampled zooplankton at hydrothermal vent sites using a pump system, which had a much lower capacity than anticipated for commercial mining operations. Hydraulic entrainment of meroplankton may be a particular problem for dispersal of benthic fauna at these sites, where planktonic larvae of vent invertebrates tend to be concentrated (Van Dover, 2014); however, larval release at the mining sites will be strongly reduced when the benthic fauna is already widely destroyed, but larvae advected from other sites may be affected.

Generation of light and noise

Collectors will most likely be equipped with strong lights for illuminating the seafloor at the mining path, enabling camera control of the operations. Further light emissions will come from survey, inspection and maintenance ROVs. Underwater noise will be generated by the collector machinery and the riser system close to the bottom, but vibrations and friction in the lift and release pipes may produce sound also in mid water.

Potential impacts

Sunlight does not penetrate deeper than 1000 m into the ocean, and consequently, many deep-sea organisms have partly or completely reduced eyes or light sensing organs. However, there are also many fishes and invertebrates with fully developed eyes, which are probably particularly sensitive to the very low light levels of bioluminescence (Douglas *et al.*, 1995). This is produced by a wide range of organisms spanning from bacteria to fish; it is the only natural light source in the deep sea and a ubiquitous phenomenon in all oceans (Haddock *et al.*, 2010).

- Artificial **light** in the deep sea may have various effects. Some fishes are known to be attracted to light, whereas others avoid light or do not show any reactions (e.g., Raymond and Widder, 2007; Ryer *et al.*, 2009; Widder, 2010). Attraction to light may enhance the danger of, for example, hydraulic entrainment. The ecological function of bioluminescence will be locally masked by bright illumination. The very high intensity of flood lights, as compared to bioluminescence, may irreversibly damage the eyes of organisms in the vicinity, as suggested for vent shrimps by Herring *et al.* (1999).

By contrast to the upper water column, the role of **sound** in deep-sea ecosystems is still largely unknown, but it is suggested that deep-sea fishes may use sound for communication (Rountree *et al.*, 2011; Wall *et al.*, 2014), and mechanoreception is probably important in deep-sea scavengers for the near-field detection of food falls (Klages *et al.*, 2002). Some cetaceans dive down to bathyal depths and use sound for echolocation. Since underwater sound propagation, particularly at low frequencies, reaches very far, noise from ore extraction may travel distances of hundreds of kilometres (e.g., Stocker, 2002) and impact large areas. Sound propagation is omnidirectional, and therefore is likely to reach the upper water column below the pycnocline or even above, thus having the potential to affect mammals and other marine life not only in the deep, but also in surface waters.

- Stocker (2002) summarises the active and passive use of sound in marine animals, including, among others, prey detection, communication, navigation. Besides directly damaging acoustic sensors or inducing certain behaviour, as is evident in marine mammals (e.g., Kastelein and Jennings, 2012), anthropogenic noise may interfere with the natural use of sound, either by masking biologically relevant sounds, or by triggering false responses (Stocker, 2002). However, since information about the sound generation and propagation due to deep-sea mining is not available and knowledge about sound perception in deep-sea animals is poor, the likely impacts of noise generation by deep-sea mining tools can currently not be predicted.

Compacting of bottom substrate

Depending on the technology, the mining tools for SMS and manganese nodules will move directly on the deep-sea floor, thereby compacting the sediment in the tracks. This is less relevant in FeMn crusts. The intermediate deposition of ore may also compact the sediment underneath.

Potential impacts

A direct effect of compacting the sediment on the pelagic and benthopelagic fauna is not expected, but alteration of the benthic fauna may indirectly affect also the pelagic/benthopelagic communities.

Generation of operational sediment plumes

The operation of the mining tool (raking, cutting, scraping), side cast and pre-processing (grinding, crushing, washing) will generate sediment plumes, and the movement of collectors on the seafloor will result in a greatly enhanced resuspension of sediment. The sediment plumes, which comprise anorganic particles and probably some, mostly refractory, organic material, may reach several tens of metres above the seafloor (Ozturgut *et al.*, 1981) and are subject to dispersal by the near-bottom currents and turbulent mixing. Depending on particle size and associated settling velocity, the suspended material will be re-deposited close to the mining site or at some distance thereof.

There are currently no reliable estimates of the extent of operational sediment plumes with respect to particle concentrations which may affect zooplankton. Usually, only sedimentation rates, i.e. the benthic footprint, are provided. According to Nautilus Minerals Niugini Limited (2008), model simulations calculate the benthic footprint of the sediment plume at the SMS deposit Solwara I to be about 3.5 km^2, with sediment deposition ranging from 0.5 m close to the mining pit to <1 mm at a distance of 700 m. However, these results are disputed by Luick (2012) who argues that the area affected and the sediment cover may be larger by one order of magnitude. The mining of FeMn nodules will affect large areas in the range of several hundred km^2 annually (Ozturgut and Lavelle, 1984; Sharma, 2015; Volkmann and Lehnen, 2017); the extent of the sediment plume and its settling area is naturally to be much larger. Recent modelling of the benthic footprint of the sediment plume generated by a 1 year mining operation at a 12*12 km nodule extraction site indicates a deposition of >0.1 mm sediment per year up to a distance of 50 km (MIDAS Consortium, 2016). This still exceeds the background sedimentation rate 100fold and does neither include the cumulative effects of longer term mining operations, nor does it consider the very fine fraction which remains afloat for years (Rolinski *et al.*, 2001).

No information is available for FeMn crusts at seamounts. The interactions between steady flow, tidal oscillations and topography result in complex flow patterns (Lavelle and Mohn, 2010), which will make the affected areas difficult to predict. Upwelling and turbidity flows will further complicate the scenarios.

Potential impacts

The deep-sea environment is characterised by very low sedimentation rates in the order of millimetres per 1000 years (Glover and Smith, 2003). Turbidity and particle load are usually very low, but they may increase in the near-bottom water layer due to resuspension and form a nepheloid layer (Nyffeler and Godet, 1986), which was, however, not observed at the Clarion-Clipperton-Zone (Lipton *et al.*, 2016). Depending on the surface production and water depth, the flux of organic matter to the seafloor is very low, amounting to <3 % of the export flux (Turner, 2015) and resulting in a low productivity and small standing stocks of deep-sea organisms.

An enhanced load of (inorganic) particles in the near bottom water layers may directly affect the pelagic and benthopelagic fauna in various ways

- Burying/smothering of animals. Although being a main concern for benthic organisms, this effect will probably be minor in the near-bottom pelagic fauna. Some problems could be possible for less mobile benthopelagic animals, such as jellyfish, close to the source, where massive sedimentation occurs, but no information is available.
- Impairment of respiration through clogging of gills. No information is available.
- Influence on feeding and food availability. The deep sea is generally a food-poor environment which ultimately depends on the energy supply from the epipelagic zone, although chemoautotrophy may locally add to the food supply, for example at hydrothermal vent systems. Information on the feeding ecology of benthopelagic deep-sea fauna, except fishes (see Drazen and Sutton, 2017 for a review), is poor, but detrivory is supposed to be common in near-bottom zooplankton. Higher trophic levels rely on benthic or pelagic prey or scavenge on food falls.
- High loads of suspended inorganic particles may result in the clogging of the filtration apparatus with unpalatable particles, for example in copepods. Similarly, the mucus nets in flux feeders, for example pteropods, may be clogged by suspended inorganic particles, leading to enhanced weight and sinking speeds and reduced availability of proper food items. The competition of unpalatable particles with organic food particles and the ingestion of particles without or with reduced nutritional value (Anderson and Mackas, 1986; Hirota, 1981; Hu, 1981) will result in enhanced energy expenditure for feeding and may lead to starvation and reduced growth rates in the near-bottom zooplankton, probably with a cascading effect to higher trophic levels.
- Interference with odour plumes. Olfactory is supposed to be the main mechanism for attracting and leading benthopelagic scavengers to food items (e.g., Sainte-Marie, 1992). The sediment plumes generated by mining activities will interfere with odour plumes released from food falls, resulting in lower detection rates and generally lower food availability for scavengers.
- Suppression of communication. Many deep-sea organisms emit light, and this bioluminescence is used, among others, for communication, for example mate finding (e.g., Widder *et al.*, 2005). The enhanced turbidity in the sediment plumes will attenuate the light transmission and hence may largely decrease the visibility of light organs, leading to a reduced probability of finding a mate and to lower reproduction rates in an environment with extremely low abundances and encounter probabilities for mates.
- Chemosensory is known to be important for mate finding in some shallow-water copepods (Kiørboe and Bagøien, 2005), but it is not known whether chemical cues are used for reproduction also in deep-water animals. A sediment plume would interfere with such chemical trails and lead to decreased reproductive success.

Generation of discharge sediment plumes

At the extraction sites, the (crushed or grinded) ore will be pumped to a surface support vessel presumably using a hydraulic riser system. Alternatively, a continuous line bucket system is possible. The hydraulic riser system involves the dilution of the ore with large amounts of water. The resulting slurry has to be dewatered on the support vessel, and the tailings, comprising waste water including sediment and fine-grained solids from crushing and abrasion, will be returned to the sea, generating a sediment plume at the release site. Estimates for tailings masses range from 400 t d^{-1} dry solids suspended in about 50,000 t of water per collector associated with FeMn nodule mining (Oebius *et al.*, 2001) to 9,700 t d^{-1} dry solids suspended in 400,000 t of water from metalliferous mud mining (Thiel *et al.*, 2015). For SMS extraction, Jak *et al.* (2014) assumed a return of 6,000 t d^{-1} dry solids in 40,000 t of water, but according to Nautilus Minerals Niugini Limited (2008) all particles >8 µm will be retained on the support vessel and disposed of on land, reducing the amount of discharged sediment considerably. However, the remaining very fine material will settle very slowly and be dispersed over wide areas.

Potential impacts

The area affected by the discharge sediment plume depends on the duration of the discharge, the amount and grain size distribution of discharged material, the depth of release and the oceanographic conditions. Model simulations suggest that coarse material settles rapidly close to the source, whereas fine particles may stay afloat for years and be dispersed over hundreds of kilometres (Rolinski *et al.*, 2001). Observations of deep-reaching eddies suggest that these may be a means of long-distance transport for waste material from mining activities (MIDAS Consortium, 2016).

The effects described for the operational sediment plume are basically applicable also to the discharge plume. Depending on the depth of release, additional effects may occur:

- Release in the epipelagic zone (0-200 m): Discharged material will stay in the water column for long periods and affect also layers below the epipelagial. The enhanced turbidity in the photic zone may lead to lower light availability resulting in a significant reduction of primary productivity (Chan and Anderson, 1981; Hyun *et al.*, 1998), with possible cascading effects to higher trophic levels. Chan and Anderson (1981) predicted a 50 % reduction of primary production for a full-scale nodule mining operation over an area of 18x2 km, but assumed that this effect would be only temporary due to dilution, advection and settling of particles. However, a persistent discharge over periods of years would certainly result in a long-term effect on the phytoplankton community. The uptake of inorganic particles by zooplankton results in lower growth rates, as described above, but may also induce enhanced particle fluxes due to higher sinking rates of fecal pellets (Hirota, 1981). The discharge current and differences in density between ambient and discharge water may locally induce convection and disrupt stratification of the upper water layer, but possible effects on the ecosystem cannot be predicted.
- Release in the mesopelagic zone (200-1000 m): The presence of vertical migrators is typical for the twilight zone; they forage in surface waters at night and stay at several hundred metres depth during the day. This might result in effects of sediment release in this layer being transferred to the epipelagial. A marked oxygen minimum zone is present at low latitudes. An enhanced turbidity due to sediment plumes may reduce the foraging success of visual predators, or of predators which attract prey with a bioluminescent lure, such as anglerfishes. Communication by bioluminescence may be inhibited. The uptake of inorganic particles by zooplankton may induce higher sinking rates of faecal pellets (Hirota, 1981). Similarly, the sinking velocity of mucus nets may be enhanced. It is not clear, however, whether the resulting enhanced particle flux will be associated with substantially higher organic fluxes, which might improve food availability for the deep-sea fauna. Further, it is not clear whether and how the biological and microbial carbon pump might be affected.
- Release in the bathy- and abyssopelagic zones below 1000 m: These zones are completely dark except for bioluminescence. The effects of enhanced particle load will be similar to the zones above, including inhibited ecological function of bioluminescence, but may be more severe because the natural turbidity is extremely low ('clear-water minimum') in these layers, and the competition between sediment particles and natural organic (food) particles is probably substantially stronger than in the zones above, where natural particle abundance is much higher.
- Release close to the bottom: This will affect the smallest area in comparison to the layers above, because the settling distance of particles is shortest, but will greatly amplify the impacts of the operational discharge plumes.

Alteration of habitat

The removal and deposition of substrate, the resedimentation of operational and discharge sediment plumes, and the compacting of substrate will strongly alter the microtopography and structure of the seafloor at the mining sites of all deposit types. Due to the low natural sedimentation rates and near-bottom current velocities, these changes will persist for long periods. The reconstitution of FeMn nodule and FeMn crust substrate will even take millions of years. Although some recolonisation may occur after destruction of the ambient benthic fauna, a long-term alteration of the benthic communities is expected and has been shown in small-scale mining tests (Jones *et al.*, 2017; MIDAS Consortium, 2016).

Potential impacts

Although primarily affecting the benthic communities, both the changes in seafloor structure and the resulting changes in the composition of the benthic communities will also impact the benthopelagic fauna. Since the character of the association and interaction between benthopelagic fauna and the seafloor is extremely poorly known, the possible impacts remain largely speculative.

- Traces of life such as mounds, or other micro-elevations may provide shelter for benthopelagic zooplankton from currents or predators, as suggested for shallow waters (Huys and Thistle, 1989). The destruction of such elevations, or the forming of new structures such as tracks and grooves, may influence the behaviour of benthopelagic organisms and prefer certain species and discriminate against others.
- The removal of habitat-forming benthic fauna, such as corals and sponges, will have a negative effect on pelagic animals utilising this habitat for food or shelter.
- An altered composition of the benthic fauna will affect the trophic pathways between benthos and benthopelagos, and thus may favour or discriminate against certain feeding interactions and ultimately change the composition of the benthopelagic communities.
- Benthic suspension feeders are likely to recover only very slowly from mining activities. The suppressed food competition may favour benthopelagic suspension feeders and increase their abundance.

Destruction of benthic communities

The removal of substrate will destroy all benthic fauna in the path of the mining tool. A larger area will be affected by the operational and discharge sediment plumes and will also kill all or part of the benthic animals through smothering or secondary effects.

Potential impacts

Besides the long-term effects of altered benthic communities, as discussed above, the lethal effects of mining on benthic fauna will induce changes in food supply of benthopelagic species.

- Species depending on living benthic prey, either epifauna or infauna, will experience a local shortage of food. For example, deep-sea fishes can be placed in feeding guilds (Drazen and Sutton, 2017) and may not be able to switch from benthic to pelagic food sources, which requires completely different feeding strategies. Moving to unaffected areas would increase competition with the local fauna for a limited food resource there.
- At hydrothermal vents, there exist numerous trophic interactions between vent fauna and surrounding mobile predators (Levin *et al.*, 2016a), which will be interrupted during the mining process, and re-established only when a rapid recolonisation occurs, as may be possible from nearby active vents in fast-spreading ridge systems with rapid re-growth of chimneys (Boschen *et al.*, 2013).

- The dead animals associated with the mining activities may provide a short-term enhanced food supply for benthopelagic scavengers, for example lysianassoid amphipods and fishes. It is, however, not clear whether this food source, which will comprise mainly small invertebrates, can be exploited to a large extent by the more mobile and rare scavengers which rely on odour plumes for the detection of food items.

Alteration of near-bottom flow characteristics and turbulence

The mining operations proper, but also an altered rugosity and microstructure of the seafloor as result of excavation, deposition, movement of mining tools and resedimentation, may influence the flow characteristic and turbulence in the near-bottom water layer. Injection of the discharge plume with temperatures higher than the ambient water in the near-bottom layer will induce turbulence. However, no studies of these issues exist to date.

Potential impacts

Currently, possible impacts of these changes cannot be foreseen.

Release of toxic compounds

Both the mining process and the discharge of sediment plumes are associated with the release of potentially toxic substances, for example heavy metals, into the environment (Hauton *et al.*, 2017). The bioavailability and toxicity of metals largely depend on environmental conditions and are species-specific. Leaching of heavy metals associated with MnO_2, as found in FeMn nodules and FeMn crusts, is supposed to be rather low, but could be greatly enhanced under reducing conditions, for example if tailings are discharged in oxygen minimum zones or if unoxic sediment is unearthed (Koschinsky *et al.*, 2001). Sulfide-rich ores, as in SMS deposits, 'may leak significant amounts of potentially toxic metals' (Ramirez-Llodra *et al.*, 2015). The mining of metalliferous mud in the reducing environment of the Red Sea brine pools would 'constitute a significant influx to the basin' (Thiel et al. 2015 (Thiel *et al.*, 2015)).

Potential impacts

Toxic compounds such as heavy metals are known to generally have acute or chronic adverse effects on organisms. Such effects have, for example, been shown for mine tailings in shallow water (Anderson and Mackas, 1986; Ramirez-Llodra *et al.*, 2015). Only limited data are available on the sensitivity of deep-sea pelagic and benthopelagic fauna to high metal concentrations, for example in deep-sea vent mussels (Martins *et al.*, 2017). Naturally enhanced metal concentrations have been found in several deep-sea fishes (Company *et al.*, 2010; Cronin *et al.*, 1998), probably indicating a reduced sensitivity to metal accumulations in the deep-sea environment. In a review of potential toxic impacts of metals released during deep seabed mining, Hauton *et al.* (2017) conclude that, considering the influence of temperature, pressure and composition of effluents, reliable predictions of the toxicity on individual organisms are currently not possible. However, the authors propose '*to adopt a Weight of Evidence (WOE) approach to quantify the risk associated with mining a particular resource*' (Hauton *et al.*, 2017).

- High concentrations of bioavailable metals released with the discharge plume in the water column will definitely harm the affected communities, resulting, for example, in enhanced mortality, inhibition of growth (Fuchida *et al.*, 2017) or lower reproductive rates (Hook and Fisher, 2001). Higher trophic levels, including species which are important for human consumption, may be particularly affected due to bioaccumulation in the food chain, and extend the sphere of influence through vertical and horizontal migrations.
- The effect of metal release close to the bottom may be smaller than in the water column if the fauna living there is in fact less sensitive to high metal concentrations, for example at active

SMS deposits (Nautilus Minerals Niugini Limited, 2008), but this has to be experimentally confirmed.

Acidification

The mining of SMS has the potential to generate acids on the seafloor and in tailings through sulfide mineral oxidation (Bilenker *et al.*, 2016).

Potential impacts

Experiments indicate that the production of acids from SMS mining does not exceed the buffer capacity of the seawater (Bilenker *et al.*, 2016). However, the effect increases with decreasing pH of seawater, implying that an increasing ocean acidification due to climate change may amplify by the release of acid from crushed SMS deposits.

Release of nutrients

The discharge of nutrient-enriched deep-sea water close to the surface may locally increase nutrient concentrations in the photic layer.

Potential impacts

The surface mixed layer at low latitudes is usually very poor in nutrients, such as N, P and Si, which are rapidly recycled. The phytoplankton community is adapted to these low nutrient concentrations and comprises mainly very small cells, the picoplankton, which has maximum abundances in or below the thermocline.

- Enhanced nutrient concentrations in the photic zone may locally increase primary production and alter the composition of the phytoplankton community, for example favouring the development of diatoms. The deep chlorophyll maximum may be lifted to shallower depths. However, long-term and large-scale effects are not anticipated (Chan and Anderson, 1981).
- Iron is an important micronutrient and may be limiting primary productivity in some areas. Metals such as iron will be released with the discharge plume and may boost primary production, but the potential scale of such effects is not known.

Oxygen depletion

The ore extraction and tailings disposal may induce the release of anoxic sediments to the near-bottom water layers and the water column, respectively. Mass deaths and subsequent microbial decomposition at the mining sites would increase the oxygen demand in the Benthic Boundary Layer.

Potential impacts

The bathy- and abyssopelagic water column and the near-bottom water layer are well oxygenated, and an increased oxygen demand due to the release of anoxic sediments or the microbial decomposition of dead benthic fauna in the mining path, would most likely have negligible effects on the dissolved oxygen concentration in those layers. The release of a discharge plume containing considerable amounts of anoxic sediment in the oxygen minimum zone, could, at least locally, decrease oxygen concentrations further and lead to anoxic conditions, excluding most zooplankton and micronekton from this layer.

Injection of water with different than ambient temperature

The temperature of the water at the deep-sea mineral deposits is very low, ranging from <2 to 10 °C depending on depth. The water used for pumping the ore to the support vessel will be subject to warming in the upper water layers and during processing of the slurry.

Potential impacts

Water with different than ambient temperature may cause, besides physical effects such as turbulence and vertical flows, also direct biological effects. The deep-sea fauna is generally adapted to low temperatures with very little variation, whereas communities living higher in the water column experience greater temperature variations.

- The release of warmer water in the bathy- and abyssopelagic zones and close to the bottom will most likely impair or even kill the animals subjected to these discharges. It is not known whether more mobile organisms are able to sense and avoid such areas of increased temperatures. Due to rapid mixing with ambient water, the spatial extent of the impact will likely be small.
- The release of cold deep-sea water in the epi- and mesopelagic zone will probably have little direct effect on the communities concerned.

2.4.6.2 Conclusions on the vulnerability of pelagic organisms

This compilation shows that, independent of the fact that only a tiny fraction of the fauna living in the deep-sea pelagic realm is known, many of the processes associated with the mining of deep-sea metalliferous deposits will impact not only the benthic communities, but also the pelagic components of the ecosystem, and particularly the benthopelagic fauna with its associations to the seafloor (for more detail on knowledge gaps and recommendations for further research, see report in Annex 8 (Part III). Some of the impacts will be directly lethal, but most will impair processes associated with feeding, growth and reproduction, which can ultimately lead to smaller standing stocks, altered communities and loss of biodiversity. However, potential consequences of these indirect effects for the deep-sea populations, the food web and the overall ecosystem are extremely difficult to verify.

The dispersal capabilities of nekton and zooplankton, including meroplanktonic larvae, are likely relatively high, as compared to the majority of purely benthic fauna (McClain and Hardy, 2010). This implies on the first hand that local losses can rapidly be compensated for by advection from unaffected waters in the surrounding, given a minimum overall abundance is present and the faunal composition is similar. However, composition and biodiversity may be altered if the composition of the communities is not homogeneous over large areas, as reported, for example, for the scavenging fauna of the Clarion-Clipperton-Zone (Leitner *et al.*, 2017). Similarly, the reconstitution of very rare, highly dispersed species may be inhibited, reducing the overall biodiversity. Mobile species may be able to avoid mining effects by moving to unaffected areas, but will have to compete there for the limited resources with the local fauna. Most current scenarios of deep-sea mining activities will not largely affect the downward flux of organic matter to the deep sea. That means, the energy input, except for chemoautotropic input at SMS sites, will remain the same during and after the mining event, and principally, the overall productivity should not be altered, or for short periods only. However, the changes in the benthic communities, which will be persistent for very long periods in most cases (e.g., MIDAS Consortium, 2016), will affect the food availability and the trophic pathways and thus induce long-term alterations in the composition of the benthopelagic communities as well.

Because the knowledge of life history traits, zoogeographic distribution and connectivity in deep-sea pelagic and particularly benthopelagic zooplankton is extremely poor and the dimensions and technology of the planned mining operations are still under discussion, it is currently not possible to predict whether the consequences of deep-sea mining for these compartments are locally and temporally restricted, or whether they are persistent and affect larger regions. We can, however, anticipate that large-scale changes in the bottom communities will also lead to a long-term altered near-bottom pelagic fauna in the areas affected, which may add up to changes caused by ocean warming and acidification.

2.4.7 Summary recovery potential

All three deep-water mineral resource types have specific ecosystem characteristics which limit their recovery potential with respect to long-lasting, spatially extensive cumulative impacts from deep seabed minerals mining as can be envisaged today. No recovery back to the former ecosystem state can be expected.

Different faunal communities dominated by otherwise rare opportunistic species can be expected to develop as a consequence of polymetallic nodule and crust mining, resulting in a different set of ecosystem functions, goods and services. It may be that in some cases, for example with careful mining at hydrothermal vent fields, the dominant species may be retained, however it will likely be impossible to even know about the fate of the rarer species.

2.4.8 Recommendations

Recommendations

- The concept of vulnerable marine ecosystems (VMEs) should be adapted for the purpose of indicating sites with communities and habitats which are particularly vulnerable to the impacts of seabed mining for all three resources in the Area;
- The concept should be made operational by setting criteria for the LTC to consider when evaluating a future plan of work for exploration or exploitation.
- An overarching approach is required for determining how to ensure effective protection and prevent significant adverse effects on the ecosystems targeted by mining and the broader surroundings. This should include the option that mining will cause an unacceptable degree of damage and should therefore not be authorised.
- A practical way forward will be to set up a working group of experts mandated by the LTC to assist with finding solutions in this context.
- In particular, further research should be conducted on pelagic fauna and ecosystems, including establishing the baselines in contractor areas. Recommendations for research and for amending the ISA Guidance for contractors (ISBA/21/LTC/15 and ISBA/19/LTC/8) can be found in Annex 8.

3 Governance towards Ambitious Environmental Standards

3.1 An Ecosystem Approach to the Management of Human Activities

As signatories to global and regional environmental agreements, and supporters of other international instruments, almost all states on earth are committed to implementing an ecosystem approach to the management of human activities, EAM, within their jurisdictions. For example, EAM has been recommended by the UN General Assembly[58], the Convention on Biodiversity[59], and the Johannisburg Plan of Implementation of the World Summit on Sustainable Development[60]. Also ISA aims to apply the concept for particular regions (International Seabed Authority, 2011) and eventually all over the Area (International Seabed Authority, 2017b).

An ecosystem approach to the management of human activities, EAM[61], is an integrative, holistic and participatory management approach which is grounded on a long-term perspective on the current and future state of the respective ecosystems. The aim is to coordinate all existing and proposed activities to satisfy human needs in such a way that the long-term integrity of affected ecosystems is not compromised. This approach to management shall enable the long-term conservation of the marine environment while allowing for sustainable use. EAM is best applied for a particular region, as defined by ecological and eventually practical criteria, and communicated by an agreed overarching strategy, including an Environmental Strategy (see Chapter 3).

For example, OSPAR and HELCOM (OSPAR and HELCOM, 2003) define the ecosystem approach as:

> *'the comprehensive integrated management of human activities based on the best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity'. The application of the precautionary principle is equally a central part of the ecosystem approach.*

At the core of the ecosystem approach to management stand a number of principles: the Precautionary Approach (see Chapter 3.4.1), the Polluter-Pays Principle, transparency and participation (see Chapter 3.4.4), the use of Best Environmental Practice, Best Available Technologies, and where possible an adaptive management cycle to address uncertainties in the outcome of regulation (see Chapter 3.4.1 and 3.4.3).

The implementation of EAM requires an agreed vision, goals and objectives guiding any management decisions for the respective region, as commonly developed by all stakeholders. Decision-making shall be based on best available knowledge, including non-scientific knowledge, and is supported by assessment tools such as Strategic Assessments (AXYS Environmental Consulting Ltd.), project-related Environmental Impact Assessments, EIAs, accompanied by appropriate indicators and thresholds to verify the level of impact from existing or planned activities at the appropriate scales. The delivery tools include the conduct of a marine spatial planning process, the designation of protected areas and the regulation of activities. EAM is therefore strongly knowledge-driven.

Due to the large uncertainties with respect to the relationships between certain activities, the corresponding pressure and the environmental effects, decisions on management measures will

[58] UN GA A/61/63, pp. 31 ff.

[59] COP 5 Decision V/6

[60] WSSD, 2002. Report of the World Summit on Sustainable Development. A/CONF.199/20.

[61] see notes on the terminology at http://www.biodiversitya-z.org/content/ecosystem-approach; comprehensive background and guidance for implementation at https://www.cbd.int/ecosystem/about.shtml

necessarily involve also value choices. Therefore, the transparency and accountability of decision-making is particularly important and societal choices should be integral to the considerations leading to decisions. In the case of an EAM process in mineral exploration regions, the overall lack of understanding of the marine environmental functions and processes should lead to management procedures and decisions which ensure that the error is on the precautionary side.

3.1.1 The integrative scope of EAM

At the latest since 2002, a holistic and inter-sector approach to sustainable development has been promoted (WSSD Plan of Implementation 2002). Therefore, a holistic view on all activities and pressures in a region and their effects on the environments is required, which can only be achieved by fully transparent mechanisms, enabling the participation of a wide range of stakeholders. The integrative scope of EAM not only relates to the range of stakeholders and the breadth of knowledge involved in developing regional management but also to the evaluation of the potential of all possible influences in the region to cause detrimental and undesired effects on the marine environment, which includes (Abaza *et al.*, 2004)

- The substantive integration of the impacts derived from separate environmental, economic, social *etc.* impact assessments;
- The horizontal integration of different types of impacts into one assessment at different stages of the planning cycle;
- The integration of assessments into decision-making.

Full integration of all impact assessments is required to evaluate whether a plan/programme or project contributes to the sustainable development goals as benchmarked by international agreements and national targets (Abaza *et al.*, 2004). Strategic Environment Assessments could be an instrument to deliver this integration, but this is up to the responsible planner. In any case, do integrated assessments also require a coherent, cross-sector policy response.

Climate change and biodiversity are particularly important parameters to be integrated to all steps in the EIA (and SEA) (European Commission, 2013): Climate change trends and interactions with biodiversity are the evolving baselines, likely to influence the long-term perspectives and impacts of a project, which should be looked at cumulatively in an ecosystem approach to management with the aim to '*avoid biodiversity and climate change effects from the start, before considering mitigation or compensation. For biodiversity, EIA should focus on ensuring no-net-loss*' by a.o. avoiding irreversible losses of biodiversity (see also IAIA, 2005)).

Ecosystem services provided by biodiversity should be an integral part of the assessments (Abaza *et al.*, 2004). The main biodiversity concerns are

- Degradation of ecosystem services,
- Loss of habitats, fragmentation (including in terms of the extent or quality of the habitat, protected areas, habitat fragmentation or isolation),
- Alteration of processes,
- Loss of genetic diversity.

In the context with deep seabed mining, an ecosystem approach implies that all impacts and measures are considered on the appropriate spatial and temporal scales and in conjunction with naturally or otherwise shifting baselines, and impacts arising from and measures taken by other sectoral organisations in the same area. This can best be realised through a strategic assessment of all expected or likely pressures and effects in the region, including expected cumulative and synergistic impacts (see Chapter 3.4.5).

3.1.2 The practical implemention of EAM

As can be seen from the above, the implementation of an ecosystem approach to the management of human activities is more like a philosophy HOW to approach management - away from top-down sectoral management and strictly governmental regulation with the aim to enhance support and compliance by taking into consideration the needs of all affected stakeholders. The spatial scope for which the EAM-developed management applies can be e.g. all or part of national waters, shared waters by several coastal states (e.g. the OSPAR regions), or waters beyond national jurisdiction (the Area and the High Seas).

With regards to the Area, preferentially ecologically defined regions are the most practical unit for implementing. An example is Clarion-Clipperton-Zone in the Pacific or the Mid Atlantic and Indian Ocean ridges, where the existence of multiple seabed minerals exploration contracts pre-defines an area of potential conflict with other sectoral activities and regulation, and the obligation to protect and preserve the marine environment, including in the High Seas.

Therefore, if the ISA, as the competent body for regulation of activities in the Area, initiates a process towards ecosystem based management in all or part of its regulatory area, then the scope of assessment will have to include all activities (including all types of seabed mining-related activities, should there be spatial overlap), and all waters from seabed to surface. The appropriate tool for implementing all requirements of EAM is the a Strategic Assessment, which results in a published strategy and corresponding management plans (see also Chapter 3.4.5.2).

The first steps to implementing EAM are dedicated to creating a most comprehensive knowledge base on the region as a basis for all future policy and management decisions. Among these, the identification of the relevant stakeholders, and the creation of a communication and participation mechanism is crucial. In parallel, a synthesis on the environment, past and present human activities (Drivers), direct and indirect pressures as well as the effects of these is required. This could for example be delivered in the form of periodically updated Quality Status reports (example OSPAR QSRs), a regional (strategic) assessment, and accompanied by a socio-economic study.

Based on this assessment of the situation, all stakeholders are asked to agree on environmental goals and objectives to be achieved in a defined period of time. In Europe, this goal is to return all marine waters back into 'good environmental status', which is then defined in more detail on a regional basis. The core of the concept is to negotiate the response measures applied to those human activities which threaten the environment in the region not only within one sector but in concert with measures for other sectors.

For allocating the spatial preferences and needs of conservation and sectoral use, marine spatial planning is a crucial tool (2014; Ardron *et al.*, 2008; Foley *et al.*, 2010; Katsanevakis *et al.*, 2011; Wedding *et al.*, 2013). A representative network of marine protected areas and other sectoral protection or no-exploitation areas potentially provide a buffer to the uncertainties of marine planning and management. In addition, the intensity and eventually temporal and spatial extent of activities need to be regulated, if possible in an adaptive management cycle approach (see Chapter 3.4.1 and 3.4.3).

A document which outlines the overall strategy, such done by OSPAR (OSPAR Commission, 2010b), the Arctic Council (Arctic Council, 2015) or other international organisations, can be a useful tool to communicate the aims and priorities in implementing the environmental mandate. Based on the strategy, environmental management plans for regions or subregions will provide the legal basis for the management of activities.

In the box below, a possible option for implementing EAM in context with seabed mining in the Area is described.

Steps for implementing EAM by ISA

ISA should spearhead an integrated, ecosystem-based approach in ocean governance that is aligned with its mandates to administer the Common Heritage of Mankind, and the effective protection of the marine environment. This requires ISA actions to be coordinated with other sectoral activities and other pressures impacting on the health of the oceans. A strategic approach enables a local and regional synthesis of pressures, impacts and potential remedies. The tools for this are regional strategic assessment and resulting management plans, which should provide the regulatory context for decision-making on project applications (see, e.g., International Seabed Authority, 2017e).

Possible steps for implementation include (modified after Government of Ireland, 2004):

- Establish a management body with sufficient capacity and budget to guide the long-term process including stakeholder participation. This could be within the ISA Secretariat, an advisory working group under LTC, or a new body;
- Define the applicable space, e.g. a region, based on ecological/biogeographic and/or political criteria;
- Initialise a process comparable to strategic environmental assessment (see chapter 3.4.5), which could include the following actions (not necessarily in consecutive order):

  l) Establish a stakeholder inventory, and definition of communication and participation strategy, including the definition of the influence of stakeholders on the decision-making; Stakeholders are e.g. other global and regional organisations and competent authorities, legitimate users of the sea;
  m) Agree on the steps in the process, ownership, roles and responsibilities, modes of communication and a tentative time table;
  n) Establish a sound knowledge base synthesised from all available sources, including

     - An environmental baseline description and evaluation of the state of the environment (e.g. in a Quality Status Report), including observed natural variability, interconnectedness with other regions, and vulnerabilities to impacts from human activities;
     - An inventory of past, present and planned human activities and their current regulation,
     - An assessment of the environmental impacts and threats from direct and indirect pressures, including cumulative and synergistic effects
     - A social and economic impact assessment;

  o) Agree on a policy vision, goals and objectives for the Area/region, which will reflect how ISA will implement the Common Heritage Principle, and the obligations of Article 145, Part XII of UNCLOS, and the committments of States such as under the Convention on Biodiversity and the UN Sustainability Agenda;
  p) Carry out an integrated sensitivity/vulnerability/risk assessment as a necessary basis for considering the future direction of management in the region;
  q) Identify reasonable alternative development strategies and evaluate against policy objectives (3.4) with a view to establish the most sustainable option;
  r) Determine key principles and agree operational guidance including possible significance thresholds and indicators;
  s) Agree on applicable management tools (e.g. EIAs, protected areas, APEIs, VMEs, marine spatial planning, regulation of activities);

   t) Consider technological, locational mitigation options, other alternatives and the no-action option;

- Elaborate an overarching strategy document, including an Environmental Strategy, to communicate how ISA will globally and/or regionally deliver on its mandate, including

   a) How the mining of minerals in the Area today will contribute to achieving the Sustainable Development Goals (UN General Assembly, 2015) and other high level commitments on biodiversity and climate protection made by the member States;
   b) How irreversible loss of biodiversity (genes, species, communities, ecosystem functions) shall be prevented;
   c) How the interests of future generations will be protected;
   d) Whether there will be any measurable benefits for mankind, and how these benefits would be distributed in an equitable way;
   e) What the overall environmental and societal costs of mining will be.

- Assess whether and if yes which significant environmental effects are likely to occur as a consequence of the implementation of the prefered management strategy.
- Modify strategy to reduce, eliminate or otherwise mitigate significant adverse effects.
- Identify and plan monitoring measures to survey expected adverse effects.
- Based on the above, elaborate an environmental management plan for the respective region, REMP, to be periodically updated and revised, including the spatial, temporal and sectoral measures taken to achieve ‘effective protection of the marine environment’.

Plans of Work of applicants for exploitation contracts will have to demonstrate that based on the environmental baseline and technological information delivered, there are no indications that the effects caused by the proposed activities are likely to cause harm/significant harm to the marine environment, in line with the overall objectives, and any other measures to implement Article 145.

In the following chapters, some of the the elements of the ecosystem approach are described in more detail.

3.1.3 Recommendations

Recommendations

All States and international organisations of which they are members are committed to implementing the ecosystem approach to the management of human activities (EAM), including the ISA. Therefore,

- ISA member States should enable the Authority to implement EAM in the Area using appropriate institutional, procedural and financial arrangements.
- The EAM needs to be fully reflected in the ISA’s institutional, procedural and regulatory framework, including the steps necessary for implementing EAM;
- The Council could ask the LTC to develop and recommend an implementation scheme for EAM to be considered by the Council and observers (and, if possible, in consultation with experts and stakeholders).
- Until a full-scale process for implementing an ecosystem approach and a management strategy (see 3.1.2. and box above) have been designed, the draft regulations and further revisions should be subject to a strategic assessment of the potential environmental consequences of the legislation, including the discussion of alternatives (see e.g. ESPOO

Protocol on Strategic Environmental Assessment, 2003). This will contribute to a 'high level of protection' of the marine environment by

a) '*Ensuring that environmental, including health, considerations are taken thoroughly into account in the development of plans and programmes;*
b) *Contributing to the consideration of environmental, including health, concerns in the preparation of policies and legislation;*
c) *Establishing clear, transparent and effective procedures for strategic environmental assessment;*
d) *Providing for public participation in strategic environmental assessment; and*
e) *Integrating by these means environmental, including health, concerns into measures and instruments designed to further sustainable development*' (Article 1, ESPOO SEA Protocol).

A strategic environmental assessment of the draft regulations will entail an environmental report including the consideration of alternatives; a transparent public participation mechanism; consultation with other authorities; decision-making concerning the performance of the regulations with respect to the ISA's environmental obligations ('effective protection'); and, after approval, monitoring and communication of the results to the public and other authorities.

3.2 An Environmental Strategy for the regulation of deep seabed mineral mining to implement the ecosystem approach to management in the Area

Strictly speaking, prior to the start of mineral exploitation an assessment of the overall environmental, social and economic consequences of seabed mining in the Area should be addressed in a high-level, well-structured, transparent and integrative process, such as a Strategic Assessment. This would give effect to the implementation of an ecosystem approach (see Chapter 3.1). As at the time of UNCLOS negotiations the environmental risks of mining were much more uncertain, and the overall state of the marine environment was far less at risk than today, there is a need to re-examine the impact of mining on the environment in light of the Common Heritage Principle, the global committment to sustainability, Agenda 2030, and todays alternatives to mineral exploitation from the deep sea.

Consideration should be given to the following:

- How to give effect to UNCLOS Article 145 (to 'take the necessary measures to ensure effective protection of the marine environment from harmful effects which may arise from mining-related activities' in light of the scarcity of knowledge on the deep-sea ecosystems, the untested technologies, and the overall uncertainty as to the nature and scale of environmental impacts.
- How to take account of the wider implications of deep seabed mining on ecosystem functionality, delivery of ecosystem services, such as mitigating climate change, and societal benefits in terms of new biotechnology products from marine genetic resources;
- How to create a fair system of benefit-sharing for this and future generations. This should take account of the overall economic, social and environmental sustainability of deep seabed mining in the Area, balance between sharing of economic benefits now and in the future, (if benefits occur), and losses of environmental benefits for future generations;
- Whether to provide for compensation of environmental harm as a consequence of environmental degradation and loss of ecosystem services. Given that mineral mining by its nature will inevitably cause irreversible damage to the deep-sea ecosystems in question, such a compensation mechanism will be needed for the benefit of future generations.

Such a strategic assessment could be initiated by the International Seabed Authority, ISA, Assembly, the representation of all UNCLOS signatories and be conducted in an open and transparent format involving relevant and interested stakeholders[62]. The resulting Strategy, although developed from an integrated perspective, would likely be owned by ISA and address issues within the sectoral mandate of ISA.

3.2.1 Necessity for an Environmental Management Strategy for the ISA

A core challenge for the ISA is to balance a potential exploitation of mineral resources with adequate environmental protection standards and measures, in line with its mandate laid down in the UN Convention on the Law of the Sea, UNCLOS, and the related 1994 Agreement[63]. States have a general obligation to protect and preserve the marine environment (Art. 192). The ISA as an institution is required to take '*necessary measures [...] to ensure effective protection for the marine environment from*

[62] As of March 2018, upon request from the Assembly, the Secretary General presented a ISA Strategic Plan to the members of the Council and for consultation (https://www.isa.org.jm/news/isa-draft-strategic-plan-open-submissions), however this plan is not based on a strategic assessment.

[63] Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea (adopted 28 July 1994, entered into force 28 July 1996) 1836 UNTS 3, annex section 1(5).

harmful effects which may arise' from activities of exploration for, and exploitation of, the resources of the Area (Art. 145).

This was further emphasized by the ISA Secretary General, Nii Allotey Odunton, in 2013:

> *'it is imperative to ensure that adequate measures are in place for the protection of the marine environment. A prerequisite for this is the establishment of an environmental baseline against which to assess the impacts of mining on the marine environment.'*[64]

While the ISA has incorporated several substantive environmental protection obligations into the Mining Code as currently in force (covering prospection and exploration), significant challenges remain. First, the substantive requirements, such as EIAs and a precautionary approach, need to be given effect, including by incorporating them into the ISA's decision-making processes. Second, measures for the protection of the marine environment are, at present, decided on an *ad hoc* basis. As such, they are both incomplete and prone to being overlooked in the context of transitioning to the mineral exploitation phase. Examples include the need to integrate the assessment of environmental impacts into the ISA's decision-making processes as well as to implement the requirement on the Legal and Technical Commission, set forth in the Exploration Regulations, to:

> *'develop and implement procedures for determining, on the basis of the best available scientific and technical information [...] whether proposed exploration activities in the Area would have serious harmful effects on vulnerable marine ecosystems and ensure that, if it is determined that certain proposed exploration activities would have serious harmful effects on vulnerable marine ecosystems, those activities are managed to prevent such effects or not authorized to proceed.'*[65]

Ensuring that these measures are established in a timely manner requires moving beyond *ad hoc* activities, as already suggested in the ISA Technical Study Number 11 (International Seabed Authority, 2013). Moreover, while some environmental measures can and should be applied by contractors, other measures exceed the capacity of individual contractors and instead require commitment and action by the ISA as a whole. Examples are addressing cumulative environmental impacts as well as regional-scale environmental assessments and management.

A detailed strategic vision to implement the ISA's environmental obligations during the exploration and the exploitation stages would be instrumental to ensure that appropriate and systematic environmental protection measures are adopted and implemented in a timely manner. These will help to conserve the diversity of deep ocean biota and ecosystem functions in the context of providing for rational use of mineral resources.

Therefore, a holistic and globally applicable environmental strategy would support the ISA in giving effect to its mandate (Jaeckel, 2015a) by establishing systematic environmental safeguards during both the exploration and exploitation phases. Moreover, developing such a strategy would support the implementation of the ISA's obligation to apply a precautionary approach (ITLOS, 2011)[66].

[64] 'Report of the Secretary-General of the International Seabed Authority under Article 166, Paragraph 4, of the United Nations Convention on the Law of the Sea' (ISBA/19/A/2, 22 May 2013), paragraph 6.

[65] *Regulations on Prospecting and Exploration for Polymetallic Nodules in the Area*, ISBA/6/A/18 (13 July 2000), amended by ISBA/19/A/9; ISBA/19/A/12 (25 July 2013) and ISBA/20/A/9 (24 July 2014), regulation 31(4). See also *Regulations on Prospecting and Exploration for Polymetallic Sulphides in the Area*, ISBA/16/A/12/Rev.1 (15 November 2010), amended by ISBA/19/A/12 (25 July 2013) and ISBA/20/A/10 (24 July 2014), regulation 33(4); *Regulations on Prospecting and Exploration for Cobalt-rich Ferromanganese Crusts in the Area*, ISBA/18/A/11 (27 July 2012), amended by ISBA/19/A/12 (25 July 2013), regulation 1(3)(a)-(b), regulation 33(4).

[66] Nodules Exploration Regulations, regulations 2(2), 5(1), 31(2)-(3); Sulphides Exploration Regulations, regulations 2(2), 5(1), 33(2)-(3); Crusts Exploration Regulations, regulations 2(2), 5(1), 33(2)-(3).

The intra-ISA aims of an environmental strategy would be threefold:

- To ensure all relevant environmental measures are identified and allocated to the appropriate actors;
- To ensure strategic environmental management is fully integrated into the ISA's decision-making processes and supported by institutional capacity;
- To ensure environmental management measures are given effect in a timely manner.

3.2.2 The concept of an Environmental Strategy

To the outside world, an Environmental Strategy will serve to demonstrate how ISA intends to implement the 'uniform application of the highest standards of protection of the marine environment, the safe development of activities in the Area and protection of the common heritage of mankind', as requested by the advisory opinion of the Seabed Disputes Chamber of the International Tribunal for the Law of the Sea, ITLOS (ITLOS, 2011, § 159). Therefore, the Environmental Strategy is the place where the management instruments for carrying out the required 'checks and balances' would be defined. The Strategy would thus be a high level policy tool to ensure a globally uniform operationalisation and implementation of:

- The overarching principles (including the precautionary principle, and the Common Heritage principle);
- The ISA-specific environmental vision, goals and objectives and integration with global conservation targets;
- The decision-making processes, including division/sharing of responsibilities as well as public and expert participation. This also includes criteria for minimum information required for taking decisions.
- The hierarchical framework for assesssment and decision-making (global/regional assessment and strategy, regional environmental assessment and management plan, local EIAs);
- The procedures and criteria for the evaluation of the acceptability/sustainability of seabed mining in light of alternatives;
- The evaluation of benefits and costs for present and future generations;
- The cross-sectoral integration of ISA environmental management with other human uses;
- The resolution of conflicts with other uses (e.g. fishery, laying of submarine cables, use of marine genetic resources), and between different mining projects;
- Adaptive management;
- Mine closure and decommissioning requirements; and
- Enforcement mechanisms.

Yet, several issues need further clarification to develop further the elements of an agreed Environmental Strategy:

- Which formate should an Environmental Strategy take (ISA policy, part of ISA regulations, etc)?
- How could the elements be implemented to ensure a high binding force?
- Which Strategy elements should be further defined in the Mining Code, and which part of the Mining Code would be the appropriate place (*i.e.* Environmental Regulations, Mining Inspectorate/Control and Enforcement Regulations, annexes or guidelines)?
- Which entity shall be responsible for the development and implementation of which elements of the Strategy (*i.e*. planning instruments, monitoring and control, SEA and EIA processes, adaptive management, evaluation of baseline studies)?
- What are the exact terms of reference for the Mining Inspectorate?
- What institutional change is required to enable
  - a separation of power between the ISA's regulatory and executive functions and
  - the creation of a system of checks and balances,

- independent expert and science advice to be taken into account,
- public accountability of decision-making?

In light of the above questions, an Environmental Strategy could describe the use of all available tools for comprehensive, integrated environmental management, their interaction as well as the sharing of tasks among different actors contributes to achieving the agreed environmental objectives. All procedures and substantive criteria must be laid down in the Environmental Regulations/ the ISA Mining Code.

However, even if the governance questions can be solved, substantial problems remain. These include the challenge to technically develop a concept for ecologically meaningful ecological thresholds and for the implementation of an adaptive management approach for an likely highly sensitive ecosystem which is largely unknown, very expensive and time-intensive to investigate, species-rich but abundance-poor, and functionally slow. To address these problems, the following can be used as guiding questions:

- How to generate the baseline data required for SEA?
- What are the minimum data requirements for an adequate baseline(quality, quantity, spatial and temporal distribution)?
- What kind of research is required for filling the gaps of contractor work
- What are the environmental values, incl. ecosystem services, and which areas should be ‘to be avoided’?
- How to determine/model the full extent of environmental impacts and indicators/thresholds for environmental quality assessment and impact assessment given the insufficient spatial and temporal resolution of existing data?
- What would an inclusive, precautionary decision-making procedure for SEA look like (e.g. acceptance/rejection criteria and public involvement)?
- How to make regulations without environmental and technical baseline information?
- How can periodic review of REMPs and SEAs be included in the licensing of operations (adaptive conditions for existing contracts, or stepwise licensing)?

3.2.3 Recommendations

Recommendations

An environmental strategy, as a subset of an overall ISA strategy, will serve to communicate to the outside world how the ISA intends to implement the ‘uniform application of the highest standards of protection of the marine environment, the safe development of activities in the Area and protection of the common heritage of mankind’ as specified in the ITLOS Advisory Opinion (ITLOS, 2011, § 159). Accordingly, it will also be instrumental in organising the related work streams. Essential elements of the strategy are:

- The overarching principles (including the precautionary principle and the principle of the common heritage of mankind);
- The ISA-specific environmental vision, goals and objectives, and their integration with global conservation targets;
- The decision-making processes, including division and sharing of responsibilities as well as public and expert participation. This also includes criteria for minimum information required for informed decision-making.
- The hierarchical framework for assesssment and decision-making (global/regional assessment and strategy, regional environmental assessment and management plans, local EIAs);

- The procedures and criteria for the evaluation of the acceptability and sustainability of seabed mining in light of the alternatives;
- The evaluation of benefits and costs for present and future generations;
- The cross-sectoral integration of ISA environmental management with other legitimate uses;
- The resolution of conflicts with other uses (e.g. fishery, laying of submarine cables, use of marine genetic resources), and between different mining projects;
- Adaptive management;
- Mine closure and decommissioning requirements; and
- Enforcement mechanisms.

While the environmental strategy can be a policy framework, the roles and responsibilities of actors, as well as the core elements and their procedural linkages need to be part of the binding regulatory framework.

3.3 Environmental objectives

The ecosystem approach embraces new integrated thinking related to defined ecological spatial units such as defined in the Environmental Management Plan of the Clarion-Clipperton-Zone (International Seabed Authority, 2011). An important component is the ambition to manage human activities towards agreed environmental quality objectives (could e.g. be the avoidance of significant adverse impacts *sensu* FAO, 2009, or towards 'Good Environmental Status' in EU waters (2008) which requires the setting of impact thresholds (limits, precautionary and target, see Chapter 3.4.6), a mechanism which should also be developed for the assessment of environmental acceptability of marine mining.

Strategic objectives, including environmental objectives, for the work of ISA are required for being able to address a range of issues:

- Precautionary approach: Without environmental objectives, it is impossible to assess whether a protective measure is effective in and proportionate to (the two key criteria for selecting precautionary measures) the desired preservation outcome;
- EIA/SEA: EIAs and SEAs provide the basis for determining whether the expected harm reaches an unacceptable level and should, thus, not be allowed to proceed, or should only be permitted with measures to reduce or mitigate the harm. Without conservation objectives, it remains unknown what level of harm is acceptable. Further, without conservation objectives, it is impossible to determine e.g. how many mining operations can be conducted in parallel within a particular region or over a certain timeframe without jeopardising the desired conservation outcome;
- Assessment of new applications: without conservation objectives, it is unclear how the LTC assesses, whether an application provides for '*effective protection and preservation of the marine environment including, but not restricted to, the impact on biodiversity'*[67];
- Transparency: Without conservation objectives that can guide the ISA's decisions, it is unclear whether all applications are held to the same environmental standard. At present, the LTC has to conduct not only scientific and technical assessments but also make subjective determinations regarding the acceptability of risks, without objective evaluation criteria or the benefit of overarching conservation objectives.

The objectives should reflect best scientific advice as well as public opinion about the acceptability of risk and the values placed on seafloor minerals, marine biodiversity, and deep ocean ecosystems.

3.3.1 The vision, goals and objectives of the Clarion-Clipperton-Zone EMP

The regional environmental management plan, EMP, for the Clarion-Clipperton-Zone (International Seabed Authority, 2011; Lodge *et al.*, 2014) is the first and only example for setting out a regional, holistic approach to environmental management in a region of interest to seabed mining in the Area. So far, the plan lacks substantial elements of implementation (International Seabed Authority, 2016c; Seascape Consultants ltd., 2014). However, the plan is the only place where ISA not only defines its guiding principles for environmental management[68], but also its vision, goals, strategic aims and operational and management objectives for the entire region, contract areas and the areas of particular environmental interest, APEIs, which are exempt from mining.

[67] *Nodules Exploration Regulations*, regulation 21(4)(b); *Sulphides* and *Crusts Exploration Regulations*, regulation 23(4)(b).

[68] Common Heritage of Mankind, precautionary approach, protection and preservation of the environment, prior environmental impact assessment, conservation and sustainable use of biodiversity, transparency; International Seabed Authority, 2011. Environmental Management Plan for the Clarion- Clipperton Zone. ISBA/17/LTC/7., 13 (a-f))

3.3.1.1 The vision

The vision contains three elements (§32-34 of International Seabed Authority, 2011):

- Sustainable exploitation, while preserving representative and unique maine habitats and species
- Facilitate mining while a) minimize as far as practically possible the impact of seabed mining activities, and b) preserve and conserve marine biodiversity and ecosystem structure and function in the Clarion-Clipperton-Zone
- A holistic approach to regional management, giving consideration to relevant global initiatives an new legislation.

It rests to be evaluated whether this wording is in line with the meaning of Article 145, which obliges ISA to take the necessary measures to '*ensure effective protection for the marine environment from harmful effects which may arise from*' activities in the Area (see Chapter 3.4.6.1). Questions arise from

- The wording 'sustainable exploitation': what should be sustainable and on what time scale?
- Preserving only representative and unique habitats and species: a license to deteriorating all other places?
- To facilitate mining as a first priority and not conditionned by being able to ensure effective protection.

Normally, conservation visions are framed to lay out the visionary goal which shall be achieved over a period of decades. The timeframe is missing here. And in this case, the development of a new activity is in the focus of the vision, rather than the achievement of a particular environmental state.

3.3.1.2 The goals

Also the goals focus on the exploitation of seabed mineral resources (§35a). However §35 b makes a link to the goals and targets set out in the Plan of Implementation of the World Summit on Sustainable Development (WSSD, 2002), including

- To halt the loss of biodiversity;
- To establish ecosystem approaches to management
- To develop marine protected areas, including representative networks by 2012.

In line with that, the further goals relate a.o. to the management of the CCZ according to integrated ecosystem-based management, monitoring of effects of mining related tests, cooperative research. The preservation goals are

- To maintain regional biodiversity, ecosystem structure and function across the CCZ;
- Enable the preservation of representative and unique marine ecosystems.

It remains to be investigated whether the regional preservation of biodiversity equals a halt to the loss of biodiversity. According to science, biodiversity loss is inevitable, once commercial mining starts (see Chapter 2.3).

3.3.1.3 The strategic aims

Again, the first aim set out is to '*ensure environmentally responsible seabed mining ... to enable effective protection of the marine environment from activities related to seabed mining*' (§36 a). This somehow turns the logic upside down: as the goal and aim must be to ensure effective protection under Article 145. Therefore, mining activities have to be environmentally responsible. Interestingly, here for the first and only time the term '*natural resources of the Area*' comes up (§36 e) as a subject for protection and conservation and for reduction of impact. This reduction of impact could be related to pressures other than from mining-related activities, however, this is outside the competence of ISA, yet within the competence of the member states.

3.3.1.4 The operational objectives

The operational objectives are set out separately for the entire region, the contract areas, and the APEIs. For the region, the objectives are to periodically update the environmental baseline data, to untertake cumulative EIAs based on exploitation proposals, and to consider the environmental risks for technical developments. This leaves a number of questions:

- So far, no regional environmental baseline has been established that could be updated. When will that happen? International Seabed Authority (2016c) set the date of 2018, once the environmental database will be fully operational.
- Cumulative assessments based on exploitation proposals can only be done if ISA is able to extrapolate the potential impacts from commercial mining operations from e.g. the monitoring and assessment results of site-specific equipment and mining system testing during the exploration phase. So far there is no requirement for exploration contractors to carry out tests, or carry out monitoring and assessment in a standardised formate. The so far published draft exploitation regulation versions do not mention an obligate testing phase ahead of applying for an exploitation contract.
- Environmental risks are not only related to '*technological developments in mining technologies*', however if the environmental risks of all currently developed technologies would be systematically investigated, then this would aid greatly the development of 'best available techniques' and in conjunction with application, the 'best environmental practice', BEP.

For contract areas, the operational objectives seem to reflect what ISA can ensure the contractors to do: application of BEP, collection and dissemination of environmental data, guidelines for preservation and impact reference zones, and

- Develop plans to ensure responsible environmental management to enhance the recovery of habitats and faunal communities.

This is interesting, as the objective is not to implement environmentally responsible mining practices, as could be expected, but to enhance the recovery after mining.

3.3.1.5 Management objectives

Also, the management objectives of the CCZ EMP are set out separately for the region, the contract areas and the APEIs. Across the region, ISA wants to collate the information produced by contractors and other sources, consider cummulative impacts of mining and other human activities and exchange information on new and developing technologies and their environmental impacts (§40).

What is missing here, is an environmental assessment of the collated information on a regional scale, including a cumulative impact assessment, resulting in a regional strategic plan which determines management direction based on the overall environmental objectives. The formate of a strategic assessment is likely an appropriate tool (see chapter 3.4.5).

Only one of the management objectives set out for the contract areas relates to environmental protection, namely

- Contractors are required to minimize potential impacts on established preservation zones, and the Authority should consider the potential for impact on established preservation zones in evaluating any application for a mining licence (§41 d).

Remarkably, there is no wording on minimising environmental impacts overall, no mention of best available technique and best environmental practice to be developed under active contribution of the contractors, and applied to the region. ISA merely wants to exchange information, but seemingly does not strive to develop standards.

None of the management objectives translates the vision, goals and strategic aims in relation to the preservation of the marine environment into management objectives for ISA and the contractors. This is likely due to the ad-hoc and rather unsystematic process in which the EMP was created in 2010, but should be addressed in the future revision of the management plan.

In terms of structure, none of the goals, aims and objectives of the CCZ EMP are SMART: To formulate clear and achievable targets, each one should be:

- **S**pecific (simple, sensible, significant);
- **M**easurable (meaningful, motivating);
- **A**chievable (agreed, attainable);
- **R**elevant (reasonable, realistic and resourced, results-based); and
- **T**ime bound (time-based, time limited, time/cost limited, timely, time-sensitive).

Also, there is no clear hierarchy: The goals should support the achievement of the overall vision. Goals either determine a generic action or an outcome which shall be achieved, and are set out for the longer term. Objectives identify specific action supporting the attainment of a specific goal and should be measureable and tangible in the mid to shortterm. The review period of an EMP and the time horizon for objectives should coincide. This should be redressed in any review of the CCZ EMP and in the drafting of any new regional environmental management plan.

In the whole document, neither the contractors nor the ISA actions shall aim at an 'effective protection of the marine environment from harmful effects' arising from mining-related activities in the Area. There is also just one cross-reference to the goals of the WSSD at the level of the goals, however the potential contribution of the CCZ EMP to the achievement of the WSSD targets may in the end be limited to the designation of the Areas of Particular Environmental Interest, APEIs, as sectoral closures, as biodiversity loss will likely not be possible to be prevented. This is cynical in view of the large scale deterioration of the marine environment to be expected from mining.

3.3.2 Environmental objectives in the developing exploitation regulations

Referring to UNCLOS Article 145 as guiding the policy objectives of the ISA with regard to the protection of the marine environment and the obligation to take necessary measures through adoption of rules, regulations and procedures, the 2017 draft environmental regulations International Seabed Authority (2017a) concludes:

> *'Ideally, the Authority (and its stakeholders) need to establish ecological objectives and environmental goals and relevant targets and measurable environmental indicators for the status of the mined and adjacent areas (Section I, 7.17)'*

Also the first draft of the exploitation regulations (ISBA/23/LTC/CRP.3, Part IV, Draft Regulation DR 17) set out for consultation in July 2017 lists a number of principles to be applied to any measures for implementing Article 145, a.o.:

- A fundamental consideration for the development of environmental objectives shall be the protection and conservation of the marine environment, including biological diversity and ecological integrity;
- The Best Environmental Practices shall be adopted and applied, and Recommendations for the guidance of contractors and Good Industry Practice **should** be followed by Contractors;

- In the assessment and management of risks to the Marine Environment the precautionary approach, as reflected in principle 15 of the Rio Declaration, shall be applied, and the Best Available Scientific Evidence shall be taken into account.

No further specification of an environmental objective is included. In Regulation 23, a couple of obligations of Contractors towards the Marine Environment are named, however these do not substantiate the overall objective to protect and conserve the marine environment as in DR17a. Contractors shall only be obliged to minimise the risk of incidents, the risk of pollution, other environmental effects and take '*all reasonable and practicable mitigation measures to protect the marine environment*'.

The question is whether this wording is in line with Article 145 and with the due diligence obligations as set out by the Seabed Disputes Chamber (ITLOS, 2011), in particular if loss of biodiversity can neither be prevented nor mitigated (Niner *et al.*, 2018; Van Dover *et al.*, 2017). In any case, several broader obligations to contractors are missing, a.o.:

- To consider the contract area as a loan from mankind which should be safeguarded for future generations;
- To contribute to the achievement of the global targets agreed by the UN (UN General Assembly, 2015), the Convention on Biodiversity (Convention on Biological Diversity, 2012b) and the Paris Agreement (UN Framework Convention on Climate Change, 2015).
- To identify and protect marine protected areas, vulnerable marine ecosystems and/or other ecologically and biologically significant areas within their contract areas according to the criteria of other international and adjacent national agreements and legislation;
- To identify and protect potential marine genetic resources or habitats for such resources;
- To identify and minimise conflicts with the use or protection of natural resources (MGR, fisheries) - so far only 'reasonable regard to other activities' (DR 26) is required;
- To optimise the 'consumption' of minerals, *i.e.* to minimise environmental damage.

3.3.3 Developing ISA environmental objectives

The environmental objectives to be determined by ISA are required for informing on how ISA will implement its environmental mandate, and will direct its regulations, recommendations and guidance for contractors, as well as all assessment procedures. In particular, the formulation of environmental objectives will have a bearing on the weighing of economic ambitions and environmental concerns. The objectives could be instrumental to determining procedural safeguards and a strategy for how to deal with uncertainties.

Therefore, objectives (could be split up into vision, goals, operational and management objectives) would be needed on an overarching strategic level, together with social, economic and other objectives, globally applicable to all of ISAs policy and regulation. These more strategic objectives could be supplemented with more focussed, operational objectives for specific resource types, and particular regions, comparable to the structure in the CCZ Environmental Management Plan.

The environmental objectives, as a minimum, should reflect UNCLOS Article 145 and Article 192 (see Chapter 4) obligations to ISA and states, respectively, to protect the marine environment, as well as Article 136, dedicating the Area and its resources to mankind as a whole (see Chapter 0).

With regards to environmental protection, the following elements are captured in the wording of UNCLOS, *inter alia*

- The prevention of interference with the ecological balance of the marine environment (Art. 145 (a));

- The protection from harmful effects of e.g. drilling, dredging, excavation, disposal of waste, construction and operation, maintenance of installations, pipelines and other devices related to such activities (Art. 145 (a));
- The protection and conservation of the natural resources of the Area (Art. 145 (b));
- The prevention of damage to the flora and fauna of the marine environment (Art. 145 (b)); .
- The protection and preservation of the marine environment (Art. 192);
- The prevention, reduction and control of pollution of the marine environment from any source (Art. 194.1); Measures shall minimise to the fullest possible extent the
  - Release of toxic, harmful or noxious substances, e.g. by dumping (Art. 194.3a)
  - Prevention of pollution from vessels (Art. 194.3b);
  - Prevention of pollution from installations and devices used in exploration and exploitation of the natural resources of the seabed (Art. 194.3c);
  - Protection and preservation of rare or fragile ecosystems as well as the habitats of depleted, threatened or endangered species and other forms of marine life (Art. 194.5).

Several other tasks and responsibilities listed in UNCLOS should also be taken up in ISAs strategic and management objectives:

- All rights in the resources are vested in mankind as a whole on whose behalf the Authority shall act (Art. 137.2)
- Activities in the Area shall be carried out for the benefit of mankind as a whole (Art. 140.1);
- Use of the Area for exclusively peaceful purposes (Art. 141);
- The rights and legitimate interests of coastal states shall be regarded (Art. 142);
- Marine scientific research in the Area shall be promoted and encouraged by the Authority. Collaboration is encouraged (Art. 143);
- Technology and knowledge transfer (however reduced to scientific exchange by the 1994 Agreement);
- Activities in the Area shall be carried out with reasonable regard for other activities in the marine environment (Art. 147);

According to Article 150 the objective of the policies relating to activities in the Area is not only directed at a healthy resource economy and trade but also the

- Promotion of international co-operation for the overall development of all countries, especially developing states (Art. 150);
- Orderly, safe and rational management of the resources of the Area, including the efficient conduct of activities in the Area and, in accordance with sound principles of conservation the avoidance of unnecessary waste (Art. 150 (b).
- Development of the common heritage for the benefit of mankind as a whole (Art. 150 (i).

In addition, the Seabed Disputes Chamber in its Advisory Opinion (ITLOS, 2011) considers several modern principles of environmental management as direct obligation and part of the due diligence obligations of the sponsoring state ('obligation to ensure', §110, Section V):

- The application of the Precautionary Approach in line with Principle 15, Rio Declaration 1992 ('in situations where scientific evidence concerning the scope and potential negative impact of the activity in question is insufficient but where there are plausible indications of potential risks'). Disregarding such risks would constitute a failure of due diligence.
- The application of Best Environmental Practices, BEP;
- The obligation to provide recourse to compensation;
- The conduct of an Environmental Impact Assessment;

It is also indicated that the obligations to preserve the environment of the high seas and in the Area is owed to the international community as a whole (§76, 226). The Advisory Opinion acknowledges that the standard of 'due diligence' may vary over time and depends on the level of risk and on the activities involved (§242.3 A) while requesting ISA to ensure the 'uniform application of the highest standards of protection of the marine environment (§159).'

This emphasises not only the need for the establishment of globally applicable and regionally harmonised strategic and environmental objectives, but also demands corresponding oversight and enforcement action and capacity on the local, regional and global scale. The necessary action to translate high level environmental objectives into operational processes to assess activities and plans for their potential support or counter the objectives includes *inter alia*:

- The operationalisation of the precautionary approach (see, e.g., Jaeckel, 2017);
- The development and operationalisation of Best Environmental Practice
- The development and operationalisation of Best Available Technique;
- The capacity and competence to measure, monitor, assess and respond to a.o. cumulative 'harmful effects';
- Agreement on a management system (e.g. procedures, measures, data, criteria, participation, decision-making);
- The capacity and competence to ensure oversight and compliance

Consequently, ISA will not be able to review and decide on the acceptability of Plans of Work for exploitation, including the evaluation of feasibility studies and of prior environmental impact statements, until there are agreed environmental (and other strategic) goals and objectives, and the necessary tools and capacity to operationalise them.

Building on the above, below a first attempt to formulate a set of high level environmental goals:

- The Area is a place of value for this and future generations. The value not only comes from mineral resources, but from its natural resources, ecosystems and functions in the global carbon cycle.
- The exploitation of minerals in the Area will only be considered if there is a clear need of society for the minerals, there are no alternatives, significant financial and other benefits accrue to be shared, and environmental damage is minimised.
- The exploitation of minerals in the Area shall contribute/shall not counteract the achievement of the sustainable development goals, the WSSD target, the Aichi Targets and the Paris Agreement, including to halt the loss of biodiversity.
- The integrity and health of the benthic and pelagic systems, species and habitats affected by minerals mining shall be maintained.
- The integration of the precautionary principle in the regulations and ecosystem approach to management ensures careful decision-making in the face of high risks and uncertainties.
- An ongoing process will ensure the continuous assessment and implementation of the best available techniques and environmental practices.
- Collaboration and cooperation of ISA, contractors and independant research through international research programmes will maximise the knowledge increase on the ecosystems and the environmental effects of technologies, and reduce risks and uncertainties;

Each goal will need to be substantiated by a set of SMART targets and objectives.

3.3.4 Recommendations

Recommendations

The ISA should be supported in developing **overarching strategic objectives**, including an environmental vision, goals and objectives.

- ISA environmental objectives should not only reflect the obligations set by UNCLOS, but operationalise the substance of

  a) the principle oft he common heritage of mankind;
  b) the precautionary principle;
  c) the polluter-pays principle;
  d) other obligations and commitments of the ISA and States under international agreements, conventions and UN resolutions;

- The definition and agreement of the strategic objectives could best be done by Parties and observers to ISA. A dedicated Council or Assembly working group might be a tool to ensure broad debate and transparency.

As a starting point, the following **high level environmental goals** are proposed for consideration:

- The Area is a place of value for present and future generations. This value comes not only from mineral resources, but from its natural resources, ecosystems and functions in the global carbon cycle.
- The exploitation of minerals in the Area will only be considered if there is a clear societal need for the minerals, there are no alternative sources, any significant financial and other benefits accrued from mining are shared, and environmental damage is minimised.
- The exploitation of minerals in the Area shall contribute to and not counteract the achievement of the sustainable development goals, the WSSD targets, the Aichi Targets and the Paris Agreement, including to halt the loss of biodiversity.
- The integrity and health of benthic and pelagic systems, species and habitats affected by mineral mining shall be maintained.
- The integration of the precautionary principle into the regulations and the ecosystem approach to management ensures careful decision-making in the face of high risks and uncertainties.
- An ongoing process will ensure the continuous assessment and implementation of the best available techniques and environmental practices.
- Collaboration and cooperation between the ISA, contractors and independent researchers through international research programmes will maximise knowledge of ecosystems and the environmental effects of technologies, thereby reducing risks and uncertainties;

Each goal will need to be substantiated with a set of SMART targets and objectives.

3.4 The Principles

3.4.1 The Precautionary Approach[69]

Deep seabed mining has the potential to cause significant environmental harm and is an activity characterised by numerous uncertainties. The precautionary approach is a crucial tool to address these challenges, both at a regulatory and management level.

The mineral resources of the seabed beyond national jurisdiction are governed by the International Seabed Authority (ISA). Its Mining Code, regulating the prospecting, exploration and (in future) exploitation of minerals, specifically obliges all actors (the ISA, sponsoring states, and mining operators) to apply the precautionary approach.[70] Moreover, in its landmark Advisory Opinion in 2011, the Seabed Disputes Chamber strongly supported the precautionary approach and identified it as an element of the general obligation of due diligence by sponsoring States.[71] Yet, the challenge lies in translating this abstract obligation into meaningful actions. Placing a focus on the seabed mining context, this brief summarises what the precautionary approach entails.

[69] This note is largely based on: Jaeckel, 2015, 2017.

[70] *Nodules Exploration Regulations*, Regulation 2(2), 5(1), 31(2) and (5), *Sulphides and Crusts Exploration Regulations*, Regulations 2(2), 5(1), 33(2) and (5).

[71] *Responsibilities and Obligations of States Sponsoring Persons and Entities with Respect to Activities in the Area* (Advisory Opinion) (Seabed Disputes Chamber, Case No 17, 1 February 2011), paragraphs 131–132.

Precautionary Principle or Precautionary Approach?

There has been a somewhat dormant debate about the differences of the terms precautionary *approach* and *principle*. In short, both concepts are substantially similar and the debate is mainly academic. To summarise, some have argued that the term *approach* entails more flexibility.[72] Indeed, there has been a trend in recent practice to opt for *approach*,[73] especially in the fisheries sector.[74] In the *EC Biotech* case before the World Trade Organization, the US argued for the use of the term *approach* instead of *principle*, as the latter might imply a legally binding nature.[75]

However, in terms of substantive differences, both concepts have little divergence.[76] An extensive survey of precaution under customary law[77] found that 'no substantive differences exist between commitments to apply the 'precautionary principle' and commitments to apply the 'precautionary approach.''[78] Most importantly, both terms are used in the legal instruments most relevant to seabed mining, the ISA *Exploration Regulations* and the *Rio Declaration on Environment and Development*.[79] The French text of the *Exploration Regulations* mentions 'le principe de précaution' whereas the English version refers to 'a precautionary approach.'[80] Similarly, the French version of the Principle 15 of *Rio Declaration* refers to 'des mesures de précaution' whilst the English version uses 'the precautionary approach.'

Consequently, some have described the debate as mainly 'semantic squabble'[81] and use the terms interchangeably.[82] Fitzmaurice highlights that the debate around terminology 'is without merit' as precaution means different things in different contexts.[83]

72 *Southern Bluefin Tuna Cases (New Zealand v Japan; Australia v Japan)* (Provisional Measures) (ITLOS Cases No 3 & 4, 27 August 1999), paragraph 19 (separate opinion of Judge Laing); see also separate opinion of Judge Ad Hoc Shearer. Note: Although a judge's separate opinion is legally relevant, it does not carry the same weight as the majority opinion.

73 Alex G Oude Elferink, 'Governance Principles for Areas beyond National Jurisdiction' (2012) 27 *The International Journal of Marine and Coastal Law* 205–259, page 225; see also the use of 'approach' in the aforementioned Advisory Opinion.

74 David Freestone, 'Implementing Precaution Cautiously: The Precautionary Approach in the Straddling and Highly Migratory Fish Stocks Agreement' in Ellen Hey (ed), *Developments in International Fisheries Law* (Kluwer Law International, 1999) 287-325, pages 304-322; Simon Marr, *The Precautionary Principle in the Law of the Sea: Modern Decision Making in International Law* (Martinus Nijhoff, 2003), page 17.

75 WTO, *European Communities - Measures Affecting the Approval and Marketing of Biotech Products*, WT/DS291-293/INTERIM (29 September 2006), paragraph 4.541.

76 Alex G Oude Elferink, 'Governance Principles for Areas beyond National Jurisdiction' (2012) 27 *The International Journal of Marine and Coastal Law* 205–259; Ellen Hey, 'The Precautionary Concept in Environmental Policy and Law: Institutionalizing Caution' (1992) 4 *Georgetown International Environmental Law Review* 303–318, p. 304.

77 Arie Trouwborst, *Evolution and Status of the Precautionary Principle in International Law* (Kluwer Law International, 2002), pages 3-5, 186.

78 Arie Trouwborst, 'The Precautionary Principle in General International Law: Combating the Babylonian Confusion' (2007) 16 *Review of European Community & International Environmental Law* 185–195; Simon Marr, *The Precautionary Principle in the Law of the Sea: Modern Decision Making in International Law* (Martinus Nijhoff Publishers, 2003).

79 *Rio Declaration on Environment and Development* (adopted 14 June 1992) 31 ILM 874.

80 *Nodules Exploration Regulations*, regulation 31(2); *Sulphides* and *Crust Exploration Regulations,* regulation 33(2).

81 Nicolas De Sadeleer, *Environmental Principles: From Political Slogans to Legal Rules* (Oxford University Press, 2002), page 92; see also Rosie Cooney, 'A Long and Winding Road? Precaution from Principle to Practice in Biodiversity Conservation' in in Elizabeth Fisher, Judith Jones, and René von Schomberg (eds), *Implementing the Precautionary Principle: Perspectives And Prospects* (Edward Elgar Publishing, 2006) 223-244, page 224.

82 Arie Trouwborst, 'The Precautionary Principle in General International Law: Combating the Babylonian Confusion' (2007) 16 *Review of European Community & International Environmental Law* 185–195, page 186; Rosie Cooney, 'A Long and Winding Road? Precaution from Principle to Practice in Biodiversity Conservation' in Elizabeth Fisher, Judith Jones, and René von Schomberg (eds), *Implementing the Precautionary Principle: Perspectives And Prospects* (Edward Elgar Publishing, 2006) 223–244, page 224.

83 Malgosia Fitzmaurice, *Contemporary Issues in International Environmental Law* (Edward Elgar Publishing, 2009), page 8; See also the discussion in Patricia Birnie, Alan Boyle, and Catherine Redgwell, *International Law and the Environment* (Oxford University Press, 3rd ed, 2009), pages 154-157.

In light of this discussion, this note uses the term 'precautionary approach' because of its usage in the English version of the Mining Code.

3.4.1.1 Defining the Precautionary Approach

Based on extensive discussions of the precautionary approach in the literature, three components of the approach can be identified: (a) threat of environmental harm, (b) uncertainty, and (c) action.[84]

Threat of environmental harm

The primary purpose of the precautionary approach is to prevent and reduce environmental harm. The threat that seabed mining is likely to cause significant environmental harm, thus, calls for the application of the precautionary approach.

Uncertainty

The second component, uncertainty, takes into account the complexities of natural systems and the evolving nature of scientific knowledge. It recognises the limited success of evidence-first approaches and establishes a tool for proactive environmental management. In other words, the precautionary approach calls for actions at an *earlier* stage, even when there is no conclusive scientific evidence as to the harmfulness of an activity. Under the precautionary principle, the benefit of any such doubt is to go to the environment. *In dubio pro natura.'*[85]

This includes two types of uncertainty,[86] both of which are relevant for deep seabed mining. Epistemic uncertainties derive e.g. from incomplete data and can be reduced over time with an increase in scientific research and the testing of mining systems. In contrast, ontological uncertainties are intrinsic to studying complex and variable systems. Marine biodiversity and deep ocean ecosystems fall within this latter category. These uncertainties are not temporary and go beyond strictly scientific uncertainties.

Importantly, precaution applies not because of uncertainty, but *in spite* of it. Principle 15 of the *Rio Declaration* reads: '*Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation*.' In other words, protective actions should not be impeded by uncertainty. The trigger for precaution is the concern over environmental harm, not uncertainty itself.

Action

The third, and most crucial, component of precaution is that of remedial action at an *early* stage. As the Rio Declaration states, the precautionary approach requires 'measures to prevent environmental

[84] Arie Trouwborst, *Precautionary Rights and Duties of States* (Martinus Nijhoff, 2006), pages 21-35; see also Stephen M Gardiner, 'A Core Precautionary Principle' (2006) 14 *Journal of Political Philosophy* 33-60; James Cameron and Juli Abouchar, 'The Status of the Precautionary Principle in International Law' in David Freestone and Ellen Hey (eds), *The Precautionary Principle and International Law: the Challenge of Implementation* (Kluwer Law International, 1996) 29-52, page 45.

[85] Arie Trouwborst, *Evolution and Status of the Precautionary Principle in International Law* (Kluwer Law International, 2002), page 187.

[86] Cooney, *A Long and Winding Road? Precaution from Principle to Practice in Biodiversity Conservation*, page 229; Arie Trouwborst, *Precautionary Rights And Duties of States* (Martinus Nijhoff Publishers, 2006), pages 72-82; W E Walker et al, 'Defining Uncertainty: A Conceptual Basis for Uncertainty Management in Model-Based Decision Support' (2003) 4 *Integrated Assessment* 5-17, pages 13-14; S R Dovers and J W Handmer, 'Ignorance, the Precautionary Principle, and Sustainability' (1995) 24 *Ambio* 92-97.

degradation.'[87] Without it precaution would be meaningless. Yet, this is precisely where the challenge lies. Which measures are necessary? Two criteria are identified in the literature: precautionary measures must be both **effective** and **proportionate.**

Any precautionary measure must first and foremost be effective, meaning it has to be capable of achieving the desired level of protection.[88] This applies to both high-level policy measures as well as project-specific management measures. Comparing measures requires examining both costs and benefits of various (in)actions and includes considering both short-term and long-term effects.[89] Assessing the effectiveness of a measure also requires the determination of the desired level of protection. **For seabed mining, no desired level of protection has been agreed on.** This is a crucial omission, which renders the application of the precautionary approach difficult. In contrast, in some fisheries contexts the conservation benchmark, although not without criticism,[90] is to 'maintain or restore stocks at levels capable of producing maximum sustainable yield'[91] or the less specific objective of no 'significant adverse impacts on vulnerable marine ecosystems'.[92] With respect to the latter, although the ISA Mining Code contains a similar provision for exploration work, the standard has not yet been applied.[93]

Precautionary measures must also be proportionate to the desired level of protection[94] and, thus, not more restrictive than necessary. Assessing the proportionality of measures requires considerations of both short and long-term effects, which may include taking into account the impacts affecting future generations.[95] The European Commission further stresses that '*one should also consider replacing the product or procedure concerned by safer products or procedures.*'[96] For seabed mining, such a comprehensive approach includes considering alternative means of meeting the demand for minerals.

Both the proportionality and the effectiveness of precautionary measures will depend on whether the potential harm is reversible. Irreversible harm, such as the destruction of endemic species, or long-term harm, such as the destruction of ancient habitat, requires stricter measures. Sediment plumes have to be considered as generating irreversible harm, but on comparatively shorter time scales, whereas noise pollution will usually be a reversible, short-term impact in the ecosystem perspective, which calls for less restrictive measures.

[87] *Rio Declaration*, principle 15.

[88] Commission of the European Communities, *Communication from the Commission on the precautionary principle*, COM(2000) 1 final (2 February 2000), page 17.

[89] Commission of the European Communities, *Communication from the Commission on the Precautionary Principle*, (2 Feburary 2000), page 18; Rosie Cooney and Barney Dickson, 'Precautionary Principle, Precautionary Practice: Lessons and Insights' in Rosie Cooney and Barney Dickson (eds), *Biodiversity and the Precautionary Principle: Risk, Uncertainty and Practice in Conservation and Sustainable Use* (Earthscan, 2005) 287-298, 295; Jorge Rabinovich, 'Parrots, Precaution and Project Ele: Management in the Face of Multiple Uncertainties' in Rosie Cooney and Barney Dickson, op cit, 173-188.

[90] Daniel D Huppert, 'Risk Assessment, Economics, and Precautionary Fishery Management' in *Precautionary Approach to Fisheries Part 2: Scientific Papers* (FAO Fisheries Technical Paper 350/2, 1995).

[91] *Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks*, (adopted 4 August 1995, entered into force 11 Dec 2001) 2167 UNTS 3, (*Fish Stocks Agreement*) article 5(b).

[92] UNGA, UN Doc A/RES/61/105 (8 December 2006), paragraph 83.

[93] *Nodules Exploration Regulations*, regulation 31(4); *Sulphides* and *Crusts Exploration Regulations*, regulation 33(4).

[94] Marr, *The precautionary principle in the law of the sea: modern decision making in international law*, pages 35-37; Ronnie Harding and Elizabeth Fisher (eds), *Perspectives on the Precautionary Principle* (Federation Press, 1999), page 12.

[95] Commission of the European Communities, *Communication from the Commission on the Precautionary Principle*, pages 17-18.

[96] Ibid.

3.4.1.2 What does the Implementation of the Precautionary Approach Entail?

Although the precautionary approach is widely accepted, the challenge lies in translating it into practice. Various interpretations exist as to what this implementation entails. From these interpretations, three dimensions can be identified that are involved in the implementation of the precautionary approach: institutional and procedural dimensions, as well as the taking of protective measures (see also Figure 2).

Institutional dimension

The precautionary approach is applied by institutions, in this case the ISA, which require the institutional capacity and competencies to provide for precautionary decision-making, adopt protective measures, and ensure their monitoring and enforcement. Institutional measures include the capacity to enforce protective measures and amend existing measures if new knowledge is acquired. At present, the institutional capacity of the ISA to facilitate risk assessment and risk management, in line with the precautionary approach, is very limited.

Procedural dimension

The precautionary approach includes an important procedural dimension, namely the decision-making process about potentially harmful activities, such as seabed mining. This encompasses **assessments of the environmental risks and impacts**,[97] including **cumulative and long-term impacts**, of seabed mining. It also includes assessment of the ***effectiveness*** and ***proportionality*** of potential protective measures as well as any potential counter-effects of these measures.[98]

Importantly, precautionary decision-making includes not only the consideration of **scientific knowledge** but also the identification and examination of **uncertainties**.[99] Indeed, because of the limited scientific knowledge about the deep oceans, deciding on precautionary measures comprises three considerations: scientific knowledge *(what are the known facts?)*, uncertainties *(where is the limit of our knowledge, can it be extended, and which assumptions are made?)*, and value considerations *(how safe do we want to play?)*. Because of the latter, subjective values, it is particularly important to ensure **public participation**, as this allows administrative bodies to capture the various concerns and viewpoints on perceptions of risk and acceptability of harm.[100] This is especially relevant for the ISA as it is obliged to act on behalf of humankind.[101] Moreover, ensuring **transparent** decision-making is important to balance potentially competing interests.[102]

However, transparency, public participation, and the identification of uncertainties have been problematic in the ISA context. First, applicants are not required to identify the uncertainties inherent

[97] Nicolas De Sadeleer, *Environmental Principles: From Political Slogans to Legal Rules* (Oxford University Press, 2002), pages 202-211.

[98] Cooney, *A Long and Winding Road? Precaution from Principle to Practice in Biodiversity Conservation*, pages 236-238.

[99] Jacqueline Peel, *The Precautionary Principle in Practice: Environmental Decision-Making and Scientific Uncertainty* (Federation Press, 2005), pages 156-159; E Fisher, 'Precaution, Law and Principles of Good Administration' (2005) 52 *Water Science and Technology* 19–24, page 19.

[100] Joyeeta Gupta, 'Glocalization: The Precautionary Principle and Public Participation' in David Freestone and Ellen Hey (eds), *The Precautionary Principle and International Law: the Challenge of Implementation* (Kluwer Law International, 1996) 231-246, page 246; David Vanderzwaag, 'The Precautionary Principle and Marine Environmental Protection: Slippery Shores, Rough Seas, and Rising Normative Tides' (April 2002) 33 *Ocean Development & International Law* 165–188, page 175.

[101] UNCLOS, article 137(2).

[102] Jacqueline Peel, *The Precautionary Principle in Practice: Environmental Decision-Making and Scientific Uncertainty* (Federation Press, 2005), pages 156-157, 225.

in their project design and assessments and to demonstrate how these are addressed in their plans of work. Similarly, the LTC is not required to communicate any uncertainties to the Council when issuing its recommendations as to whether or not to approve an application. Second, the decision-making process is at risk of granting undue influence to the subjective opinions of LTC members as to the uncertainties and value considerations. This is because no conservation objectives have been agreed and the LTC has no guidance as to how to respond to uncertainties. Third, the ISA's decision-making process has been criticised for its lack of transparency and public participation,[103] although the stakeholder surveys conducted in 2014 and 2015 are an encouraging sign.

Balancing scientific advice and subjective values can, for example, be aided through what Walker calls 'science policies', that is '*decision rules about the way in which risk assessment scientists should proceed when they encounter specified types of uncertainties*.'[104] This can allow expert bodies to conduct risk assessment and make decisions over risk management in a principled way, taking into account value decisions reached by political bodies, in close consultation with the public and stakeholders.

Protective measures

Finally, the precautionary approach also incorporates the most obvious category of measures, those that are in themselves protecting the environment.[105] Without concrete policy and management measures, the precautionary approach would have little effect.[106] Common examples of protective measures include banning certain activities or substances,[107] establishing safety margins,[108] and using the best available technology,[109] but also include scientific and economic research to enhance knowledge of long-term options.[110] Determining suitable measures requires considering the situation at large including possible counter-effects that protective measures might trigger.[111] The goal, after all, is to find measures that are *effective* in reaching the conservation objective but also *proportionate* to it.

The Burden of Proof

[103] Michael Bothe, 'The Protection of the Marine Environment Against the Impacts of Seabed Mining: As Assessment of the New Mining Code of the International Seabed Authority' in Peter Ehlers, Elisabeth Mann Borgese, and Rüdiger Wolfrum (eds), *Marine Issues* (Kluwer, 2002) 221–231, page 226; Jeff Ardron, *Ocean Sustainability through Transparency: Deep sea mining and lessons learnt from previous resource booms*, Background paper for IASS Ocean Governance Workshop (29-30 October 2014) (unpublished).

[104] Vern R Walker, 'The Myth of Science as a Neutral Arbiter for Triggering Precautions' (2003) 26 *Boston College International and Comparative Law Review* 197–228, page 214.

[105] Commission of the European Communities, *Communication from the Commission on the Precautionary Principle*, pages 15-20; Cooney, *A Long and Winding Road? Precaution from Principle to Practice in Biodiversity Conservation*, pages 232-233; James Cameron and Juli Abouchar, 'The Status of the Precautionary Principle in International Law' in David Freestone and Ellen Hey (eds), *The Precautionary Principle and International Law: the Challenge of Implementation* (Kluwer Law International, 1996) 29–52, pages 50-51.

[106] Rosie Cooney and Barney Dickson, 'Precautionary Principle, Precautionary Practice: Lessons and Insights' in Rosie Cooney and Barney Dickson (eds), *Biodiversity and the Precautionary Principle: Risk, Uncertainty and Practice in Conservation and Sustainable Use* (Earthscan, 2005) 287–298, page 301.

[107] David Freestone and Ellen Hey (eds), *The Precautionary Principle and International Law: the Challenge of Implementation* (Kluwer Law International, 1996), pages 249-268; Trouwborst, *Precautionary Rights And Duties of States*, pages 165-169; Rosie Cooney, *The Precautionary Principle in Biodiversity Conservation and Natural Resource Management: An Issue Paper for Policy-Makers, Researchers and Practitioners* (IUCN, 2004), page 30.

[108] Rosie Cooney, *The Precautionary Principle in Biodiversity Conservation and Natural Resource Management: An Issue Paper for Policy-Makers, Researchers and Practitioners* (IUCN, 2004), page 30; Trouwborst, *Precautionary Rights And Duties of States*, pages 169-170.

[109] Trouwborst, *Precautionary Rights And Duties of States*, pages 172-174.

[110] Ellen Hey, 'The Precautionary Concept in Environmental Policy and Law: Institutionalizing Caution' (1992) 4 *Georgetown International Environmental Law Review* 303–318, page 311; Trouwborst, *Precautionary Rights And Duties of States*, pages 174-177.

[111] Cooney, *A Long and Winding Road? Precaution from Principle to Practice in Biodiversity Conservation*, pages 231-233.

Reversing the burden of proof is *not* a necessary requirement of the precautionary approach but may be applied in individual circumstances. In the ISA context, the burden of proof is not reversed in a strict sense.[112] However, a **presumption of harm** is integrated into the legal framework. Both the UN Convention on the Law of the Sea (UNCLOS) and the Mining Code recognise that seabed mining could cause environmental damage.[113] The LTC is required to only recommend approval of an application for an exploration contract, if it is satisfied that the application provides 'for effective protection and preservation of the marine environment.'[114] Whilst proof of an absence of risk is not required, the focus is on demonstrating that environmental protection is ensured. This could amount to a moderate form of precaution, if a number of criteria were met, which are currently not satisfied: a) defining what effective environmental protection means; b) establishing criteria for the LTC to assess the environmental performance of the proposed work; c) detailed and transparent EIAs for the proposed exploration work; and d) detailed and transparent description of how the proposed project aims to protect the marine environment.

A parallel regime, which also includes a presumption of harm rather than a strict reversal of the burden of proof, is the 1995 *Fish Stocks Agreement*. However, in contrast to the seabed mining regime, it sets a clear a **conservation objective**, namely to '*maintain or restore stocks at levels capable of producing maximum sustainable yield*.'[115] The agreement requires states parties to determine 'stock-specific reference points and the action to be taken if they are exceeded.'[116] As Freestone notes: '[…] *instead of the burden of proof being on those arguing for conservation to prove definitively that stocks are threatened before conservation measures are put in place (as has been the situation in the past), a number of stock management parameters are established ab initio and if these are exceeded then conservation measures will automatically become applicable*.'[117] A similar conservation objective could be set by the ISA (see further Chapter 3.3, 3.3.3).

Despite not being an inherent element of the precautionary approach, reversing the burden of proof can nevertheless be an important **implementation measure**.[118] It has been applied e.g. to large-scale pelagic driftnet fishing by the UN General Assembly,[119] cockle fishing in the Wadden Sea by the EU,[120] and bottom fishing in areas with seamounts, hydrothermal vents, cold water corals, and sponge fields in the area managed by several Regional Fisheries Management Organisation, for example the newly established South Pacific Regional Fisheries Management Organisation.[121] It has also been suggested

[112] See e.g. UNCLOS, Article 162(2)(x); ISA, ISBA/19/LTC/8 (1 March 2013), paragraph 18. Compare the draft regulations developed by the Preparatory Commission, which still provided that '[a]ctivities in the Area shall only take place if they do not cause serious harm to the marine environment.' (LOS/PCN/SCN.3/WP.6/Add.5 (8 February 1990), article 105).

[113] UNCLOS, article 145; *Nodules Exploration Regulations*, regulation 31; *Sulphides* and *Crusts Exploration Regulations*, regulation 33; ISA, ISBA/19/LTC/8 (1 March 2013).

[114] *Nodules Exploration Regulations*, regulation 21; *Sulphides* and *Crusts Exploration Regulations*, regulation 23.

[115] *Fish Stocks Agreement*, article 5(b), annex II paragraph 2.

[116] *Fish Stocks Agreement*, article 6(3)(b).

[117] David Freestone, 'Implementing Precaution Cautiously: The Precautionary Approach in the Straddling and Highly Migratory Fish Stocks Agreement' in Ellen Hey (ed), *Developments in International Fisheries Law* (Kluwer Law International, 1999) 287–325, page 293.

[118] Trouwborst, *Precautionary Rights And Duties of States*, page 223.

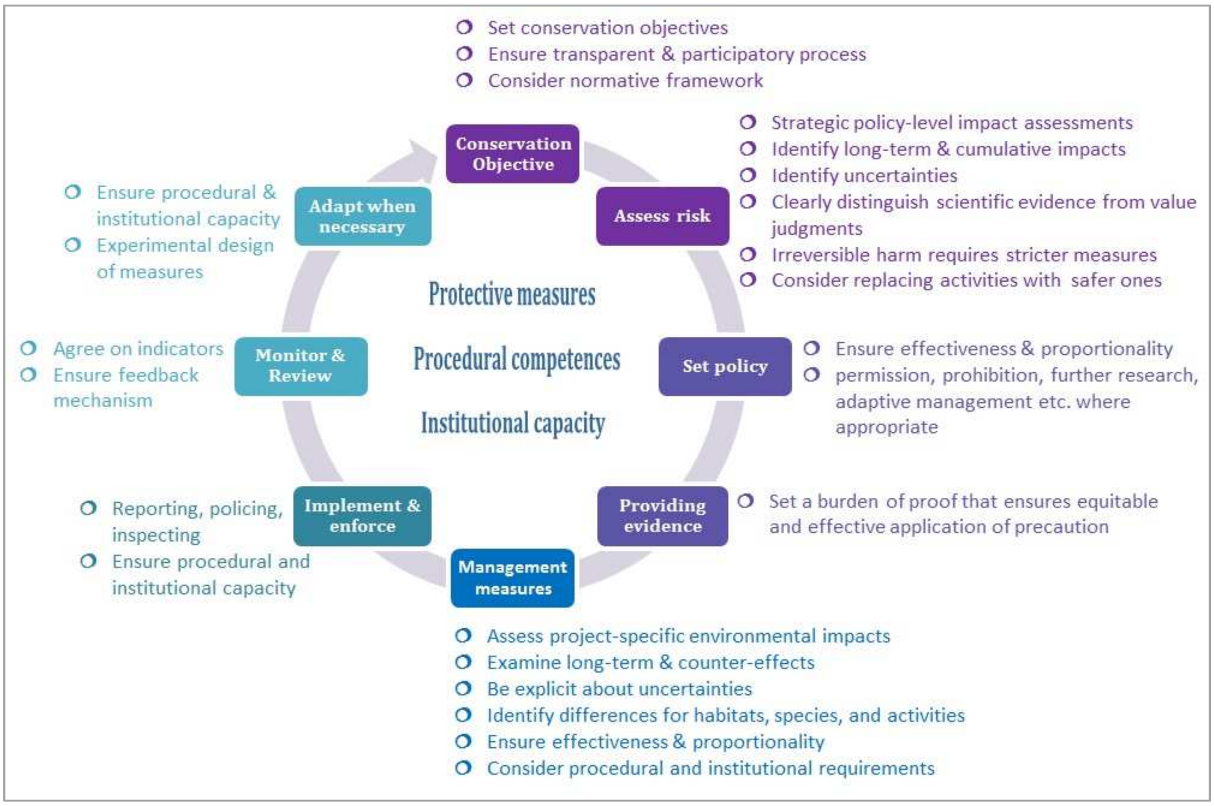
[119] UNGA, UN Doc A/44/225 (22 December 1989), paragraph 4.

[120] *Landelijke Vereniging tot Behoud van de Waddenzee and Nederlandse Vereniging tot Bescherming van Vogels v Staatssecretaris van Landbouw, Natuurbeheer en Visserij* (C-127/02) [2004] ECR I-7405, paragraphs 44-45, 59, 67; See also Elen R Stokes, 'Liberalising the Threshold of Precaution - Cockle Fishing, the Habitats Directive, and Evidende of a New Understanding of 'Scientific Uncertainty'' (2005) 7 *Environmental Law Review* 206-214.

[121] Interim measures adopted by participants in negotiations to establish the South Pacific Regional Fisheries Management Organisation (2007) http://www.southpacificrfmo.org/interim-measures/, paragraphs 3, 6 in the section on bottom fisheries.

for marine protected areas in areas beyond national jurisdiction.[122] Thus, reversing the onus of proof for selective sites or activities can be a means to implement the precautionary approach. The ISA has not yet used a reversed burden of proof for specific sites or activities.

Figure 1 Steps required to implement the precautionary approach. Achieving implementation requires not only (a) the taking of protective measures, but also (b) procedural competences and (c) institutional capacity to conduct precautionary decision-making[123]



Adaptive Management/Governance

Adaptive management is a widely endorsed tool also designed to respond to uncertainties and can be linked with the precautionary approach. The difficulties of applying adaptive management in the seabed mining context are discussed in Jaeckel (2016). The following provides a very brief summary of adaptive management.

Adaptive management entails modest and reversible management interventions, designed as experiments to generate further knowledge about the resource being studied. It includes four elements:[124]

- Monitoring the impacts of a management option based on agreed indicators;

[122] UN Doc A/61/65 (20 March 2006), annex I paragraph 61.

[123] Image modified from Aline Jaeckel, The International Seabed Authority and Marine Environmental Protection: A Case Study in Implementing the Precautionary Principle (PhD thesis, University of New South Wales, Australia, 2015).

[124] Rosie Cooney and Barney Dickson, 'Appendix: Guidelines for Applying the Precautionary Principle to Biodiversity Conservation and Natural Resource Management' in Rosie Cooney and Barney Dickson (eds), *Biodiversity and the Precautionary Principle: Risk, Uncertainty and Practice in Conservation and Sustainable Use* (Earthscan, 2005) 299-306, page 304.

- Promoting scientific research;
- Periodic evaluation of management options and feeding information back into the decision-making process; and
- Effective compliance mechanisms.

Adaptive management can be particularly suitable for biodiversity management[125] and complex systems in general as well as for situations in which the main danger is the cumulative impact of small actions.[126] However, adaptive management is not suitable where effects cannot be followed by biological indicators on a short-time scale. Similarly, it should not be applied to activities that can quickly cause very serious or irreversible harm, such as invasive alien species.[127] Moreover, it can be misused in an attempt to postpone protective measures, in effect preventing more rigorous precautionary actions. This is particularly relevant in light of the danger of a relatively speedy transition towards exploitation contracts, which would then be difficult to modify. Similarly, there is a risk of a degree of complacency once exploitation has been allowed.[128] In sum, 'used indiscriminately or inappropriately, adaptive management mechanisms can operate to water down regulatory requirements, reduce public scrutiny of planning and development approval processes and accord preferential treatment to favoured industries, thus substantially detracting from any precautionary role they might serve in addressing uncertainty.'[129]

The widespread support for adaptive management led to calls for adaptive governance, that is policy and governance structures, which enable adaptive management.[130] In the ISA context, adaptive management, if deemed an effective and proportionate method, would need to be accompanied by adaptive governance. In other words, the ISA would require mechanisms to adjust environmental standards for mining operations on a continuous basis, which is not the case at present.

3.4.1.3 Precautionary and Risk-Based Approaches

A risk-based approach is a further tool to arrive at policy and management decisions regarding seabed mining in a precautionary context. For example, the European Commission[131] '*considers that measures applying the precautionary principle belong in the general framework of risk analysis, and in particular risk management*' and point out that '*the precautionary principle is relevant only in the event of a potential risk*', for example due to insufficient scientific data and uncertainty.

[125] CBD COP07, *Decision VII/12,* UNEP/CBD/COP/DEC/VII/12 (13 April 2004), paragraphs 10-12; Cooney, *A Long and Winding Road? Precaution from Principle to Practice in Biodiversity Conservation*, pages 238-239; Brendan Moyle, 'Making the Precautionary Principle Work for Biodiversity: Avoiding Perverse Outcomes in Decision-Making Under Uncertainty' in Rosie Cooney and Barney Dickson (eds), *Biodiversity and the Precautionary Principle: Risk, Uncertainty and Practice in Conservation and Sustainable Use* (Earthscan, 2005) 159-172, pages 170-172.

[126] Holly Doremus, 'Precaution, Science, and Learning While Doing in Natural Resource Management' (2007) 82 *Washington Law Review* 547–579, pages 555-557; David A Keith et al 'Uncertainty and Adaptive Management for Biodiversity Conservation' (2011) 144 *Biological Conservation* 1175-1178, page 1178.

[127] R Cooney and Andrew T F Lang, 'Taking Uncertainty Seriously: Adaptive Governance and International Trade' (1 June 2007) 18 *European Journal of International Law* 523–551, pages 536-537.

[128] Carl J Walters, 'Is Adaptive Management Helping to Solve Fisheries Problems?' (2007) 36 *Ambio: A Journal of the Human Environment* 304-7.

[129] Peel, *The Precautionary Principle in Practice: Environmental Decision-Making and Scientific Uncertainty*, page 154; see also Sidney A Shapiro and Robert L Glicksman, Risk Regulation at Risk: Restoring a Pragmatic Approach (Stanford University Press, 2003), pages 167-173.

[130] R Cooney and Andrew T F Lang, 'Taking Uncertainty Seriously: Adaptive Governance and International Trade' (2007) 18 *European Journal of International Law* 523–551; Carl Folke et al, 'Adaptive Governance of Social-Ecological Systems' (2005) 30 *Annual Review of Environment and Resources*, 441-473.

[131] European Commission, 2000. Communication from the Commission on the precautionary principle. COM (2000) 1 final. COM (2000), p.12-13.

It describes a process of quantitatively or qualitatively estimating the risks of an activity during its life-cycle. The estimation is based on the probability of harm occurring as well as the severity of the consequences. The steps involved in risk assessment vary but generally include: problem formulation; hazard identification; release assessment; exposure assessment; consequence assessment; and risk estimation[132] (see further Chapter 3.4.5.4).

The concept of risk is intrinsically linked with the precautionary approach. The probability and severity of an activity influence which protective measures are *effective* in and *proportionate* to precautionary aims. In other words, the risk influences the choice of precautionary measures. However, the precautionary approach specifically recognises the need for action even if scientific knowledge does not allow conclusive assessments of the risks involved.

The key challenge for applying a risk-based approach to deep seabed mining is the lack of environmental data and the high levels of uncertainty. While it is clear that seabed mining, like its land-based cousin, will likely cause long-lasting environmental damage, numerous uncertainties remain,[133] including uncertainty as to the cumulative effects of repeated habitat disturbances from seabed mining as well as interaction with other activities.[134] In light of our limited knowledge, an accurate prediction of the environmental impact of seabed mining is currently impossible.[135] As the Secretary-General of the ISA summarised in 2011: '*The current level of understanding of deep-sea ecology is not yet sufficient to allow conclusive risk assessment of the effects of large-scale commercial mining*.'[136]

3.4.1.4 Is the ISA Implementing the Precautionary Approach?

The ISA has implemented some aspects of the precautionary approach, yet significant shortcomings and lacunae remain, in particular regarding the establishment of a procedural framework that enables effective risk assessment and adjustment of risk management measures as well as a timely implementation of protective measures. While the ISA's limited resources undoubtedly play a role, these challenges may also be linked to the absence of an environmental management strategy. The following sections discuss individual aspects of the ISA's strengths and shortcomings.

Absence of a conservation objective

A major shortcoming is that the Mining Code does not articulate a conservation objective. As a result, it is impossible to assess whether a protective measure, even if adopted specifically to give effect to the precautionary approach, is *effective* in and *proportionate* to precautionary management aims. This in turn has institutional implications. At present, the LTC is required to determine whether an application for an exploration contract provides for 'effective protection and preservation of the

[132] Robyn Fairman, Carl D Mead and W Peter Williams, 'Environmental Risk Assessment - approaches, experiences and information sources' (European Environment Agency, 2011), http://www.eea.europa.eu/publications/GH-07-97-595-EN-C2/riskindex.html.

[133] International Council for the Exploration of the Sea (ICES), *Report of the ICES/NAFO Joint Working Group on Deep-Water Ecology*, 16-20 February 2015, Portugal, ICES CM 2015/ACOM:27, pages 44-45; Cindy Lee Van Dover, 'Mining Seafloor Massive Sulphides and Biodiversity: What Is at Risk?' (2010) 68 *ICES Journal of Marine Science* 341–348.

[134] CL Van Dover, 'Tighten Regulations on Deep-Sea Mining' (2011) 470 *Nature* 31–33.

[135] Adrian G Glover and Craig R Smith, 'The Deep-Sea Floor Ecosystem: Current Status and Prospects of Anthropogenic Change by the Year 2025' (2003) 30 *Environmental Conservation* 219–241.

[136] ISA, ISBA/12/A/2 (13 June 2011), para 68; see also Jochen Halfar and Rodney M Fujita, 'Danger of Deep-Sea Mining' (18 May 2007) 316 *Science* 987; Cindy Lee Van Dover, 'Mining Seafloor Massive Sulphides and Biodiversity: What Is at Risk?' (2010) 68 *ICES Journal of Marine Science* 341–348), page 342.

marine environment including, but not restricted to, the impact on biodiversity.'[137] In the absence of a conservation objective, the LTC has no guidance as to what *effective protection* means.

Lack of transparency, public participation, and obligation to identify uncertainties

Precautionary decision-making would require the identification of scientific knowledge and remaining uncertainties in a transparent manner, so as to enable the selection of protective measures that can meet conservation objectives, and which reflect public opinion about the acceptability of risk as well as the values placed on seafloor minerals, marine biodiversity, and deep ocean ecosystems. At present, this process is undermined, not only by an absence of a conservation objective and requirement to identify uncertainties, but also by a lack of transparency and public participation with respect to decision-making by the ISA.

Central role for scientific advice

Through the LTC, the ISA institutionalises an important precautionary method, namely a central role for scientific information. This may be seen as one of the core strengths when compared to other regulatory organisations. However, the LTC currently faces an unmanageable workload and the expertise it represents would need to be enlarged to incorporate comprehensive and detailed expertise over environmental impact assessments and environmental management. Alternatively, an expert group could be established to provide LTC or the Authority overall with independant advice on environmental issues.

Timely Action

The precautionary approach requires protective measures at an *early* stage, in spite of remaining uncertainties. However, the lack of an environmental management strategy, coupled with an incremental approach to standard setting, makes it difficult for the ISA to meet this temporal requirement.

Three specific gaps exist: First, although the LTC is required to make recommendations to the Council on implementing the precautionary approach,[138] no such recommendations have been made (with the exception of the Environmental Management Plan for the Clarion-Clipperton-Zone (EMP-CCZ)). Second, the LTC is required to develop and implement procedures for determining whether proposed *exploration* activities in the Area would have serious harmful effects on vulnerable marine ecosystems, such as hydrothermal vents, seamounts, and cold water corals. If this is the case, the LTC must ensure '*those activities are managed to prevent such effects or not authorized to proceed*.'[139] However, despite repeated calls for action from the UN General Assembly,[140] the LTC has not yet acted upon this obligation. Instead, numerous exploration contracts were given out for areas containing vulnerable marine ecosystems (see Chapter 2.1). Third, the EMP-CCZ is perhaps the single most important protective measure by the ISA. However, it also demonstrated that the effectiveness of spatial management, and thus also its value in serving as a precautionary measure, is reduced when it is applied only *after* substantial parts of the region have been allocated to exploration contracts. This is

[137] *Nodules Exploration Regulations*, regulation 21(4)(b); *Sulphides and Crusts Exploration Regulations*, regulation 23(4)(b).

[138] *Nodules Exploration Regulations*, regulation 31(3); *Sulphides and Crusts Exploration Regulations*, regulation 33(3).

[139] *Nodules Exploration Regulations*, regulation 31(4); *Sulphides and Crusts Exploration Regulations*, regulation 33(4).

[140] UNGA, UN Doc A/Res/67/78 (11 December 2012), paragraphs 190-191; UN Doc A/RES/68/70 (9 December 2013), paragraphs 206-207; UN Doc A/RES/69/245 (29 December 2014), paragraph 221-222.

particularly important given that geographical location of exploration sites will determine where mineral exploitation will take place in the future.

Procedural Challenges Associated with Environmental Impact Assessments and Adaptive Management

While a more detailed account of environmental impact assessments (EIAs) and adaptive management in the seabed mining context is provided in Chapter 3.4.5 and Chapter 3.4.3, respectively, the following is a very brief summary. Although the regulatory framework incorporates a substantive obligation to carry out EIAs when certain circumstances during exploration are met, significant procedural challenges remain.

First, the procedural framework[141] neither incorporates the detailed requirements of EIAs, such as independent reviews, nor consequences that must be taken if an EIA identifies risks of unacceptable levels of harm. A conservation objective would be needed to determine what level of harm is deemed acceptable. At present, the risk is that EIAs will be considered a mere administrative formality rather than a crucial step in identifying the risks and uncertainties of seabed mining in order to ensure their minimisation in accordance with the ISA's mandate.

Second, the efficacy of EIAs as well as adaptive management is uncertain in the current procedural framework. Full EIAs are only required *during* the course of exploration work, in other words, once the ISA has already granted a 15-year exploration contract. In order for EIAs to have a practical effect, the ISA would need to be able to require contractors to adjust their operations based on new information generated by the EIAs. However, the procedural framework fails to provide an effective mechanism through which the ISA can amend environmental standards during the lifetime of an exploration contract. This goes to the heart of the challenge to implement the precautionary approach. The ISA develops its environmental standards incrementally. As more information becomes available, the ISA could, and to some degree has, adjusted the environmental parameters of seabed mining. However, the procedural framework is not designed to facilitate such adjustments once an exploration contract has been granted. It is crucial for the future exploitation regulations to address this lack of regulatory control.

Lack of an Environmental Management Strategy

At present, the ISA lacks a strategic plan for the environmental management of seabed mining. The review of the Area regime under article 154 of the Convention has led the ISA Assembly to request the Secretary General to present a llong-term strategic plan by 2018. At present, all protective measures are adopted on an *ad hoc* basis and environmental standards are set incrementally, making them vulnerable to being disregarded particularly if commercial pressure to commence the exploitation phase increases. However, under Article 145 UNCLOS as well as the 1994 Implementing Agreement, the effective protection of the marine environment is a core obligation of, and indeed a priority task for, the ISA. Nonetheless, the ISA has not yet adopted an environmental management strategy (Jaeckel, 2015a). Similarly, the regulatory framework does not yet include strategic environmental assessments (SEAs). SEAs can be procedural tools to scale up environmental assessments to a global and regional level and integrate cumulative effects. However, although both the ISA's Recommendations regarding EIAs and the EMP-CCZ foreshadow the assessment of regional and cumulative impacts,[142] these assessments are not integrated into the current procedural framework.

Role of the ISA in Marine Scientific Research

[141] ISA, ISBA/19/LTC/8 (1 March 2013), part II A, part IV. See also Durden, J.M., Lallier, L.E., Murphy, K., Jaeckel, A., Gjerde, K., Jones, D.O.B., 2018. Environmental Impact Assessment process for deep-sea mining in 'the Area'. Marine Policy 87, 194-202.

[142] ISA, ISBA/19/LTC/8 (1 March 2013), paragraph 16; ISA, ISBA/17/LTC/7 (13 July 2011), paragraphs 34, 37, 40(b), 43, 51.

Scientific research is an integral element of the precautionary approach. Although the Mining Code requires contractors to gather environmental baseline data, the Code is silent with respect to the ISA's role in conducting targeted research projects, in line with its mandate to coordinate, promote, and even carry out marine scientific research in the Area.[143] Nonetheless, the ISA has been active in supporting contractors to use standardized taxonomy for faunal species they discover.[144]

Interestingly, although the ISA has collaborated in a number of scientific projects to generate new biodiversity data, these were not necessarily driven by the Authority itself, no doubt partly due to a lack of funding. Examples are the ISA's collaboration with the Census of Marine Life and its contribution to the Kaplan project, which resulted in the recommendation to establish protected areas in the Clarion-Clipperton-Zone. Collaborations must be welcomed to maximize efficiency and source detailed expertise from the scientific community. However, the lack of a strategic research agenda can lead to the ISA relying, to a degree, on the scientific research community carrying out projects relevant to the seabed mining.

3.4.1.5 Potential Ways Forward

The following is a summary table (Table 1) of suggestions that could better align the ISA's regulatory framework with the requirements of a precautionary approach. These measures could support the development of a strategic environmental management framework for the ISA, in order to move beyond *ad hoc* measures for environmental protection and give effect to the environmental mandate of the ISA.

Table 1 Potential measures to strengthen the implementation of precaution by the ISA

Potential measures strengthen the implementation of precaution
Protective Measures
Commission strategic marine scientific research studies to increase the quality, quantity, and verifiability of environmental baseline data.
Ensure environmental management plans and marine protected areas are established before exploration sites are allocated within a region.
Ensure measures for the protection of vulnerable marine ecosystems are adopted before exploration work is authorized which may harm them.
Procedural Measures
Determine conservation objectives in line with best scientific advice and public opinion regarding the values placed on seafloor minerals, marine biodiversity, and deep ocean ecosystems.
Conduct strategic environmental assessments regarding the impacts of deep seabed mining on regional scales (including comparisons with alternative means of ensuring supply of minerals).
Incorporate regional environmental management plans into the *Exploration Regulations* to clarify their binding nature, for example by making their establishment a compulsory prerequisite to granting mining contracts in a particular area, as has been suggested by the Netherlands.[145]

[143] UNCLOS, article 143.

[144] See https://www.isa.org.jm/workshops.

[145] ISA, ISBA/20/C/13 (3 June 2014).

Require the LTC and Council to specify which scientific, technical, and value considerations as well as uncertainties inform a particular decision.

Require applicants to identify the uncertainties inherent in their project design and assessments and to demonstrate how these are addressed in their plans of work.

Establish criteria to evaluate whether an application for an exploration contract provides for 'effective protection and preservation of the marine environment including, but not restricted to, the impact on biodiversity'.[146]

Provide detailed guidance regarding the requirements for and content of preliminary EIAs (submitted with application for exploration contract) and EIAs required prior to specific exploration work.

Establish procedural safeguards to ensure environmental baseline and monitoring data is supplied to the ISA.

Set out steps to follow if EIAs indicate the risk of failing to meet the conservation objectives.

Ensure the ISA retains the power to amend environmental requirements placed on contractors once a contract is in force, not least to enable adaptive management (flexibility in contract).

Adopt a staged approach to mineral exploitation to retain some control.[147]

Increase transparency by publishing environmental baseline and monitoring data, EIA and SEA reports, meeting reports and/or minutes.

Improve public participation for example through access to meetings for observers, an Ombudsperson for present and future generations, further stakeholder surveys, and utilizing external surveys that capture public opinions regarding the acceptability of risks and the values placed on minerals, biodiversity, and ecosystem services.

Conduct the contractors' environmental studies through a centrally coordinated consortium or consultant scientists, financed by the contractors.

Institutional Measures

Ensure the institutional capacity to assess and manage environmental risks and monitor compliance, for example through establishing an Environmental Commission that represents detailed expertise in environmental management, as well as a Mining Inspectorate within the ISA Secretariat.

[146] *Nodules Exploration Regulations*, regulation 21(4)(b); *Sulphides* and *Crusts Exploration Regulations*, regulation 23(4)(b).

[147] Allen L Clark, Jennifer Cook Clark, and Sam Pintz, *Towards the Development of a Regulatory Framework for Polymetallic Nodule Exploitation in the Area (Technical Study: No. 11)* (ISA, 2013).

3.4.1.6 Recommendations

Recommendations

- Measures to protect the environment should be procedurally integrated into the ISA's decision-making process. It should be clearly specified that REMPs set required environmental and management baselines against which the overall effects as established in project-specific EIAs are assessed, and that mining contracts cannot be granted without them.
- Because precaution requires *timely* action, protective measures should be taken *before* any mining occurs. This includes establishing REMPs, deciding on the protection of VMEs, establishing clear conservation objectives, clearly defining the content and procedure of EIAs, and ensuring baseline data is sufficient. Germany could highlight this point in the ISA Council.
- The Mining Code should require the LTC and Council to specify which scientific, technical, and value considerations as well as uncertainties inform a particular decision. This will lead to much greater transparency, including about the reasons why the LTC recommends approval of a certain application, and shift power to the States represented in the Council.
- Establish criteria for the LTC to evaluate whether an application for an exploration contract provides for 'effective protection and preservation of the marine environment including, but not restricted to, the impact on biodiversity'. At present, it is unclear how this evaluation is made.
- In line with the precautionary principle, applicants should be required to identify the uncertainties inherent in their project design and assessments and to demonstrate how these are addressed in their plans of work.
- The ISA requires the institutional capacity to assess and manage environmental risks and monitor compliance, for example through a Mining Inspectorate. To enable this capacity, States will have to be willing to finance these operational costs.

3.4.2 The Common Heritage of Humankind[148]

3.4.2.1 Introduction

The legal framework for deep seabed mining on the international seabed, the Area, is set out in Part XI of the 1982 United Nations Convention on the Law of the Sea (UNCLOS). Article 136 of Part XI defines the Area and its resources as the common heritage of mankind (CHM). This CHM principle is fundamental to the regime for the Area and it guides the interpretation and application of Part XI.[149] Article 311(6) of UNCLOS prohibits any derogation from the CHM principle.

The CHM principle includes the preservation of the environment and its natural resources for future generations.[150] However, despite the importance of setting environmental standards early as well as the central role of the CHM principle in the Part XI regime, the practical implementation of the principle remains unclear. The International Seabed Authority (ISA), which was established to administer the Area and its resources 'on behalf of mankind as a whole',[151] has not yet specifically developed the CHM principle further to ensure it is being given effect.

Rather than recounting the historical development of the CHM principle, which has been done in detail elsewhere,[152] this note focuses on the environmental protection dimension of the CHM principle. Section 2 defines the CHM principle and puts it in the context of sustainable development. Section 3 then identifies several environmental standards and measures that can be derived from the CHM principle. These standards and measures could inform discussions at the ISA about how the CHM principle can be translated into practice.

3.4.2.2 The Principle of Common Heritage of Mankind

Elements of common heritage of mankind principle

Although UNCLOS does not provide a definition of the common heritage principle, the broad scope of the principle is captured in several key provisions of Part XI as reflected in Table 2.

[148] Parts of this note are based on: Jaeckel, A., Ardron, J., Gjerde, K.M., 2016. Sharing benefits of the common heritage of mankind – is the deep seabed mining regime ready? . Marine Policy 70, 198-204, Jaeckel, A., Gjerde, K.M., Ardron, J.A., 2017. Conserving the common heritage of humankind – Options for the deep-seabed mining regime. Ibid. 78, 150-157.

[149] Satya N Nandan, Michael W Lodge, and Shabtai Rosenne, *United Nations Convention on the Law of the Sea, 1982: A Commentary, Volume VI* (Martinus Nijhoff Publishers, 2002), at p 99.

[150] Jennifer Frakes, 'The Common Heritage of Mankind Principle and the Deep Seabed, Outer Space, and Antarctica: Will Developed and Developing Nations Reach a Compromise?' (2003) 21 *Wisconsin International Law Journal*, 409-434, at p 413; Dinah Shelton, 'Common Concern of Humanity' (2009) 39 *Environmental Policy and Law*, 83-86, at p 85; Alexandre Kiss, 'The Common Heritage of Mankind: Utopia or Reality?' (1985) 40 *International Journal*, 423-441, at p 438; Joyner, C. C. (1985). Legal Implications of the Concept of the Common Heritage of Mankind. *International and Comparative Law Quarterly*, *35*(01), 190–199, p 195.

[151] UNCLOS, Art. 153(1), 137.

[152] See e.g. Kemal Baslar, *The Concept of the Common Heritage of Mankind in International Law* (Martinus Nijhoff Publishers, 1998); Satya N Nandan, Michael W Lodge, and Shabtai Rosenne, *The Development of the Regime for Deep Seabed Mining* (Kluwer Law International, 2002).

Table 2 Elements of the Common Heritage Principle

Element	Explanation	Source
Non-appropriation	All rights in the resources of the Area are vested in mankind as a whole and no state can claim sovereignty or sovereign rights over the Area and its resources.	Art. 137
Common management	All seabed mining activities in the Area are organised and controlled by the ISA on behalf of mankind as a whole.	Arts. 156-185
Regulated utilisation	The rules, regulations and procedures adopted by the ISA are binding on *all* member states, regardless of individual consent.	Arts. 137(2), 153(1)
Environmental protection	The ISA is required to protect and preserve the marine environment from harmful effects of seabed mining, including for future generations.	Art. 145
Benefit sharing	Activities in the Area must be carried out for the benefit of mankind as a whole, taking into particular consideration the interests of developing states. The ISA is to provide for equitable sharing of financial and other economic benefits derived from activities in the Area. Other distributive mechanisms include equal participation of all states, transfer of technology (to enable equal participation), preferential treatment of developing states, and protection against adverse effects of deep seabed mining on land-based mining interests.	Arts. 140, 144, 148
Marine scientific research (MSR)	MSR in the Area is to be carried out exclusively for the benefit mankind as a whole. The ISA and its member states must support the research capacity of developing states, support the transfer of technology and scientific information relating to seabed mining, and provide for the effective participation of developing states in the seabed mining regime.	Art. 143, 144, 148; IA, annex section 5
Peaceful purposes	The Area is open to use exclusively for peaceful purposes by all states.	Art. 141
State responsibility	States parties must ensure that activities in the Area are carried out in conformity with the international regulatory framework. Damage caused by failure to comply with these responsibilities entails liability.	Art. 139

Benefit-sharing and the common heritage of mankind

A key aspect of the CHM principle is the sharing of benefits with present and future generations, taking into particular consideration the needs of developing states. The sharing of benefits can take various forms, including:

(a) Direct participation in deep seabed mining through a common entity (e.g. the Enterprise);

(b) Sharing of the financial benefits derived from deep seabed mining;

(c) Reserving some mineable areas for developing states (so-called parallel system);

(d) Technology transfer to support developing states to participate in deep seabed mining;

(e) Preserving the ecosystem services provided by the deep ocean for present and future generations;

(f) Sharing increased knowledge about the deep oceans.

(g) Setting aside mineable areas for future generations.

The initial legal regime for the Area foresaw options a, b, c, d, e, and f.[153] However, the 1994 Implementing Agreement withdrew funding for the Enterprise (a) and subjected technology transfer (d) to intellectual property rights, effectively creating an uncertain future for both measures.[154] In recent years, the parallel system[155] (c) has been gradually changed through the ISA Mining Code. The Exploration Regulations for Sulphides and Crusts include an alternative to the parallel system, whereby an applicant can elect to grant the Enterprise an equity interest in his future mineral exploitation,[156] instead of contributing a reserved area at the time of filing an application for an exploration license.[157] The implications of this change have yet to be discussed. However, the change might involve a shift away from helping developing states to explore and exploit mineable sites and towards the sharing of financial benefits instead.

The sharing of financial benefits (b) is specifically foreseen in UNCLOS[158] and the ISA is currently developing the first rules and regulations for a financial mechanism (ISBA/23/LTC/6, section F). The idea of setting aside a proportion of mineable sites in the Area for future generations (g) is not included in UNCLOS and has not yet been discussed.

Of these seven measures, only two have been specifically strengthened over time: protecting the marine environment as a global common good (e) and conducting marine scientific research (f). Both of these are highlighted as priority tasks in the 1994 Implementing Agreement, which the ISA must address before the start of the mineral exploitation phase.[159]

Intergenerational Considerations & Sustainable Development

What has become clear is that whilst the common heritage of mankind principle requires the sharing of benefits, these can take various forms, such as financial, environmental, developmental, and/or technological benefits. In addition, the CHM principle requires the taking into account of not only the interests of present generations, in developing states and elsewhere, but also of future generations. In his recollection of the negotiations of UNCLOS, Pinto confirms that inter-generational considerations and the preservation of the environment were important elements of the CHM principle from the start:[160]

> *'It was a concept that could embody the common values and aspirations of all human beings, and could, moreover, serve to unite the values and aspirations of the present generation with those of future generations. When dealing with non-renewable*

[153] UNCLOS, Arts. 140, 143, 144, 145, 153, 158(2), annex III articles 8 and 9, annex IV.

[154] 1994 Implementing Agreement, annex sections 2(3) and 5. For a discussion on the gradual changes to and future of the Enterprise, see Section 3.2 of Jaeckel, A., Ardron, J., Gjerde, K.M., 2016. Sharing benefits of the common heritage of mankind – is the deep seabed mining regime ready? . Marine Policy 70, 198-204..

[155] The parallel system requires an application for an exploration contract to include information for two sites capable of allowing two mining operations. While the applicant receives one site, the other site becomes a *reserved area* held by the ISA. The minerals of a reserved area can then be explored and exploited by the *Enterprise* or a developing State without the costs and efforts associated with locating a potential mine site. UNCLOS, annex III articles 8, 9; 1994 Implementing Agreement, annex section 1(10).

[156] The equity interest is at least 20 percent and could be up to 50 percent if so negotiated. The specific terms still have to be developed.

[157] Sulphides and Crusts Exploration Regulations, regulations 16-19.

[158] UNCLOS, articles 140(2), 160(2)(f), (g), 162(2)(o), annex III article 13(1)(d); 1994 Implementing Agreement, annex sections 8, 9(7).

[159] 1994 Implementing Agreement, annex section 1(5).

[160] See also Kemal Baslar, *The Concept of the Common Heritage of Mankind in International Law* (Martinus Nijhoff Publishers, 1998), page 235-236.

> *resources, and the preservation of the environment, which the Convention set out to do, such a concept could be an important reference point and was, in fact, used as such.'*[161]

This combination of aims links the CHM principle to the concept of sustainable development. As Wolfrum, Judge at the International Tribunal for the Law of the Sea, notes: 'An important part of the intertemporal dimension of the common heritage principle is the principle of sustainable development.'[162] Sustainable development captures the struggle of, and requires the balance between, inter alia the interests of present and future generations as well as the aims of supporting the advancement of developing states and ensuring the integrity of the Earth's systems. In relation to mineral resources, this balance is elaborated on in the Brundtland Report to the UN:

> *'As for non-renewable resources, like fossil fuels and minerals, their use reduces the stock available for future generations. But this does not mean that such resources should not be used. In general the rate of depletion should take into account the criticality of that resource, the availability of technologies for minimizing depletion, and the likelihood of substitutes being available. Thus land should not be degraded beyond reasonable recovery. With minerals and fossil fuels, the rate of depletion and the emphasis on recycling and economy of use should be calibrated to ensure that the resource does not run out before acceptable substitutes are available. Sustainable development requires that the rate of depletion of non-renewable resources should foreclose as few future options as possible.'*[163]

The report also stresses the need for development to not endanger the life-support systems:

> *'[…] Today's interventions [in natural systems, such as through mineral mining] are more drastic in scale and impact, and more threatening to life-support systems both locally and globally. This need not happen. At a minimum, sustainable development must not endanger the natural systems that support life on Earth: the atmosphere, the waters, the soils, and the living beings.'*[164]

Finding the right balance between the economic, social, and environmental dimensions of sustainable development as well as the CHM principle will be complex. Fortunately, the Seabed Disputes Chamber provided important guidance in its 2011 Advisory Opinion on the '*Responsibilities and Obligations of States Sponsoring Persons and Entities with Respect to Activities in the Are*a'.[165] The Chamber highlighted that ensuring the highest standards of environmental protection is of greater importance than ensuring preferential treatment of developing States with respect to state responsibility and liabilities.[166] To allow for differential treatment regarding states' responsibilities and liability '*would*

161 M.C.W. Pinto, *The Common Heritage of Mankind: Then and Now* (Recueil des Cours, Collected Courses, Volume 361, Martinus Nijhoff Publishers, 2013), page 58.

162 Rüdiger Wolfrum, 'Common Heritage of Mankind' in *Max Planck Encyclopedia of Public International Law* (2009), paragraph 22; see also Kemal Baslar, *The Principle of the Common Heritage of Mankind in International Law* (Martinus Nijhoff Publishers, 1998), at p 104-105.

163 *Report of the World Commission on Environment and Development: 'Our Common Future',* annexed to UNGA, UN Doc. A/42/427 (4 August 1987), chapter 2 paragraph 12.

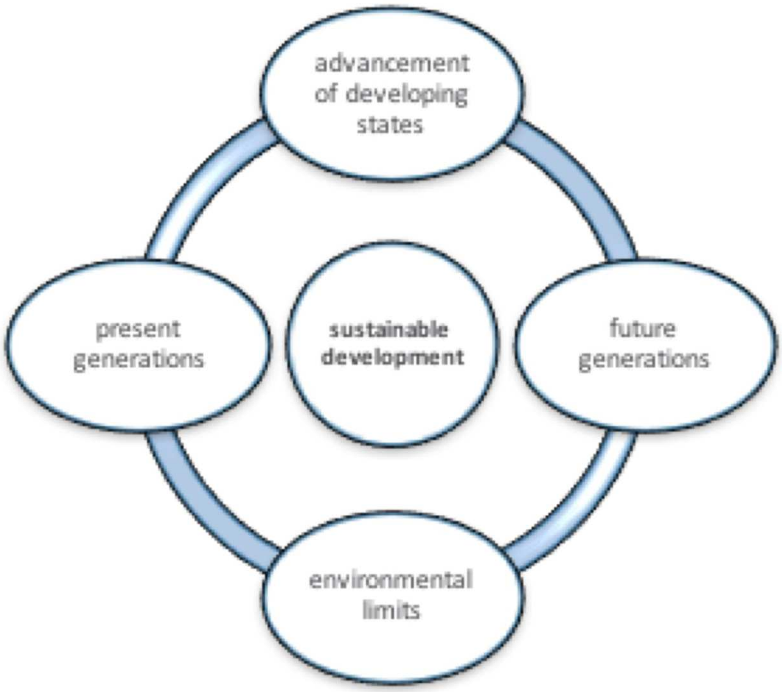
164 *Report of the World Commission on Environment and Development: 'Our Common Future',* annexed to UNGA, UN Doc. A/42/427 (4 August 1987), chapter 2 paragraph 9.

165 *Responsibilities and Obligations of States Sponsoring Persons and Entities with Respect to Activities in the Area* (Seabed Disputes Chamber of the International Tribunal of the Law of the Sea, Case No 17, 1 February 2011).

166 Ibid, para, 151-157.

jeopardize uniform application of the highest standards of protection of the marine environment, the safe development of activities in the Area and protection of the common heritage of mankind.'[167]

Figure 2 Multiple considerations are involved in achieving sustainable development in the context of seabed mining.



3.4.2.3 Multiple Considerations Involved in Achieving Sustainable Development in the Context of Seabed Mining

The principle of the common heritage of mankind, similar to the concept of sustainable development, does not dictate specific measures. Rather, it provides a philosophical and broad legal framework to guide decisions regarding resource management (see also Figure 3). As noted in the introduction, the ISA has yet to develop the CHM principle and discuss specifically how it intends to give effect to it. In light of the current development of exploitation regulations, one of the critical steps will be for the ISA Assembly or Council to have a discussion about how the CHM principle will be integrated into the Mining Code. This will involve debates about the sharing of monetary and non-monetary benefits, the future of the Enterprise, and the implications for developing states of the aforementioned shift away from reserved areas and towards equity interest options.[168] Any decisions taken by the ISA could then serve as a cornerstone for the development of future regulations.

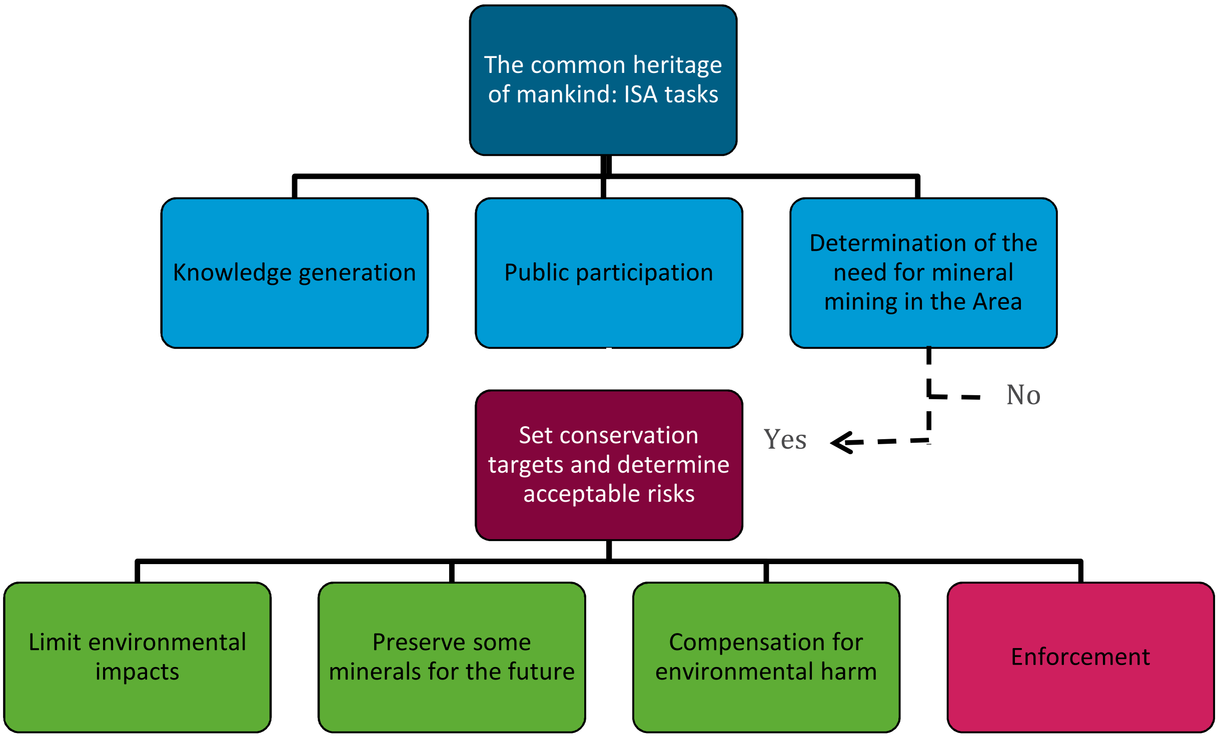
With respect to environmental measures that can be derived from the CHM, the following is a selection of options that could be taken, arranged in two levels of actions (Figure 4): determining preconditions

[167] Ibid, para 159. See also paragraph 158. Nonetheless, the Chamber confirmed that economic differences may be relevant in applying a precautionary approach as a direct obligation under the Mining Code. The Mining Code references Principle 15 of the Rio Declaration, which in turn requires States to apply the precautionary approach '*according to their capabilities*.' (*Seabed Advisory Opinion*, para 129-135.)

[168] For a discussion of the measures to ensure benefit-sharing under the CHM principle, see Aline Jaeckel, Jeff A Ardron, Kristina M Gjerde, Sharing benefits of the common heritage of mankind – is the deep seabed mining regime ready?, Marine Policy 70, 198-204 (2016).

and conditions for deep seabed mining. The first level focuses on what preconditions might be considered before deep seabed mining is authorised, in the context of the common heritage principle. The second level includes considerations that are important if and when it has been determined that some deep seabed mining will be conducted. These options are non-exhaustive.

Figure 3 Hierarchy of potential measures for environmental protection in the context of the principle of the common heritage of mankind



3.4.2.4 Preconditions

Funding marine scientific research to increase knowledge for humankind

The prevention of serious environmental harm in the context of deep seabed mining depends on the extent of scientific knowledge on the deep ocean and its ecosystems. Indeed, the extension and deepening of mankind's knowledge concerning the common heritage of humankind may be considered as one of the key non-material benefits for all (Wolfrum, 2009). An option to further this element of the CHM principle is a 'Seabed Sustainability Fund', which was proposed in the ISA's report on developing a regulatory framework for mineral exploitation. The report notes:

> *'The idea and rationale of a fund is for the Authority to be in a position, based on expert recommendations, to direct further research e.g. in relation to marine ecosystems in the Area and to develop institutional capacities. At the moment the Authority / Common heritage of mankind are in a 'Catch 22' with no budget for large-scale research activities.'*[169]

Such a fund would be an important instrument to finance and coordinate the systematic increase of knowledge and understanding of the deep ocean and its ecosystems. It would also be in line with the ISA's mandate to promote as well as coordinate and disseminate the results of marine scientific research and analysis.[170] Indeed, the fund could address a current challenge, namely that even though the ISA has collaborated in a number of scientific projects, these were not necessarily driven by the Authority itself, no doubt partly because of a lack of funding.[171] Examples are the ISA's collaboration with the Census of Marine Life and the Kaplan project, which resulted in the recommendation to establish protected areas in the Clarion-Clipperton-Zone. Collaborations can be welcomed to maximize efficiency and source expertise from the scientific community. Nonetheless, the absence of a strategic research agenda can lead to the ISA relying, to a degree, on the scientific research community carrying out projects relevant to seabed mining. In addition, a dedicated fund could ensure scientific research is conducted independently. A potential lack of independence is a current challenge for the ecological research carried out by contractors as part of their resource exploration. A dedicated fund to finance independently developed research programmes relevant to the seabed mining regime would help to address these shortcomings.

However, the timing is a challenge. If such a fund is established in the future exploration regulations, to come into effect during the commercial mining phase, this will arguably be too late for fundamental research into the environmental effects of deep seabed mining.

Public participation in value-based decisions

Closely linked to the previous section is the need for public participation. Governing common property resources, especially when numerous uncertainties are involved, requires a weighing of social risk and acceptability, in essence value judgments. This includes discussions over what value we place on, for example:

- increasing the supply of minerals now as opposed to preserving them for future generations?
- preserving ecosystem services?
- preserving particular ecosystems, species, or the deep ocean in general?
- investing into alternatives to deep seabed mining including the risks these alternatives carry?

Given that the ISA administers the Area and its resources on behalf of mankind as a whole, and its work involves the aforementioned value considerations, enabling public participation in the decision-making process would be an important step. An intensified public involvement in the work of the ISA

[169] ISA, *Developing a Regulatory Framework for Deep Sea Mineral Exploitation in the Area: Draft Framework, High Level Issues and Action Plan, Version II*, (15 July 2015) <https://www.isa.org.jm/files/documents/EN/OffDocs/Rev_RegFramework_ActionPlan_14072015.pdf>, pages 35-36.

[170] LOSC, article 143(2).

[171] Jaeckel, A., 2017. *The International Seabed Authority and the Precautionary Principle. Balancing Deep Seabed Mineral Mining and Marine Environmental Protection*. Brill/Nijhoff., chapter 6.2.

may reveal that a high priority is being placed on environmental protection, as several studies illustrate.[172]

A 2012 survey by Jobstvogt and others about deep sea biodiversity in Scottish waters demonstrated that 73 percent of the Scottish public 'found it worth paying for protection of deep-sea areas, because society would benefit from it in the long-term.'[173] The study concluded that '*policy makers are better off to consider the existence value that people associate with species protection in combination with the direct benefits of marine protection, and that overlooking non-users will necessarily lead to undervaluation of marine ecosystems*.'[174] Another study by Glenn and others demonstrated that the Irish public placed a high value on protecting cold-water deep corals off Ireland:

> *'87% of respondents agreed that they should be protected to provide [inter alia] raw materials for the biomedical industry, essential fish habitat and as a carbon sink to assist with climate change. 90% endorsed their protection for the benefit of the next and future generations and 84% considered that they should be protected purely in their own right given the unique and fragile ecosystem they represent.'*[175]

When involving stakeholders, it is crucial to ask the right questions. Guirco and Cooper highlight this point by using the example of an Australian consultation on seabed mining, which disregarded questions about patterns of metal consumption and recycling opportunities.[176] Neglecting to situate seabed mining within the broader context of sustainable development can distort the picture.

This was the shortcoming of a survey conducted by the European Commission in 2014 to collect opinions about seabed mining from civil society, public authorities, research organisations, and the private sector. The survey did not inquire about 'increasing recycling' because '*boosting resource efficiency and recycling is a separate pillar of the [EU's] Raw Materials Initiative*.'[177] However, numerous submissions, particularly from civil society, noted the need to consider the recycling of metals in the context of making decisions regarding seabed mining.[178]

Furthermore, even though all four groups of respondents suggested research on environmental impacts of deep seabed mining as a clear priority action,[179] the responses illustrated an overwhelming scepticism from civil society towards the possibility of deep seabed mining contributing *'towards a sustainable and economical supply of raw material for EU industry and agriculture*.'[180] In addition, civil society urged for greater caution in dealing with the risks of deep seabed mining:

> *'Most researchers and most private companies believe that deep-sea mining is not intrinsically better or worse than other marine activities but it depends on how and where it*

[172] The following discussion is based on Aline L Jaeckel, *The International Seabed Authority and the Precautionary Principle - Balancing Deep Seabed Mineral Mining and Marine Environmental Protection* (Brill, 2017), chapter 7.4.2.

[173] Niels Jobstvogt et al, 'Twenty Thousand Sterling under the Sea: Estimating the Value of Protecting Deep-Sea Biodiversity' (2014) 97 *Ecological Economics*, 10-19, page 15.

[174] Ibid, page 18.

[175] H Glenn et al, 'Marine Protected Areas - Substantiating Their Worth' (2010) 34 *Marine Policy* 421–430, 427; P Wattage et al, 'Economic Value of Conserving Deep-Sea Corals in Irish Waters: A Choice Experiment Study on Marine Protected Areas' (2011) 107 *Fisheries Research* 59–67.

[176] Damien Giurco and Carlia Cooper, 'Mining and Sustainability: Asking the Right Questions' (2012) 29 *Minerals Engineering* 3–12.

[177] European Commission, *EU Stakeholder Survey on Seabed Mining: Summary of Responses*, SWD(2015) 119 final (9 June 2015) <http://ec.europa.eu/dgs/maritimeaffairs_fisheries/consultations/seabed-mining/index_en.htm>, page 2.

[178] All responses to the survey are listed at <http://ec.europa.eu/maritimeaffairs/seabed-mining-consultation/replies_to_questions.htm>.

[179] European Commission, EU Stakeholder Survey on Seabed Mining: Summary of Responses, SWD(2015) 119 final (9 June 2015) <http://ec.europa.eu/dgs/maritimeaffairs_fisheries/consultations/seabed-mining/index_en.htm>, page 24.

[180] Ibid, page 18.

is done. The civil society response was different. They do consider the impact to be worse. Again, our uncertain knowledge of potential damage was given as a reason for caution.'[181]

Debate the need for and alternatives to deep seabed mining

The discussion in the previous section, about the need to involve the public in the management of the common heritage of mankind, leads to the next action which the ISA could take: assessing the need for deep seabed mining in the context of alternatives. This would be in line with target 12.5 of the 2030 Agenda for Sustainable Development to 'substantially reduce waste generation through prevention, reduction, recycling and reuse.'[182]

It may be queried whether the CHM status of the Area could require the ISA to actively participate in the broader discussion over the need for deep seabed mineral mining. This would involve a debate over the economic and social necessity for seabed mining, beyond the fact that advances in technology may make seabed mining possible. It would entail discussions over the risks and benefits of seabed mining in light of potential alternatives, such as land-based mining, reprocessing of land-based tailings, recycling of metals from electronic waste and building material, as well as how mineral demand could be reduced through substitution and greater efficiency.[183] (Considering alternatives to potentially harmful practices can be a requirement under the precautionary approach,[184] which the ISA is required to apply.[185])

This discussion should take place in the context of sustainable development, which includes the need to consider the sustainability of consumption patterns, not only production patterns.[186] Moreover, target 14.2 of the 2030 Agenda for Sustainable Development requires active restoration of the marine environment:

'By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans.'[187]

In making these considerations, the needs of future generations for mineral resources are also important:

'With minerals and fossil fuels, the rate of depletion and the emphasis on recycling and economy of use should be calibrated to ensure that the resource does not run out before acceptable substitutes are available.'[188]

181 Ibid, page 23.

182 UNGA, *Transforming Our World: The 2030 Agenda for Sustainable Development*, UN Doc No A/RES/70/1 (25 September 2015), page 22.

183 See also Elaine Baker and Yannick Beaudoin (eds), *Deep Sea Minerals and the Green Economy* (Vol. 2, Secretariat of the Pacific Community, 2013).

184 Commission of the European Communities, *Communication from the Commission on the precautionary principle*, COM(2000) 1 final (2 February 2000), pages 17-18.

185 See e.g. Nodules Exploration Regulations, Regulations 2, 5, 31; *Responsibilities and Obligations of States Sponsoring Persons and Entities with Respect to Activities in the Area* (Advisory Opinion) (Seabed Disputes Chamber, Case No 17, 1 February 2011); UNGA, UN Doc A/RES/58/240 (5 March 2004), paragraph 52

186 UNGA, *Transforming Our World: The 2030 Agenda for Sustainable Development*, UN Doc No A/RES/70/1 (25 September 2015), preamble, page 2; *Report of the World Commission on Environment and Development: 'Our Common Future'*, annexed to UNGA, UN Doc. A/42/427 (4 August 1987), chapter 2 paragraphs 5, 62.

187 UNGA, *Transforming Our World: The 2030 Agenda for Sustainable Development*, UN Doc No A/RES/70/1 (25 September 2015), page 23.

188 *Report of the World Commission on Environment and Development: 'Our Common Future'*, annexed to UNGA, UN Doc. A/42/427 (4 August 1987), chapter 2 paragraph 12.

Finally, such a discussion would involve a high level global assessment of whether an increased supply of minerals is actually required at this point in time.[189]

The practical challenge for this debate is which forum would be best suited to generate such discussion. Although alternatives are important to consider within the wider debate over mineral consumption and the green economy,[190] the role of the ISA in these considerations may be limited since its mandate focuses on seabed mining. On the other hand, the ISA Assembly, which in principle represents all contracting parties to the LOSC, may be the suitable organ for leading such a high-level debate, given that the ISA is the central organization overseeing assessments of the environmental impacts of seabed mining in the Area. Another organisation, such as the UN General Assembly, might also play a role in this discussion.

3.4.2.5 Conditions for deep seabed mining

If and when it is determined that some deep seabed mining will be conducted, further elements of the principle of common heritage of mankind become relevant. First, the ISA would need to set conservation targets. Based on these targets, the ISA would then need to ensure that environmental impacts are limited and it could consider whether some mineable areas should be preserved for future generations. In addition, compensation for environmental harm to the common heritage could be considered in parallel to the general influence of the CHM principle on enforcement of the legal regime. Each of these five points is considered in turn.

Setting conservation targets

An important consideration for the ISA is to ensure that deep seabed mining does not endanger the natural life support systems, which include biodiversity and marine ecosystem services.[191] To do otherwise would compromise the systems underpinning life for both present and future generations. As noted in the Brundtland Report: '*At a minimum, sustainable development must not endanger the natural systems that support life on Earth: the atmosphere, the waters, the soils, and the living beings*.'[192]

It is well understood that deep seabed mining will cause at least some long-term and irreversible damage, such as habitat destruction.[193] In addition, numerous uncertainties remain, for example with

[189] This remains uncertain at present. In response to a consultation by the European Commission regarding seabed mining, Seascape Consultants, who coordinate the EU MIDAS project on the environmental impact of deep-sea mining, stated: 'We are looking into this aspect and we have not completed our data gathering. However, our information to date does not suggest there is a significant need for these metals. The costs of deep-sea mining will not be competitive until metals become much more difficult to find on land. For example, the demand for cobalt is less than 80,000 tons per year and many mines do not bother to extract it.' European Commission, *EU Stakeholder Survey on Seabed Mining: Summary of Responses*, SWD (2015) 119 final (9 June 2015) <http://ec.europa.eu/dgs/maritimeaffairs_fisheries/consultations/seabed-mining/index_en.htm>, pages 18-19.

[190] See also Elaine Baker and Yannick Beaudoin (eds), *Deep Sea Minerals and the Green Economy* (Vol 2, Secretariat of the Pacific Community, 2013).

[191] See e.g. *Report of the World Commission on Environment and Development: 'Our Common Future',* annexed to UNGA, UN Doc. A/42/427 (4 August 1987), chapter 2 paragraph 9.

[192] *Report of the World Commission on Environment and Development: 'Our Common Future',* annexed to UNGA, UN Doc. A/42/427 (4 August 1987), chapter 2 paragraph 9.

[193] See e.g. Elaine Baker and Yannick Beaudoin (eds), *Deep Sea Minerals: Manganese Nodules, a Physical, Bio- Logical, Environmental, and Technical Review* (Vol. 1B, Secretariat of the Pacific Community, 2013); ECORYS, *Study to Investigate the State of Knowledge of Deep-Sea Mining - Final Report to the European Commission under FWC MARE/2012/06 - SC E1/2013/04*, (28 August 2014), <https://webgate.ec.europa.eu/maritimeforum/sites/maritimeforum/files/FGP96656_DSM_Final_report.pdf>, pages 94-110; B S Ingole, S Pavithran, and Z A Ansari, 'Restoration of Deep-Sea Macrofauna after Simulated Benthic Disturbance in the Central Indian Basin' (2005) 23 *Marine Georesources & Geotechnology* 267–288; International Council for the Exploration of the Sea (ICES), *Report of the ICES/NAFO Joint Working Group on Deep-Water Ecology*, 16-20 February 2015, Portugal, ICES CM 2015/ACOM:27, pages 44-45; Hjalmar Thiel, 'Evaluation of the Environmental

respect to cumulative impacts on the marine environment.[194] In this context, the ISA would need to determine as best as possible, through the involvement of scientists, what type and level of impact from deep seabed mining would endanger life support systems. Given the uncertainties involved in this estimation, a determination as to what level of risk is deemed acceptable must be included. Here, the ISA's obligation to apply the precautionary approach is relevant. This obligation requires the ISA to err on the side of caution and determine acceptable risks in a transparent and participatory manner. Based on the conservation target established by the ISA, it can then be determined if deep seabed mining can be sustainable and if so with which conditions attached.

Limiting environmental impacts & moving beyond the first-come-first-serve system

A key influence of the CHM principle on the ISA's environmental management is the need to preserve the Area, its resources, and its ecosystems for future generations. Several potential consequences follow from this.

First, in line with the aim of preserving not only the mineral resources but also the ecosystem services provided by the deep sea for future generations, the ISA could look into whether representative no-mining areas might be capable of compensating for the disturbance of ecosystem structure and function caused by the mining activities.[195] This remains unclear at present, not least because deep seabed mining will likely cause some irreversible spatial disruptions, the scale of which will have to be determined by focused and local scientific research for each of three types of minerals. Such action would support target 14.5 of the 2030 Agenda for Sustainable Development, which states: '*By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information*'.[196] .

A second consideration would be to determine the threshold for cumulative impacts on biota as well as ecosystem structures and functions arising directly and indirectly from several mining operations that may be conducted in parallel or in a given region over a certain time frame, in order to not compromise the conservation targets. This would, by extension, require an upper limit of the number of areas that may be mined at any given time. Such a system would need to apply a long-term view on the cumulative impacts of current (or proposed) operations, including the size, location, and duration of mining operations, in conjunction with those impacts arising from other sectors as well as climate change.[197] A limit on mining operations would likely be controversial and includes challenges, such as the question as to the point in the future when these areas may be mined.

The current licensing system applicable to the Area enables the acquisition of exploration contracts on a first-come-first-serve basis with no determined global or regional limit. If an upper limit was to be established, it would be important to move beyond the first-come-first-serve system. This is crucial in order to not disadvantage developing states, which may only be in a position to apply for a contract at a later stage, if and when they have generated the necessary resources. The parallel system, as

Consequences of Polymetallic Nodule Mining Based on the Results of the TUSCH Research Association' (2001) 48 Deep Sea Research II 3433; Cindy Lee Van Dover, 'Mining Seafloor Massive Sulphides and Biodiversity: What Is at Risk?' (2010) 68 *ICES Journal of Marine Science* 341–348.

194 CL Van Dover, 'Tighten Regulations on Deep-Sea Mining' (2011) 470 *Nature* 31–33.

195 L M Wedding and others, 'Managing Mining of the Deep Seabed' (2015) 349 *Science* 144–145.

196 UNGA, *Transforming Our World: The 2030 Agenda for Sustainable Development*, UN Doc No A/RES/70/1 (25 September 2015), page 24.

197 Craig R Smith and others, 'Abyssal Food Limitation, Ecosystem Structure and Climate Change' (2008) 23 *Trends in Ecology and Evolution* 518–528; Cindy Lee Van Dover, 'Impacts of Anthropogenic Disturbances at Deep-Sea Hydrothermal Vent Ecosystems: A Review' (2014) 102 *Marine Environmental Research* 59-72.

envisaged in UNCLOS, can also support the participation of developing states. Potential alternatives to the present system would be to grant contracts by auction or tender.[198]

Importantly, these considerations are only applicable if it can be determined which levels of environmental impacts do not endanger the Earth's life-support systems, including biodiversity and marine ecosystem services.

Preserving mineable sites for future generations

Closely linked to limiting the environmental impacts from deep seabed mining is the question whether, and if so which, fraction of the common heritage should be preserved for future generations to ensure access to mineral resources for future generations. As noted above, this is not specifically foreseen in UNCLOS. Nonetheless, it could contribute to the goal set out in the Brundtland Report: 'Sustainable development requires that the rate of depletion of non-renewable resources should foreclose as few future options as possible.'[199] Questions here include the quantity of mineable sites that should be preserved for future generations as well as the point in time in the future at which these sites can be mined.

A compensation scheme for environmental harm

The CHM nature of the Area could also affect future regulations about the legal consequences in case serious environmental harm does occur. Transboundary environmental harm in the context of land-based mining is subject to international law of state responsibility and usually requires remediation and financial compensation. However, contrary to States who 'only' represent the interests of their citizens, the ISA must act on behalf of mankind as a whole. The question then arises as to what kind of compensation, if any, would be required in the case of serious environmental harm caused by seabed mining? The ISA's technical study no 11 summarises the issue:

> *'[...] even under the best of intentions and using the best technology, seabed mining is inherently destructive to the seabed and parts of the water column. [...]The environmental implications of seabed mining under the common heritage principle is complicated and is comparable only to the emerging issues surrounding international greenhouse gas regulation. If environmental degradation of the marine ecosystem is inherent in seabed mining and if remediation is not practical or technologically possible, the logical alternative is financial compensation for the environmental damage and loss of ecosystem services from the seabed. While compensation might take place under the royalties and fees provisions in the UNCLOS Treaty, this approach is quite different from the logic used to justify royalties in terrestrial mining agreements.'*[200]

Any such compensation scheme would have to be developed in the context of the ISA's regulations for the exploitation of minerals. Questions that would need to be discussed include who would be compensated, for what, and how could causation be proven? Ocean processes operate on very long

[198] For a discussion of these options and a comparison of their current usage in other contexts, see Allen L Clark, Jennifer Cook Clark, and Sam Pintz, *Towards the Development of a Regulatory Framework for Polymetallic Nodule Exploitation in the Area (Technical Study: No. 11)* (ISA, 2013), pages 33-38.

[199] *Report of the World Commission on Environment and Development: 'Our Common Future',* annexed to UNGA, UN Doc. A/42/427 (4 August 1987), chapter 2 paragraph 12.

[200] Allen L Clark, Jennifer Cook Clark, and Sam Pintz, *Towards the Development of a Regulatory Framework for Polymetallic Nodule Exploitation in the Area (Technical Study: No. 11)* (ISA, 2013), at p 50-51.

timescales. It is likely that changes to ecosystem structures, functions, and resulting ecosystem services will, if measurable at all, only be detected decades after mining has started.[201]

Implications for enforcement of the legal framework

The special legal status of the Area and its resources also affects the extent to which environmental obligations can be enforced. In its 2011 Advisory Opinion, the Seabed Disputes Chamber faced the question of who would be entitled to claim compensation from a State that sponsored activities in the Area following a breach of obligations and the occurrence of environmental harm.

First, the Chamber envisaged that compensable damage 'would include damage to the Area and its resources constituting the common heritage of mankind, and damage to the marine environment.'[202] This suggests that pure environmental harm, *i.e.* without direct impact on any particular State, could give rise to enforcement proceedings and the payment of damages.

Second, the Chamber speculated that a range of actors may be entitled to bring a case against a sponsoring State who is in breach of its obligations: 'Subjects entitled to claim compensation may include the Authority, entities engaged in deep seabed mining, other users of the sea, and coastal States.'[203] Particularly important here is the idea that the ISA itself may be entitled to claim compensation. Although this is not explicitly stated in UNCLOS, the Chamber argues that such entitlement is implicit in the ISA's obligation to act on behalf of mankind.[204] As such, the CHM principle could strengthen the enforceability of the ISA's environmental standards for seabed mining.

Additionally, the Chamber notes that '*each State Party may […] be entitled to claim compensation in light of the erga omnes character of the obligations relating to preservation of the environment of the high seas and in the Area*.'[205] An '*erga omnes* obligation' is an obligation owed to the international community as a whole as opposed to only to an injured party. French summarises the significance of this finding: '*The potentially radical claims made by the Chamber should not be lost here — the finding of erga omnes obligations, the affirmation of essentially what would be an actio popularis in international environmental law,[…] and the institutional right to claim*.'[206] In other words, it may be possible for any State to start legal action and claim compensation for serious environmental harm to the Area and the high seas, e.g. through seabed mining. This could increase the risks for mining contractors and sponsoring States to be exposed to legal proceedings. Needless to say, this has not yet been tested in practice.

3.4.2.6 Conclusion

The CHM principle does not dictate specific measures that must be taken. Rather, the ISA is tasked to discuss and decide how the principle will be given effect within the framework of UNCLOS. The measures discussed in this note are options, which might be relevant to such a discussion.

Nonetheless, the CHM principle provides a normative framework for the ISA regime, including the requirement to preserve natural resources for future generations. The inter-generational dimension closely links the principle to the concept of sustainable development.

[201] Lisa A. Levin and Nadine Le Bris, 'The Deep Ocean under Climate Change' (2015) 350 *Science* 766–768.

[202] *Seabed Advisory Opinion*, para 179.

[203] *Seabed Advisory Opinion*, para 179.

[204] *Seabed Advisory Opinion*, para 180; LOSC, Art 137(2).

[205] *Seabed Advisory Opinion*, para 180.

[206] Duncan French, 'From the Depths: Rich Pickings of Principles of Sustainable Development and General International Law on the Ocean Floor — the Seabed Disputes Chamber's 2011 Advisory Opinion' (January 01, 2011) 26 *The International Journal of Marine and Coastal Law*, 525-568, at p 546.

To provide for the sustainable development of the common heritage of mankind, the ISA would need to ensure that no serious long-term or irreversible harm is caused to the marine environment and its ecological balance which would undermine access to resources and ecosystem services for future generations. This involves consideration of the cumulative effects of parallel operations over time and in conjunction with the short- and long-term impacts of other human activities and the effects of climate change. In any event, the ISA will need to further develop the CHM principle and define measures and standards through which it can be given effect.

A range of potential measures exist, as discussed in this note, and new ones may be added. Given that the ISA administers the Area and its resources on behalf of mankind as a whole, it is important that public opinions are taken into account regarding the risks and benefits of seabed mining, alternatives to seabed mining, the value of marine ecosystems, and the sharing of benefits intra-generationally as well as inter-generationally.

3.4.2.7 Recommendations

Recommendations

- The CHM principle requires preserving natural resources for future generations. As such, some mineable areas might be reserved for future generations.
- The ISA has yet to develop the common heritage of humankind (CHM) principle and specifically discuss how it intends to give effect to it. Such a discussion could be initiated by a State party in the ISA Assembly, in the context of developing the exploitation regulations.
- Options to give effect to the CHM principle include establishing preconditions for deep seabed mining, such as
  (a) funding marine scientific research to increase knowledge of the deep sea for all of humankind,
  (b) ensuring that the Mining Code is developed with participation of the public,
  (c) determining whether there is a current need for the minerals from deep seabed mining as opposed to conserving them for future generations.

3.4.3 Adaptive Management and Governance[207]

3.4.3.1 Introduction

The International Seabed Authority (ISA) is currently developing the regulatory framework for commercial-scale mining of minerals on the deep seabed. In this context, the ISA has to balance seabed mining with its mandate to protect and preserve the marine environment from harmful effect caused by mining operations. One potential tool to help strike this balance is adaptive management and governance.

The ISA's draft regulatory framework for mineral exploitation highlights the need for adaptive management as one of the tools to minimise environmental damage.[208] Indeed, in July 2015, the ISA's Council endorsed the decision by the Legal and Technical Commission (LTC) to develop an adaptive management approach as a matter of priority by late 2016.[209] However, in addition to the question whether adaptive management is suitable for the seabed mining context, there are considerable challenges to applying it.

Focussing on the procedural aspects, this note discusses some of the challenges to achieving adaptive management. Adaptive management will require procedural mechanisms through which the ISA can adjust environmental standards continuously. This note examines whether the current regulatory framework for mineral exploration provides for such flexibility. Specifically, it discusses four potential ways, including their benefits and shortcoming, in which environmental standards may be adjusted during exploration work. The current regulatory framework for mineral exploration does not as such include a requirement to apply adaptive management. However, the procedural framework through which the ISA can set and adjust environmental standards during the current exploration phase, can nevertheless provide valuable information and experience regarding the challenges for achieving adaptive management.

The discussion highlights the current lack of comprehensive mechanisms to adjust environmental standards, which makes it difficult, if not impossible, to achieve adaptive management. This provides crucial information for the design of the future regulatory framework.

3.4.3.2 Adaptive Management and Governance

Adaptive management entails modest and, importantly, reversible management interventions, designed as experiments to generate further knowledge about the resource being studied. It includes careful monitoring of the impacts of deep seabed mining based on agreed biological indicators, continual evaluation and refinement of the management practice, as well as compliance

[207] This note is largely based on *Jaeckel, A., 2016. Deep seabed mining and adaptive management: The procedural challenges for the International Seabed Authority. Marine Policy 70, 205-211..*

[208] ISA. Developing a Regulatory Framework for Deep Sea Mineral Exploitation in the Area: Draft Framework, High Level Issues and Action Plan, Version II (15 July 2015), https://www.isa.org.jm/files/documents/EN/OffDocs/Rev_RegFramework_ActionPlan_14072015.pdf.

[209] ISA, ISBA/21/C/16 (15 July 2015), annex 3; ISA, ISBA/21/C/20 (21 July 2015). However, whereas the 2017 Discussion paper on environmental regulation International Seabed Authority, 2017a. Developing a regulatory framework for mineral exploitation in the Area. A Discussion Paper on the development and drafting of Regulations on Exploitation for Mineral Resources in the Area (Environmental Matters). International Seabed Authority, Kingston, Jamaica, pp. 1-102. emphasises the need for adaptive management as part of best environmental practice, the most recent version of the draft regulations International Seabed Authority, 2017b. Draft Regulations on Exploitation of Mineral Resources in the Area. ISBA/23/LTC/CRP.3*. International Seabed Authority, Kingston, Jamaica, pp. 1-107. mention adaptive management only once as part of the contractors´ Environmental Management Plan in Annex VII.

mechanisms.[210] Adaptive management can be particularly suitable for biodiversity management and complex systems.[211] However, it is not suitable for activities for which impacts must be measured on long-term scales and for activities that can quickly cause serious or irreversible harm.[212] Moreover, it can be misused in an attempt to postpone protective measures, in effect preventing more rigorous regulatory actions.[213] This is particularly relevant in light of the danger of a relatively speedy transition towards exploitation contracts, which would then be difficult to modify. Similarly, there is a risk of a degree of complacency once exploitation has been allowed in principle.[214]

The widespread support for adaptive management led to calls for adaptive governance, that is policy and governance structures, which enable adaptive management.[215] In the ISA context, adaptive management, if deemed an effective and proportionate response, would need to be accompanied by adaptive governance. In other words, the ISA would require mechanisms to adjust environmental standards for mining operations on a continuous basis.

In practice, if considered appropriate, adaptive management could include permitting test mining operations on a small scale for a short period of time in order to then assess the environmental effects and adjust policies and environmental management based on the new information gained. This would require the capacity and infrastructure to continuously monitor environmental impacts, which has proven to be a critical shortcoming of adaptive management when applied to other natural resources.[216] What is more, adaptive management would require mechanisms for the ISA to continually adjust environmental standards. However, although the ISA has the power to set environmental standards, there are currently no comprehensive and effective mechanisms to adjust these environmental standards during the lifetime of 15-years exploration contract, as this note will discuss.

3.4.3.3 The law-making powers of the International Seabed Authority

The ISA not only decides over access to minerals in the Area but also determines the conditions for such access. Both of these functions deserve attention, as they influence the extent to which the ISA can apply adaptive management.

The legal framework for seabed mining in the Area is set out in Part XI of the 1982 *United Nations Convention on the Law of the Sea* (UNCLOS),[217] as modified by the 1994 *Agreement Relating to the*

[210] Rosie Cooney, 'A Long and Winding Road? Precaution from Principle to Practice in Biodiversity Conservation' in in Elizabeth Fisher, Judith Jones, and René von Schomberg (eds), *Implementing the Precautionary Principle: Perspectives And Prospects* (Edward Elgar Publishing, 2006) 223-244, page 238.

[211] CBD COP07, Decision VII/12, UNEP/CBD/COP/DEC/VII/12 (13 April 2004), paragraphs 10-12; Cooney (n 210), page 238; Brendan Moyle, 'Making the Precautionary Principle Work for Biodiversity: Avoiding Perverse Outcomes in Decision-Making Under Uncertainty' in Rosie Cooney and Barney Dickson (eds), *Biodiversity and the Precautionary Principle: Risk, Uncertainty and Practice in Conservation and Sustainable Use* (Earthscan, 2005) 159-172, pages 170-172.

[212] R Cooney and Andrew T F Lang, 'Taking Uncertainty Seriously: Adaptive Governance and International Trade' (2007) 18 *European Journal of International Law* 523–551, pages 536-537.

[213] Jacqueline Peel, *The Precautionary Principle in Practice: Environmental Decision-Making and Scientific Uncertainty* (Federation Press, 2005), page 154; Sidney A Shapiro and Robert L Glicksman, Risk Regulation at Risk: Restoring a Pragmatic Approach (Stanford University Press, 2003), pages 167-173.

[214] Carl J Walters, 'Is Adaptive Management Helping to Solve Fisheries Problems?' (2007) 36 *Ambio: A Journal of the Human Environment* 304-7.

[215] Cooney and Lang, *Taking Uncertainty Seriously: Adaptive Governance and International Trade*; Carl Folke et al, 'Adaptive Governance of Social-Ecological Systems' (2005) 30 *Annual Review of Environment and Resources*, 441-473.

[216] Walters (n 214).

[217] *United Nations Convention on the Law of the Sea* (adopted 10 December 1982, entered into force 16 November 1994) 1833 UNTS 3.

Implementation of Part XI of the United Nations Convention on the Law of the Sea (IA).[218] Pursuant to the UNCLOS, mining operations in the Area can only be carried out under a contract issued by the ISA, which grants exclusive but temporary rights to the mining operator, called the contractor.[219] Contractors can be states parties, state enterprises, or private corporations that possess the nationality of states parties or are effectively controlled by them or their nationals.[220] Additionally, *if* established in the future, the Enterprise could also become a contractor and carry out mining operations as the commercial arm of the ISA.[221] The Enterprise was envisaged to become the commercial arm of the ISA and carry out mining operations itself, but it has yet to be established.[222]

The process of becoming a contractor involves an application to the ISA with a plan of works for exploration of, or in the future exploitation for, a specific type of mineral deposit. The ISA has the competence to determine the details of the application documents and the contracts, as well as to develop the specific rules, regulations, and procedures pertaining to the mining regime.[223]

These law-making powers of the ISA were necessitated by the lack of knowledge about the deep oceans and deep seabed mining at the time when the legal regime was negotiated in the 1970s and 1980s. Indeed, even today the deep sea remains 'the largest and least known ecosystem on the planet.'[224] Thus, although the UNCLOS sets out the legal framework for the deep seabed mining regime, it was necessary to leave numerous detailed rules to be decided at a later stage in parallel with advances in scientific research.[225]

Using its law-making powers, the ISA is continuously developing the Mining Code, a collective term for the regulations and recommendations that set out the detailed rules, regulations, and procedures for seabed mining in the Area. As part of the Mining Code, the ISA develops two main types of documents: regulations as well as recommendations.

To date, the ISA has adopted three sets of regulations for prospecting and exploration, one for each of the types of mineral deposits in which interest has thus far been shown (polymetallic nodules, polymetallic sulphides, and ferromanganese crusts) in 2000, 2010, and 2012, respectively. Pursuant to articles 137(2) and 153 of the UNCLOS, these Exploration Regulations are binding on the ISA, contractors, and all member states without requiring individual consent and, more importantly, without the possibility for members to opt out.[226] In addition, the ISA has adopted a number of recommendations, including regarding the assessment of environmental impacts during exploration work.[227]

3.4.3.4 Setting environmental standards

Pursuant to Article 145 UNCLOS, a key aspect of the ISA's mandate is to '*ensure effective protection for the marine environment from harmful effects which may arise*' from mining activities. To this end, the

[218] *Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea*, (adopted 28 July 1994, entered into force 28 July 1996) 1836 UNTS 3.

[219] UNCLOS, annex III articles 3, 16.

[220] UNCLOS, article 153(2)(b), annex III articles 3, 4.

[221] UNCLOS, article 153(2)(a); IA, annex section 2(4).

[222] UNCLOS, article 170(1), annex IV article 1; IA, annex section 2.

[223] UNCLOS, articles 82, 137(2), 145, 160(2(f), 162(2)(o), 209, annex III article 17(1).

[224] Meryl Williams et al, *Scientific Results to Support the Sustainable Use and Conservation of Marine Life: A Summary of the Census of Marine Life for Decision Makers* (Census of Marine Life International Secretariat, 2011).

[225] James Harrison, *Making the Law of the Sea: A Study in the Development of International Law* (Cambridge University Press, 2011), pages 116, 122-146.

[226] Harrison (n 225).

[227] ISA, ISBA/19/LTC/8 (1 March 2013).

ISA is specifically required to incorporate into the Mining Code rules, regulations, and procedures to ensure that mining activities do not result in marine pollution, interfere with the ecological balance of the marine environment, or cause damage to the flora and fauna of the marine environment. This provision assigns the primary responsibility for preventing environmental harm to the ISA.[228] At the same time it grants the ISA a broad capacity to enact protective measures as it deems necessary.

To act upon this far-reaching mandate, the ISA must include specific environmental standards into the future exploitation regulations, which it is currently developing. These standards become binding on contractors. However, adaptive management will require the ISA to not only set environmental standards in the Mining Code, but also adapt them during the course of the mining operations, especially following test mining. This is particularly important in light of the continuing lack of knowledge about the environmental impacts of seabed mining or indeed the ecological baselines before mining.[229] In other words, adaptive management will likely involve amending the environmental standards that sponsoring states, the ISA, and contractors must observe, even after a mining contract has already been granted. Here is where the challenges lie. To achieve such flexibility, the ISA must have procedural mechanisms to require contractors to change particular environmental measures and standards. At the same time, the contractor must be protected from arbitrary or discriminatory changes.

Two aspects are relevant here: First, under the UNCLOS, the ISA is required to control seabed mining activities '*on behalf of mankind as a whole.*'[230] Indeed, the Mining Code[231] requires contractors to submit a written undertaking accepting 'control by the Authority of activities in the Area.'[232] Second, a contractor enjoys security of tenure and a contract can only be revised with the consent of both parties, as provided for in the UNCLOS and reiterated in the Mining Code.[233] The interaction of both rules can be difficult, as an examination of the current procedural framework for mineral exploration highlights.

The following section discusses the current procedural framework and examines four potential mechanisms, including their strengths and shortcomings, through which environmental standards could be amended *after* an exploration contract has been granted. This provides crucial information regarding the procedural hurdles that need to be overcome in order to achieve adaptive management.

3.4.3.5 Four options for amending environmental standards

Amending regulations

Regulations are the primary means through which the ISA develops the seabed mining regime. The obligations of mining operators are set out in the standard clauses of the exploration contracts, which are annexed to the Exploration Regulations. Thus, the most apparent way for the ISA to change environmental standards for the contractors is to amend the Exploration Regulations and the standard clauses.

[228] Satya N Nandan, Michael W Lodge, and Shabtai Rosenne, *United Nations Convention on the Law of the Sea, 1982: A Commentary, Volume VI* (Martinus Nijhoff Publishers, 2002), page 194.

[229] Nandan, Lodge, and Rosenne (n 228).

[230] UNCLOS, Article 153, annex III article 3(4)(b).

[231] To limit unnecessary repetitions, this note refers to the relevant provisions of the Exploration Regulations for polymetallic sulphides, although the Exploration Regulations for polymetallic nodules and ferromanganese crusts contain similar provisions.

[232] *Sulphides Exploration Regulations*, regulation 15(b), annex II section 25(b), annex IV section 13(2)(c).

[233] UNCLOS, article 153(6), annex III articles 18, 19; *Sulphides Exploration Regulations*, annex IV sections 2, 24.

However, such amendments do not automatically affect *existing* contractors, as the standard clauses and the Exploration Regulations themselves are specifically incorporated into the contract.[234] The contracts can only be revised with the consent of both the contractor and the ISA.[235] In other words, any changes need to be negotiated with the contractors on a case-by-case basis. Consequently, although amending exploration regulations is a way in which the ISA can set environmental standards for future contractors, it is insufficient to automatically bind existing contractors unless they specifically consent.

Two recent amendments to the Exploration Regulations illustrate these difficulties. In 2013 the Exploration Regulations were amended to require contractors to pay annual overhead charges to cover the ISA's costs of administering the contracts. The ISA Assembly's decision specifically requested the Secretary-General to renegotiate existing contracts in line with the changes.[236] Two years later, in July 2015, ten out of the 14 contractors that had obtained their contracts prior to July 2013 had agreed to the amendments, while consultations with the other contractors were still ongoing.[237]

In contrast, when the Exploration Regulations for polymetallic nodules were formally amended in 2013, largely to increase environmental standards and obligations, the ISA merely requested pending applications to incorporate the changes.[238] Consequently, the operators that obtained their exploration contracts prior to July 2013 are not bound by the amended, higher environmental standards.

This is significant not least because it demonstrates that different contractors can be bound by different environmental standards, depending on the time they obtain their exploration contract. Interestingly, in its Advisory Opinion on the *Responsibilities and Obligations of States Sponsoring Persons and Entities with Respect to Activities in the Area,* the Seabed Disputes Chamber highlighted the need for uniformity and progressive environmental protection standards in the ISA regime. The Chamber made two findings in this respect.

First, when addressing the question whether developing and developed states that sponsor mining operators may carry different responsibilities and potential liability in case of environmental harm, the Chamber stressed the need for uniformity. It noted the responsibilities and liability of sponsoring states apply equally to all states, whether developing or developed. To find otherwise 'would jeopardize uniform application of the highest standards of protection of the marine environment, the safe development of activities in the Area and protection of the common heritage of mankind.'[239]

Second, the Chamber demonstrated that the due diligence obligation of sponsoring states, to ensure contractors comply with their respective obligations, balances out the discrepancies between the three sets of Exploration Regulations. Specifically, in relation to states' obligation to apply best environmental practices, which at the time of the Advisory Opinion had only been incorporated into the Exploration Regulations for polymetallic sulphides, the Chamber observed:

> *'In the absence of a specific reason to the contrary, it may be held that the Nodules Regulations should be interpreted in light of the development of the law, as evidenced by the subsequent adoption of the Sulphides Regulations.'*[240]

[234] *Sulphides Exploration Regulations*, annex III clause 1.

[235] UNCLOS, annex II article 19; *Sulphides Exploration Regulations*, annex IV section 24.

[236] ISA, ISBA/19/A/12 (25 July 2013), paragraph 4.

[237] ISA, ISBA/21/LTC/8/Rev.2 (6 July 2015), annex II.

[238] ISA, ISBA/19/C/17 (22 July 2013), paragraph 3.

[239] *Responsibilities and Obligations of States Sponsoring Persons and Entities with Respect to Activities in the Area* (Advisory Opinion) (Seabed Disputes Chamber, Case No 17, 1 February 2011), paragraph 159.

[240] Advisory Opinion (n 239), paragraph 137.

The Chamber clearly aimed to ensure that all sponsoring states would be held to uniform and high environmental standards. Nonetheless, unequal standards for contractors that enter the seabed mining regime at different times are built into the regulatory framework.

Amending recommendations

A second, and perhaps the most promising, mechanism for the ISA to adjust environmental standards is by amending its recommendations or indeed adopting new ones. Recommendations are developed and adopted by the LTC to assist contractors in implementing the ISA's regulations.[241] These recommendations are of a technical or administrative nature and provide a greater level of detail regarding the obligations of contractors, such as specifying the data to be collected by contractors in order to implement their obligation to establish environmental baselines.

Recommendations can be amended flexibly by the LTC. The standard terms for exploration contracts require contractors '[t]o observe, as far as reasonably practicable, any recommendations which may be issued from time to time by the Legal and Technical Commission.'[242] This provision integrates recommendations into the exploration contracts, yet already provides for flexible amendments or indeed new recommendations. Importantly, recommendations and amendments thereto are applicable to all current and future contractors. Thus, adopting or amending recommendations presents a mechanism through which the ISA can change the environmental standards for contractors.

However, there are two limitations. First, given the nature of recommendations, as assisting contractors in the implementation of the regulations, the ISA may not be able to establish entirely new environmental standards through recommendations. Nevertheless, measures such as special protection for vulnerable marine ecosystems that are foreseen in the Exploration Regulations[243] could be implemented through recommendations. Moreover, the obligations on current contractors to prevent pollution as well as apply the precautionary approach and best environmental practices[244] may capture a broad range of environmental standards that can be defined through recommendations. The question becomes one of scope.

Second, recommendations are not strictly binding on contractors, which could somewhat limit their value as a means to require adaptive management. Nonetheless, in practice recommendations carry significant weight not least because they offer more detail than regulations. Moreover, they are adopted by the LTC, the same body that plays a significant role in deciding whether a contractor's application for an extension of exploration rights, or exploitation rights, will be approved.[245] Indeed, in order to obtain an extension for their exploration contracts, contractors must provide specific information '*in accordance with the relevant recommendations […].*'[246] As such, amending recommendations could provide a valuable, albeit somewhat limited, means by which the ISA can amend existing environmental standards within the scope of the Exploration Regulations.

Reviewing a programme of activity

A third means by which the ISA could influence the environmental standards observed by a contractor is through the programme of activities. This programme is binding by way of being annexed to the

[241] *Sulphides Exploration Regulations*, regulation 41(1).
[242] *Sulphides Exploration Regulations*, annex IV section 13.2.
[243] *Sulphides Exploration Regulations*, regulation 33(4).
[244] *Sulphides Exploration Regulations*, annex IV section 5.
[245] Harrison (n 225).
[246] ISA, ISBA/21/C/19 (23 July 2015), appendix 1.

exploration contract.[247] It sets out the specific activities a contractor will undertake over the next five years. The first 5-years programme of activities is developed by the contractor and submitted to the ISA together with the application for an exploration contract. Adjustments are then negotiated after 5 years to update the programme of activities for the following 5-years period.[248] Since an exploration contract is 15-years, it comprises three programmes of activities. The question then arises whether the review of a 5-years programme of activity might present an opportunity for the ISA to require the contractor to observe new environmental standards.

The answer is in the negative. The review of the programme of activities is undertaken jointly by the contractor and the ISA Secretary-General to assess the implementation of the programme over the previous 5 years. The contractor must then indicate its next programme of activities '*in light of the review*.'[249] This procedure does not provide for the ISA to require the contractor to incorporate certain environmental standards into the next programme of activities. Indeed, the review process does not appear to scrutinise the contractor's environmental work. Even though the Secretary-General must report the review to the LTC and the ISA Council, he merely needs to indicate '*whether any observations transmitted to him by states parties to the [UNCLOS] concerning the manner in which the contractor has discharged its obligations under these Regulations relating to the protection and preservation of the marine environment were taken into account in the review*.'[250] In sum, the review and adjustment of a programme of activities is unlikely to present a mechanism through which the ISA can exercise its mandate to set environmental standards for mining activities in the Area.

Updating regional environmental management plans

The last mechanism through which the ISA might be able to amend environmental standards for existing contractors is through regional environmental management plans. Currently, the only example of such a plan is the Environmental Management Plan for the Clarion-Clipperton-Zone (EMP-CCZ). The EMP-CCZ is a spatial management plan for the Clarion-Clipperton-Zone in the central Pacific. The plan specifically foresees flexibility for its nine no-mining areas to accommodate advancements in scientific knowledge in line with the precautionary principle and adaptive management.[251]

The important question is whether changes to the EMP-CCZ can create obligations for contractors and require them to observe specific environmental standards. The answer is ambiguous. As the EMP-CCZ was only established in 2012, environmental management plans are not yet referred to in the Exploration Regulations and are not incorporated in the exploration contracts. Rather, the EMP-CCZ is a regional management plan centrally managed by the ISA. Thus, it can be amended flexibly, without individual consent from contractors. In that respect, an environmental management plan has advantages over de-centralised methods, such as negotiating changes to an individual exploration contract or programme of activity.

A further crucial question is whether the EMP-CCZ is binding on contractors. At present, its legal status is not defined. It is difficult to judge whether a regional management plan could create new obligations for existing contractors, because the current EMP-CCZ does not attempt to do so. Rather, it restates existing obligations incorporated in the Exploration Regulations and mentions a *future* obligation for contractors to establish site-specific environmental management plans when they apply for

[247] *Sulphides Exploration Regulations*, annex III, annex IV section 4.

[248] *Sulphides Exploration Regulations*, regulation 30, annex IV section 4.4.

[249] *Sulphides Exploration Regulations*, regulation 30.

[250] *Sulphides Exploration Regulations*, regulation 30.

[251] ISA, ISBA/17/LTC/7 (13 July 2011), paragraphs 30-31; ISA, ISBA/14/LTC/2* (28 March 2008), paragraph 6.

exploitation rights.[252] This obligation could, of course, also be integrated into the future exploitation regulations, which would eliminate doubts as to its binding nature. Instead of creating new obligations, the core function of the EMP-CCZ was to establish nine no-mining zones located outside existing contract areas. Nonetheless, the EMP-CCZ informs the work of the ISA, which can, in turn, integrate such information into its development of the Mining Code.

In principle, amending regional environmental management plans could present a mechanism through which the ISA could adjust environmental standards on an ongoing basis. However, currently the role of environmental management plans is somewhat unclear. This could be changed by incorporating such plans into the regulations to clarify the legally binding nature of the plans.

3.4.3.6 Implications for adaptive management

Adaptive management for seabed mining requires mechanisms through which the ISA can adjust environmental standards continuously, in order to respond to new information from mining operations, monitoring programmes, and impact assessments. However, the current regulatory framework for the mineral exploration phase does not sufficiently provide for such a mechanism. The ISA can set environmental standards for new contractors through adopting the Mining Code. Yet there is no comprehensive and effective mechanism to amend environmental standards for those mining operations already underway, although amending recommendations might provide a valuable, albeit somewhat limited, starting point.

Given the ISA's mandate to 'control' mining activities in the Area as well as its far-reaching obligation to take 'necessary measures' to protect and preserve the marine environment,[253] the question is not whether the ISA has the competence to apply adaptive management. Rather, the challenge lies in establishing procedures and mechanisms to facilitate adaptive management, if it is deemed to be an appropriate tool in the seabed mining context. At present, the ISA's control over mining activities reduces significantly, once an exploration contract has been concluded. Before approval of a new exploration contract, the ISA can set environmental standards through the Mining Code, which then become binding on the new contractor. Indeed, the ISA must only approve applications for new exploration contracts if they provide for '*effective protection and preservation of the marine environment [...],*'[254] although how this determination is made is unclear. In contrast, once an exploration contract is concluded, it is significantly more difficult for the ISA to amend environmental standards and require existing contractors to observe them.

In the context of discussing ways in which this challenge could be addressed, especially for the future exploitation regulations, it is important that any approach balances the ISA's obligations with the rights and obligations of the contractors. In particular, contractors must be protected from discriminatory or arbitrary obligations. As such, it will be important for environmental standards to be applied equally to all contractors that face similar environmental challenges. For example, incorporating these environmental standards in the ISA's recommendations or regional environmental management plans could ensure their non-discriminatory application and provide a level of accountability for the ISA. In contrast, potentially adjusting environmental standards through the review of a programme of activities could lead to differing obligations for the contractors, as these reviews are conducted on a case by case basis. However, as discussed in Section 4.1 above, it must be stressed that the current framework already provides for differing standards applying to contractors that enter the seabed mining regime at different times.

[252] ISA, ISBA/17/LTC/7 (13 July 2011), paragraph 41(a).

[253] UNCLOS, article 145, 153(1), annex III article 3(4)(b).

[254] *Sulphides Exploration Regulations*, regulation 23(4).

Perhaps the most difficult challenge is to balance a contractor's interests and the ISA's mandate to regulate as well as control mining activities. Two questions arise in this context. First, what does 'control' entail? Does it include the capacity for the ISA to require adjustments to mining activities in case new evidence warrants, for instance, the establishment of buffer zones around specific marine ecosystems? A second question is whether an amendment of environmental standards requires the revision of a contract, and hence the consent of each contractor.

The answer to the latter question may depend on the nature of the amended environmental standard. At present, exploration contracts include the obligation to *'take necessary measures to prevent, reduce and control pollution and other hazards to the marine environment*' arising from the contractors' activities. Moreover, contractors must apply the precautionary approach and best environmental practices.[255] These general obligations may be given specific meaning through the ISA's recommendations and regional environmental management plans. Thus, some flexibility is built into the contracts, notwithstanding the limitations discussed in Section 4 in relation to recommendations and environmental management plans.

In addition, it is important to note that a mining contract must be understood in the context of the unique legal regime for the Area. The ISA is not only a contractual partner but also wears a number of other hats. The ISA is: (a) the custodian or, as Ambassador Pardo denoted it, the 'trustee'[256] of the Area and must act '*on behalf of mankind as a whole*';[257] (b) the regulator and administrator of the development of mineral resources of the Area;[258] (c) the institution that decides over the granting of mining contracts; (d) the institution responsible for ensuring the effective protection of the marine environment from seabed mining activities; and (e) even the institution who could propose and conduct mining in the future through the Enterprise. Thus, the ISA will have to strike a balance between numerous interests and obligations in its future exploitation regulations to facilitate adaptive management.

It must also be noted that contractors require a degree of certainty to provide for financial planning. At the same time, the ISA must fulfil its numerous roles on behalf of mankind. Thus, while a regulatory framework needs to protect contractors from discriminatory or arbitrary obligations imposed during the lifetime of a contract, the regulatory framework also needs to reflect the frontier nature of seabed mining including the financial risks and potential profits that accompany frontier activities. In this context, the ISA's Technical Study No 11 (International Seabed Authority, 2013) notes:

> *'In short, the ISA will need to reserve for itself substantial power and authority to manage, regulate and oversee the exploitation regime based upon the principles of:*
>
> 1. *High sensitivity to environmental concerns and use of the precautionary principle.*
> 2. *Highly technical and as yet unknown challenges associated with successful deep ocean mining.*
> 3. *Obligation to preserve and to direct benefit flows to the developing world.*
> 4. *Actively demonstrating good governance.*
> 5. *Maintaining the reputation of the UN as a fair, independent and competent regulator.'*

[255] *Sulphides Exploration Regulations*, annex IV section 5.
[256] UNGA, UN Doc A/C.1./PV.1516 (1 November 1967), paragraph 8.
[257] UNCLOS, article 153(1).
[258] UNCLOS, article 140, 150(a).

3.4.3.7 Potential ways forward

Facilitating adaptive management will require a degree of flexibility in the mining contracts and the establishment of mechanisms that allow the ISA to adapt environmental standards continuously. Several options exist in this regard.

First, regional environmental management plans could be integrated into the Mining Code to clarify their legal status and allow the ISA to set regional, binding environmental standards that can be amended in line with an adaptive management approach. This may be linked to the recent proposal by the Netherlands to introduce a 'compulsory establishment by the Authority of an environmental management plan as a requirement for granting contracts for exploitation in a designated area.'[259]

Second, the future regulatory framework could build upon the ISA's current system of amending the LTC's recommendations. This would include requiring the periodic review of relevant recommendations to incorporate the information generated by monitoring programmes and impact assessments.

Third, the Mining Code and mining contracts could specify mechanism for the adjustment of environmental protection measures in response to new knowledge. This may also include the specification of particular action that must be taken based on the results of strategic environmental assessments or project-specific environmental impact assessments (EIAs). For example, if an impact assessment indicates risks for environmental harm beyond an agreed conservation objective, the regulations could set out specific actions in order to prevent such damage. (Importantly, no specific conservation objective has been agreed as of yet.) Depending on the design of the exploitation contract, these mechanisms and actions may also be integrated into site-specific environmental management plans that provide for adaptive management, including continuous monitoring and regular impact assessments. Such flexibility could be applied to the exploration as well as the exploitation phase. At present, contractors have to conduct EIAs during their exploration work, after a contract has been granted.[260] However, there are no mechanisms for the ISA to require the contractor to observe particular environmental measures based on the EIA.[261] This calls into question the efficacy of the EIA conducted during a contractor's exploration work.

The key difficulty here relates to the contractors' interest in predictability. However, as noted in the previous section, the ISA must carry out its numerous roles and act on behalf of humankind. Moreover, a contract should arguably reflect the frontier nature of deep seabed mining, including the financial risks this necessarily entails. It may be queried whether adaptive management could really be applied without flexible contracts. The question is whether this flexibility would be sufficient to fully apply adaptive management. In particular, in relation to exploitation contracts, the aforementioned risk of complacency warrants careful consideration.

Fourth, mineral exploitation could follow a staged approach, as suggested in the ISA Technical Study No 11 (International Seabed Authority, 2013).

> *'[…] the ISA will need to develop a regulatory method, based upon foreseeable events, to ensure slow, measured development and sufficient regulatory control over a project before it advances to the stage where, if problems arise, it can no longer be clawed back, modified or terminated. One way to accomplish this is to provide for a 'provisional' mining licence that would mandate that an operator demonstrate competence in deep*

[259] ISA, ISBA/20/C/13 (3 June 2014), paragraph 12.

[260] *Sulphides Exploration Regulations*, annex IV section 5.2; ISA, ISBA/19/LTC/8 (1 March 2013), paragraphs 19-21.

[261] Durden, J.M., Lallier, L.E., Murphy, K., Jaeckel, A., Gjerde, K., Jones, D.O.B., 2018. Environmental Impact Assessment process for deep-sea mining in 'the Area'. Marine Policy 87, 194-202.;see further Chapter 3.4.5.3

ocean engineering and mining and associated environmental responsibility to the ISA before receiving a 'tenured' mining licence.'

As the Study highlights, to obtain a provisional license contractors should be required to submit an environmental impact statement, a site-specific environmental management plan, and a pre-feasibility study based on previous exploration, transportation, processing and testing data and analysis (International Seabed Authority, 2013). Such a staged approach would provide contractors with a chance to demonstrate environmental and engineering competence, whilst allowing the ISA to adjust the scale and parameters of an exploitation contract before concluding it, based on the knowledge gained during the pilot operations (see further Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**).

A staged approach would be a step towards facilitating adaptive management, provided the pilot mining is designed so as to produce the comparative information required to inform the design of the exploitation operations. This aim could be supported by strategically commissioned marine scientific research. However, a staged approach does not address the current lack of flexibility during the lifetime of a mining contract. As such, combining a phased approach with the aforementioned flexibility during the lifetime of a contract would go some way towards facilitating adaptive management.

3.4.3.8 Conclusion

Adaptive management has been identified as a tool to minimise environmental harm expected to be caused by commercial-scale mineral mining on the deep seabed. However, in order to facilitate adaptive management, the ISA would require procedures and mechanisms to continuously adjust environmental standards based on new information from mining operations, monitoring programmes, and impact assessments.

The present regulatory framework for the mineral exploration phase does not sufficiently provide for such procedures and mechanisms. After an exploration contract has been concluded, during the lifetime of the contract, there are four potential options to adjust environmental standards, none of which provides a comprehensive and effective mechanism to do so.

First, an amendment of the ISA's Exploration Regulations does not apply to existing contractors, unless they individually consent to the changes. Second, although amendments to recommendations apply to all contractors, their scope and legal force is somewhat limited. Third, the renegotiation of a 5-years programme of activities does not provide the ISA with a mechanism to require a contractor to adjust environmental standards. Lastly, it remains unclear whether the adoption or revision of a regional environmental management plan can establish binding environmental standards for contractors. In order for the future regulatory framework for mineral exploitation to facilitate adaptive management, these procedural shortcomings will have to be addressed.

3.4.3.9 Recommendations

Recommendations
▸ To enable adaptive management, the ISA will need to reserve the power to require adjustments to environmental standards for mining operations on a continuous basis. ▸ Adaptive management would require the capacity and infrastructure to continuously monitor environmental impacts. Independent monitoring will be necessary to ensure reliability of the observations.

3.4.4 Transparency and Public Participation

3.4.4.1 Introduction

Captured in principle 10 of the Rio Declaration on Environment and Development (1992b), transparency and accountability are emerging standards in environmental governance[262] (Ardron, 2014; Ardron, 2016; Ardron *et al.*, 2018; Wiser, 2001). Already the Agenda 21 (UNCED, 1992) has acknowledged broad public participation in decision-making as 'one of the prerequisites for the achievement of sustainable development'. Currently, the Aarhus Convention (1998) and related Protocol, which acknowledge the right of citizens to a healthy environment, are the only legally binding[263] international instruments establishing the right of individuals and civil society to have

- Access to environmental information;
- Participation in decision-making in environmental matters;
- Access to justice in environmental matters.

Parties to the Aarhus Convention are required to '*promote the application of the principles of the Convention in international environmental decision-making processes*' (UNECE, 2005, see also Annex x). And globally, indigenous people have the right to free prior public consent on all matters of their concern (UNGA, 2007).

Enabling conditions for public participation include (as summarised in Jaeckel, 2017): access to meetings of decision-making bodies; publication of minutes and working documents; and also public access to environmental information, such as risk assessment guidelines, EIAs and environmental data. Transparency is particularly relevant for novel activities with global consequences, such as deep seabed minerals mining. It aids the implementation of the precautionary principle in that transparency enables an identification of the extent to which decisions by the responsible authority are informed by scientific knowledge, uncertainties, and value considerations. For example, transparency can help to identify the degree to which EIAs have been considered in the decision-making as compared to political and economic considerations. Transparency can also help to identify and minimise possible biases within the information used. This addresses the potential conflict of interest which arises when environmental standards for contractors are being set based on the data provided largely by the contractors themselves.

In the case of deep seabed minerals mining, governance will have to take place in the face of a high complexity of problems and uncertainties with regards to the environmental (and also economic) risks. Foley *et al.* (2015) argue that such types of new activities require anticipatory governance, *i.e.* the anticipation of upcoming challenges and opportunities, strategic planning, as well as analysis of the long-term consequences in a feedback system of adaptive management. Anticipatory governance also means to build the capacity to manage emerging technologies while such management is still possible, such as e.g. to manage the emerging geoengineering technologies (Foley *et al.*, 2015).

In order to effectively contribute to collective decision-making over public goals, engaging institutions in committing to those goals, and measuring progress against them (Foley *et al.*, 2015), the public dialogue has to start early, as long as all options are open, due account has to be taken of its outcome,

[262] see e.g., in the EU Transparency Regulation (EC) No. 1049/2001; Sutherland et al. (eds), 2004. The Future of the WTO: Addressing Institutional Challenges in the New Millennium, Geneva; World Bank, 2010. World Bank Policy on Access to Information. http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2010/06/03/000112742_20100603084843/Rendered/PDF/548730Access0I1y0Statement01Final1.pdf

[263] currently 47 parties, including the European Union

and it needs to be sited in a transparent, interactive governance framework (UNECE, 2014). Then public participation can ensure benefits such as:

- Enhanced legitimacy and facilitation of public acceptance of a treaty regime;
- Improved quality of decision-making by increasing the information and perspectives available to decision makers;
- Enhanced accountability of decision-making through public scrutiny; and
- Assisting small and less-developed states in building their capacity to participate effectively in the agreement (Wiser, 2001).

Peters (2014) proposes that while total transparency may not be appropriate or possible, a presumption of transparency should be acknowledged. Such a presumption means that '*the non-release of documents and the closure of meetings to the public must be specifically justified on the basis of legal exceptions which have been clearly defined and circumscribed prior to the fact. These exceptions can only be granted by stating the reasons for them publicly. The burden of explaining and of proving the need for secrecy is thereby placed on the institution itself – not on those outsiders who request access*'. Any lack of transparency would become more acceptable if the reasons were disclosed and discussed in public. This strategy was also recommended to ISA by (International Seabed Authority, 2016a).

The International Seabed Authority (ISA), established by the United Nations Convention on the Law of the Sea (UNCLOS) and the related Implementing Agreement of 1994, is the authority that administers the Area and its resources on behalf of and for the benefit of mankind as a whole (UNCLOS, Arts. 136, 137(2), 153(1)), while protecting the marine environment from the harmful effects that may arise as a result of seabed mining and related activities (Art. 145).

The status of the Area and its mineral resources as a common heritage of mankind strengthens the call for transparency (Jaeckel *et al.*, 2016). It may be argued that the common heritage of mankind should be administered in a more transparent and participatory manner than other high seas natural resources to ensure the public can participate in the decision-making on whether and how these mineral resources may be exploited for the benefit of mankind today or in the future (Ardron, 2016). Neither UNCLOS, nor the Implementing Agreement of 1994, or the Mining Code discusses transparency *per se,* nor are terms used in Articles 168 and 181 'industrial secret', 'proprietary data', 'confidential information', or the exact nature of related 'data and information' defined (International Seabed Authority, 2016a). However, it is made clear in UNCLOS (Annex II, Art. 14(2)) and the mining code that data necessary for the formulation by the ISA of rules, regulations and procedures concerning protection of the marine environment and safety, other than equipment design data, shall not be deemed proprietary (see Annex 5).

3.4.4.2 Transparency at the ISA today

In 2011, the ISA has adopted a first regional environmental management plan for the Clarion-Clipperton-Zone in the Northeast Pacific, which could be seen as a first step to implement more transparency, as it lists transparency among its guiding principles. The plan states: *'The Authority shall enable public participation in environmental decision-making procedures in accordance with the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Aarhus Convention 1998), and its own rules and procedures*' (ISBA/17/LTC/7).

Access to information

According to the ISA rules of procedure for the Council and the Assembly member states and accredited observers are informed of the annual sessions and receive the publically available documents for the meetings. These are also posted on the ISA website[264]. These meeting documents provide a good overview of the issues at stake during the respective LTC, Council and Assembly sessions. However, a substantial part of the information available for controlling the compliance of existing and new ISA exploration licence holders are classified as confidential[265] (see also Annex 5).

The further development of the environmental rules and regulations by the ISA in direction to establishing a mining regime depends to a large extent on information from exploration contractors. Since the ISA does not have the means to initiate own independent research, and independent scientific records are scarce, the contractors' data are the prime source of scientific baseline information available to the ISA, for example for compiling a regional environmental baseline such as required under the Clarion-Clipperton-Zone regional environmental management plan (see above, ISBA/17/LTC/7).

Therefore, contractors are obliged to gather, and report to the ISA Secretary-General annually, data collected during exploration work according to the plan of work adopted by the Council[266], including those generated during the oceanographic and environmental baseline studies. Such environmental baseline data are exempt from the general confidentiality of data submitted to the ISA (see Annex 1). However, to date no data submitted to the ISA by contractors have been made available to the public or science.

Apart from the original scientific environmental data and knowledge, also the annual contractor reports, including those sections covering the environmental baseline studies, and the environment-related sections of the past, present or future plans of work of new or existent license holders have not been made publically available. With respect to applications for exploration licenses, the location and description of the site(s) are not disclosed prior to adoption by the Council, and the measures proposed to be taken to ensure the '*effective protection and preservation of the marine environment*', are not disclosed at all.

New applications for exploration licenses are assessed by the Legal and Technical Commission. Importantly, neither details of the applications, nor any reasoning or considerations on remaining uncertainties are disclosed to the Council, the organ that ultimately decides over applications (Jaeckel, 2017). As such, it remains unclear how the LTC determines whether an application provides for '*effective protection and preservation of the marine environment'*. Neither the Council nor other stakeholders know which environmental work was proposed in an application, or indeed whether exploration will take place in a particularly sensitive area.

The ISA central data repository was last updated in 2008, but it did not offer data from any contractor (Seascape Consultants ltd., 2014). The data repository is currently offline. Also, the bibliographic database, which originally provided a searchable thematic bibliography, now only offers a statistical overview of its 2500 references collected until 2005 [267]. As a result, it cannot be assessed by anyone outside the LTC whether and how the contractors fulfil their contractual obligation to establish an environmental baseline, and how they carry out environmental impact assessment. The first such assessment for dredging operations was reported in 2014[268].

[264] See e.g. https://www.isa.org.jm/sessions/24th-session-2018.

[265] ISBA/20/C/31 (23 July 2014), paragraph 10; ISBA/18/C/20 (20 July 2012), paragraph 11; Nodules Exploration Regulations, regulations 7, 36(2); Sulphides Exploration Regulations, regulations 7, 38(1); Crusts Exploration Regulations, regulations 7, 38(2)

[266] Section 5, Standard Clauses for Exploration Contracts, https://www.isa.org.jm/files/documents/EN/Regs/Code-Annex4.pdf

[267] see https://www.isa.org.jm/central-data-repository and https://www.isa.org.jm/bibliographic-database, last accessed 29 March 2018

[268] ISBA/20/C/20 (16 July 2014), annex I paragraph 14

Also the assessment of 'Best Environmental Practice' will be an issue of public interest, which will have to be enabled to some extent in the course of public participation in Strategic and local Environmental Impact Assessment processes (see Chapter 3.4.5).

3.4.4.3 Participation

At present, there are several options for public participation within the ISA system: UN-accredited and other invited non-governmental organisations can apply for an observer status with the ISA. These observers have the right to participate in the annual Assembly meetings, where they may make oral statements and submit written statements (International Seabed Authority, 1994a, Rule 82). Observers may also participate in the annual Council meetings (International Seabed Authority, 1994b, Rule 75). Lately, observers were given the opportunity to make oral and written statements in the Council meetings, although the Rules of Procedure do not mention these competences. The meetings of the Legal and Technical Committee are generally closed. Participation for member states and observers is possible during open sessions, which are only held occasionally, to discuss matters of general interest to the ISA.[269] Open sessions have been held only 3 times so far,[270] one of these to discuss the fate of the proposed regional environmental management plan for the Clarion-Clipperton-Zone in 2010.

Also States have only limited options to influence the technical content of documents and decisions: States which are not members of the Council, may only review Council decisions without having the right to reject, only to send back for further consideration[271]. Also States represented at the Council, although bearing the responsibility to decide upon the matter, have to rely on the factual correctness of the recommendations of the Legal and Technical Commission, LTC, or reject with two-thirds majority.[272] The basis for a Council decision is a summary document of the non-confidential information on a particular case. In 2017, for the first time further clarification was requested from LTC, when cases of possible non-compliance were reported.[273] This resulted in the Council requesting greater detail in the reports delivered to the Council, and the Secretary General to negotiate with the contractors the release of contract information to the public.[274]

The large number of developing states are particularly underpowered, as the Council groups d (special interests) and e (regional representation)[275] count as only one group, compared to the groups a-c (major consumers, largest investors, major exporters).

So far, all contractor-related information, including the environmental and impact-related information delivered by contractors remains in a feedback loop between the contractors, the ISA Secretariat and the LTC. As of 2018, the ISA is about to implement a new data base management system which shall allow access to original data to a certain extent also for public users such as scientists[276]. However, contract-related information other than scientific data are seemingly not part of the database. Also the Seabed Mining Register, as envisaged to be set up under the upcoming exploitation regulations (International Seabed Authority, 2017b, draft regulation 78) will not provide access to contracts,

[269] Rules of Procedures of the Legal and Technical Commission, rule 6.

[270] one session each in 2014, 2004, and 2003. ISBA/20/C/20; ISBA/10/C/4, paragraph 20; ISBA/9/C/4. An open session in 2016 was held without prior announcement and prior to arrival of delegations.

[271] ROP Rule http://www.isa.org.jm/sites/default/files/documents/EN/Regs/ROP-Assembly.pdf.

[272] ROP Rule 56 http://www.isa.org.jm/sites/default/files/documents/EN/Regs/ROP-Council.pdf

[273] ISBA/24/C/4

[274] preliminary information https://www.isa.org.jm/sites/default/files/files/documents/enb25157e.pdf, page 4.

[275] as determined in Rule 84 ROP of the Assembly, see n 271

[276] ISBA/22/LTC/15.

reasoning for decision-making, or substantive information from annual reports or monitoring and assessment.

Currently, all technical work is being carried out by the LTC which underlies particular confidentality provisions. The options for the participation of external experts, such as scientists, in the development of the Mining Code and regional management plans are therefore limited, unless the research has been carried out with support of the ISA. Known experts in the field may be invited to join technical workshops organised by or supported by the ISA[277]. The expertise gathered during these technical workshops may inform the work of the LTC, though it is difficult to discern from available documents the degree of influence external advice has had on LTC decisions and recommendations. The workshops are well documented and some also video-taped.

Marine scientific research projects, specifically dedicated to seabed minerals mining[278] have started to communicate their information and findings via side-events during recent annual meetings of the ISA. However, such direct scientific information sharing should not replace a coordination of scientific expertise within the regular institutional structure of the ISA. For example, a Science Council advising LTC, or an Environmental Commission advising the Council could offer potential solutions. Such scientific advisory bodies are common practice in other international bodies (e.g. under the UN FCCC, the London Protocol, and CBD) and many fisheries management bodies.

Since 2014, the next step in developing the regulatory framework for seabed mining in the Area has picked up pace: An exploitation code is under development, initially for the mining of polymetallic nodules. The ISA has introduced a new instrument for participation, a stakeholder survey. In a first round in 2014, the ISA has inquired for stakeholders' views on the necessary elements of an exploitation code. In 2015, comments were requested on a first draft structure of the code and prioritisation of the work. The consultations received responses from a broad audience.[279] However, there is currently no feedback mechanism to respondents. Neither an overview of the stakeholder views is being provided, nor any indications as to how the responses were weighed and influenced the revision of the document (compare the requirement under Art.6, paragraph 9 of the Aarhus Convention).

A draft stakeholder consultation and participation strategy for the Authority was presented to the Legal and Technical Commission meeting in February 2016. This strategy had been commissioned by the ISA Secretariat upon request from the LTC and the Council. The document was published as a discussion paper (International Seabed Authority, 2014). As of 2017, no stakeholder-related strategy has been discussed or presented to the Council.

In parallel to developing the framework for exploitation regulations, a first periodic review was undertaken, in accordance with Art. 154 UNCLOS.[280]. External reviewers carryied out a general and systemic review of the manner in which the Authority has operated in practice, based on a representative set of interviews (Johnson *et al.*, 2016). They recommend measures for improving the operations of the ISA. An Assembly report and resolution[281] concluded the process with recommending a.o.

- To enhance data management and data-sharing mechanisms

[277] https://www.isa.org.jm/workshops

[278] e.g. the EU FP7 project MIDAS, or the EU JPIO project MiningImpact

[279] https://www.isa.org.jm/survey/stakeholder-survey-march-2014; https://www.isa.org.jm/survey/2015-exploitation-framework-survey

[280] https://www.isa.org.jm/news/isa-commences-first-periodic-review

[281] ISBA/23/A/3 and ISBA/23/A/13.

- To enable the Council to better study the recommendations of LTC through improved timelines and more detail in LTC reporting to Council;
- To share widely non-confidential information, such as that relating to the protection and preservation of the marine environment;
- To develop the finance provisions in full transparency;

3.4.4.4 Debate about Transparency in the Deep Seabed Mining Regime

As the work of the ISA progresses towards developing regulations for mineral exploitation, stakeholder interest has increased considerably in recent years. The number of accredited observers has risen to 30 states, 32 intergovernmental organisations, and 25 NGOs[282]. It can be assumed that all of these have some interest in the development of the deep seabed minerals mining regime, to which some or all observers may wish to contribute.

Already at the Potsdam Ocean Governance workshop in 2014, deep seabed mining was discussed in relation to transparency (Ardron *et al.*, 2014a), and as a follow-up, a multi-stakeholder dialogue group was formed in 2015.

In parallel, a Conference on Transparency and Best Practices for Deep Seabed Mining has taken place in October 2015. The Conference was convened by the World Economic Forum Global Agenda Councils on Oceans and the Future of Mining and Metals and brought together 24 invited representatives from industry, academia, civil society, government, and international organizations at the Rockefeller Foundation Bellagio Center in Bellagio, Italy. The primary focus of the conference was to achieve an initial consensus on required transparency and best practices in deep seabed minerals mining (DSM) in general, as well as to inform the design of an exploitation code by the International Seabed Authority (WEF, 2016).

The conference addressed three primary categories of questions and issues:

- Procedural and operational matters, including the optimal design of institutions, processes, and procedures to promote transparency, investment, and good governance in DSM, as well as an adequate flow of financial and economic benefits from DSM;
- Distributional issues, namely the role of DSM in fostering economic and social development, particularly for Small Island Developing States, and related economic and equity considerations;
- Environmental issues, principally related to the negative consequences of DSM for poorly-understood deep-sea species and ecosystems;

There was general agreement among the participants that:

- Transparency ought to be increased throughout the DSM process;
- Better information and knowledge-sharing was required to support decision-making;
- The three principles of the Aarhus Convention, namely public participation in decision-making, access to information and access to justice should be considered the benchmark for a transparent governance system of the ISA;
- The transparency of data, decision-making processes and reporting are important components of an effective governance approach;
- There was a pressing need to establish good practices in promoting transparency before commercial exploitation commences (WEF, 2016).

[282] https://www.isa.org.jm/observers

Subsequently, transparency was the topic of a side-meeting at the ISA annual meeting in 2016, when the need for transparent and accountable processes and decision-making as well as participation and expert advice was discussed with a broader stakeholder group, including States and contractor representatives.[283]

A systematic evaluation of the current ISA regulatory system with regards to transparency would provide the best starting point for improvements. Ardron *et al.* (2014a) proposed a simple 3x3x3 meta-standard matrix to qualitatively check the transparency performance of the ISA's decision-making processes. Since then, Ardron has gone on to do the first assessment of the ISA's transparency practices, using a methodology previously used to assess regional fisheries management organisations (Ardron, 2016; Clark *et al.*, 2015). In that study, the ISA receives scores across the board that are much lower than the high seas fisheries bodies. Also in comparison to good governance practices in existing codes of conduct, regulations, international agreements and voluntary standards, as plausibly applicable also to deep seabed mining, improvements of current ISA practices are recommended in six fields (Ardron *et al.*, 2018)

- Access to information
- Reporting
- Quality assurance
- Compliance information/accreditation
- Public participation
- Ability to review/appeal decisions.

3.4.4.5 Options for Increasing Transparency

Below are some suggestions for the reforms needed to make the ISA a (more) transparent international organisation.[284]

Access to information

The guiding principles of the World Bank Policy on Access to Information (World Bank, 2010) may be a good starting point for developing transparency rules for ISA, further elaborated by Ardron *et al.* (2018), namely

- To set out an ISA transparency policy and measurable criteria (Ardron *et al.*, 2018) including the definition of rights of stakeholders in the sense of the Aarhus Convention and Protocol, and in line with the Almaty Guidelines;
- To maximize access to information - yet an information overload or qualitatively bad information is as non-transparent as no access to it (Ardron, 2014);
- To set out a clear list of which information should be publically accessible and which information should remain confidential;
- To safeguard the deliberative process;
- To provide clear procedures for making information available;
- To recognize requesters' right to an appeals process.

[283] https://www.isa.org.jm/files/documents/EN/Regs/DraftExpl/TransparencyRep.pdf

[284] The results of this section have been condensed in the IASS policy brief "Towards Transparent Governance of Deep Seabed Mining", http://publications.iass-potsdam.de/pubman/item/escidoc:1592897:6/component/escidoc:1592899/IASS_Policy_Brief_2016_2_en.pdf.

As the Area and its mineral resources are the common heritage of mankind, there should in the first place be a presumption to make all information accessible to the broad range of stakeholders, for example on the website. This should include a public database holding the copies of successful contract applications, and copies of the resulting contracts including work programmes, all documents related to environmental baseline information and environmental impact assessments in an easy to search format.[285]

The root-cause of the challenges regarding public access to environmental information/confidentiality is the fact that some environmental data can also provide information about the mineral resources. For example, in the case of manganese nodules, the biological information from seafloor photography, species inventories and diversity allows also for conclusions on the density of the mineral resource, and hence its economic value. It may be necessary to legally clarify further the types of data which may be held back for confidentiality reasons (for example through a request for an Advisory Opinion from the Seabed Disputes Chamber, see also International Seabed Authority (2016a).

In addition to the above considerations on the potential confidential information content of environmental data, the fact that nearly all data are gathered by contractors or contracted scientists as part of the exploration programmes leads to tensions with the establishment of a regional, representative data pool as required to establish a regional baseline. Biological sampling is time-consuming and may often be limited during exploration cruises[286]. In addition, the sampling strategies, taxonomic identification and data storage have not yet been standardised (but efforts are made) across the Clarion-Clipperton-Zone, and limited reporting exists in direction to the ISA (International Seabed Authority, 2011, Section X).

Not many scientific results of exploration cruises are published in peer-reviewed journals, with some notable improvements in recent years, e.g. from IOM, German, French and lately UK nodule exploration areas in the Clarion-Clipperton-Zone[287]. The first investigations of Areas of Particular Environmental Interest, APEIs, in the Clarion-Clipperton-Zone point to large ecological differences between the license areas and regions (Amon *et al.*, 2016). As a result, the combined lack of standardisation of sampling and the overall lack of accessible environmental data prevents science from being able to make progress with a substantiated regional environmental baseline.

In the future, it may be necessary to supplement (or replace) the environmental research carried out by contractors by strategically planned, independent scientific research projects. This will enable to establish the ecological baselines for the regions of interest for exploration and exploitation, and for the parallel investigation of the environment in the Areas of Particular Environmental Importance, APEIs, as designated by the Council in the Clarion-Clipperton-Zone (ISBA/18/C/22). Until today, despite new guidelines for reporting, neither are the annual contractor reports publicly accessible, nor are there objective criteria for the LTC to evaluate the acceptability of the work reported or to measure progress against the aims of the respective work plan (Madureira *et al.*, 2016). As a first step, contractors are requested to provide key milestones and minimum thresholds for achieving these in their final 5-year work programmes for exploration.[288]

[285] with the exception of such information which may not lawfully published. SPC response to Stakeholder Consultation 2015, https://www.isa.org.jm/sites/default/files/spc.pdf

[286] see contractor presentations at ISA Technical Workshop ‚Standardization Workshop on Macrofaunal Taxonomy for Polymetallic Nodules Exploration Areas in the Clarion- Clipperton Fracture Zone', https://www.isa.org.jm/workshop/workshop-taxonomic-methods-and-standardization-macrofauna-clarion-clipperton-fracture-zone

[287] examples are Radziejewska, T., 2014, Veillette et al., 2007, Miljutin et al., 2011, vanReusel et al., 2016, Glover et al., 2016 and many more recent publications.

[288] ISBA/19/C/14, Section II B paragraph 8.

Access to information also requires transparency about who is doing the work and why, and how decisions are taken. For example, recruitment to the ISA's Legal and Technical Commission (LTC) does not appear to be undertaken on a competitive meritorious basis[289] . As regards the technical work, currently law firms and other consultancies get into contracts to carry out technical work under the supervision of the ISA Secretariat. There does not seem to be a public tender for these consultancies, nor are names and work plans disclosed, or a budget presented to the public.

In order to address in a proper form the needs of all relevant stakeholder groups, ISA will need to adopt a communication and transparency strategy, ensuring a.o. the accountability of all its organs. ISA might also consider to extend its communication department to enable a translation of the technical language to the needs of the wider public, journalists, and non-specialist government officials and politicians in the various world regions, as well as to respond to requests for information.

Examples for the communication tasks include:

- Inform comprehensively on the applied stakeholder engagement strategy, including criteria for establishing mailing lists, workshop invitations, invitations to consultations etc.
- Inform comprehensively in a public register on the state of licensing overall, and allow to track the progress made within each license area by the ISA (Council decisions, LTC recommendations, incl. uncertainties and reasoning for recommendation), contractors (contact, applications, maps, annual reports, EIAs, reports on incidents and measures, related reports and publications, and associated explanatory information).
- Launch public awareness programmes in the media. The tools for providing the messages could include videos, interviews, educational scientific films and more. Ideally, an interactive forum for stakeholder engagement could be created.
- Share consultation materials to networks and mailing lists – including to NGOs and CSOs.
- Install and maintain open-access to a centralised web-based information sharing system for data (CDR), an up-to-date bibliographic database and map service.
- Establish and maintain a directory of experts in DSM-related fields with all stakeholders.
- Establish and maintain a directory of consulting firms which have worked for the ISA, or may do so in the future.

In any case, a public-friendly website is a prerequisite for successful stakeholder communication. It needs to be well-structured, kept up-to-date with all documentation, but also public tenders and announcements and invitations to workshops well ahead of their taking place as well as the outcomes.

Participation

As outlined by the South Pacific Community, SPC, in their response to the 2014 ISA stakeholder consultation,[290] the elements of a meaningful public participation include:

- The identification of interested parties and the best methods to reach them;
- A timely provision of relevant information and consultation materials explaining the grounds for a proposed decision or policy where there is one;
- Providing sufficient time for review and discussion by recipients (and seeking of expert advice if necessary);
- A means for questions to be raised in case of any ambiguities in the consultation materials or processes;

[289] https://www.isa.org.jm/sites/default/files/spc.pdf, question 32

[290] https://www.isa.org.jm/sites/default/files/spc.pdf

- A forum in which suggestions for changes to the proposal can be received;
- A process that ensures any submissions are properly considered by the decision-maker;
- Feedback from the decision-maker about what submissions were received, whether the original proposal has been altered, and if so, in what way and for what reasons; and
- A mechanism for review or challenge, if those consulted do not consider the decision has been properly made, taking into account all the submissions received.

Little of this exists presently. For example, the present stakeholder consultation process lacks a response strategy, and for the first time, in 2018, an overview report of the responses received was presented.[291]

In order to enhance the buy-in of States, observers and civil society, including of representatives of the scientific community, in the development of the rules and regulations of the ISA, several options emerge:

- Enabling collaboration in sub-committees and working groups. Council working groups could set the frame for LTC technical guidance and recommendations;
- Consultation of ISA States and observers, eventually the public, on draft LTC documents[292];
- Integration of external scientific advice, e.g. as proposed by the Deep Ocean Stewardship Initiative (DOSI);[293]
- Pooling of environmental data, coordinating work across contractor areas and the compilation of regional quality status reports, such as will be done for the Clarion-Clipperton-Zone;
- Allowing for (co-)authorship and provision of input documents to sessions of the LTC, the Council and the Assembly;
- Holding LTC sessions in an open manner as a rule, not an exception, to provide for accountability and transparency in the decision-making process.

It is likely that some institutional adjustments will be required to enable more and independent participation. There are several options for including more external advice on environmental matters:

- Technical working groups under the Council could address issues of relevance for the directing future LTC work, such as strategic questions related to the long-term time schedule, work prioritisation, subjects of special concern. This has been raised by Germany, Australia and others.
- For example, New Zealand supports the establishment of an independent technical expert working group/sub-committee to assist the LTC in considering applications and ensure it has access to the right technical expertise. They emphasise the importance of a robust, rigorous and comprehensive process for managing applications. This would include providing opportunity for early engagement between applicants and the Authority, and making sure that a multidisciplinary group of experts is available to the LTC throughout the evaluation of applications.'[294]
- If only scientific advice shall be better integrated into the ISA decision-making processes, then a Science Council could provide advice to the work of the LTC. A science council could also be

[291] ISBA/24/C/CRP.1

[292] so far, only contractors are asked to provide comments on draft LTC documents ,e.g. the revised " *Recommendations for the guidance of contractors for the assessment of the possible environmental impacts arising from exploration for marine minerals in the Area" ISBA/19/LTC/8*

[293] Deep Ocean Stewardship Initiative (DOSI). 2014. Submission to the International Seabed Authority on Developing a Regulatory Framework for Mineral Exploitation in the Area: Stakeholder Survey. May 16, 2014. http://www.isa.org.jm/files/documents/EN/Survey/Responses/DOSI.pdf

[294] New Zealand response to Stakeholder Consultation 2015

instrumental for the design of monitoring programmes or dedicated environmental research projects.

- If broader stakeholder engagement is to be achieved, then the members of an Environmental Commission could reflect the environmental interest of a broad range of states and observers. An Environmental Commission would be responsible for providing advice on the regulation, execution and surveillance of all issues in relation to the marine environment. It could act as a clearing house for advice and knowledge from science and civil society. Such a Commission should act in parallel to and in cooperation with the Legal and Technical Commission in advising the Council.

Most importantly, it has to be considered that participation is a two-way process. Not only must the public, civil society or other stakeholders take time and effort to review, discuss and consider the information; to raise questions or concerns, and to formulate views or recommendations. The ISA and contractors also must take time to hear, understand and reflect upon comments received and provide a substantive response.

Access to outcomes

The ISA publishes the decisions taken by the Council and the Assembly, including the reports of the LTC to the Council. These documents are accessible among the session documents on the webpage of ISA soon after the meeting, and a bound volume of the matters dealt with by the Council and the Assembly is published several months after the meeting. However, there are no ISA meeting reports or minutes which would provide information on the debates. Since 2017, the Council and Assembly sessions are documented by IISD Reporting Services, their Earth Negotiations Bulletin being published daily on the ISA session website. Sessions could also be video-streamed to enable participation abroad.

Currently, most decisions are taken in the LTC, although formally the Council holds the decision-making power. A significant increase in transparency would be acquired, if the LTC and the Council were required to specify which scientific, technical, and value considerations and uncertainties informed a particular decision. Such a procedural requirement would make uncertainties explicit and help to disentangle scientific information from political or value considerations, as required by the precautionary approach (Jaeckel, 2015a).

To enable the measuring of the effectiveness of the procedural and regulatory work of the ISA, objectives, supplemented by indicators and monitoring and assessment programmes as well as public reporting, for the conservation of the marine environment and well-regulated deep seabed minerals mining will have to be agreed (Ardron, 2016; Jaeckel, 2015a).

Representation

Public participation, including that of future generations, could also be institutionalized through an ombudsperson, whose office could create information channels between the ISA and civil society (Jaeckel, 2017). The ombudsperson could be a member of the Secretariat charged with coordinating interactions with the public and representing its views at ISA meetings, particularly in the Council. The ombudsman could also be the representative of future generations, in particular on environmental and financial matters in line with the common heritage of mankind principle (UNGA, 2013).

3.4.4.6 Conclusions

Since its establishment, the International Seabed Authority has slowly evolved into a functional regulatory body. However, as its statutes were designed in the 1970s, it does not comply any more with modern standards for transparency and public participation in international organisations - in particular when considering the ISA's role as a trustee for administering the mineral resources of the

Area on behalf of mankind as a whole, preventing any mining-related activities to cause harmful effects on the marine environment. While on its way to develop the regulations for the exploitation of the minerals, the ISA should best agree on a communication and participation policy which maximises transparency and participation of States, observers and specialists like scientists, engineers and economic experts, as well as civil society organisations and the wider public.

3.4.4.7 Recommendations

Recommendations[295]

- Adopt an open information and data policy to maximise accountability. The ISA should implement a presumption of public accessibility of all information relating to the regulation of deep seabed mining and the protection of the marine environment and safety.
- Ensure the active involvement of all interested stakeholders. The ISA should develop a mechanism that enables the engagement with and participation of stakeholders in decision-making, consistent with the principle of the Common Heritage of Mankind.
- Establish an environmental advisory body. The ISA should establish a new organ to provide comprehensive advice on matters of the environment.

[295] see Christiansen, S., Ardron, J., Jaeckel, A., Singh, P., Unger, S., 2016. Towards Transparent Governance of Deep Seabed Mining. IASS Policy Brief 2/2016. Institute for Advanced Sustainability Studies, Potsdam, p. 11.

3.4.5 Preventive action

3.4.5.1 Introduction

Formally, Environmental Impact Assessments (EIAs) and Strategic Environmental Assessments (SEA) are structured approaches for obtaining and evaluating environmental information prior to its use in decision-making in the development process (Abaza *et al.*, 2004). The assessments relate to the potential environmental change due to the proposed or alternative actions. Whereas EIAs are carried out at the scale of individual projects, SEAs provide a mechanism to evaluate the environmental, social and economic effects of proposed actions and relevant alternatives at the level of new or amended laws, policies, programmes and plans. Due to its broader scope, SEA precedes the first applications for EIAs and serves to provide early warnings of large-scale and cumulative effects, including those resulting from a number of smaller-scale projects that individually would fall under thresholds for triggering a project EIA (Abaza *et al.*, 2004).

In general, the overall goal is to avoid/prevent undesired negative environmental and social impacts of an activity, policy or programme programme measured against agreed national or international environmental objectives. Other than EIAs, SEAs address to a large extent the root causes, related to the policy priorities and choices, of an existing or upcoming problems (do Rosário Partidário, 2012). As such, SEAs can be a key tool to assess the overall sustainability of a development.

3.4.5.2 Strategic Assessment

Due to its history rooted in the sectoral management of emerging human activities in and on the oceans, the UN Law of the Sea does not foresee the assessment of cumulative impacts (Jaeckel, 2015a), be it over time, or from impacts arising from more than one sector or from multiple operations within a given (eco-)region. A modern instrument to address this is the Strategic Environmental Assessment, SEA, also not existing at the time of the UNCLOS negotiations.

Many definitions and objectives of Strategic Environmental Assssment, SEA, exist (e.g. Espoo Convention, see below), and it is acknowledged that its scope has become more inclusive over time and increasingly has a strategic role in priority setting and initialising a multi-stakeholder process (Loayza, 2012). SEAs aim to integrate environmental considerations into policies, plans and programmes, and evaluate the interlinkages with economic and social considerations (OECD-DAC, 2006).

The SEA Protocol to the Espoo Convention[296] defines Strategic environmental assessment to mean

> *'the evaluation of the likely environmental, including health, effects, which comprises the determination of the scope of an environmental report and its preparation, the carrying-out of public participation and consultations, and the taking into account of the environmental report and the results of the public participation and consultations in a plan or programme' (Art. 2.6).*
>
> *'Environmental, including health, effect' means any effect on the environment, including human health, flora, fauna, biodiversity, soil, climate, air, water, landscape, natural sites, material assets, cultural heritage and the interaction among these factors (Art. 2.7).*

As such, Strategic Environmental Assessment is a tool to implement the ecosystem approach, in particular the precautionary approach to management, as it allows to address problems of

[296] Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context. http://www.unece.org/env/eia/sea_protocol.html

environmental deterioration at their source, rather than mitigating the environmental impacts on project level. SEA has a longer term and broader scope compared to project-level EIAs, which potentially enables early warning of large-scale and cumulative effects. Ideally SEA is an element of the ecosystem approach to management of human activities, integrating environmental sustainability in the policy making process (see e.g. Abaza *et al.*, 2004). The World Bank (World Bank, 2016) recognizes SEA as a key means of integrating environmental and social considerations into policies, plans and programs, particularly in sector decision-making and reform and promotes the use of SEA as a tool for sustainable development.

Eight guiding principles have been formulated for an appropriate scope, orientation and content of the SEA process (see e.g. Abaza *et al.*, 2004):

- Fit-for-purpose
- Led by environmental goals and priorities;
- Contribute to environmentally and socially sustainable development;
- Cover all levels and types of decision-making likely to have significant environmental effects;
- Provide sound information in a form appropriate to the level of decision-making
- Include consideration of social, health and other effects as necessary;
- Provide an opportunity for public involvement
- Achieve its purpose in a timely and expeditious manner, including, as practicable, setting a context for project EIA.

The International Association for Impact Assessment (IAIA) has established performance criteria according to which good quality SEAs processes are integrated, sustainability-led, focused, accountable, participative and iterative. SEA and EIAs are considered to be an important step towards fully holistic and integrated assessment of environmental impacts (Abaza *et al.*, 2004). As a consequence, also ecosystem services have to be integrated in the SEA processes (Atkins *et al.*, 2011; UNEP, 2014).

Internationally, SEA is regulated by the 2003 SEA Protocol to the UNECE Convention on Environmental Impact Assessment (EIA) in a Transboundary Context, Espoo Convention, which entered into force in 2010. All EU member states are obliged to carry out Strategic Assessments according to Directive (2001).[297] The SEA Directive does not have a list of plans/programmes similar to the EIA. However, an SEA is **mandatory** for plans/programmes which **set the framework** for future development consent of projects listed in the EIA Directive, or have been determined to require an assessment under the EU Habitats Directive (1992a).

Once the risks involved in certain activities have been considered as being generally acceptable, the formal Environmental Impact Assessment procedure of concrete project applications should lead to the environmentally least damaging project operation, after evaluation of alternative solutions and mitigation options. The results of consultations and the information gathered as part of the EIA must be taken into consideration in the development consent procedure.

[297] see also http://ec.europa.eu/environment/eia/sea-legalcontext.htm

Case Study EU

In Europe, due to the subsidiarity principle, at the Community level only a minimum environmental assessment framework has been created, setting out the broad principles of the environmental assessment system (Directive 2001/42/EC 2001). The implementation is subject to the individual member states.

The **objective** of the SEA Directive is '*to provide for a high level of protection of the environment ... by ensuring that, ..., an environmental assessment is carried out of certain plans and programmes which are likely to have significant effects on the environment*'. It requires the preparation of an **Environmental report** as a basis for decision making which summarises i.a.

- The main objectives of the plan or programme;
- The current state and assumed development of the environment;
- The environmental characteristics of areas likely to be significantly affected
- Existing environmental problems
- Relevant established environmental protection objectives at international, Community or Member State level, and the way those objectives and any environmental considerations have been taken into account during its preparation
- The likely significant effects on the environment, including on biodiversity, fauna, flora, water
- The measures enviraged to prevent, reduce and as fully as possible offset any significant adverse effects on the environment
- Selection and assessment of alternatives
- Monitoring measures

Public consultation during the assessment of the plan or programme, as well as the consideration of '*reasonable alternatives*' are important components to enable the weighing of benefits and costs of new policies.

The **plans and programmes concerned** are those which are subject to a legislative procedure and which are required by legislative, regulatory or administrative provisions. Environmental Assessment is required for such plans and programmes which

- Set the framework for future development consent of projects which are likely to be subject to Environmental Impact Assessment procedures (listed in Annexes I and II to Directive 85/337/EEC now amended to 2014/52/EU (2014), or
- Which, in view of the likely effect on Natura 2000 sites, require an Appropriate Assessment (pursuant to Article 6 or 7 of Directive 92/43/EEC (1992)).

It is up to the Member States to determine whether other plans and programmes are likely to have significant environmental effects based on the criteria set out in Annex II of the Directive. The criteria scale the plans or programmes and consider the characteristics of the effects, associated risks and vulnerability and protection status of the environment. The assessment is done either through case-by-case examination, by specifying types of plans or projects or by a combination of both. The Assessment has to be concluded prior to to the legislative procedure enacting the plan or programme.

In 2010, based on a Commission report of 2009 (COM (2009) 469 final), the Committee of Regions has requested substantial improvements, e.g. with respect to setting unambiguous environmental standards at European level to measure impacts against, as yet missing formal links to the Habitats Directive and Biodiversity Action Plan, and mandatory consideration of alternatives.

A less comprehensive form of spatially-defined assessment is the *Regional and sectoral environmental assessment (REA and sectoral EA)* as defined and widely used at the World Bank to comply with its safeguard policies (Loayza, 2012). In line with the World Bank definition, a REA for deep seabed mining in the Area could be defined as:

Regional environmental assessments (REAs) are impact-centered SEAs which examine regional environmental issues and impacts in context with the ISA environmental strategy and associated regional environmental management plans prior to opening up the respective regions to one ore more mining projects.

Therefore, a SEA carried out by ISA would provide the following output:

- Examinination of environmental issues and impacts associated with ISAs strategies, policy, plan, or program or with a series of projects for a particular region or sector (in this case all steps related to activities in the Area), with particular attention to long-term and potential cumulative impacts of multiple activities.;
- Evaluation and comparison of the existing and expected impacts against those of alternative options;
- Assessment of legal and institutional aspects relevant to the issues and impacts;
- Recommendations of broad measures to strengthen environmental management in the region or the sector.

In any case, a Strategic (Environmental) Assessment can only be carried out in relation to agreed global and regional environmental objectives and should result in a regional Environmental Management Plan (see below). For operationalising a Strategic Assessment, the development of indicators (e.g., Potts, 2006; Potts *et al.*, 2015), the setting of impact thresholds as well as consideration of resilience (Hughes *et al.*, 2005; Palumbi *et al.*, 2009; Walker, 2005), the ecological functions of rare species (Mouillot *et al.*, 2013), and ecosystem health (Tett *et al.*, 2013) are required.

3.4.5.3 Environmental Impact Assessments

Environmental Impact Assessments in the Area

Conducting environmental impact assessments (EIAs) is a general obligation under customary international law (ITLOS, 2011; Warner, 2012) and under the UN Convention on the Law of the Sea (UNCLOS, Articles 165(2) d, f, h and 206), reflected in Article 6 of the European Treaty. In the Area, EIAs are required to be carried out for mineral exploration activities exceeding the dimensions of research, for pilot mining and for exploitation applications (1994 Implementing Agreement, ISA mining codes, see also sources in Jaeckel (2015b, footnote 109). UNCLOS requires national jurisdiction to be '*no less effective than international rules, standards and recommended practices and procedures*' (Art. 208). Coastal states are expected to harmonise their respective national laws and regional policies accordingly.

In the water column above the Area, the high seas, presently no such general requirement to conduct an EIA of potentially harmful activities exists. However, for fishing with bottom-touching fishing gear outside the current fishing footprint as defined by regional fisheries management organisations, in so-called new fishing areas, Environmental Impact Assessments are required (UNGA Resolution 61/105 and ff., 2006; (FAO, 2009). This is to avoid damage or destruction to 'vulnerable marine ecosystems, VMEs' (see further Chapter 2.4).

With respect to minerals mining activities in the Area, the precautionary principle is to be implemented on two routes (International Seabed Authority, 2012; Jaeckel, 2017):

- The Authority is under a duty to establish and keep under review environmental rules, regulations and procedures to ensure effective protection for the marine environment from harmful effects which may arise from activities in the Area.

- Regulations impose a duty on each contractor to '*take necessary measures to prevent, reduce and control pollution and other hazards to the marine environment arising from its activities in the Area as far as reasonably possible using the best technology available to it*.'

'*The burden of the precautionary approach falls on the entity making the application and undertaking the EIA. The State [the Authority] and its decision-making authority bear the responsibility of verification*.' (International Seabed Authority, 2012). This verification would normally be achieved by peer review of the information supplied by the applicant, as well as monitoring the environment and surveillance of the activities. There may however be a conflict which will be difficult to resolve: in the case of deep seabed mining, the verifying authority will not hold applicant-independant data and information. Therefore, an independant assessment of the completeness and appropriateness of the data submitted and the assessments made will not be possible unless independant research programmes will deliver such information.

Possibly, a different set up and role model for the EIAs may be justified: all environmental data are to be submitted to ISA via contractual obligations anyway. ISA/an ISA-related body will carry out an Environmental Impact Assessment based on the informations delivered by the applicant, in conjunction with all available other data and experiences. The applicant will bear the costs.

It is the task of the Legal and Technical Commission, LTC, of the International Seabed Authority to only recommend approval of an application for an exploration (and later exploitation) contract, if it is satisfied that the application provides '*for effective protection and preservation of the marine environment*.' Contractors are therefore not required to prove the absence of risk, but the focus is on demonstrating that environmental protection is ensured.

However, so far no criteria are defined to unambiguously and transparently check whether the measures suffice to protect the environment. Several sets of criteria are required which:

- Define what effective environmental protection means;
- Establish criteria for the LTC to assess the environmental performance of the proposed work;
- Provide detail on expected EIAs for the proposed exploration and exploitation work, respectively; and
- Assess if and how the proposed project protects the marine environment.

As laid out in the technical report on environmental management needs for deep seabed mining (International Seabed Authority, 2012), the Authority considers a comprehensive risk assessment of the effects of large-scale commercial seabed mining impossible at the present time (see Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**). Reasons are among others the limitations set by the current level of knowledge and understanding of environmental baseline conditions, natural variability and the potential impacts of minerals mining. As a consequence,

> *'there is a need for the collection of more, and synthesis of all available data, as well as for a cautious, stepwise proceeding towards the exploitation of seabed minerals'*
> *(International Seabed Authority, 2015a).*

EIA in the exploration phase

The purpose of a prior environmental impact assessment in the exploration phase should be to ensure control over activities potentially causing negative effects on the marine environment, to ensure learning from experiences by operators of such activities, and to enable decision-making over tolerable and intolerable environmental changes caused by such activities. Ideally this would extend to a staged approach to testing of collection systems and equipment *in situ* (see also Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**).

As all activities in relation to mining on the deep sea floor are novel and no experience exists to date on the severity and longivity of environmental effects of such testing, it would be paramount to establish a fully transparent EIA process, such as proposed by and discussed in Durden *et al.* (2018). Such a multi-staged process will not only include public consultation but also feedback loops to Sponsoring States and the ISA in order to gain full control over the activities and related impacts (see below). This is also of utmost importance to initiate a process for developing standards for Best Environmental Practices, BEP, and Best Available Techniques, BAT.

According to the present regulatory framework, during the exploration phase, several types of activities require prior environmental impact assessment, accompanied by an environmental monitoring programme to be carried out prior to, during and after the specific activity (ISBA/19/LTC/8, sect. IV. Environmental impact assessment, § 19):

- Sampling resulting in a disturbance area of more than the limit specified in the respective guidance to contractors for specific mineral resources (sect. IV F. §31-33), *i.e.* for manganese nodules 10000 m^2 of seafloor.
- Use of systems to create artificial disturbances on the sea floor;
- Testing of collection systems and equipment;
- Rock sampling.

The Environmental Impact Assessment, as specified in ISBA/19/LTC/8 comprises the following elements[298]:

e) Delivery *at least one year before* the activity takes place and at least three months in advance of the annual session of the Authority

- Prior environmental impact assessment, including a general description and a schedule of the proposed exploration programme, including the programme of work for the immediate five-year period. This general description should include scientific baseline studies that would enable an assessment of the potential environmental impact of the proposed exploration activities; proposed measures for the prevention, reduction and control of pollution and other hazards to, as well as possible impacts on the marine environment; the preliminary assessment of the possible impact of the proposed exploration activities on the marine environment; the delineation of impact reference areas and preservation reference areas (§26).
- Some or all of the technical and environmental information requested in §27.
- Specification of the events that could cause suspension or modification of the activities owing to serious environmental harm, if the effects of the events cannot be adequately mitigated (§28).

f) Delivery *within one year* of the cruise (§35)

- Cruise report with station list,
- List of activities
- Other relevant metadata.

[298] Table 8 in Annex 6 lists all the elements required by contractors to be delivered and open issues in conjunction with an assessment of the possible environmental impacts arising from exploration for marine minerals in the area according to LTC guidance (ISBA/19/LTC/8 2013).

g) Delivery *within 4 years after* the completion of the cruise (§36)

- Data and information that are necessary for formulation by the Authority of rules, regulations and procedures concerning the protection and preservation of the marine environment and safety, other than proprietary equipment design data ... (as in Annex III, Article 14 (2));
- Metadata detailing "analytical techniques, error analyses, descritions of failures, techniques and technologies to avoid, comments on sufficiency of data and other relevant descriptors".

h) *Periodical* reporting (§37)

- Assessed and interpreted results of the monitoring;
- Raw data.

Wheras §21 specifies that '*Environmental monitoring data are required prior to, during and following test mining at the mining site and at comparable reference sites*', the provision of information on the monitoring programme is not listed among the information to be provided by the contractor to the Authority as part of the prior Environmental Impact Assessment information package (§26-28). As such, the design of the monitoring programmes does not seem to be open to critique and revision by the Authority or other competent external sources, such as from science or environmental advisory bodies of member States. Also the data and information generated through the monitoring programme will not be delivered to the Authority as part of a EIA process (see Durden *et al.*, 2018)) with feedback to the regulator on the observed impacts during and after the testing as opposed to the assumed impacts prior to testing.

The delivery of such data and information shall be done periodically as part of the contractors´ annual reports, at the latest 4 years after the cruise during which the disturbance was created as part of the annual contractor reports (ISBA/21/LTC/15 B. 10(a) and §38-39) This will preclude a detailed analysis and learning from the experiences gained during testing, except possibly by the Authority using not yet determined criteria and mechanisms. It is unclear, whether the assessed and interpreted results of the monitoring (§37) will become public, and in which form. So far, only the environmental data (§38) collected seem to fall under the clause to be made freely available to scientific analysis.

In addition, the period before and after the disturbance for which environmental monitoring is required is not specified at all. The only information given on monitoring is that

- The monitoring programme must be properly designed to be able to '*detect impacts in time and space and to provide statistically defensible data*' (§21);
- Mining tests and tests of any test-mining component should be monitored intensively and the information gained be made available (§23);
- Monitoring of test mining should allow the prediction of impacts to be expected from the development and use of commercial systems (§24).

However, the scope of the impact assessment has been determined to address (§22)

- Impacts on benthic, benthic boundary layer and pelagic environments;
- Not only areas directly affected by mining but also the wider region impacted by near-bottom plumes, the discharge plume and material released by transporting the minerals to the ocean surface, depending on the technology used.

As it stands, each contractor can run its own design of monitoring programme - each using different instrumentation, different spatial and temporal sampling and recording patterns, investigating an own selection of parameters. This will render the comparison between different contractors and the environmental impacts caused by their activities extremely difficult. To sum up, there is currently

- No prior review and reflection of the necessity of the disturbance/alternatives, the design of the technology used, and the design of the monitoring programme;
- No standardised minimum temporal and spatial monitoring programme design with a minimum set of compulsory indicators and assessment procedures;
- No post activity assessment of environmental impacts by ISA for gathering experience with the environmental effects of certain activities and technologies, thus no option for developing BEP or BAT over time, and no way to influence the design of the next contractor´s activity design from the learning experience.
- No transparency.

Some of the above elements certainly need development over time and may be spurred by scientifically monitored testing of equipment. However, in order to develop uniform standards for all contractors, ISA will need to initiate a process which enables a learning process integrating information from all areas within a region and all contractors.

Suggestion for review of the EIA process during exploration

The exploration phase should be instrumental to collecting data, information and experience on the environmental effects of disturbances of any kind, and the technical and environmental performance of equipment and collection systems to enable an informed decision on an application for a future Plan of Work for Exploitation. The exploration regulations and guidances for the three mineral resources in the Area allow for *in situ* testing at all scales (see chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**). Any small- to large scale experiences with disturbances of the deep seafloor or water column should therefore contribute to a pool of data and information held by the Secretariat/LTC and shared with the scientific community and the public, which can later be used to determine eventual activity thresholds, impact thresholds or mitigation measures, including the development of BEP and BAT standards.

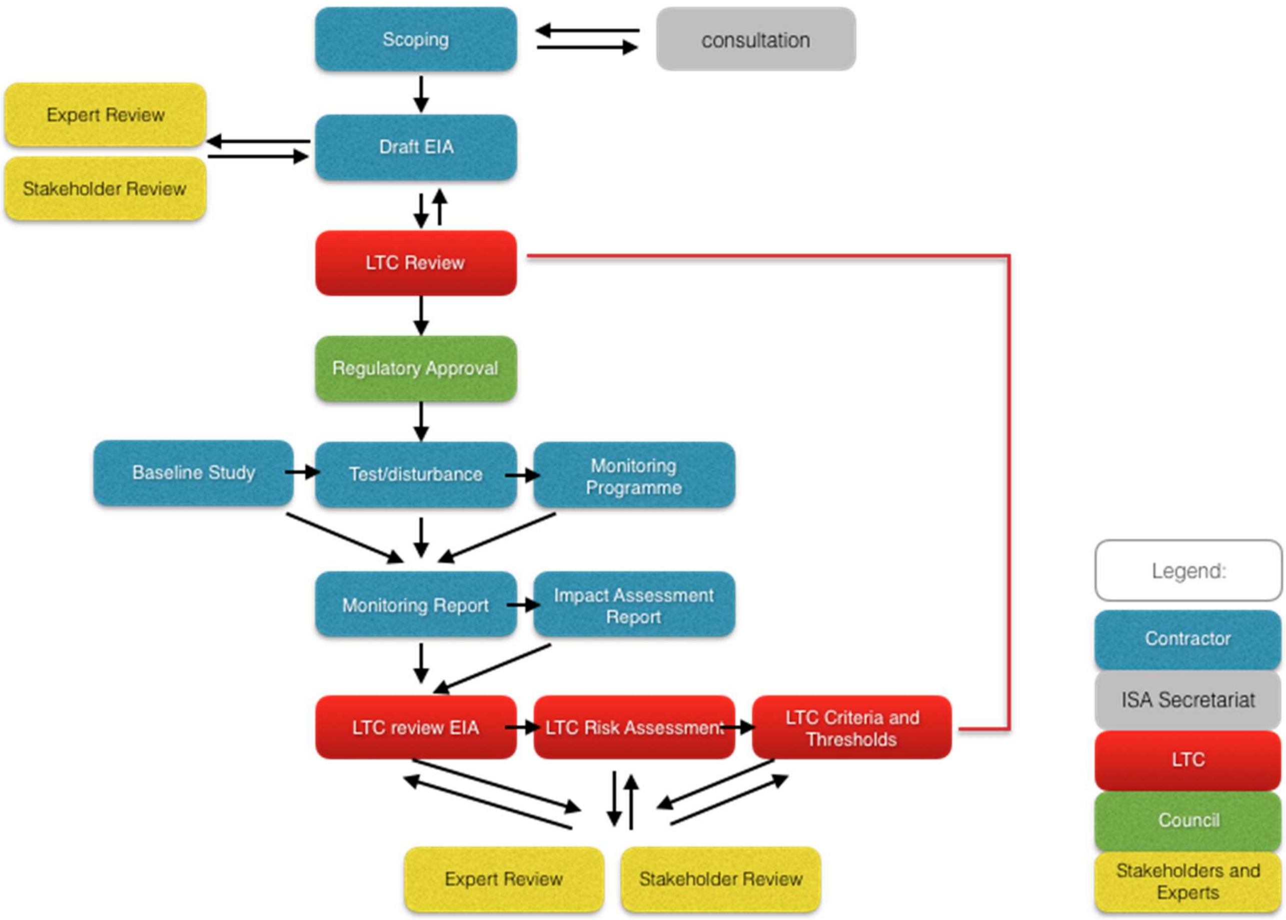
To this end, each activity that falls under the criteria of ISBA/19/LTC/8 to submit what is called a EIA to LTC prior to the activity being carried out, should be subject a standard EIA process, including public review and publication of the monitoring and impact assessment results after the disturbance. In addition, a standard minimum monitoring programme in line with best scientific practice should be required and reported on as part of the compliance reporting. The information requirements, the assessment standards and methods, monitoring and reporting should become more demanding and stringend with increasing risks from the activity, as indicated by the Seabed Chamber (ITLOS, 2011).

So far, no decision-making on the acceptability of the respective activity is foreseen at all, and no criteria exist for doing so. However, cumulatively, all experiences and data gained with such activities could lead to a knowledge pool which would enable the ISA organs to take the political and technical decision over acceptable environmental effects of activities related to seabed mining.

In order to develop this knowledge pool, it is imperative, that reporting, assessment and monitoring of all activities subject to EIA from all contractors are reasonably comparable and feed a common data and information pool. To this end also a EIA process has to be developed which seamlessly fits into the needs of decision-making in the future EIA ahead of commercial mining. Therefore, a similar EIA process as in the exploitation phase should be employed. An important precondition is that the testing of equipment and mining systems within the license area, preferably the later mining area, becomes mandatory for an exploitation EIA.

A further development of the current EIA requirements as in ISBA/19/LTC/8 is suggested. Building on a broad international experience, Durden *et al.* (2018) propose an 'ideal' EIA process in context with deep seabed mining in the Area, which is here modified to suit the needs of the exploration phase and feeds into the needs of a EIA prior to commercial mining during the exploitation phase (see **Fehler! Verweisquelle konnte nicht gefunden werden.**).

Figure 4 Proposed steps for using experiences with environmental effects from artificial disturbances during the mineral exploration in a ISA contract area, as reported by contractors, for developing decision-making criteria on disturbance levels.



The main suggestions for changing the requirements in ISBA/19/LTC/8 are to

- Introduce a sort of scoping process to develop the formate and elements of the prior EIA (Environmental Impact Statement) appropriate to the particular case. This could then also ensure that there are higher stakes for higher risks and all information accumulates into one comprehensive EIA report over the exploration period.
- Introduce an option for LTC to develop guidance on a standard monitoring programme - specify how many years before and after a disturbance, spatial and temporal set-up, minimum set of biota and processes - in order to be able to synthesise the information coming from different contractors. As long as there are no such guidances, monitoring and assessment should be designed according to best scientific standards - maybe request a scientific opinion?
- Require annual monitoring and impact assessment reports post activity, eventual a final report at the end of the contract. These can be used by LTC to develop risk assessment procedures and criteria and thresholds required for decision-making on commercial mining EIAs.
- EIA report (draft EIS) and monitoring+assessment results should be made available as timely as possible to enable experts and other stakeholders to keep track of the activities environmental impacts.

Using one and the same EIS template (International Seabed Authority, 2017b, Annex V) throughout the exploration and exploitation phase for all activities subject to EIA by one contractor in one contract area, over time, contractor and regulator/Sponsoring State will cumulatively gain insight into the environmental impacts of different technologies and scales of disturbances.

EIA in the draft exploitation regulations

The proposed governance framework for EIAs

Project-specific EIA (*i.e*. the decision-making on the environmental acceptability of an EIA application) should be embedded in an overall environmental governance framework from global (ISA Environmental Policy/Strategy) to regional (SEA, regional EMPs, see International Seabed Authority, 2017e). This framework does not yet exist. Yet, contractors would like to know the scope of their EIA obligations as early as possible.

Preconditions for and all steps to be taken in an EIA process prior to permitting exploitation operations, including the roles, timelines, participation and review, as well as performance criteria for the environmental reports and assessment have yet to be developed. Funding and institutional changes need to be clarified (to ensure an independent EIA). There are numerous models for EIA procedures in national legislation and international law (Espoo Convention1991; 2011a; Abaza *et al.*, 2004; CBD SBSTTA, 2010; Ellis *et al.*, 2017) and recent proposals how to develop appropriate procedures in context with deep seabed minerals mining in the Area (Collins *et al.*, 2013; Durden *et al.*, 2018; International Seabed Authority, 2017c, e).

As the development of the ISA exploitation code is in its early stages, so far mainly formal preconditions have been set out for Environmental Impact Assessments, in particular the Environmental Impact Statements to be delivered by applicants (International Seabed Authority, 2017b).

The criteria for the assessment of applicants (DR 7) concern mainly the financial and technical capabilities of the operator, the sponsor country and the economic feasibility of the operation. LTC needs to ensure that *'the EIS (and EMMP and CP) will meet the criteria specified in DR 7(3) and (4) with respect to the effective protection of the marine environment in accordance with Article 145 of the Convention*' (DR 21). The criteria for checking the technical capability of an applicant are:

- The necessary technical and operational capability to carry out the proposed Plan of Work in accordance with Good Industry Practice;
- Adopted internationally recognized quality control and management standards;
- Established the risk assessment and risk management systems;
- Necessary access to insurance.

According to this list, the applicants, like their Sponsoring States, only have the duty to ensure, not to provide evidence on the ground. This leaves wide open the question how environmental management will be carried out on the ground.

Likewise, the criteria in DR 7.4 for the Commission examining whether the proposed Plan of Work meets the conditions for effective protection lead back to DR 21 without any further specification. This leaves 'effective protection' undefined (see Chapter 3.4.6). A continued lack of conservation objective (see Chapter 3.3) and decision-making criteria and thresholds (see Chapter 3.4.6) will further intransparent procedures where details of applications and environmental assessments are not even disclosed to the member States and observers.

Problems with the proposed EIA process and EIS template

One of the points where this becomes evident is the application stage, when a potential operator is seeking approval of its Plan of Work, including the approval for its Environmental Impact Assessment.

In general, the effectiveness of an EIA process as an instrument to ensure environment protection depends on the comprehensiveness of environmental and technical baselines. Therefore, the information base provided by the applicant is crucial. To guide contents and depth of the EIS, there has to be a prior scoping determining which aspects are of particular importance and which aspects are not. Furthermore, it has to be clarified whether and how socio-economic aspects have to be considered. Finally, whether and how alternatives (including the no-action alternative, kinds of alternative) have to be taken into account.

Following the scoping exercise, an **Environmental Impact Statement, EIS**, is prepared by the applicant together with the regulating body and with public input. The EIS represents the body of facts for the EIA and as such to include a most comprehensive description and species inventory of the potentially directly and/or indirectly affected environment, and the specification of any likely significant effects with respect to biodiversity, habitats and ecosystems arising from activities in the Area such as:

- The use and/or disturbance of biotic and abiotic resources;
- The emission of pollutants, sediments, noise, vibration, light, heat and radiation, the creation of nuisances, and the disposal and recovery of waste;
- The likely risks to the environment (for example due to accidents or disasters);

The preliminary formate of the EIS is included in International Seabed Authority (2017b, Annex V), and the EIS shall [further] include (DR 19.2)

i) The results of the Environmental Impact Assessment in respect of the Environmental Impact Area;
j) An environmental risk assessment in accordance with Good Industry Practice;
k) A description of mitigation, monitoring and management measures;
l) The description of the environmental management system, based on internationally recognized standards; and
m) An assessment of any other issue referred to in the Recommendations for the guidance of contractors.

However, the EIS template itself as set out in International Seabed Authority (2017b, Annex V) does not request applicants to assess/evaluate the impacts caused by the activities on the physico-chemical, biological and socio-economic environment (Section 7-9): The preferred approach recommended only requires the <u>description</u> of

'(i) the nature and extent of any actual or potential impact, including cumulative impacts;

(ii) measures that will be taken to avoid, remedy or mitigate such impacts; and

(iii) the unavoidable (residual) impacts that will remain.

It is important for these sections to make clear the expected longevity of residual effects [and whether or not the biological environment is expected to recover, and in what timeframe, following disturbance.]'

It remains open whether at all, which body on which grounds and with which methods an <u>evaluation</u> of a likely significance of environmental and socio-economic effects from mining-related activities will be undertaken.

Comparing the EIS template annexed to the 2017 DR (International Seabed Authority, 2017b, Annex V), with the draft EIS template in International Seabed Authority (2017c), elaborated in cooperation with stakeholders, several crucial sections are missing, a.o.:

- Former Section 9 development timetable does not request reporting on monitoring during operations, rehabilitation and 'Commissioning and operational schedules' anymore;
- Former Section 13 for reporting on activities and results related to testing of equipment or mining systems;
- Former Section 15.2 for reporting on the impact assessment methods employed, incl. a first risk assessment;
- Former Section 8.4 on 'Hazardous materials handling'
- Former Section 8.8 description of the workforce;
- And in particular former Section 8.9 on a detailed description and evaluation of alternatives. Whereas in the 2016 workshop template (International Seabed Authority, 2017c), the applicant is requested to elaborate on alternatives considered and rejected from analysis with respect to
  - the site selection process,
  - the mining production scenario,
  - transport and materials handling,
  - on-site processing,
  - the no-mining alternative,

  The template included in the draft regulations (International Seabed Authority, 2017b) only asks for an '*overview of the other locations, methods, etc, that were considered, and rejected, in favor of what is being proposed'.*

In summary, the EIS template as currently included in the draft regulations (International Seabed Authority, 2017b) will likely not result in reliable and quantified assessments of likely environmental, health and socio-economic impacts or a substantial examination of alternatives. It is much more likely, that applicants will provide a lot of prosa which will not be comparable with that from other applicants or be suitable for regional impact assessments - not to speak of a serious external scientific assessment. This was also the case with the EIS of Nautilus Minerals (Coffey Natural Systems, 2008)

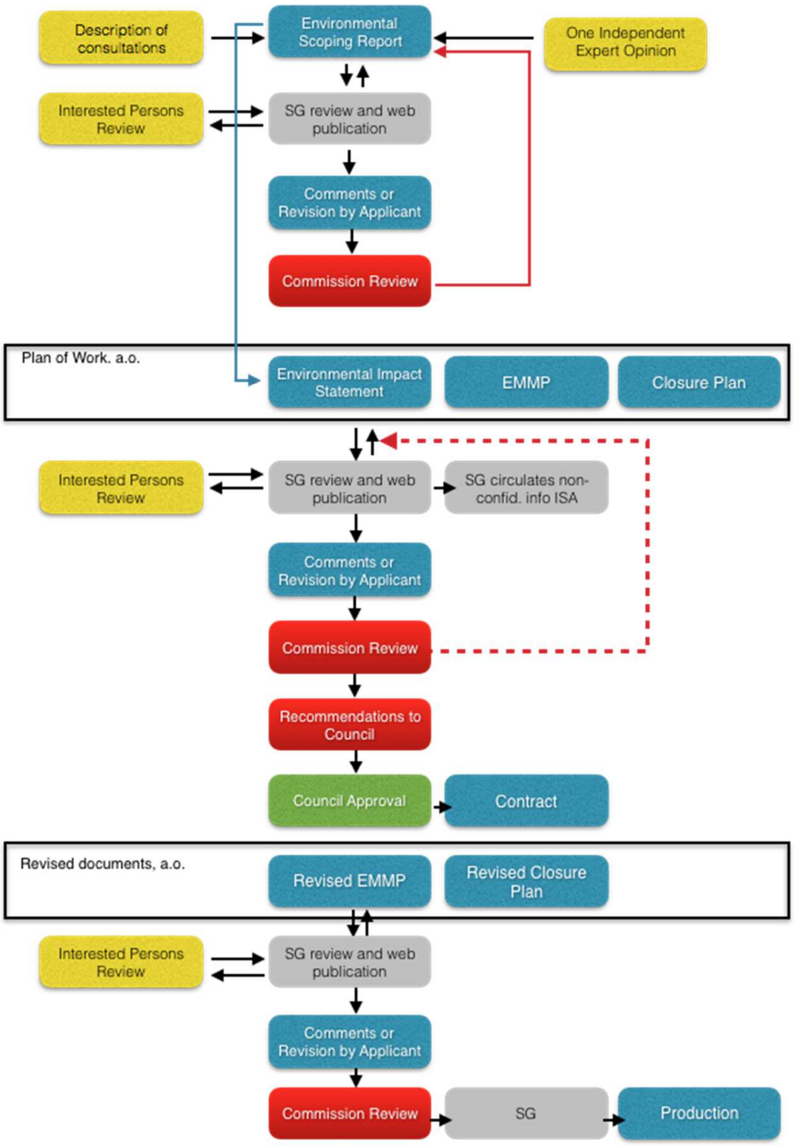
Also procedurally, the review of the application documents is limited. Draft regulation (DR) 19.3 requires applicants to submit the Environmental Impact Statement (EIS), together with the Environmental Management and Monitoring Plan (EMMP) and Closure Plan (CP) as part of its application for approval of a Plan of Work under regulation 4. These will be published and reviewed (DR10) and comments shall be taken into the considerations of LTC when evaluating the Plan of Work of the applicant. However, there is no feedback loop foreseen from the Commission to the applicant for eventual revision. The Commission can only recommend or discard a Plan of Work. This may mean that once a Plan of Work is on the table of the Commission, there are hardly any grounds for not approving it.

It becomes apparent that the Council will be consulted only once in the process, namely upon a recommendation issued by the Commission on a Plan of Work for exploitation. The Plan of Work includes a broad set of documents (see DR4) from which only the non-confidential parts will be disclosed to the Council. Experience from the exploration phase leads to the assumption that a brief summary will be provided as an information base to the Council and member States.

A contract will be issued upon the approval of the Council for a submitted Plan of Work, but prior to the submission of updated Feasibility Study, Financing Plan, Environmental Management and Monitoring Plan, EMMP, and Closure Plan which must be delivered to the Secretary General only one year prior to the start of production (DR22). The review of these revised documents will only be done by the SG, "Interested persons" and the Commission, and production will start upon acceptance of the documents.

The application process as described in International Seabed Authority (2017b) is outlined in Figure 6.

Figure 5 Simplified outline of the approval process for a Plan of Work, in particular the components relating the enviromental assessment and management, as suggested in the draft regulations (International Seabed Authority, 2017b). Contractor action is colored in blue, Secretary General in grey, the Commission in red, stakeholders/ interested persons in yellow and the Council approval in green. The dashed red line indicates the need for a feedback from the Commission to the applicant.



Suggestions for improving the EIA process during exploitation

The current draft exploitation regulation (International Seabed Authority, 2017b) lack a set of procedural preconditions which could help to ensure that only applicants and Sponsoring States with a good environmental track record are eligible for contracts in the Area, e.g.

- The explicit need for a prior exploitation contract with the ISA;

- The full compliance with the exploration contract, including criteria for determining what full compliance means in terms of environmental performance;
- The delivery of temporally and spatially adequate environmental baseline information (as testified by independant review);
- The designation and long-term monitoring of IRZ and PRA prior to (test-)mining;
- Subsequent to a prior risk assessment, fully transparent and scientifically monitored successful test mining at appropriate scales is required, which enables a reliable risk assessment and Environmental Impact Assessment. The results of the assessment shall demonstrate that the environmenal impacts of a full-scale mining operation will be acceptable within the limits set.
- The nature of the sponsoring state control of the activities of the operator.

Prior to the start of exploitation, environmental objectives, Regional Environmental Management Plans and Strategic Environmental Management Plans, developed and adopted by the ISA, should be in place to set the overall management framework within which to decide upon multiple applications for exploitation and their presumed environmental impacts.

Precautionary action needs to be at the heart of decision-making and pre-emptive action to avert serious harm to the marine environment incl.

- Definition of what effective protection/serious harm means, including criteria, indicators and threshold values (Levin *et al.*, 2016b) and how they contribute to the management aim as well as identification of consequences should risks of serious harm be identified (International Seabed Authority, 2017d).
- A regular assessment of environmental change on a local and regional scale based on comprehensive, publicly available environmental baselines.
- Identification of least destructive technical solutions and environmental practice.
- Support of the conservation of biodiversity through the creation of marine protected areas in proximity to the mining footprint (Wedding *et al.*, 2013);
- Adoption of an incremental test bed approach to a mining activity where impacts are uncertain, e.g. authorize test mining rather than immediately authorizing commercial-scale activity (Houghton *et al.*, 2017).

Prior to arriving at an operational EIA process, a number of technical issues have to be solved by ISA, such as:

- Clarification of the expectations with regards to the scope, quality and level of detail of the information contents of a Environmental Impact Statement, EIS, report and Environmental Management Plan; Clark *et al.* (2017) may be helpful to develop such quality standards.
- Recommendation of methods for assessing and evaluating the environmental change, and if data are sufficient, the level of environmental risk. This may include the recommendation of certain types of models or other means in line with highest scientific standards;
- Enabling inter-contractor comparisons and synthesis of data by design of a compulsory minimum standard environmental investigation programme including standard assessment methodology for evaluation of data and information and incentives for more extensive work (guidance on monitoring and assessment);
- Agreement on indicators for environmental intactness, as well as criteria and thresholds to guide decision-making on acceptablity of impacts related to operation under application (guidance on decision-making).
- Determination of methods for Regional integration of all available data and evaluation of cumulative and synergistic effects;
- Clarification of the nature and scope of alternatives to be examined;
- Guidance on mitigation options, do they exist at the scale required?

- Agreement on methodology to determine and implement best environmental practice and best available technologies?
- Impact reference zones as a monitoring approach;
- Procedural integration of independent review and advice;
- Assessment of major accidents/incidents.

In the EIS, the **impact description** provided by the applicant should cover all activities related to the process chain of minerals mining, and address to the extent possible quantitatively the likely

- Direct, indirect and secondary effects,
- The cumulation of effects with other existing and/or approved projects, taking into account any existing environmental problems relating to areas of particular environmental importance likely to be affected or the use of natural resources;
- Transboundary,
- Short-, medium- and long-term,
- Permanent and temporary,
- Positive and negative effects of the project.

This description should take into account the environmental protection objectives as specified in UNCLOS and as agreed for the Area and its subregions by ISA (see 2.2.) and enable the responsible body of the ISA to carry out an independant assessment of the **likely significant effects** on the marine environment, taking into account:

- The magnitude and spatial extent of the impact (for example geographical area and size of the population likely to be affected);
- The nature of the impact;
- The transboundary nature of the impact;
- The intensity and complexity of the impact;
- The probability of the impact;
- The expected onset, duration, frequency and reversibility of the impact; the cumulation of the impact with the impact of other existing and/or approved projects;
- The possibility of effectively reducing the impact.

Other criteria to be considered include the resilience of the affected environment, the existence of environmental standards or the degree of public interest (European Commission, 2000a). Climate change and biodiversity are particularly important parameters to be integrated to all steps in the EIA (and SEA) (European Commission, 2013): Climate change trends and interactions with biodiversity are the evolving baselines, likely to influence the long-term perspectives and impacts of a project, which should be looked at cumulatively in an ecosystem approach to management with the aim to '*avoid biodiversity and climate change effects from the start, before considering mitigation or compensation. For biodiversity, EIA should focus on ensuring* no-net-loss' by a.o. avoiding irreversible losses of biodiversity (see also IAIA, 2005).

Ecosystem services provided by biodiversity should be an integral part of the assessment (Abaza *et al.*, 2004). The main **biodiversity concerns** are

- Degradation of ecosystem services,
- Loss of habitats, fragmentation (including the extent or quality of the habitat, protected areas, incl. N2000 sites, habitat fragmentation or isolation, as impact on processes are important for the creation and/or maintenance of ecosystems,
- Loss of genetic diversity.

In order to be effective with regards to ensuring a more sustainable use of the environment, the no-net-loss or any other environmental sustainability goal needs to be a binding objective to any EIA process and decision-making (Jay *et al.*, 2007). However, in practice, the neglect for clear technical standards and inconsistency in decision-making over the significance of impacts, in particular with respect to valuing the sensitivity of biota is leading to assessments which come to different results for comparable impacts (Maclean *et al.*, 2014; Wood, 2008). Also the inherent natural variability of ecosystems and the fuzziness (no strict thresholds in biology) of impacts may prevent consequent decision-making.

Deep seabed minerals mining will have a considerable, yet unquantifiable bearing on all three of biodiversity concerns listed above. In particular the aim to ensure no-net-loss of biodiversity will likely be impossible to verify due to the lack of ecological overview at relevant scales (Niner *et al.*, 2018; Van Dover *et al.*, 2017)(see Chapter 2.3) and the resulting inability to predict the likely extent of ecological impacts with some certainty. Also the mitigation hierarchy will not provide viable options to avoiding biodiversity loss due to mining operations (Van Dover *et al.*, 2017). An alternative option could be to follow the alternative strategy to set significance thresholds for particular habitat types or ecosystems such as for Commonwealth marine areas in Australia (Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Yet, as long as it cannot be determined which species, habitats and functions are crucial, such an approach may eventually just direct the attention on the wrong issues.

3.4.5.4 Dealing with risks and uncertainty

The perception of risks is highly individual. [299] It depends not only on the magnitude and probability of the damage but also on the (perceived) controllability of consequences, its nature and whether being expected and of personal relevance (Vlek, 2004 in van der Sluijs and Turkenburg, 2009). There is also a cultural plurality to environmental or economic risks. Therefore, a systematic approach to the assessment of risks from an activity such as deep seabed mining is required to enable the regulator and/or the operator an objective evaluation of the likely risks involved on the regulatory and the project-scale.

Generally, a major impediment is seen in the problematic of setting a safe level impact baseline due to the uncertainty of the risks, such as in the case of greenhouse gas emissions (van der Sluijs and Turkenburg, 2009). This is also relevant to deep seabed mining (see Chapter 3.4.6). The application of the precautionary principle, as detailed in Principle 15 of the Rio Declaration 1991,

> *'In order to protect the environment, the Precautionary Approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.'*

is invoked where risks have been identified but cannot be assessed and managed due to scientific uncertainty e.g. due to a lack of appropriate investigations (ignorance, Buhl-Mortensen, 1996; Frid *et al.*, 2006; Hildén, 1997), poor data analysis (Buhl-Mortensen, 1996; Friess and Webb, 2011), limited transferability of existing scientific results (incommensurability) or a general unlikeliness to ever understand the complexity and variability of ecosystem functions, such as in the deep sea (ontological uncertainty, Cooney, 2006; Walker *et al.*, 2003). The latter is what was called the 'unknowable' by the

[299] Risk perception is defined in ISO Guide 73:2009, as a 'stakeholder's view on a risk'. According to the Guide, risk perception reflects the stakeholder's needs, issues, knowledge, belief and values.

Census of Marine Life Project (COML, 2010)[300]. Therefore, more research does not necessarily reduce uncertainty (usually, new questions are raised), and political decisions have to be made before conclusive evidence is available (Wardekker *et al.*, 2008).

Both types of uncertainty, the imperfection in scientific research and the 'unknowable' underlying natural variability, are inherent to the prevailing knowledge and understanding of the deep sea, and thus limit the capacity to assess change in the natural environment overall, and any degree of impact on natural processes caused by deep seabed mining.

The difficulty to assess and incorporate uncertainty in the evaluation of risks leads to differential applications of the precautionary principle, from precaution in the sense of prevention of eventual damage on the one hand, to science (evidence)-based regulation on the other (e.g. Stirling, 2001). In view of the unavoidable biasses inherent in the pure scientific risk management, it is recommended that the acknowledgement of uncertainty under a precautionary approach, including a step-wise process to remedy the open questions, may be the scientifically most rigorous way forward to an appropriate regulatory process. As an important component, this may include the differentiation between what is known, what is almost certain and what is less certain (Rosenberg, 2007).

So, is risk assessment only possible in data-rich environments? In the deep sea, knowledge is generally poor for numerous reasons (see Chapter 2.3), and it is unlikely, that it will be possible to predict the effects of seabed minerals mining with any certainty.

How can risk assessment be made a useful tool to address the limited understanding in a precautionary way? How can it be used to integrate the risks for deep sea ecosystems arising from natural and human-induced pressures such as climate change (Levin and Le Bris, 2015; Sweetman *et al.*, 2017) or mining (Levin *et al.*, 2016b; Van Dover *et al.*, 2017)?

Risk assessment and management for implementing the precautionary principle in the EU

The EU Commissions' approach to using the precautionary principle (European Commission, 2000b), adopted by the European Parliament, is based on the finding that in practice, its application is appropriate where '*there are reasonable grounds for concern that the potentially dangerous effects on the environment, human, animal or plant health may be inconsistent with the high level of protection chosen for the Community*'.

However, the Commission emphasises that the full scope of its application depends on case law, which to some degree is influenced by prevailing social and political values. Along that line, Stokes (2008) observed a move in recent years of European Courts to interpret the precautionary principle more and more from a risk assessment perspective, requiring that clear, or 'concrete', evidence of harm is established before intervention is justified. She posits three explanations for this shift: (i) the 'better regulation' initiative within Europe; (ii) the Commission's Communication on the Precautionary Principle; and (iii) WTO litigation on precautionary safeguard measures.

[300] Quote from CoML, 2010: '*As it worked, the Census found that the causes separating the known, unknown, and unknowable about marine life fall into five categories: the invisibility of the lost past, the vast expanse of the oceans, difficulties of assembling knowledge of parts into knowledge of a whole, blinders we put on ourselves by choosing not to learn or spend, and unpredictable disturbances such as tsunamis.*'

Case Study European Commission Guidelines, 2000

The Communication (European Commission, 2000b), comes with guidelines defining criteria for applying the precautionary principle in practice. The Commission recommends to determine precautionary measures within a decision-making framework of risk analysis and management. A generally prudent approach should be part of the risk assessment policy, prior to the actual risk assessment.

The **decision-making process** is structured in three steps:

1. 5-steps risk assessment process (see below),
2. The choice of risk management and
3. The communication of the risk.

Based on a complete-as-possible scientific evaluation with identified uncertainties, (1.) it has to be determined whether, and (2.) which precautionary action is deemed necessary. As the Communication stresses, the judgement on what constitutes an 'acceptable' level of risk for society is a political decision. It involves the weighing of social, economic and environmental factors against the legal and environmental objectives of the EU, including inherently dynamic perceptions of the societies (Proelß and Houghton, 2012). Therefore, (3.) transparency and the consideration of public concerns are important components of the decision-making process.

The decision-making on the acceptability of the environmental, social and economic risks to be expected can either result in a decision not to act, or to initiate measures of some kind (European Commission, 2000). Such **measures** should be consistent with the principles of risk management, *i.a.* be

- **Proportional** to the chosen level of protection.
- **Non-discriminatory** in their application
- **Consistent** with similar measures taken
- Based if possible on a **economic cost/benefit analysis** of action/inaction
- **Subject to review**, *i.e*. be adapted to more complete scientific knowledge, and maintained only as long as uncertainty persists
- Capable of assigning responsibility for producing the scientific evidence necessary for a more comprehensive risk assessment

Under this frame work, the **burden of proof** or the responsibility to deliver scientific evidence to enable a risk assessment can be allocated either

- Fully on the operator - in cases of positive lists of substances are deemed *á priori* hazardous
- Fully on the legislator, the user or other public stakeholder - in cases where no prior approval is required
- On a case by case basis as a follow-up of precautionary measures taken on the applicant to deliver better data to enable adaptation of measures.

Integrating the consideration of risk into the management cycle

Ecological risk assessment '*evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors*' (EPA, 1992). In the case of deep seabed mining, the direct and indirect effects of the mining activity on the marine environment are to be considered from seabed to surface. The risk needs to be evaluated in conjunction with other prevailing risks for environmental change against objective criteria and thresholds which are independent of management measures.

A useful approach is to integrate the assessment of the risks to the environment into an Ecological Risk Assessment Framework (ERAF) for ecosystem-based oceans management, such as the one proposed by O *et al.* (2015). Here, the risk assessment is part of an overall management cycle, including

- The characterization of the ecosystem and socio-economic environment, assessments and gap analyses;
- The adoption of high level objectives;
- After the conduct of an ecological risk assessment, identification of indicators, thresholds and target,
- The refinement of conservation objectives to be SMART, and setting of operational objectives;
- The consideration of management options for the risks perceived in view of all objectives and legal framework, taking account of the risk assessment results, the above conservation and operational objectives, the legislation and regulatory framework and policy priorities;
- The monitoring and assessment of the effectiveness of the management measures and the development of ecosystem status against the set indicators and conservation objectives.

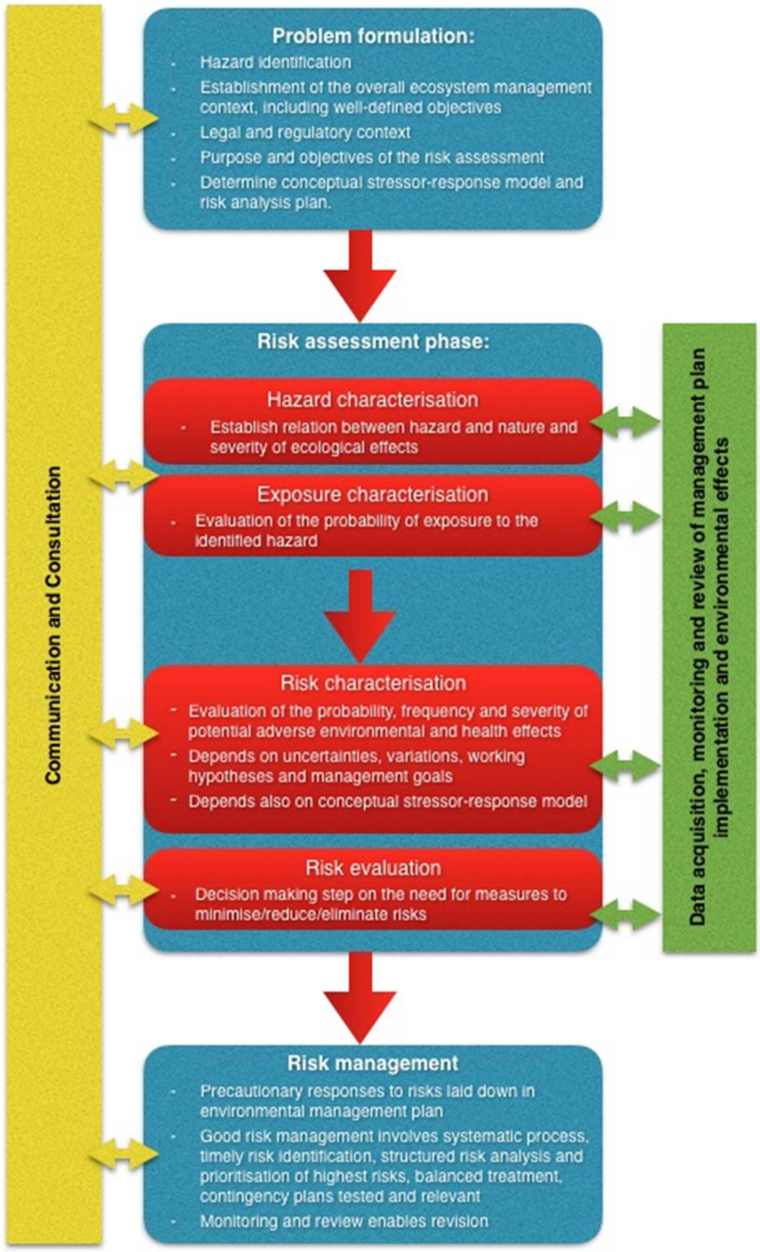
Similar to O *et al.* (2015), ICES (2013) and UNECE (2012) consider a prior establishment of the overall ecosystem management context, including well-defined objectives as preconditions of an environmental risk management process. This feeds into the problem formulation phase, which should articulate the purpose and objectives of the risk assessment and define the problem and possible regulatory action.[301]

A multitude of different risk assessment schemes is recommended by various sources, differences primarily being the naming and scoping of the steps in the process. In the ecosystem risk management approach adapted from the ISO 31000:2009 risk management standard (ICES 2013) distinguish risk assessment, risk treatment, risk communication and review, with risk assessment involving steps of risk identification, risk analysis and risk evaluation. All steps require multiple feedback and exchange actions (ICES, 2013).

In the following, the description of the phases involved in successful risk management follows a modified concept as given in (ICES, 2013) with a problem formulation phase as recommended by EPA (1998), see Figure 7, and the four steps in the risk assessment phase as detailed by European Commission (2000, Annex III). It is important to note that communication and consultations can/should take place in adequate form throughout the whole process to ensure transparency and enable scientific advice. Data acquisition and later monitoring and implementation review are characteristics of the assessment phase.

[301] see e.g. EPA 1998. Guidelines for Ecological Risk Assessment EPA/630/R-95/002F https://www.epa.gov/sites/production/files/2014-11/documents/eco_risk_assessment1998.pdf

Figure 6 Ecosystem risk management approach modified after ICES (2013), EPA (1998) and European Commission (2000).



Ecological risk assessment and management in the Area

In theory, lack of knowledge and experience in relation to the environmental, social and economic consequences of a deep seabed mining development should automatically trigger precautionary action: ideally a halt to the development in order *to avoid serious and irreversible harm* until it can be shown that no such risk exists. In practice, the developer has to demonstrate that no such harm will arise from the developments (realizing the changed burden of proof). However, as long as no comprehensive baseline scientific knowledge exists, such claims cannot be verified or falsified.

Therefore, the application of the systematic problem formulation - risk assessment - decision making framework as shown above will help to ensure an objective consideration of the acceptability of certain risks, and once this decision is taken, about the required measures to limit environmental change to pre-agreed levels. In particular, the **risk evaluation resulting from the assessment**

process, which should be based on a widely consulted problem description is crucial. The political decision taken on the acceptability of the expected environmental change requires a broad, inclusive public debate about the subject prior to having the first developments and investments on the ground.

Therefore, overall risk assessment of new and developing policies, plans and projects should ideally be at the core of a Strategic Environmental Assessment (see Chapter 3.4.5.2)., considering the cumulative and large scale environmental impacts from all sources. This has to precede any project-scale Environmental Impact Assessment.

Problem formulation incl. hazard identification

Prior to entering into the assessment of any risks, a comprehensive problem formulation is required. Wolt *et al.* (2010) distinguish two phases:

- The elaboration of the **problem context** which develops the parameters and identifies constraints for the ecological risk assessment process, which may arise from the binding and non-binding regulatory framework. It sets the parameters for the risk assessment, including protection goals, environmental scope, the environmental values to be safeguarded in any case, the assessment methodology. In addition, the problem context describes the specific case in question, with a determination of all possible hazards/pressures and resulting risks based on comprehensive baseline information. A critical part of this phase to determine observable, measurable properties that allow to check whether the environmental quality is still within the desired boundaries.
- The **definition of the problem**. Here a scoping exercise to prioritize the potential risks identified in the context formulation phase to shape the risk assessment into a manageable form for analysis. The identification of inherent uncertainties is a precondition for an adequate risk assessment process.

Further to compiling the statutory context of an activity, hazard identification is the next step to find, recognize and describe risks.

'Hazard identification means identifying the biological, chemical or physical pressures that may have adverse effects, i.e. causing with some likelihood a change of state in the environment.' (European Commission, 2000b, COM (2000) 1, Annex III).

At this stage, a comprehensive list of events that might create, enhance, prevent, degrade, accelerate of delay the achievement of objectives is required. The risks may be direct or indirect, and include the risk of no action (ISO 31000). DNV-GL (2016) propose to apply a method called environmental aspect and hazard identification (ENVID)[302] which is a cooperative process to identify both accidental events and planned operational procedures related to a [mining] operation that can cause an impact on the environment. This method can be applied by individual operators, or for collective hazards, by the regulator.

In the case of the envisaged deep seabed minerals mining, this means that the pressures from machinery and operations on the seafloor, in the water column and on the surface, including during transport and re-loading are clearly determined. This includes the establishment of technical data such as weight of machinery, noise generated, quantities of material moved or crushed, area mined per unit time and longevity of the operation. The machinery creates hazards to the marine environment through four main operating processes (SPC, 2013b, c):

- The dislodging of minerals including the physical removal of organisms, rock and sediment;

[302] see e.g. http://www.hazoptima.com/products/envid-environmental-aspects-identification/

- The creation of a sediment plume significantly enlarging the actual mining footprint in time and space
- The dewatering of the ore onboard a ship process which delivers contaminated and potentially highly turbid seawater into the water column; and
- The operation of the mining equipment giving rise to disturbance due to noise, light, vibrations, oil spills and leaks from hydraulic equipment, sewage and other contaminants from the ore carriers and support vessels.

Polymetallic nodules, cobalt-rich crust and seafloor massive sulphides are each part of a different deep sea ecosystem (abyssal plain, seamount slopes, hydrothermal vents on ocean ridges and seamounts), where the operation of the respective mining equipment will result in different hazards and risks. The actual hazard posed by the activities to the marine environment are then specific to the local environment and the type of mineral exploited and subject to the spatial and temporal patterns of disturbance.

However, there is one commonality in the effects of mining on all three habitats: the activities will lead to the removal of abiotic and biotic structure on the seabed at various scales from micro- to megastructure. The resultant homogenization alone will reduce biodiversity due to lack of niches and biogenic structure (Buhl-Mortensen *et al.*, 2010).

So far, the technical equipment and processing required for the exploitation, transportation and refinery of minerals from deep seabed sources has either not yet been developed or, in the case of mining seafloor massive sulphides by the company Nautilus Minerals, not yet been tested in practice.

After to the identification of pressures that may pose risks to the environment (or to the success of a company or regulatory decision) the prioritization of the risks according to the magnitude of the threat to the environment is required to clearly define the following risk assessment procedure.

Overarching protection goals play a key role in a proper risk assessment process when broken down to measurable (SMART) objectives. This is likely to be a major problem in the deep sea, as there is not only uncertainty as to the appropriate biota or other environmental parameter to use as indicators, but also are the causal mechanisms and time scales of change completely unknown. Therefore, the necessary hypotheses on risks have to err on the precautionary side.

An inadequate problem formulation may add to the prevailing uncertainties. Wolt *et al.* (2010) provide several example outcomes of such inadequate problem formulation, including continuing request for more data, disproportionate risk mitigation measures and miscommunication of risk findings, all of which leads to increased environmental concerns and delayed decision-making.

Risk assessment

Generally, a risk assessment framework should be (Hobday *et al.*, 2011):

- Comprehensive (identify and analyze all potential hazards);
- Flexible (applicable to all types of activities);
- Transparent and repeatable (be clear about the methods, data, and assumptions used in the analyses);
- Understandable (easy for everyone to follow);
- Cost effective (make use of existing knowledge, information, and data within realistic limits of time and resources);
- Scientifically defensible (independent scientific peer review);
- Useful for management (inform appropriate responses); and,
- Take a precautionary approach to uncertainty.

The focus of risk assessments vary with the main source of risk identified.

Hazard characterization

'Hazard characterization consists of determining, in quantitative and/or qualitative terms, the nature and severity of the adverse effects associated with the causal agents or activity. It is at this stage that a relationship between the amount of the hazardous substance and the effect has to be established. However, the relationship is sometimes difficult or impossible to prove, for instance because the causal link has not been established beyond doubt' (European Commission, 2000b, COM (2000) 1, Annex III).

Hazards that adversely affect the assets, the economy or safety of humans become 'risks', can originate or be exacerbated by human activities (Elliott *et al.*, 2017).

a) General characteristics of ecological impacts to be expected from mineral mining

There is no uncertainty as to the destructive effects of deep seabed minerals mining, only in relation to the magnitude and persistence of impacts.

Any mining operation will have ecological effects on a much larger area than the actual mine site and include the water column habitats, (see Chapter 2.4). In the case of polymetallic nodules probably at least 2-5 times the size of actual mined area (Thiel, 2001, see below). To be economically viable, the operation must continue for 15 to 20 years (Volkmann and Lehnen, 2017), causing a very **long lasting** and accumulating impact on the deep sea.

The mining of manganese nodules, polymetallic suphides and cobalt-rich crusts will **deepen the direct human impact** to ocean zones so far least affected (except for pollutants, garbage and the indirect effects of climate change in terms of hydrological and chemical alterations). Given the important role of the oceans in the mitigation of climate change effects, and the resulting pressures on the ecosystem, the conservation of intact, resilient ecosystems to provide the full range of ecosystem services is a core interest of mankind.

The real extent of the risks from deep sea mining cannot be assessed as the **ecological baselines are missing**. Neither the species pool, nor the communities or the ecological functioning in the various deep sea ecosystems is sufficiently known (see Chapter 2.3). On the other hand, new discoveries may reveal so far unknown treasures of high values to humans (e.g. for medical use, for energy generation).

Deep sea mining will take place in remote, naturally little perturbed regions of the ocean. Therefore the species and communities inhabiting bathyal and abyssal depths are **not adapted to cope with disturbance**, but rather with unregular and scarce food opportunities. This favours species with slow growth, long life spans and few and irregular recruitment.

The **recovery** of species and habitats directly impacted by mining can therefore not be predicted or even estimated, and is likely to take decades to millennia depending on the species concerned (see chapter 2.4). The mineral seafloor habitat (the nodules, the SMS deposits and seamount crusts) takes millions of years to form again and are thus a non-renewable resource. The soft sediment habitats may recover earlier, but not within a human lifetime as abyssal disturbance experiments and 26 y time-laps photographs have shown (Chung *et al.*, 2002; Miljutin *et al.*, 2011).

All deep-sea species, habitats and ecosystems when at risk from human activities have to be considered as **vulnerable marine ecosystems** (see Chapter 2.4). In addition, these ecosystems are prime candidates for ecologically and biologically significant areas according to the criteria adopted by CBD (Convention on Biological Diversity, 2008), and therefore for designation as part of the global network marine protected areas and protective measures.

The general **categories of impacts** to be expected from deep seabed minerals mining are

- **Physical impacts** due to removal of the substrate, perturbation of the upper sediment structure, re-sedimentation of soft sediments, deployment of waste rock, machinery on the seafloor and water column, noise generated by the operation, litter, modifications of water and sediment properties, etc.

- **Chemical impacts** due to pollution on the ground, waste water during surface processing, normal ships operation
- **Environmental impacts** caused by the physical and chemical impacts of mining which are
- Additive to natural disturbance
- Additive/cumulative over space and time due to very long, continuous periods of activity. The impacts have to be looked at in an integrated and cumulative way within an Ecosystem Approach such as against the objective to achieve Good Environmental Status (GES), as required by the Marine Strategy Framework Directive (MSFD).

The degree of impact on communities depends on degree of natural disturbances. Natural disturbance is generally decreasing with depth, with the exception of hydrothermal vents which are to a varying degree spatially and temporally dynamic ecosystems (Van Dover, 2014).

b) Risks to abyssal fauna

The environmental impacts of mining the nodules will include (modified from Glover and Smith, 2003):

- Removal of the only hard substrate present on the deep sea floor, thus habitat loss and local extinction of nodule fauna as well as functionally associated epifauna
- Removal and overturning of the top 5 cm of sediment, altered oxygen, nutrient and toxic contents in bottom water layer, loss of bioturbation layer, leading to complete change of sedimentary and benthopelagic habitat;
- Creation of constant sediment plume with re-sedimentation of suspended sediments in adjacent areas leads to smothering/burying the the low disturbance, low nutrients system benthic in- and epifauna, both for filter- and sediment feeders by animals.
- Suspension of the fine abyssal sediments leads to high turbidity in benthopelagic layer up to 100 m, possibly impacting the nutrition balance and clogging the feeding apparatus of both benthic and benthopelagic filter feeders;
- In addition, likely the discharge of toxic effluents, acid mine tailings in surface or deepwaterlayers may lead to bioaccumulation and contamination effects on physiology, increased turbidity;
- Constant noise and lights interfere with marine mammal and other organism communication system.

The **footprint** of a single manganese nodule mining operation will be enormous. According to a German study (Kuhn *et al.*, 2011), the exploitation of manganese nodules will be commercially viable if a mining operation can process annually 2 mio tons of nodules at a minimum density of 10 kg dry weight/km^2, and for a lifetime of the operation of at least 20 years. This will require the harvesting of nodules from ca. 200 km^2 per year, or about 70 soccer fields per day. In 20 years, this will sum up to the direct physical destruction of 4000 km^2 of seafloor.

It is expected that redeposition of suspended sediments impact and area at least 2-5-fold larger than the actually mined area (Thiel, 2001). Per ton of nodules excavated, it has been estimated that 2.5-5,5 t sediment will be resuspended (Amos and Roels, 1977), resulting in sediment concentrations of 3 to 30 times the ambient concentration within approx. 100 m of the source (Ozturgut *et al.*, 1981). To be economically viable, the operation must continue for 15 to 20 years, causing a very **long lasting and accumulating impact** on the deep sea, resuspending annually ca. 500x10^7 t of sediments (Sharma *et al.*, 2001). This will result in at least 8000-20000 km^2 of impacted abyssal plain.

Glover and Smith (2003), assuming lower densities of nodules, conclude that '*in any given year, nodule mining by two or three contractors might severely damage seafloor communities over areas of 1200-12000 km², and 15 years of such mining could impact as much as 180000 km² of seafloor*'.

c) Risks to hydrothermal vents and deposit fauna

Van Dover (2014b) considers mineral extraction to be

> *'The single proposed enterprise that could have major, local, impacts on vent ecosystems; the impact of a single mining event is arguably expected to be on the scale of a volcanic eruption.' 'Of particular concern is the impact of cumulative mining events in a region, with potential for species extinctions and unanticipated changes in ecosystem structure and function if the extractive activities aren't appropriately managed.'*

The expected **risks and impacts** of mineral mining specific to benthic communities at SMS mine sites can be summarized as (Van Dover, 2007; Van Dover, 2011):

- Loss of sulphide habitat;
- Degradation of sulfide habitat quality;
- Modification of fluid flux regimes;
- Local, regional, or global extinction of endemic or rare taxa;
- Decreased diversity (at all levels: genetic, species, phylogenetic, habitat, etc.);
- Modification of trophic interactions;
- Risk of transplanting organisms from one mining site to another;
- Exposure of surrounding seafloor habitats (non-sulfide) to sediment and
- Heavy metal deposition;
- Cumulative impacts of multiple habitat loss events within a region;
- Lost opportunity to gain knowledge about what is currently not known.

In addition to the direct effects of mining on the benthos of the mine site, mining SMS deposits in deep waters, such as in the Manus Basin vent fields as envisaged by Nautilus Minerals Inc., will affect three broad pelagic ecological zones in addition to the directly impacted bottom zone (Gena, 2013):

- The surface mixed layer down to 200 m depth with mostly pelagic fish species such as tuna, squid and sharks, dolphins, turtles and migrating whales.
- The mesopelagic zone between ~200-1000 m depth, with vertically migrating fauna including squid, foraging tuna and migrating whales.
- The bathypelagic zone, where the water column is deeper than ~1000 m, where in the Manus Basin, animals typical of active hydrothermal vent sites, such as gastropods, shrimp, crabs, barnacles, etc. occur. Away from active venting, the deepwater fauna includes bamboo coral, stalked barnacles, hydroids and other sessile filter feeders. Benthopelagic taxa include octopus, swimming sea cucumbers, Chimera, deep sea fish species.

Gena (2013), based on Blackburn *et al.* (2010), and Boschen *et al.* (2013), expects impacts on each or any of the **pelagic zones** from

- **Desalination** of seawater on the production support vessel (PSV) and consequent brine discharge of treated water.
- Water **pollution** caused by accidental hydraulic fluid leaks, fuel spills during transfers at the site of the production support vessel, ore spills during transfer to barges and bulk ore carriers and in extreme cases due to accidental collisions resulting in loss of vessels, or loss of material from Riser and Lifter system.

- **Noise and vibration** disturbance from vessel power generation, its dynamic positioning system, and the Seafloor Mining Tool within a 2 km radius, however the sounds may be audible to whales at up to 600 km distance. Masking effects may occur within approx. 15 km distance from the source.
- **Sediment plumes** and dewatering discharges
- Large amounts of unconsolidated sediments and waste rock have to be separated from the mined ore and disposed on site which will generate sediment plumes smothering the seafloor and impacting the pelagic communities. Modelling studies indicated that increased sedimentation thicknesses of up to 500 mm may occur within 1 km of the discharge site (Coffey Natural Systems, 2008). Some particulate material may extend up to 10 km from the site, but settle at lower than natural rates. It is assumed that the high concentrations of heavy metals in these plumes will pose a minimal risk to vent fauna, but eventually a substantial risk to fauna adapted to inactive deposits or the general background fauna (Boschen et al., 2013).
- **Dewatering** of the mined material (the slurry) will lead to large amounts of oxydized, acidified and toxic waste water which will be pumped back to sea. Toxic effects are to be expected at local to regional scale for a prolonged duration, at least for non-hydrothermal vent organisms downstream of the mining site.

Further details are given in Chapter 2.4.6.1.

d) Risks to seamount fauna

There is currently no developed technology for mining the cobalt-rich ferromanganese crusts on seamounts. So far, the thickness of the crust can only be measured by drilling, which does not enable a volume estimation easily. For recovery of the crust, it will have to be separated from the host rock.

It can be expected that mining the crust, once feasible, will involve huge crawler-type machines to extract and crush the desired ore, involving the production of sediment plumes and large volumes of waste rock discharged back into the sea.

Potential threats and impacts have been reviewed by (SPC, 2013a). The expected effects include **risks and impacts** on the seafloor and overlying water column, midwater and surface waters (see also Chapter 2.4.5):

- The physical removal of the particular crust habitats and associated species;
- The loss of ecosystem functions and services provided by crust communities such as cold water coral thickets and other sessile megafauna;
- A potentially irreversible shift of benthic communities from K to r-strategists (Althaus *et al.*, 2009; Clark *et al.*, 2016a; Clark and Rowden, 2009);
- The disturbance of abyssal fauna from noise, vibration, light emitted by the excavation and pumping machines;
- Potentially impacts to the benthic boundary layer community from process waters discharged to the near bottom layers – eco toxicological studies do not exist;
- The disturbance of pelagic fauna from noise, vibration, light, ship movements, waste water, toxic effluents etc.

The cobalt crust **extraction area** will depend on crust thickness, its accessibility and type of seamount and is expected to range in size between several hundred and several thousand km^2 (Hein *et al.*, 2009). Commercial mines may target several seamounts in a region or several mines on one large seamount to be profitable (Hein *et al.*, 2009). Due to the desired proximity of mine sites, the sediment plumes to be expected will for the decades of the operations impact on very large areas downstream.

A detailed table of ecological impacts to be expected from cobalt crust mining by way of pressures as defined by the Marine Strategy Framework Directive (2008) has been elaborated by the ICES Working Group on Deepwater Ecosystems 2015 (see annexed table in ICES, 2015).

Exposure

'Appraisal of exposure consists of quantitatively or qualitatively evaluating the probability of exposure to the agent under study. Apart from information on the agents themselves (source, distribution, concentrations, characteristics, etc.), there is a need for data on the probability of contamination or exposure of the population or environment to the hazard' (European Commission, 2000b, COM (2000) 1, Annex III).

The exposure assessment can only be carried out once the details are known of the operations and the technology employed for mining the minerals. Exposure will have to consider the 3-dimensional spatial dimension of any discharge-related plumes in the water column, its chemical and physical quality as it changes with time/distance/dilution from source, as well as the direct exposure to excavation, and indirect exposure to excavation-related sediment resuspension and resettlement over time and distance from source.

Risk characterisation

'Risk characterisation corresponds to the qualitative and/or quantitative estimation, taking account of inherent uncertainties, of the probability, of the frequency and severity of the known or potential adverse environmental or health effects liable to occur. It is established on the basis of the three preceding and closely depends on the uncertainties, variations, working hypotheses and conjectures made at each stage of the process. When the available data are inadequate or non-conclusive, a prudent and cautious approach to environmental protection, health or safety could be to opt for the worst-case hypothesis. When such hypotheses are accumulated, this will lead to an exaggeration of the real risk but gives a certain assurance that it will not be underestimated' (European Commission, 2000b, COM (2000) 1, Annex II).

The ecological risk characterisation normally includes sequential steps on an increasingly quantitative scale of analyses (Clark *et al.*, 2014; Holsman *et al.*, 2017).

- Level 1, a scoping phase, where a primarily qualitative assessment (expert opinion) of the impacts of the different elements of an activity on pre-defined ecological components takes place in a scale, intensity, and consequence analysis (SICA). If the impact is higher than an agreed standard, an assessment may be required at Level 2. From this scoring process, some risks may be acceptable, requiring no further action, while others go on for more detailed analysis.
- Level 2 is a semi-quantitative approach to assess the vulnerability of particular ecological components, considering the ecosystems´ capacity for recovery from impacts.
- Level 3 is a fully quantitative approach which may include scenario analysis, eventually predictive scenarios, and error analysis.

The complexity of the analysis is not only increasing in terms of the high demand of knowledge for quantitative or modelling approaches, but also increases from single pressure, single subject to multiple pressures, multiple subjects and when including not only direct but also indirect and additive/cumulative interactions.

As a result, the criticality of risks is ranked according to the previously defined likelihood or exposure probability and the consequences to be expected (vulnerability of ecosystems and biota, valuing). Within risk assessment methods, there can be a difference in the underlying concept of risk (MacDiarmid *et al.*, 2014). For rare and unpredictable events (such as a major oil spill), usually a 'likelihood-consequence' approach is deemed appropriate. Here, risk is summarised as a product of the expected likelihood and consequence of an event. The risks arising from activities that are predictable, ongoing, and cumulative (such as fishing and some seabed mining activities) an 'exposure-effects' approach is considered to be better suited. Exposure is the total level of impact from the activity, and the effect is the ecological consequence of the impact. The overall risk is then the sum of all the effects. This approach generally requires greater knowledge of the underlying ecology of the system being impacted.

Risk characterisation will only be possible if the environmental baseline knowledge is adequate to predict or evaluate changes due to human activities, and the effects of the exposure of all or certain parts of the ecosystem affected to environmentally threatening activities can be qualified and quantified.

Risk evaluation

'The central categories of risk evaluation are the extent of damage and the probability of occurrence, damage being understood as negative evaluated consequences of human activities (in this case deep seabed mining of minerals) or events (e.g. ocean changes due to climate change) (reviewed by Stirling, 2001). In the case of seabed mining, the probability of occurrence of impacts on the ecosystem of the seafloor and water column will be certain, however, the likely scale of damage needs to be evaluated against the political objectives for improving rather than deteriorating the state of the marine environment (level of acceptability), and the rarity and scale of the affected ecosystems. Here, the lack of understanding and thus uncertainty about the effects to be expected come in' (European Commission, 2000b, COM (2000) 1, Annex III).

The purpose of risk evaluation is to assist in making decisions about the risks which need treatment, and the priority of those, based on the outcomes of risk analysis (ISO 31000). It is therefore a key decision step of risk assessment where the competent authority has to make a decision regarding the need for management action in consultation with jurisdictional partners, stakeholders, and public policy direction in light of public perception (ICES, 2013).

The decision can be that (i) no new measures are needed, (ii) existing measures are adequate, or (iii) new or enhanced measures need to be implemented. In the latter two cases, the process goes into the risk treatment phase (see below).

Risk management = Risk treatment

Risk management relates to the mitigation and minimising of the expected and unexpected impacts of a certain activity, once there is consensus that the unavoidable environmental damage is acceptable. Risk management, or treatment, should be precautionary.

Risk responses can be to mitigate the risk by corrective action, to avoid the risk, to transfer the risk to another entity or to accept the risk as such, and eventually monitor it only. Good risk management depends on a systematic risk management process and can be measured by the following criteria (UNECE, 2012):

- Risks are identified in a timely fashion.
- Risks are properly analysed and evaluated, and the most critical risks are given the highest priority.
- A balanced risk treatment is chosen.
- Risk treatment is efficiently implemented.
- Contingency plans are developed, tested and remain relevant, and resources are available to implement them.

All the above components of a systematic risk management process can be combined and illustratively displayed in a so-called Bow-Tie diagram (ISO 31010:2009 Bow-tie analysis, ICES, 2015). This method provides a structured risk analysis with the potential to demonstrate the success of existing measures and controls by visualising the relationship between e.g. undesirable events, its causes, accidental scenarios and the preventive and mitigation measures enacted. Indirect and direct causes from drivers and their corresponding pressures as well as prevention and control measures are located on the left side of the 'bow tie', which represents the actual environmental effects, the event. All initiated mitigation and restoration measures to re-establish an environmental quality as pre-agreed are located on the right side of the bow tie. Typically, enabling legislation is found between the drivers and their pressures.

Monitoring and review of the risks and risk management actions is an integral part of the risk management. It enables the revision of measures e.g. when detection of ineffectiveness, non-compliance or change of external or internal context. In the marine context this could be for example ecosystem variabilty or change due to climate forcing.

For a contractor, DNV-GL (2016) consider that the environmental risk management activities start with the environmental baseline study during the exploration phase. Subsequently, environmental impact assessment (EIA), including the risk assessment and treatment for the operation in question, should be developed within the different design phases and feed into the respective environmental statement (EIS). Preservation reference zones (PRZs) and impact reference areas (IRA) need to be designated and reported according to ISA regulations. The Environmental Management Plan of the applicant will be based on the approved EIA(s) for the various design phases and should be actively applied during the project's exploitation and decommissioning phases. Its effectiveness in terms of compliance to the overall environmental objectives set needs to be monitored throughout the licensing period, and post-operations as provided for by ISA regulations.

Risk assessment is an ongoing process and not only subject to an increasing volume of information and experience, but also to eventually new standards for judging the probability of risks or the environmental consequences of risks due to new scientific or corporate knowledge. Best Environmental Practice, BEP, and Best Available Techniques, BAT, will develop over time and provide guidance also for the risk treatment options available. Also the cumulative view of the regulator will over time influence the risk threshold of acceptable risk from individual operators and all operators collectively.

Risk communication

Risk communication means the communication of the outcome of a contractors´or regulatory risk assessment to the stakeholders concerned in verbal, written or visual form. As part of a Strategic Assessment or of an Environmental Impact Assessment, this communication likely takes place at several crucial points in the process, including before and after the risk assessment, when the risk management measures are developed/decided upon, and when risks and measures are periodically re-evaluated.

Practical experiences with risk assessment and management for deep seabed mining

New Zealand: Assessment of risks from sediment discharges during exploration and prospecting

In New Zealand, the National Institute of Water & Atmospheric Research Ltd, NIWA, undertook a qualitative assessment, using expert opinion, of the environmental risk of sediment discharges arising during exploration and prospecting for iron sands, phosphorite nodules and seafloor massive sulphide (SMS) deposits (MacDiarmid *et al.*, 2014). Due to a lack of information on the potential scale of discharges in particular in relation of SMS exploration and recovery, a so-called level 1 Scale, Intensity and Consequence Analysis was carried out according to Hobday et al. (2007), quoted in MacDiarmid *et* *al.* (2014). Level 1 assessments are generally used in data-poor situations where the scale of activity or its impacts on particular species, habitats or the ecosystem are uncertain or only partially described.

The ecological risks associated with a range of volumes of possible sediment discharge into surface waters, mid-water or near the seabed, as well as single point at one time vs. multiple discharge points over longer period were assessed. A range of biological effects was taken into account potentially affecting the pelagic and benthic communities.

The study resulted in a scaling of the vulnerability of different communities to the discharge of sediments, as well as in the description of the categories of consequences (severe-moderate-minor).

- **Severe consequences** indicate extensive impacts, with between 60 and 90 percent of a habitat affected within the area being assessed, causing local extinctions of some species if the impact continues, with a major change to habitat and community structure. Recovery is likely to take one or two decades
- **Moderate consequences** are ecologically significant, affecting between 5 and 20 percent of the habitat or community in question, with measurable changes in populations abundance, or biomass, or community composition of between 5 and 20 percent (although there is unlikely to be a major change in function). Recovery from this level of impact is expected to take up to 1-2 years.
- **Minor consequences** may be detectable, but are likely to have little impact on population size or community composition and are not expected to have any impact on the dynamics of any population or the ecosystem. Recovery from this level of impact is expected to occur within one to eight weeks.

The report finds that discharges of sediment during exploration and prospecting for seabed minerals could reach major or severe levels of consequence for the most sensitive marine benthic habitats occurring in each of the seabed mineral areas, depending on the size of the discharge. However, catastrophic consequences were likely never to be reached over the scales of discharge considered in the permit areas.

Discharge of sediment above 100 t for iron sand and phophorite nodule regions and 10 t for SMS deposit regions are likely to cause non-negligible effect, therefore a close monitoring of the discharge volumes during the exploration and prospecting activities is advised.

Example risk assessment for nodule collection

DNV-GL (2016) carry out an example risk assessment for the stepts involved in manganese nodules mining in the Clarion-Clipperton-Zone. Assuming a recovery of 8 kg nodules per km square they calculate a consumption of 200 km^2 for a commercial mining operation. The study considers the risk from an increase in water temperature due to return water being discharged near the seabed, noise emission from the collectors and ROVs, the riser and buffer, as well as the transport vessel on the surface, and light from machinery on the seafloor. A probability scale and a consequence scale for environmental impacts is presented based on which the risk of thermal pollution, discharge of return water, and the spreading and deposition of sediments on the seafloor was calculated and categorised as insignificant, critical and significant, respectively. It is shown, how mitigation measures might lower the risk.

3.4.5.5 Recommendations

Recommendations

- A Strategic Assessment process would be the suitable tool to provide for a prior evaluation of the environmental consequences of the draft exploitation legislation for the Area (ISA Mining Code, Exploitation Regulations) in a participatory and transparent way.

  a) The Strategic Assessment should be initiated as soon as a final draft of the regulations is available.
  b) ISA member states should own the process, but allow for full participation by observers and civil society.
  c) Institutional capacity building is likely required, in particular a technical advisory body next to or under the guidance of LTC will be helpful to provide the necessary environmental and managment expertise.
  d) ISA should start to build working relationships with competent authorities and organisations in the high seas as soon as possible.

- Regulatory risk assessment should be conducted as part of the initial Strategic Assessment and periodically thereafter, i.a. to address additive, cumulative or synergistic effects from different sources, and to guide the evaluation of risks against benefits to be expected from mining.
- ISA may need to develop an internal guidance for how its decision-making will address uncertainty due to lack of scientific knowledge and information on i.a. baseline environmental conditions and cause-effect relationsships.
- The current provisions for environmental impact assessment of exploration and testing activities (ISBA/19/LTC/8) need revision to establish an assessment process of environmental effects which can guide the later elaboration of environmental threshold levels. Further to contractors, also States and observer organisations should be asked to provide comments.

3.4.6 Thresholds of harm

3.4.6.1 Thresholds of harm relevant to deep seabed mining[303]

At the broadest level, UNCLOS, Article 145, requires the general protection of the marine environment from any effects of activities in the Area which may be harmful:

> *'Necessary measures shall be taken in accordance with this Convention with respect to activities in the Area to ensure effective protection for the marine environment from harmful effects which may arise from such activities.'*

This obligation was taken up in the Nodules Regulations, regulation 31:

> *'1. The Authority shall, in accordance with the Convention and the Agreement, establish and keep under periodic review environmental rules, regulations and procedures to ensure effective protection for the marine environment from harmful effects which may arise from activities in the Area.*

[303] This note is partly based on: Aline Jaeckel, The International Seabed Authority and Marine Environmental Protection: A Case Study in Implementing the Precautionary Principle (PhD thesis, University of New South Wales, Australia, 2015).

> *2. In order to ensure effective protection for the marine environment from harmful effects which may arise from activities in the Area, the Authority and sponsoring States shall apply a precautionary approach, as reflected in principle 15 of the Rio Declaration, and best environmental practices[304].'*

LOSC, annex III article 17(2)(f):

> *'Rules, regulations and procedures shall be drawn up in order to secure effective protection of the marine environment from harmful effects directly resulting from activities in the Area or from shipboard processing immediately above a mine site of minerals derived from that mine site, taking into account the extent to which such harmful effects may directly result from drilling, dredging, coring and excavation and from disposal, dumping and discharge into the marine environment of sediment, wastes or other effluents.'*

However, in particular contexts the higher standard of serious damage applies:

Serious harm is used primarily in relation to

- Emergency measures[305],
- Disapproving prospecting or exploitation at specific sites[306], and
- Applying additional protective measures or even prohibiting exploration work where it would have serious harmful effects on vulnerable marine ecosystems[307].

Similarly, in the LOSC, *serious harm* is only required for

- Provisional measures, [308]
- Emergency orders[309], and
- Disapproval of sites[310].

The threshold for environmental impact assessments determined in UNCLOS, article 206, is again different:

> *'When States have reasonable grounds for believing that planned activities under their jurisdiction or control may cause substantial pollution of or significant and harmful changes to the marine environment, they shall, as far as practicable, assess the potential effects of such activities on the marine environment and shall communicate reports of the results of such assessments in the manner provided in article 205.'*

These examples show that *serious harm* is used as the threshold that may lead to mining activities being halted or prohibited. *Substantial pollution* and *significant and harmful changes* lead to environmental impact assessments.

Importantly, Regulation 1 of the *Exploration Regulations* defines '*serious harm to the marine environment*' as:

[304] *Nodules Regulations,* regulation 31.

[305] *Nodules Exploration Regulations*, regulation 33; *Sulphides* and *Crusts Exploration Regulations*, regulation 35.

[306] *Nodules Exploration Regulations,* regulations 2, 21(6)(c); *Sulphides* and *Crusts Exploration Regulations,* regulations 2, 23(6)(c).

[307] *Nodules Exploration Regulations*, regulation 31(4); *Sulphides* and *Crusts Exploration Regulations*, regulation 33(4).

[308] LOSC, article 290(1).

[309] LOSC, articles 162(2)(w); 165(2)(k).

[310] LOSC, articles 162(2)(x); 165(2)(l).

> *'any effect from activities in the Area on the marine environment which represents a significant adverse change in the marine environment determined according to the rules, regulations and procedures adopted by the Authority on the basis of internationally recognized standards and practices.'*

In short, *serious* is expressly defined as *significant*, even though the former may appear to convey a higher threshold. Consequently, any reference in the Mining Code to *serious harm*, or indeed the *Rio Declaration*, may be interpreted as encompassing a lower threshold than what is assumed at first sight. In other words, this definition reduces the difference in thresholds under UNCLOS and the Mining Code (*harmful effects*) on the one hand and the *Rio Declaration* (*serious or irreversible damage*) on the other hand. In fact, an analysis of the draft Exploration Regulations for sulphides and crusts prepared by the ISA Secretariat in 2006 specifically notes that 'it may be argued that consistency is achieved by the definition of the term '*serious harm to the marine environment*' in regulation 1 as a proxy for the '*harmful effects*' referred to in article 145 of the Convention[311].

The *Rio Declaration, principle 15,* which the Nodules Regulations refer to, also introduces a level of uncertainty compared to the wording in UNCLOS:

> *'In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.'*

Interestingly, irreversibility is neither referred to in the LOSC, nor in the Mining Code. This may be welcomed since it can be problematic to determine whether an effect is irreversible or merely long-lasting. This is especially difficult in relation to impacts in the deep sea for which long-term studies are mostly lacking.

3.4.6.2 The definition of harmful effects and significant adverse change

The remaining question is how to define *harmful effects* and *significant adverse change* in the seabed mining context. The *Exploration Regulations* are largely silent on this crucial question and merely refer to 'internationally recognized standards and practices' in relation to the definition of *significant adverse change*[312].

The Draft Regulations, prepared by the Preparatory Commission[313], did provide some detail, defining serious harm to the marine environment as:

> *'any effect from activities in the Area on the living or non-living components of the marine environment and associated ecosystems beyond that which is negligible or which has been assessed and judged to be acceptable by the Authority pursuant to these regulations and the relevant rules and regulations adopted by the Authority and which represent:*
>
> *(a) significant adverse changes in the living and non-living components of the marine and atmospheric environment;*
>
> *(b) significant adverse changes in the ecosystem diversity, productivity and stability of the biological communities within the environment; or*

311 ISBA/12/C/2 (n 214), paragraph 28.

312 *Exploration Regulations*, regulation 1(3)(f).

313 Preparatory Commission for the ISA and ITLOS, LOS/PCN/SCN.3/WP.6/Add.5 (8 February 1990), article 2(2).

(c) loss of scientific or economic values which is unreasonable in relation to the benefit derived from the activity in question.'

The International Law Commission (2001)[314] cautions that '*the term "*significant*" is not without ambiguity and a determination has to be made in each specific case. It involves more factual considerations than legal determination. It is to be understood that "*significant*" is something more than "*detectable*" but need not be at the level of "*serious*" or "*substantial*". The harm must lead to a real detrimental effect on matters such as, for example, human health, industry, property, environment or agriculture in other States. Such detrimental effects must be susceptible of being measured by factual and objective standards.*'

Guidance can also be drawn from the fisheries context. The Food and Agricultural Organisation (FAO 2009[315]) defines '*significant adverse impact's* in relation to vulnerable deep sea species and habitats and ecosystem integrity:

[314] Draft Articles on Prevention of Transboundary Harm from Hazardous Activities. Text adopted by the International Law Commission at its fifty-third session, 2675th meeting in Geneva, Switzerland on 11 May 2001

[315] FAO, *International Guidelines for the Management of Deep-Sea Fisheries in the High Seas* (2009), paragraph 17-20.

Case Study Deep-Sea Fisheries (FAO, 2009)

- Significant adverse impacts are those that compromise ecosystem integrity (*i.e.* ecosystem structure or function) in a manner that: (i) impairs the ability of affected populations to replace themselves; (ii) degrades the long-term natural productivity of habitats; or (iii) causes, on more than a temporary basis, significant loss of species richness, habitat or community types. Impacts should be evaluated individually, in combination and cumulatively.
- When determining the scale and significance of an impact, the following six factors should be considered:

  e) The intensity or severity of the impact at the specific site being affected;
  f) The spatial extent of the impact relative to the availability of the habitat type affected;
  g) The sensitivity/vulnerability of the ecosystem to the impact;
  h) The ability of an ecosystem to recover from harm, and the rate of such recovery;
  i) The extent to which ecosystem functions may be altered by the impact; and
  j) The timing and duration of the impact relative to the period in which a species needs the habitat during one or more of its life- history stages.

- Temporary impacts are those that are limited in duration and that allow the particular ecosystem to recover over an acceptable time frame. Such time frames should be decided on a case-by-case basis and should be in the order of 5-20 years, taking into account the specific features of the populations and ecosystems.
- In determining whether an impact is temporary, both the duration and the frequency at which an impact is repeated should be considered. If the interval between the expected disturbance of a habitat is shorter than the recovery time, the impact should be considered more than temporary. In circumstances of limited information, States and RFMO/As should apply the precautionary approach in their determinations regarding the nature and duration of impacts.

In the same lines, the Nagoya - Kuala Lumpur Supplementary Protocol on Liability and Redress to the Cartagena Protocol on Biosafety (2011b) defines a 'significant' adverse effect as determined by a.o.:

- The long-term or permanent change, to be understood as change that will not be redressed through natural recovery within a reasonable period of time;
- The extent of the qualitative or quantitative changes that adversely affect the components of biological diversity;
- The reduction of the ability of components of biological diversity to provide goods and services.

According to the protocol, 'damage' means an adverse effect on the conservation and sustainable use of biological diversity, taking also into account risks to human health, that is:

- Measurable or otherwise observable taking into account, wherever available, scientifically-established baselines recognized by a competent authority that takes into account any other human induced variation and natural variation; and
- Significant acc. to the definition above.

Also, the ESPOO Convention[316] provides some guidance on the determination of the environmental significance of activities, here to assist managers in screening the need for environmental impact assessments:

Case Study Transboundary Assessments (ESPOO Convention)

In considering proposed activities to which Article 2, paragraph 5, applies, the concerned Parties may consider whether the activity is likely to have a significant adverse transboundary impact in particular by virtue of one or more of the following criteria:

- **Size**: proposed activities which are **large** for the type of the activity»
- **Location**: proposed activities which are located in or close to an **area of special environmental sensitivity or importance** (such as wetlands designated under the Ramsar Convention, national parks, nature reserves, sites of special scientific interest, or sites of archaeological, cultural or historical importance)» also,proposed activities in locations where the characteristics of proposed development would be likely to have significant effects on the population»
- **Effects**: proposed activities **with particularly complex and potentially adverse effects, including those giving rise to serious effects** on humans or on valued species or organisms, those which threaten the existing or potential use of an affected area and those causing additional loading which cannot be sustained by the carrying capacity of the environment.

The concerned Parties shall consider for this purpose proposed activities which are located close to an international frontier as well as more remote proposed activities which could give rise to significant transboundary effects far removed from the site of development.

Apart from the above strictly environmentally focussed criteria for the significance of impacts from human activities, the weighing of an impact being significant should also be informed by other criteria, as for example:

- Interference with other legitimate activities;
- Conflict over the use of the resource (*i.e.* mining or genetic resource exploitation)
- Potential for cumulative impacts;
- Potential for ecosystem services being impaired;
- Mitigation options available;
- Uncertainty - risks cannot be determined with any confidence;
- Threat to protected and endangered species or their critical habitat as designated by national or other international authorities;
- Impact on cultural, traditional, natural, scientific or historic values;
- Public concern.

These examples demonstrate that any determination of significant adverse change in the environment rests on at least two elements. First, it requires scientific advice regarding the activity's effect on biodiversity and ecosystem integrity as well as the spatial and temporal scale of the impact. This presupposes adequate data to establish environmental baselines and understand ecosystem structures, at least to some extent. Second, it requires an agreed, value based environmental conservation objective to determine what is *unreasonable* or *unacceptable* change (see Chapter 3.3). Indeed, participants at a 2014 workshop by the Deep Ocean Stewardship Initiative '*recognized the extreme complexity of the issues and the enormous data gaps associated with assessing significant impact*,' concluding:

[316] Espoo Convention, APPENDIX III

> *'Huge unknowns make the determination of significant impacts extremely difficult. Such unknowns include the questions related to species rarity and possible extinction; the ecological and social importance of extinction of a single deep sea species; numerical thresholds for significant impact; and ecosystem function […]'.*[317]

3.4.6.3 Precondition environmental baselines

Fortunately, until today, the ecosystems targeted for deep seabed mining can be observed in their natural state, subject only to natural (and climate-change-induced) variations. Therefore, other than in other regions, their 'good environmental status' can be measured and used as a baseline.

ISA exploration contractors are obliged to establish and report on environmental baseline investigations as part of their Plans of Work over the lifetime of the contract[318] . The reasoning is that contractors not only deliver the necessary data to ISA to establish regional baseline conditions and later the degree of environmental change from mining-related activities, but they can also demonstrate their environmental knowledge of the licensed area, and their ability to measure and control impacts. In a later stage, these capacities will be required to demonstrate use of best available technology and best environmental practice. Such demonstration during the exploration phase should be a precondition for the acceptance of applications for exploitation.

However, for being useful to compare the performance of individual contractors, and to use the the data and information delivered in a wider, e.g. regional context, a standardised minimum scheme of investigation, processing and interpretation as well as data delivery is required. Whereas ISA is currently establishing a data management system which will incorporate all data delivered, the requirements on contractors, as set out in document ISBA/19/LTC/8[319] only describe a general research programme, yet without any methodological advice. As a consequence, for example the early data delivered by contractors could not be used for scientific analysis (Mincks and Smith, 2006).

In terms of the quantiative and qualitative requirements for assessments of contractor data, Jones *et al.* (2017, Tab. 2) provide a detailed list of recommendations. These will also help to make the requirements specific enough to become an enforcable obligation (Jones and Billett, 2017). However, prescriptions should be kept to the necessary minimum to allow for inter-contractor and regional comparisons, and not dis-incentivise more comprehensive and advanced investigations.

In terms of subject, the recommendations only refer to investigations of the physical oceanography, the geology, chemical oceanography, sediment properties, and biological communities and processes, all of it unspecified. In order to make the baseline reporting useful for assessment and management, some further suggestions can me made for information that should be contained in a 'good baseline', modified based on Jones and Billett (2017):

- Existence and location of internationally and regionally recognized marine protected areas, other areas of special interest, e.g. EBSAs, other contractor licence areas and, where appropriate, Vulnerable Marine Ecosystems (VMEs);
- The nature, magnitude and extent of other existing impacts, resulting modifications to the area (e.g. from fishing, climatic change);

[317] Deep Ocean Stewardship Initiative, *Meeting Summary: Defining 'Significance' in Environmental Impact Assessment for Deep-Sea Mining* (Scripps Institution of Oceanography, 26-28 March 2014. http://www.indeep-project.org/sites/indeep-project.org/f/document/EIAWorkshopReportwappendices.pdf.

[318] *Nodules Exploration Regulations*, regulation 32; *Sulphides* and *Crusts Exploration Regulations*, regulation 34.

[319] Recommendations for the guidance of contractors for the assessment of the possible environmental impacts arising from exploration for marine minerals in the Area. LTC, 2013

- Selection criteria and design, as well as monitoring results from impact reference areas and preservation reference areas;
- Societal values placed on the area and its resources, including the potential for Genetic Marine Resources.
- Resolution of temporal variability on seasonal and inter-annual scale, and description of other relevant, potentially episodic, and extreme events;
- Resolution of spatial habitat variability on the seafloor and in the water column
- Assessment of potential ore and sediment toxicity, including in solution;
- Existing levels of nutrient loading and pollution at sites;
- Studies of the distribution of marine mammals, fish and scavenger communities, as well as their sensitivity to light, sound and toxic effluents;
- Ecotoxicology of sediment plumes affecting benthic and pelagic communities
- Presence of alien/invasive species present in the area;
- Presence of garbage and other man-made remains.

Further knowledge gaps around the resilience of affected ecosystems and recommendations for solutions are provided by Gollner *et al.* (2017).

These considerations, including the scientific and the social dimension, must be addressed by the ISA, in accordance with its mandate to control seabed mining in the Area on behalf of humankind, to promote and conduct marine scientific research in the Area, and to protect the marine environment from harmful effects of seabed mining.[320].

3.4.6.4 The development of environmental thresholds

The definition of thresholds is a decision-support tool to translate legal and political requirements into practical action. In the environment context, the idea of thresholds is controversial, as it implies not only the existence of cause-effect and dose-response relationships, but also the knowledge and tools to measure and control these. In the oceans, and more so in the deep sea, the limited level of knowledge and understanding, but also the options for measuring and monitoring, in particular of the functional relationships in the ecosystems may preclude the formulation of 'hard' thresholds distinguishing natural variation from harmful and significantly harmful change, respectively.

Based on ecologically meaningful and statistically sufficient environmental baselines, the effects of mining-related activities on the marine environment have to be considered on various spatial and temporal scales on species-, community and ecosystem-level (Levin *et al.*, 2016b), and in conjunction with impacts from other sectoral activities and effects of global warming (Levin and Le Bris, 2015). As it is unlikely that comprehensive information on the deep ecosystems *s.s.* and *s.l.* will become available, the scientific task is to

- Determine the appropriateness of indicators for ecosystem state and ecosystem change in relation to specific pressures;
- Determine appropriate temporal and spatial scales;
- Select and test these indicators.

To make such indicators useful to regulation and management, overall environmental objectives (see Chapter 3.3) are needed which can direct management decisions and allow for the determination of threshold values to acceptable environmental change or thresholds to activities, if appropriate. The

[320] LOSC, articles 136, 137, 140, 143, 145, 153(1).

definition of acceptable change (or the goal of no man-made change) is the task of the ISA*, i.e.* its member states, observers and the concerned society. In the best case this is a negotiated compromise of a politically acceptable balance between the wish for extraction and its unavoidable environmental damage, and the internationally agreed conservation and restoration targets, and reflecting the priorities of the global sustainability agenda (see Chapter 2.2).

Based on such political guidance, science can then develop environmental thresholds for distinguishing natural variation from impacted state (harm) from significantly adversely affected state (serious harm) for the range of indicators. One could therefore envisage a simple 3-stage system where thresholds would distinguish the natural state from a state where harm is reversible and a state of irreversible change.

The regulator would then relate particular activity types and activity levels to the expected change of the environment and determine appropriate precautionary measures, *i.e*. limits to the location, intensity, type or timing of the activity. This would then set the minimum conditions for environmental permits through Environmental Impact Assessments. On a regional, not project scale, the information on environmental state and threats, including cumulative threats, could be gathered by a Strategic Assessment (see Chapter 3.4.5).

Overall, developing meaningful thresholds and indicators, as well as guidance for the temporal and spatial scales of pressures and responses in the assessments will be a time-consuming task. However, lessons can be drawn from extensive work in other regions, such as for example in Europe and by OSPAR in context with the implementation of the Marine Strategy Framework Directive (2008)[321].

In relation to deep seabed minerals mining, Levin *et al.* (2016b) make a first attempt to qualify the significance of changes that might be observed in the affected ecosystems, taking account of the specific vulnerabilities (see Chapter 3.1.4):

Significant adverse change (Levin et al., 2016)

Significant species-level changes or impacts include:

- Extinction;
- Significant decline in abundance;
- Decline in foundation species;
- Reduction below critical reproductive density;
- Loss of source populations; and/or
- Loss of critical stepping-stone populations.

Community-level impacts include

- Alteration of key trophic linkages among species in a community;
- Reduction in species diversity beyond natural levels of variability; and/ or
- Regional declines in habitat heterogeneity, such as loss of entire habitats or community types.

At the ecosystem-level, impairment of important ecosystem functions such as biomass production, nutrient recycling or carbon burial can lead to loss of major ecosystem services upon which society depends. They may include loss of carbon sequestration capacity, genetic resources, or fisheries production. These impacts can be evaluated in local, regional or global contexts.

[321] see also https://www.ospar.org/work-areas/cross-cutting-issues/msfd/msfd-advice-manuals

All changes have to be evaluated on a range of spatial and temporal scales, eventually long-term. Not all changes, and in particular eventual recovery, will be noticeable on time scales covered by the lifetime of projects, in particular projects for testing, where only 5 years of post-test monitoring is currently prescribed (ISBA/19/LTC/8).

also propose 14 indicator parameters that could be instrumental for acquiring the information necessary for the assessment of the ecosystem state and changes due to mining activities:

- Biodiversity indicators (species richness, extinction, rarity, endemicity and others)
- Community structure,
- Key functional species, incl. ecosystem engineers,
- Habitat types,
- Heterogeneity,
- Endangered species,
- Connectivity,
- Productivity,
- Respiration,
- Nutrient cycling,
- Trophic structure,
- Demographic structure,
- Recovery,
- Resilience[322].

These would all have to be measured, assessed and interpreted individually and collectively, and supplemented where possible with indicators for ecosystem service performance such as carbon sequestration rate. One option to integrate the information is to create a 'Deep Sea Health Index', as an expression of the integrated state and development of the deep ocean. The term 'health' is used as a metaphor to help conceptualize ecosystem functioning and explaine ecosystem condition also to non-specialists (Tett *et al.*, 2013). 'Health' can either be understood as an expression of the aggregate properties of an ecosystem, or of the integrated state of the system. It can be measured as the deviation from a known baseline/reference state, measured for a selected set of parameters (Tett *et al.*, 2013).

The authors define good ecosystem health as:

> *'the condition of a system that is self-maintaining, vigorous, resilient to externally imposed pressures, and able to sustain services to humans. It contains healthy organisms and populations, and adequate functional diversity and functional response diversity. All expected trophic levels are present and well interconnected, and there is good spatial connectivity amongst subsystems' (Tett et al., 2013).*

Ecosystem health could therefore provide a tool for determining trends in ecosystem change and may be developed to assess the degree of change relative to the thresholds for reversible/irreversible harm. As Halpern *et al.* (2012) and (Halpern *et al.*, 2015) showed, expert judgement can provide essential input to assessing ecosystem health in complex systems.

[322] As a draw back, some basic information was identified as knowledge gaps, including the regional distribution of habitats (active and inactive vents, seamounts, other features), understanding natural variability, connectivity, succession and endemicity of taxa, information about the ecotoxicology of plumes and their interactions with fish and fisheries (seamounts); faunal sensitivity to changes in substrate & chemistry as well as impacts within the water column and at the surface.

Further to indicating pressure-related changes, an ocean health index can generally be used to measure and illustrate progress towards meeting the sustainability goals (Halpern *et al.*, 2015). The Deep Ocean Health Index would provide a subset to this assessment.

3.4.6.5 Recommendations

Recommendations
► No exploitation contracts should be concluded until - ISA environmental goals and objectives, alternatives, as well as limits to politically acceptable mining impacts have been negotiated and agreed in a global Strategic Assessment and regional environmental assessments and management plans; - There are adequate regional environmental baselines, - The indicators and thresholds for environmental state and change are determined, and - Monitoring and assessment methodologies are developed and implemented. ► Prior to test mining, standardised baseline investigation and monitoring protocols should be applied by contractors, including criteria and guidelines for the selection of Preservation Reference areas, Impact Areas, and how to take account of other protected, ecologically important and/or vulnerable habitats and sites. ► A state-of-the-art knowledge report could be produced for example for the Clarion-Clipperton-Zone. Germany could be instrumental to this given the large volume of scientific expertise present. ► In a second step, a mandated scientific working group could elaborate proposals for how best to operationalise the monitoring and assessment of ecosystem changes and classification as ‘within natural limits’, ‘reversible harm’ or ‘irreversible harm/significant adverse/serious harm’. ► The proposed thresholds will have to be reviewed by LTC and the Council, including comments from observers and the public, and transformed into a detailed set of criteria for the evaluation by LTC of Plans of Work for exploitation in conjunction with the objectives and limits set by Strategic Assessment and regional environmental management plans. ► Measures to ensure the ‘*effective protection from harmful effects*’ (ITLOS, 2011), taking account of the precautionary and the Common Heritage principle, have to be developed. ► ISA needs institutional improvement to accomodate for independant scientific advice and a specialist forum for environmental management (e.g. Environment Commission, see Chapter 3.4.4). ► Germany could gather a like-minded group of states to lobby for a new mode of technical work in the ISA, e.g. via technical working groups in the Council. The working group could discuss about the implementation of an ecosystem approach to management in pusuit of obligations arising from Article 145 in the current work of ISA, including the regulations for exploitation (under development).

4 Analysis of International Law relating to deep seabed mining and protection of the marine environment

The legal regime addressing deep seabed mining is made up of the 1982 United Nations Convention on the Law of the Sea (UNCLOS)[323], particularly Part XI and Annex III, the 1994 Implementing Agreement on Part XI[324], and the subsequent rules, regulations, procedures adopted by the Authority to fulfill its obligations under Article 145 UNCLOS. The Mining Code, ultimately intended to address the complete system of exploration and exploitation envisioned in UNCLOS, currently consists of three sets of exploration regulations concerning the three primary resources of interest in the Area: manganese nodules[325], cobalt crusts[326] and massive sulfides[327]. Draft Regulations for the exploitation of mineral resources[328] are currently under development including specific environmental management provisions for the exploitation phase. It should be noted when considering the findings of this chapter that work at the International Seabed Authority (ISA) is still underway and that frequent changes to the documents are likely to be made until the final body of regulations making up the Mining Code has been adopted.

Rather than providing a comprehensive overview of these instruments and drafts, this chapter will examine three, in part interrelated, legal issues which became apparent in the course of research. As legal clarity and stability are fundamental for achieving effective environmental protection, these issues are relevant for the further development of the Mining Code:

- Legal, institutional and technical Issues arising from the term “activities in the Area” (Section 3.1);
- Division of responsibilities between the ISA and sponsoring States (Section 3.2); and
- Regulation of mining tests (Section 3.3).

Toward this end, each section contains a summary of findings from the research and practical recommendations to address selected issues in these areas. These include potential courses of action on the part of both the ISA and sponsoring States, as well as proposals for the Draft Exploitation Regulations, where appropriate.

*The views and findings reflected in this chapter are solely those of the author as an independent researcher and do not represent the views of the German Environment Agency, the Institute for Advanced Sustainability Studies or the other project contributors.

323 United Nations Convention on the Law of the Sea, 1833 UNTS 397.

324 Agreement relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of December 10, 1982 of July 28, 1994 (1836 UNTS 42).

325 Regulations on Prospecting and Exploration for Polymetallic Nodules in the Area, ISBA/19/C/17 of 22 July 2013.

326 Regulations on Prospecting and Exploration for Polymetallic Sulphides in the Area, ISBA/16/A/12/Rev.1 of 15 November 2010.

327 Regulations on Prospecting and Exploration for Cobalt-rich Ferromanganese Crusts in the Area, ISBA/18/A/11 of 22 October 2012.

328 Draft Regulations on Exploitation of Mineral Resources in the Area, ISBA/23/LTC/CRP.2 of 8 August 2017.

4.1 Legal, institutional and technical issues arising from the term 'activities in the Area'

The term 'activities in the Area' is surrounded by a number of legal, institutional and technical issues with consequences for how the ISA's mandate is defined, the extent to which regulation can be effectively applied to technical processes still under development and, finally, how other, more general legal instruments might interface with the specialized law addressing deep seabed mining to augment environmental protection measures. Furthermore, the effectiveness of environmental protection depends on ensuring that regulation is as specifically tailored to the activities as possible and corresponds to the technical processes ultimately in use. Due to the fact that the potential technologies for deep seabed mining are at best in a rudimentary stage of development, the legal regime must be designed to ensure that it can continually evolve in line with technological developments without sacrificing specificity in regard to environmental protection. At the same time, it must ensure stability and predictability for all actors.

4.1.1 Scope of the term 'activities in the Area'

There are a number of variations between the use of the term 'activities in the Area' in UNCLOS, the secondary regulation of the ISA and its subsequent legal interpretation in the Advisory Opinion of the International Tribunal for the Law of the Sea's Seabed Disputes Chamber on the Responsibilities and Obligations of Sponsoring States[329] (hereinafter ITLOS Advisory Opinion). The term 'activities in the Area' is defined in Article 1 (1)(3) UNCLOS as '*all activities of exploration for, and exploitation of, the resources of the Area*', which it does not more specifically define. According to Article 134 (2) UNCLOS, 'activities in the Area' are governed by Part XI UNCLOS while activities falling outside the scope of the term are governed by other parts of the law of the sea. In the Regulations on Prospecting and Exploration (Exploration Regulations) for the three types of minerals of interest in the Area – polymetallic nodules[330], polymetallic sulphides[331] and cobalt crusts[332] – currently representing the only legally binding sections of the Mining Code, the ISA provided definitions of 'exploration' and 'exploitation' to further define the scope of the term 'activities in the Area' for its purposes. The following definitions are contained in Regulation 1 (3) (a-b) of all Exploration Regulations, here quoted from the Exploration Regulations (Nodules)[333]:

> *"'Exploitation' means the recovery for commercial purposes of polymetallic nodules in the Area and the extraction of minerals therefrom, including the construction and operation of mining, processing and transportation systems, for the production and marketing of metals;"*

> *"'Exploration' means the searching for deposits of polymetallic nodules in the Area with exclusive rights, the analysis of such deposits, the use and testing of recovery systems and equipment, processing facilities and transportation systems and the carrying out of*

[329] Seabed Disputes Chamber of the International Tribunal for the Law of the Sea, Responsibilities and Obligations of States Sponsoring Persons and Entities with Respect to Activities in the Area (Case No. 17). Advisory Opinion of 1 February 2011.

[330] Regulations on Prospecting and Exploration for Polymetallic Nodules in the Area, ISBA/6/C/8/Corr.1 of 12 July 2000. [FOOTNOTE 3]

[331] Regulations on Prospecting and Exploration for Polymetallic Sulphides in the Area, ISBA/16/A/12/Rev.1 of 15 November 2010. [FOOTNOTE 4]

[332] Regulations on Prospecting and Exploration for Cobalt-rich Ferromanganese Crusts in the Area, ISBA/18/A/11 of 22 October 2012. [FOOTNOTE 5]

[333] References to the Exploration Regulations throughout this document use the Exploration Regulations (Nodules) as these were most recently revised and therefore reflect the most current regulatory development in regard to exploration.

studies of the environmental, technical, economic, commercial and other appropriate factors that must be taken into account in exploitation."

At first glance, this comprehensive definition of 'activities in the Area' seems unproblematic, however, when ITLOS examined the term 'activities in the Area' in its 2011 Advisory Opinion on the Responsibilities of Sponsoring States[334], it analyzed individual components of the technical process chain in more detail and found limits on the extent of these definitions. Interpreting the scope of Article 145 UNCLOS as reflecting the scope of 'activities in the Area', ITLOS identified *inter alia* '*drilling, dredging, excavation, disposal of waste, construction and operation or maintenance of installations, pipelines and other devices related to such activities*' as falling under this term. Likewise, it held '*shipboard processing immediately above a mine site of minerals derived from that mine site*' to constitute 'activities in the Area' on the basis of Annex III, Article 17 (2) UNCLOS. In contrast, it found that '*transporting, processing and marketing of minerals recovered from the Area*' are beyond the scope of 'activities in the Area'.[335] ITLOS did not provide any further criteria for determining the exact parameters of 'activities in the Area' in the Advisory Opinion. The Advisory Opinion did acknowledge, however, that the exclusion of '*activities conducted by the contractor which are among the most hazardous to the environment*' from the scope of 'activities in the Area' would have fundamental consequences for effective environmental protection and noted that this "would be contrary to the general obligation of States Particles, under article 192 of the Convention, 'to protect and preserve the marine environment'"[336].

It was suggested already at this point – long before the drafting process for the Exploitation Regulations had begun – that the ISA revise and ensure the consistency of its definition of 'activities in the Area' in all Exploration Regulations.[337] The ISA, however, did not revise its definitions in the amended Exploration Regulations for polymetallic nodules[338] adopted in 2013. This is likely due to the fact that the scope of the term 'activities in the Area' is central to defining the powers and functions of the ISA. While some commentators argue that the ISA also has regulatory powers beyond its "typical field of competence"[339], the prevailing view is that the ISA does not have general environmental jurisdiction over all forms of human activity occurring in the Area but instead has functional jurisdiction concerning the exploration and exploitation of the resources of the Area.[340] This view is based on Article 157 (1) and (2) UNCLOS, which provides that the '*powers and functions of the Authority shall be those expressly conferred upon it by this Convention*' to '*organize and control activities in the Area*.' It follows from this provision that the ISA is only competent in regard to 'measures…with respect to activities in the Area'[341] and therefore, that any environmental protection regulation it adopts is restricted to the legal scope of that term. Accordingly, keeping the term as expansive and open as possible is of strategic advantage to the ISA.

The Draft Exploitation Regulations' definition of 'exploitation' to include 'all other activities…in the Contract Area' as well as 'other steps preparatory to Commercial Production' clearly indicates that the

[334] ITLOS Seabed Disputes Chamber, Responsibilities and Obligations of States Sponsoring Persons and Entities with Respect to Activities in the Area, Advisory Opinion of 1 February 2011, ITLOS Reports (2011), para. 96.

[335] ITLOS, para. 84.

[336] Advisory Opinion, para. 97.

[337] Tim Poisel (2012) Deep Seabed Mining: Implications of Seabed Disputes Chamber's Advisory Opinion. 19 Australian Journal of International Law, 213-234, at 218.

[338] Regulations on Prospecting and Exploration for Polymetallic Nodules in the Area, ISBA/19/C/17 of 22 July 2013.

[339] Tullio Scovazzi (2004). Some considerations on future directions for the International Seabed Authority. In: Proceedings of the Tenth Anniversary Commemoration of the Establishment of the International Seabed Authority. ISA: Kingston. 171.

[340] Donald R Rothwell and Tim Stephens (2010). The International Law of the Sea. Oxford: Hart Publishing, 136.

[341] Michael Wood (2007). The International Seabed Authority: Fifth to Twelfth Sessions. 11 Max Planck Yearbook of United Nations Law, 59-60.

ISA seeks an expansive rather than limited mandate over ‘activities in the Area’. Although Draft Regulation 1 (1) of the Draft Exploitation Regulations states that ‘*[t]erms used in these Regulations shall have the same meaning as those in the Convention*’, this does not further clarify the exact scope of ‘exploration’ and ‘exploitation’ as these themselves are not defined in UNCLOS. Table 3 below compares the scope of the terms ‘exploration’ and ‘exploitation’ in the Exploration Regulations (Nodules) and the Draft Exploitation Regulations.

Table 3 Comparison of the Terms ‘exploration’ and ‘exploitation’ in the Exploration Regulations and the Draft Exploitation Regulations

Term	Exploration Regulations (Nodules)	Draft Exploitation Regulations
‘Exploration’	► Searching for deposits of [polymetallic nodules] in the Area with exclusive rights, ► The analysis of such deposits, ► The use and testing of recovery systems and equipment, processing facilities and transportation systems, ► Carrying out of studies of the environmental, technical, economic, commercial and other appropriate factors that must be taken into account in exploitation.	► Searching for Resources in the Contract Area with exclusive rights, ► The analysis of such Resources, ► The use and testing of recovery systems and equipment, processing facilities and transportation systems, ► Carrying out of studies of the environmental, technical, economic, commercial and other appropriate factors that must be taken into account in Exploitation.
‘Exploitation’	► Recovery for commercial purposes of [polymetallic nodules] in the Area, ► Extraction of minerals therefrom, ► Construction and operation of mining, processing and transportation systems, for the production and marketing of metals;	► Recovery for commercial purposes of Resources in the Area, ► Extraction of minerals therefrom, ► Construction and operation of mining, processing and transportation systems, for the production and marketing of metals, ► All other activities, including Exploration, in the Contract Area, ► Other steps preparatory to Commercial Production, ► Decommissioning and closure of operations.

The use of these open-ended terms creates considerable room for the ISA to develop the legal regime for deep seabed mining to address emerging needs, which is desirable from the standpoint of contractors as they would not be hindered in their work toward commercial production by the lengthy development of detailed regulations. While this approach would facilitate a quick start to commercial production and is therefore highly attractive to contractors, it poses a considerable danger from the standpoint of environmental protection. Should this expansive definition of 'exploitation' remain unchallenged, it could lead to a situation where non-specified activities result in environmental damage occur prior to the adoption of appropriate environmental protection measures by the ISA and for which regulatory competences have not been sufficiently clarified. In such cases, the default obligations contained in Part VII UNCLOS concerning the high seas, which 'co-exist' with Part XI[342], and Part XII UNCLOS addressing marine environmental protection, which applies in all maritime zones[343], would provide the applicable regulation, placing the onus on the sponsoring and/or flag State. It is, therefore, of utmost importance for the realization of the highest standards of environmental protection to firmly establish the scope of the term 'activities in the Area'. It should, however, be noted that the explicit reference to decommission and closure of operations in the Draft Exploitation Regulations is a positive development.

4.1.2 Technical issues concerning transportation and processing activities

These issues are not restricted to the term 'activities in the Area'. The interpretation of the terminology surrounding 'processing' and 'transportation' raises further issues which could influence how well environmental regulation adopted by the ISA captures the technical processes which might ultimately take place. In regard to the range of activities associated with the term 'processing', it can be argued that ITLOS failed to sufficiently take into account technical considerations when it disaggregatied terms such as '*shipboard processing immediately above a mine site of minerals derived from that mine site*' contained in Annex III, Article 17 (2)(f) UNCLOS.[344] For a technical process in which several thousand meters of water column are likely to exist between a mine site and a processing ship, the term 'immediately above' needs to be more specifically defined spatially with regard for the technologies in use in order to ensure that harmful effects of activities in the water column fall under ISA regulations. A narrow interpretation of 'immediately above' in combination with the use of an underwater collection vessel with its own means of propulsion could also result in only that processing being considered an 'activity in the Area' while further processing at the surface would fall under the high seas regime. Likewise, due to the lack of definition of 'ship' or 'vessel' in UNCLOS, other gaps in the ISA's capacity to regulate could emerge in regard to support barges and floating production, storage and offloading units also potentially involved in processing at the water surface as the language of other international conventions and State practice is inconsistent.[345]

The technological possibility of *in situ* processing – potentially the least environmentally damaging form of processing and increasingly pursued in terrestrial mining – also raises issues in relation to the term 'shipboard' and the extent of processing activities falling under the competences of the ISA. Furthermore, the term 'mine site' is not defined in UNCLOS, the Exploration Regulations or the Advisory Opinion and could potentially refer to the entire area defined in the plan of work which,

[342] Alex G. Oude Elferink (2007). The Regime of the Area: Delineating the Scope of Application of the Common Heritage Principle and the Freedom of the High Seas. 22(1) International Journal of Marine and Coastal Law, 143-176.

[343] Detlef Czybulka (2017) Article 192. In: Alexander Proelss (ed.) , United Nations Convention on the Law of the Sea: A Commentary. C.H. Beck: München, 2017. MN 5, 1280

[344] Advisory Opinion, para. 88.

[345] MARPOL defines a "ship" in Article 2 (4) as "a vessel of any type whatsoever operating in the marine environment.", which would represent a similar opportunity for action as that under the LC/LP. Furthermore, the general practice in maritime law concerning floating storage, processing and offloading units (FPSOs) used in the offshore oil and gas industry is to define them as ships and to include those activities as part of normal ship operation. This would arguably support that mining support vessels are engaged in normal ship operations at all times. For further discussion of this issue, see Section 3.2 Hossein Esmaili (2000) The Legal Regime of Offshore Oil Rigs in International Law. London: Routledge.

according to Regulation 25 (1) Exploration Regulations – Nodules shall not exceed 150,000 km^2. On the one hand, the potentially extremely large area representing a 'mine site' raises the issue of the spatial extent of environmental impact assessments, monitoring and how effective environmental management measures might be in practice. On the other hand, the determination of the boundaries of a mine site also plays a significant role in distinguishing direct and indirect impacts of a mining operation and, if interpreted narrowly, could cause more distant environmental damage to fall outside the defined area.

The term 'recovery' is another potential source of legal uncertainty in determining the scope of the term 'activities in the Area'. UNCLOS uses the term 'recovery' and the phrase 'sustained large-scale recovery operations' in Annex III, Articles 1 and 17 (2)(g), respectively, but without providing a further definition. The Exploration Regulation (Nodules) use the phrases 'recovery for commercial purposes … and the extraction of minerals therefrom' in the definition of 'exploitation' and 'the use and testing of recovery systems and equipment…' in the definition of 'exploration' contained in Regulation 1 (3)(a-b), while Regulation 19 (a)(i) refers to 'recovery and processing'. ITLOS provides that ''activities in the Area', in the context of both exploration and exploitation, includes, first of all, the recovery of minerals from the seabed and their lifting to the water surface'[346].

In this regard, an ordinary meaning interpretation of the term 'recovery' in accordance with Article 31 (1) of the Vienna Convention on the Law of Treaties[347] would suggests that the term is synonymous with basic collection and lifting and is distinct from processing. ITLOS proceeds, however, to refer to the 'evacuation of water from the minerals and the preliminary separation of materials of no commercial interest, including their disposal at sea'[348] which more closely reflects the usage of the term 'recovery' by the mining industry, which involves considerably more than mere lifting or 'evacuation of water'. As part of the overarching goal of 'metallurgical efficiency', one of the most basic concepts in processing, the mining industry understands the term 'recovery' to refer to the act of separating valuable mining material from gangue (waste material), which must then be disposed of alongside the both toxic and highly turbid wastewater resulting from the separation process.[349] This arguably corresponds to the process of preliminary separation referred to in the Advisory Opinion. *In situ* processing, as mentioned above, may eventually be able to perform more than preliminary separation. This could create the situation that the process performed by an individual technology – potentially even a best available technology – could fall both within and outside the regulatory competences of the ISA.

4.1.3 Transportation activities and the relationship between the ISA and the IMO

The extent to which 'transportation' falls under the definition of 'activities in the Area' also leaves a number of open questions. The Advisory Opinion found that, while 'transportation within that part of the high seas, when directly connected with extraction and lifting' would fall under the ISA's regulatory competences, 'transportation to points on land' would not.[350] With the International Maritime Organization (IMO) as the central international organization responsible for matters related to shipping on the one hand and the ISA as the central international organization responsible for matters related to deep seabed mining in the Area on the other, overlaps between the organizations' competences concerning transportation, as well as the operation of specific vessels, installations and devices involved in deep seabed mining are likely to be significant. Article 1 (a) of the Convention on

[346] Advisory Opinion, para. 94.

[347] Vienna Convention on the Law of Treaties of 23 May 1969. 1155 UNTS I-18232 of 27 January 1980.

[348] Advisory Opinion, para. 95.

[349] Society for Mining, Metallurgy and Exploration (2011). SME Mining Handbook, Third Edition. Peter Darling, ed., 1455.

[350] Advisory Opinion, para. 96.

the International Maritime Organization[351] sets out the purposes of the organization including 'to encourage and facilitate the general adoption of the highest practicable standards in matters concerning the maritime safety, efficiency of navigation and prevent and control of marine pollution from ships', which it understands to include 'ship design, construction, equipment, manning, operation and disposal'[352] giving effect to the provisions of Part XII UNCLOS. At the same time, the Exploration Regulations (Nodules) include the 'construction and operation of mining, processing and transportation systems' in its definition of 'exploitation' in Regulation 1 (3).

These provisions would appear to split transportation-related activities spatially between the competences of the ISA and the IMO and coastal State at the outer limits of the exclusive economic zone (EEZ) where the coastal State has jurisdiction over the protection and preservation of the marine environment in accordance with Article 56 (1)(b)(iii) UNCLOS which would be contrary to the ecosystem approach[353]. The scope of the term 'transportation' would also be technically split at the point in the process chain where a direct connection to extraction and lifting ends. While the Advisory Opinion found that 'transportation between the ship or installation where the lifting process ends and another ship or installation where the evacuation of water and the preliminary separation and disposal of material to be discarded take place' constitutes an activity in the Area[354], transfer to another ship could potentially exclude 'shipboard processing' as it may arguably no longer be immediately above the mine site if that definition is considered to require direct connection between the collector, riser and ship.

Although some discussion has taken place in both institutions about their respective competences and a draft cooperation agreement[355] was drawn up in 2015, the ISA and the International Maritime Organization (IMO) have failed to date to establish a formal basis for cooperation in 'areas of common interest'. The text of the draft agreement demonstrates that both organizations are hesitant to formally limit the scope of their activities ('IMO will, at the request of ISA, render assistance to ISA with respect to matters within the scope of activities of ISA; and ISA will, at the request of IMO, render assistance to IMO in matters falling within the scope of IMO's activities.'[356]), which certainly falls short of establishing an agreement to effectively coordinate their specific areas of responsibility. At the root of this issue between the ISA and the IMO is the still unresolved issue of flag State responsibility in deep seabed mining and how this interfaces with the responsibilities of the sponsoring State.

4.1.4 Excursus 1: Potential applicability of the London Convention/Protocol to 'processing'

The Advisory Opinion's finding that the 'disposal of material to be discarded' is also considered an 'activity in the Area' draws attention to the potential applicability of the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention - LC)[357] and the 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other

[351] Convention on the International Maritime Organization of 6 March 1948. 289 UNTS 3.

[352] http://www.imo.org/en/About/Pages/Default.aspx (accessed on 17 October 2017).

[353] Tullio Treves (2010). Principles and Objectives of the Legal Regime Governing Areas Beyond National Jurisdiction. In. Alex G. Oude Elferink and Erik J. Molenaar (eds.) The international legal regime of areas beyond national jurisdiction: current and future developments. Martinus Nijhoff: Leiden.7-26.

[354] Advisory Opinion, para. 96.

[355] Draft agreement of cooperation between the International Maritime Organization and the International Seabed Authority. Doc. ISBA/21/C/10 of 3 June 2015.

[356] Draft agreement, Para. 5.

[357] Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter of 29 December 1972. 1046 UNTS 120.

Matter, 1972 (London Protocol – LP)[358] both adopted under the auspices of the IMO. Some discussion of deep seabed mining has already taken place in the governing bodies of the LC/LP, however the issue has not yet been explored in greater detail apart from a request to the LC/LP Scientific Group to develop an 'overview on regulations and best practices in deep seabed mining' which has not yet been completed.[359] While the subject matter of the LC/LP initially appears directly applicable to both shipboard processing and transportation as 'activities in the Area' (but not deep seabed mining as a whole) as they concern 'any deliberate disposal at sea of wastes or other matter from vessels … platforms or other man-made structures at sea' (Article III (1)(a) LC), both treaties contains provisions explicitly rendering them inapplicable in this context. Article III (1)(c) LC establishes that 'the disposal of wastes or other matter directly arising from, or related to the exploration, exploitation and associated off-shore processing of seabed mineral resources will not be covered by the provisions of this Convention' while the London Protocol repeats the London Convention's exclusion clause *verbatim* in its list of definitions contained in Article 1 LP.[360]

The inapplicability of the London Protocol in regard to deep seabed mining could be seen as particularly unfortunate given the general obligation contained in Article 3 LP that '*Contracting Parties shall apply a precautionary approach to environmental protection from dumping of wastes or other matter whereby appropriate preventative measures are taken when there is reason to believe that wastes or other matter introduced into the marine environment are likely to cause harm even when there is no conclusive evidence to prove a causal relation between inputs and their effects*.' This provision might be seen as a direct corollary to Regulation 31 (2) of the Exploration Regulation (Nodules) where it is provided that '*in order to ensure effective protection for the marine environment from harmful effects which may arise from activities in the Area, the Authority and sponsoring States shall apply a precautionary approach, as reflected in principle 15 of the Rio Declaration, and best environmental practices*.' Both obligations relate directly to the implementation of Part XII UNCLOS, particularly Article 196 (1) UNCLOS where it is provided in clear reflection of the precautionary principle that '*States shall take all measures necessary to prevent, reduce and control pollution of the marine environment resulting from the use of technologies under their jurisdiction or control*.'[361]

The concept of 'cross-fertilization' of treaties is increasingly being discussed in various fields of international law and it may be arguable on this basis that the precautionary principle prompts action on the part of States to dynamically interpret their legal obligations in light of all instruments which share the same object and purpose to which they are parties and not merely in relation to an individual instrument.[362] Moreover, the increasing recognition of the precautionary principle as customary international law and an understanding of the functions of legal principles to address 'governance gaps' provides a basis for States to review the overarching interactions between instruments to achieve their intended goals. In light of the ISA's obligation under Annex III, Article 17 (2)(f) UNCLOS to draw up '*rules, regulations and procedures…in order to secure effective protection of the marine environment from harmful effects directly resulting from activities in the Area or from shipboard processing*' and the fact that this has not yet been satisfactorily done, this could be a

[358] 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972, as amended in 2006 of 7 November 1996. 36 ILM 1.

[359] Scientific Group of the London Convention, Coastal Management Issues Associated with Activities to Prevent Marine Pollution, Summary of information received on deep seabed mining. LC-SG/38/8/2 of 6 March 2015.

[360] Despite these exclusion clauses, the Draft Exploitation Regulations include the London Convention and the International Convention for the Prevention of Pollution from Ships (MARPOL) in its list of "international agreements applicable to the operation" in Section 2.3 of Annex V – Environmental Impact Statement Template.

[361] Detlef Czybulka (2017) Article 196: Use of technologies or introduction of alien or new species. In: Alexander Proelss (ed.) United Nations Convention on the Law of the Sea: A Commentary. C.H. Beck: Munich. 1319-1328, at 1323

[362] Philippe Sands (1998) Treaty, Custom and the Cross-fertilization of International Law. 1(4) Yale Human Rights and Development Journal. Available at: http://digitalcommons.law.yale.edu/yhrdlj/vol1/iss1/4.

particular impetus for States to review the exclusion clause in the LC/LP as part of a precautionary approach.[363]

The Contracting Parties to the LC/LP have notably used Article 3 LP in the past to take precautionary action concerning ocean iron fertilization and its potential threat to the marine environment, which although considered legally non-binding, nonetheless had the effect of creating a moratorium on that activity.[364] While these activities are, on the one hand exemplary for extending the applicability of a treaty, it should nonetheless be noted that marine geo-engineering and deep seabed mining are not directly comparable from a legal standpoint. Although both are highly controversial and involve the uncontained use of unproven technologies in the marine environment, ocean iron fertilization was not foreseen during the drafting of any of the potentially applicable treaties and is therefore essentially unregulated from the standpoint of international law. Deep seabed mining was not only foreseen at the time of drafting of UNCLOS, it is expressly allowed and even encouraged under the law of the sea. Furthermore, the entire technical process involved in ocean iron fertilization can be subsumed under the scope of the treaty, while in the case of deep seabed mining, the LC/LP could only apply to those steps in the process chain which produce a waste by-product, but could not be expanded to address other potentially environmentally destructive activities such as collection at the sea floor. While some potential for environmental intervention in regard to deep seabed mining is theoretically possible under the London Convention/Protocol in the same manner as was taken in regard to geo-engineering, these actions would be limited and it is unlikely that the political will would exist among the Contracting Parties to challenge core elements of UNCLOS through this forum.

One recent effort to give practical effect to the subject matter of the LC/LP in regard to deep seabed mining despite the exclusion clause and lack of legal clarity is the voluntary Code for Environmental Management of Marine Mining developed by the International Marine Minerals Society[365]. While the participating contractors commit themselves to implement a variety of environmental protection measures including all provisions of the LC/LP, the code of conduct is legally non-binding and is therefore not enforceable in any way. Although it can be argued that industry-led initiatives can play an interim role in improving environmental protection standards in their respective industries, voluntary initiatives can never replace strong environmental regulation due to the corresponding lack of enforcement mechanisms[366]. The track record of other industry-led voluntary commitments is generally disappointing and reliance on their use in deep seabed mining would be likely represent a failure to act with due diligence on the part of both the ISA and the sponsoring State given the already large number of environmental protection tasks left to the discretion of contractors without the possibility of any real external control. Likewise, it has also been pointed out that the ITLOS Advisory

[363] Amendment of the LC/LP to invalidate their exclusion clauses on deep seabed mining would be possible according to the terms of Articles 25 LC and 21 LP, respectively. In both cases, any Contracting Party may propose amendments which must be adopted by a two-thirds majority. Nonetheless, each Contracting Party must also deposit an instrument of acceptance of the amendment in order to be legally bound by any such amendment. It must be said, however, that although amendment is possible, this would take a considerable amount of time and the likelihood it would succeed is remote given that virtually all potential actors in deep seabed mining are also parties.

[364] LC/LP Conference of the Parties statement of concern in 2007 establishing their competence to address the issue (LC/SG 30/14, paras. 2.23-2.25.), followed by the non-binding Resolution LC-LP.1 in 2008 which prohibited all but legitimate scientific research on marine geo-engineering techniques and a 2010 Ocean Fertilization Assessment Framework (LC-LP.2) for evaluating such activities.

[365] International Marine Mineral Society (2010) Code for Environmental Management of Marine Mining. ISA Legal and Technical Commission Doc. ISBA/16/LTC/2 of 11 February 2010.

[366] John J. Kirton and Michael J. Trebilcock (2017) Introduction: Hard Choices and Soft Law in Sustainable Global Governance. In: Kriton and Trebilcock (eds.) Hard Choices, Soft Law: Voluntary Standards in Global Trade, Environment and Social Governance. London: Routledge.

Opinion underlines the importance of binding law in constraining private actors and sets regulation above contractual obligations.[367]

4.1.5 Excursus 2: Potential applicability of the Convention on Biological Diversity (CBD)

While the 1992 Convention on Biological Diversity (CBD)[368] certainly represents *lex generalis* when compared to the extensive body of law on deep seabed mining contained in UNCLOS and the ISA's secondary regulation, it is nonetheless important to consider whether other treaties and fora offer mechanisms for protecting biodiversity when *lex specialis* environmental protection measures are weak, ambiguous or non-existent. Likewise, the existence of broader treaty commitments to environmental protection, which, by nature, must be implemented through the national law of States, suggests that the scope of due diligence required of sponsoring States may be broader than the procedural elements commonly at the forefront.

Article 3 CBD establishes a general obligation that 'States have … the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction' while Article 4 (b) states that the CBD applies '…in the case of processes and activities, regardless of where their effects occur, carried out under its jurisdiction or control … beyond the limits of national jurisdiction.' Article 7 (c) CBD further requires States to 'identify processes and categories of activities which have or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity, and monitor their effects through sampling and other techniques…' This responsibility is further substantiated in Article 8 (l) CBD which requires that States 'where a significant adverse effect on biological diversity has been determined pursuant to Article 7, regulate or manage the relevant processes and categories of activities.' Article 14 (1)(a, d and e) CBD, in particular, sets out the responsibilities of States in regard to national procedures and measures for environmental impact assessment and emergency responses as well as their duty to 'encourage international cooperation to supplement such national efforts.'

While the Article 22 (1) CBD coordination clause states on the one hand that the CBD 'shall not affect the rights and obligations of any Contracting Party deriving from any existing international agreement', it makes an exception for situations where 'the exercise of those rights and obligations would cause a serious damage or threat to biological diversity.' Article 22 (2) CBD further clarifies that States shall implement the CBD 'with respect to the marine environment consistently with the rights and obligations of States under the law of the sea'. This means that any potential applicability of the CBD is limited to States' conduct of activities involved in deep seabed mining and could not extend to the biological diversity found in the Area itself, as States cannot exercise sovereignty or sovereign rights over any part of the Area or its resources according to Article 137 UNCLOS.[369] These overlaps again underline the importance of distinguishing the responsibilities of sponsoring States, flag States and the ISA in order to determine exactly how the interplay of the deep seabed regime with other legal instruments might be used to strengthen environmental protection.

When compared to the potential scope of applicability of the LC/LP, the CBD's scope of applicability to deep seabed mining is broader and could, if political will were somehow generated, be used to take action on biodiversity-related issues in the context of deep seabed mining in a similar manner as was used in regard to geo-engineering. This stems from the CBD's applicability to 'activities' without further specification, as opposed to the more restricted focus of the LC/LP on dumping and waste

[367] Duncan French (2011) From the Depths: Rich Pickings of Principles of Sustainable Development and General International Law on the Ocean Floor – the Seabed Disputes Chamber's 2011 Advisory Opinion. 26 IJMCL 525-568.

[368] Convention on Biological Diversity of 5 June 1992. 1760 UNTS 79.

[369] Julia Christine Friedland (2007) Der Schutz der biologischen Vielfalt der Tiefseehydrothermalquellen. Nomos: Baden-Baden, at 159,

management representing only one element of the technical process chain. This arguably demonstrates that despite the generally recognized weakness of non-specific obligations to protect biological diversity, the CBD is not a powerless instrument even when taking action through the ostensibly non-binding but nonetheless consensus-based[370] decisions of the Conference of the Parties.[371] It would be possible under the CBD to go as far as enacting a moratorium on the entire process chain in deep seabed mining – including the more legally ambiguous areas of transportation and processing, as opposed to under the LC/LP in the event of a suspension of its exclusion clause. It must, however, be noted that no action to address environmental issues associated with deep seabed mining has been undertaken in either treaty body to date so these reflections are purely hypothetical.

4.1.6 Conclusions

- The term 'activities in the Area' is the basis for defining the powers and functions of the ISA to regulate environmental protection.
- There are a number of ambiguities concerning the activities falling under the term 'activities in the Area' following the ITLOS Advisory Opinion, particularly concerning processing and transportation.
- The current regulation of 'activities in the Area' may not reflect how activities are eventually carried out when commercial-scale technologies and systems have been developed, which could lead to gaps and weaknesses in environmental protection. The final version of the Exploitation Regulations must ensure that the term 'activities in the Area' addresses all elements of the technical process chain.
- The potential applicability of other international legal instruments such as the London Convention/Protocol and the Convention on Biological Diversity could also be influenced by the interpretation of 'activities in the Area'.
- While UNCLOS and the ISA's secondary regulation clearly represent *lex specialis* on deep seabed mining, interplay with other legal obligations such as for the protection of biological diversity may bolster environmental protection and likewise add to the content of due diligence required of sponsoring States.

[370] Jutta Brunnee (2002) COPing with Consent: Lawmaking Under Multilateral Environmental Agreements. 15 *Leiden Journal of International Law* 1. Robin R. Churchill and Geir Ulfstein (2000) Autonomous Institutional Arrangements in Multilateral Environmental Agreements: A Little-Noticed Phenomenon in International Law. 94 *American Journal of International Law* 623.

[371] Concerning geo-engineering, the CBD 10th Conference of the Parties unanimously adopted a decision in 2010 prohibiting all types of geo-engineering activities[371] until specific conditions can be satisfied. These are 1) science-based, global, transparent and effective control and regulatory mechanisms are in place, which uphold the precautionary approach and Article 14 of the CBD; 2) an adequate scientific basis exists to justify the activities; and 3) assessments of risks to the environment and biodiversity, as well as social, economic and cultural impacts, have been conducted. The decision allows an exception for small-scale scientific research studies conducted in a controlled setting, provided they are justified for gathering scientific data and have been subject to a thorough prior environmental impact assessment. The criteria for the CBD COP's decision to enact a moratorium on geo-engineering seem particularly pertinent given that control and regulatory mechanisms only partially exist for deep seabed mining, a scientific justification for mining does not exist, and impact assessments have not yet been conducted. These circumstances arguably reflect "appropriate" circumstances in terms of Article 5 CBD to justify some form of action under the CBD.

4.1.7 Recommendations

Recommendations
▸ Develop and formally adopt authoritative ISA Guidelines to clarify exactly which technical equipment and activities are involved in 'shipboard processing', 'preliminary processing' and 'recovery', as well as objective criteria for determining the spatial scope of 'immediately above a mine site' in order to ensure that the term 'activities in the Area' is consistently and uniformly applied. ▸ Request a study by the LTC of gaps between the DSM regime and broader international legal obligations concerning the protection of the marine environment as already proposed by the Scientific Group of the LC/LP. ▸ Conclude a Memorandum of Understanding between the ISA and the IMO to demarcate exact areas of responsibility over different vessels and installations involved in deep seabed mining with particular regard for the activities representing preliminary processing. Particular clarification is necessary in regard to the intersections between the responsibilities of flag States and sponsoring States. ▸ Consider action in the Conferences of the Parties to the London Convention/Protocol and the Convention on Biodiversity to augment environmental protection measures developed by the ISA. Although political will does not currently exist in this regard in either treaty body, measures as far reaching as moratoria for at least part of the technical process chain are theoretically possible under both instruments. Such action to address fundamental environmental issues through additional fora arguably reflects due diligence required of sponsoring States. **Developing the exploitation regulations:** ▸ Include a legal definition of 'activities in the Area' and related terms in the final version of the Mining Code to ensure its consistency with UNCLOS and the 2011 ITLOS Advisory Opinion. ▸ Develop more detailed regulation of the individual steps making up the technical process chain, identifying the legal basis for regulating each step and clearly designating responsibilities and mechanisms for coordination when specific activities fall partially or fully outside the ISA mandate.

4.2 Division of responsibilities between the ISA and sponsoring States

4.2.1 The division of responsibilities as a dynamic construct

The division of responsibilities between the ISA and sponsoring States for the protection of the marine environment from the effects of 'activities in the Area' is not clear-cut. Although ITLOS provided an advisory opinion on the matter in 2011, it focused on the issue of due diligence on the part of sponsoring States rather than clarifying the full division of competences with the ISA or the broader responsibility for environmental protection in terms of international law. As already described above, the effectiveness of environmental protection concerning 'activities in the Area' requires clarity on the exact extent of the ISA's responsibilities as well as authoritative definitions of what activities, technologies and even what physical areas are subject to ISA regulations. How the ISA's competences are defined, in turn, defines the areas where sponsoring States continue to have primary or joint responsibility for particular actions in the deep seabed regime and how their role as 'guardians' of international environmental law is to interact with that of the ISA. When legal uncertainties are not resolved concerning the exact division of responsibilities, the ISA cannot evolve to address those areas, nor can States step up their efforts to develop effective regulation using other parts of UNCLOS and other international for a -- particularly when those instruments have rendered themselves inapplicable to deep seabed mining as described above in relation to the London Convention/Protocol.

The role of the sponsoring State in ensuring effective environmental protection for 'activities in the Area' is therefore significant, particularly when the ISA's competences are considered limited to narrow functional jurisdiction over specific 'activities in the Area' rather than more broadly constructed. As described in Section 3.1 above, several arguments support interpreting 'activities in the Area' as expansively as possible to ensure that the ISA can adopt seamless and coherent environmental protection regulation for the vast majority of activities making up the technical process chain. Others take a more restrictive approach to defining the competences of the ISA, arguing that it is a 'mere mining agency', or at least that its competences are generally limited but are broader in regard to the environment on the basis of the precautionary principle.[372] If a broader view is taken, the ISA will need to expand its capacity to address highly specialized issues in both environmental management and technology. If a more restricted view is taken, States will need to address environmental protection related to deep seabed mining through a broader range of international law beyond Part XI UNCLOS and to pay particular attention to ensuring a precautionary approach through their national legal systems in ambiguous areas.

There are advantages and disadvantages to both approaches, however it needs to be kept in mind that drafting good regulation, for example considerably revised Exploitation Regulations and Environmental Regulations, is only one part of the equation in achieving effective protection of the marine environment. The capacity of the ISA and sponsoring States to actually perform the duties eventually attributed to them in these instruments must also be given equal attention. Likewise, considerable attention to coordination processes will be necessary in situations where the ISA and sponsoring States are to uphold their obligations jointly or cooperatively.

[372] Ikechi Mgbeoji (2004) (Under)Mining the Seabed? Between the International Seabed Authority's Mining Code and Sustainable Bioprospecting of Hydrothermal Vent Ecosystems in the Seabed Area: Taking Precuation Seriously. 18 Ocean Yearbook: 383-409, at 435. Alexander Proelss (2013) The Role of the Authority in Ocean Governance. In: Harry N. Scheiber, Jin-Hyun Paik (eds. Regions, Institutions and Law of the Sea: Studies in Ocean Governance. Martinus Nijhoff: Leiden., 145-160 at 157.

4.2.2 The legal basis for a dynamic approach

According to Article 145 UNCLOS, '*necessary measures shall be taken in accordance with this Convention with respect to activities in the Area to ensure effective protection for the marine environment from harmful effects which may arise from such activities*.' It is notable that it is not specified here who is responsible for these 'necessary measures', nor are the measures limited to Part XI. Through the use of the term 'Convention' this provision can be interpreted as referring to the further relevant parts of UNCLOS, namely Part VII concerning the high seas and Part XII concerning the protection of the marine environment, which is applicable in all maritime zones. In accordance with Article 157 (2) UNCLOS, the ISA is not empowered to act beyond the powers and functions expressly conferred upon it by the Convention. In contrast, States are '*competent to act individually or jointly with regard to the Area in accordance with their rights and obligations under the Convention, including its Part XI*' in all instances that UNCLOS has not conferred powers and functions on the Authority.[373] While Article 145 UNCLOS further provides that the ISA is required '*to this end… to adopt appropriate rules, regulations and procedures…*', the use of the term 'measures' also arguably establishes a link between Articles 145 and 194 UNCLOS which sets out the fundamental obligation of States to prevent, reduce and control pollution of the marine environment.

Section 1 (3) of the Annex to the Implementing Agreement allows the ISA to take an 'evolutionary approach' to the functioning of its organs and subsidiary bodies, and accordingly, gradually adopt and revise its rules, regulations and procedures. It should be noted, however, that this 'evolutionary approach' does not create a vacant space or 'self-contained regime' excluding the remainder of international law, which the ISA can gradually fill as it satisfies its regulatory obligations.[374] Instead, it creates a dynamic relationship in which sponsoring States augment the *lex specialis* contained in Part XI UNCLOS for 'activities in the Area' and the secondary regulation of the ISA with the *lex generalis* contained in the Convention as a whole when that *lex specialis* is not sufficient. In this light, Article 145 UNCLOS can be seen as both the legal basis for the 'evolutionary design[375] of the deep seabed mining regime and the guarantee that States continue to hold the ultimate responsibility for environmental protection as this regime evolves. The danger in this diffuse, dynamic approach is that environmental protection is neglected rather than treated as a fundamental obligation in the operation of the regime.

4.2.3 State sponsorship in an evolutionary regime

The legal nuances of sponsorship in the deep seabed mining regime are complex. Article 139 UNCLOS provides that 'States Parties shall have the responsibility to ensure that activities in the Area, whether carried out by States Parties, or state enterprises or natural or juridical persons which possess the nationality of States Parties or are effectively controlled by them or their nationals, shall be carried out in conformity with this Part.' Annex III, Article 4 (4) UNCLOS further sets out that the 'sponsoring State or States shall, pursuant to article 139, have the responsibility to ensure, within their legal systems, that a contractor so sponsored shall carry out activities in the Area in conformity with the terms of its contract and its obligations under this Convention. A sponsoring State shall not, however, be liable for damage caused by any failure of a contractor sponsored by it to comply with its obligations if that State Party has adopted laws and regulations and taken administrative measures which are, within the framework of its legal system, reasonably appropriate for securing compliance by persons under its

[373] Elferink, 157.

[374] Tullio Treves (2010). Principles and Objectives of the Legal Regime Governing Areas Beyond National Jurisdiction. In. Alex G. Oude Elferink and Erik J. Molenaar (eds.) The international legal regime of areas beyond national jurisdiction: current and future developments. Martinus Nijhoff: Leiden.7-26. Tullio Treves (2009) Fragmentation of International Law: The Judicial Perspective. 27 Agenda Internacional: 213-253.

[375] Aline L. Jaeckel (2017) The International Seabed Authority and the Precautionary Principle: Balancing Deep Seabed Mineral Mining and Marine Environmental Protection. Brill: Leiden.

jurisdiction.' ITLOS noted in para. 110 of the Advisory Opinion that the obligation 'to ensure' – also referred to as 'due diligence' -- is '*an obligation to deploy adequate means, to exercise best possible efforts, to do the utmost, to obtain this result*' and is an obligation of conduct rather than result.

Annex III, Article 4 (4) UNCLOS can be interpreted to establish a two-part obligation for sponsoring States: on the one hand, they must ensure through their domestic law that a sponsored contractor carries out activities in the Area 'in conformity with the terms of *its* contracts' (*i.e*. contracts concluded between the contractor and the ISA in accordance with Part XI), but, on the other hand, the sponsoring State must ensure that a contractor upholds '*its* obligations under this Convention.' While 'its' might at first glance appear to refer to the contractor in both instances, it must be noted that contractors themselves cannot have obligations under UNCLOS as they are not bearers of rights and duties under international law. As noted in the ITLOS Advisory Opinion, it is precisely for this reason that the legal construct of sponsorship was created for deep seabed mining.[376]

The provision can therefore be interpreted to demonstrate that due diligence is not just an obligation on the part of sponsoring States in relation to the ISA and contractors. Instead due diligence is also required in relation to other States Parties to UNCLOS concerning broader environmental obligations on the basis of *pacta sunt servanda*, the customary international law that establishes that States cannot violate obligations contained in one legal instrument in order to pursue the goals of another.[377] The Advisory Opinion further supports this interpretation when referring to the obligation to take a precautionary approach as part of the due diligence of sponsoring States, which is 'applicable even outside the scope of the Regulations'.[378] This is also in line with the Advisory Opinion's understanding of due diligence as a 'variable concept' that 'may change over time as measures considered sufficiently diligent at a certain moment may become not diligent enough in light, for instance, new scientific or technological knowledge. It may also change in relation to the risks involved in the activity.'[379]

This dynamic approach to the division of responsibilities between the ISA and sponsoring States will become critical in several situations including:

- Where the ISA has not yet adopted rules, regulations and procedures (for example Exploitation Regulations and Environmental Management Regulations);
- Where the ISA has failed to develop functional mechanisms (for example an Inspectorate); and
- Where regulation is ambiguous or inadequate and sponsoring States are therefore uncertain about their legal obligations (for example in regard to mining tests, see section 3.3 below.)

4.2.4 Sponsorship and 'cooperation' in the Exploration Regulations concerning monitoring and emergency orders

In practice, the division of responsibilities between the ISA and sponsoring States is interconnected with the broader notion of cooperation in international environmental law. Indeed, the ISA itself – 'the organization through which States Parties…organize and control activities in the Area' according to Article 157 (1) UNCLOS – is a forum to enable cooperation between States. It is therefore not surprising that obligations in the Exploration Regulations regarding monitoring and emergency orders are set up as shared responsibilities between the ISA, sponsoring States and contractors.

In Regulation 31 (6) Exploration Regulations, for example, it is provided that '*contractors, sponsoring States and other interested States or entities shall cooperate with the Authority in the establishment and*

[376] ITLOS, paras. 75.

[377] Nele Matz (2003) Wege zur Koordinierung völkerrechtlicher Verträge: Völkervertragsrechtliche und institutionelle Ansätze. Springer: Berlin at 234.

[378] Advisory Opinion, para. 131.

[379] Advisory Opinion, para. 117.

implementation of programmes for monitoring and evaluating the impacts of deep seabed mining on the marine environment.' The practical implementation of this provision is then set out in Regulation 32 (1) which requires the contractor, in cooperation with the ISA and the sponsoring State, to '…*gather environmental baseline data and … establish environmental baselines…against which to assess the likely effects of its programme of activities under the plan of work for exploration on the marine environment and a programme to monitor and report on such effects.*' Based on these regulations, the duty to cooperate concerning monitoring is implemented by the contractor setting its own baselines, designing a monitoring approach for its activities and reporting the results to the sponsoring State and the ISA. The results are then, in turn, examined by the sponsoring State to ensure compliance with its own implementing legislation for deep seabed mining and environmental protection regulation in fulfilment of its due diligence obligations, and by the ISA to ensure compliance with its rules, regulations and procedures.

Likewise, the process of issuing emergency orders involves cooperation between the ISA, sponsoring States and contractors. As with monitoring, this process is also initiated by the contractor in accordance with Regulation 33 (1) which is required to *'promptly report to the secretary-General in writing, using the most effective means, any incident arising from activities which have caused, are causing or pose a threat of serious harm to the marine environment*.' The Secretary-General then issues a general notification and reports to the LTC, the Council and all ISA members on the basis of Regulation 33 (2). The Secretary-General may also then take temporary '*immediate measures of a temporary nature as are practical and reasonable in the circumstances to prevent, contain and minimize serious harm or the threat of serious harm to the marine environment*' on the basis of Regulation 33 (3). Based on the Secretary-General's report, the LTC is then required to determine the necessary measures to respond to the incident and makes a recommendation to the Council on the basis of Regulation 33 (4). Based on this information, the Council may then issue emergency orders to prevent, contain and minimize serious harm on the basis of Regulation 33 (6), which '*may include orders for the suspension or adjustment of operations*'. In general, the Secretary-General has an on-going obligation to 'monitor developments with respect to all such incidents' according to Regulation 33 (2).

In the event the contractor fails to comply with immediate measures or emergency orders, the Council is required under Regulation 33 (7) to take '*by itself or through arrangements with others on its behalf, such practical measures as are necessary to prevent, contain and minimize any such serious harm or threat of serious harm to the marine environment*'. The Council's capacity to enact such practical measures is ensured by the guarantee provided by the contractor prior to beginning testing of collecting systems and processing operations in accordance with Regulation 33 (8). The sponsoring State's responsibility in this situation is to '*take necessary measures to ensure that the contractor provides such a guarantee*' or to 'ensure that assistance is provided to the Authority in the discharge of its responsibilities under paragraph 7.' Based on these provisions, the responsibilities of the respective actors in relation to monitoring and emergency orders under the Exploration Regulations can be summarized as as shown in Table 4.

Table 4 The responsibilities of the respective actors in relation to monitoring and emergency orders under the Exploration Regulations.

Term	Exploration Regulations (Nodules)
Contractor	► Set baselines ► On-going monitoring of activities ► Report on effects of activities ► Report incidents arising from activities causing or threatening serious damag to the marine environment to the Secretary-General ► Provide Council with a guarantee of its financial and technical capability to comply with emergency orders or enable the Council to take emergency measures prior to commencing testing activities ► Take all measures necessary to ensure that its activities do not cause serious harm to the marine environment in all maritime zones
ISA Secretary-General	► Review contractors' monitoring reports for compliance with ISA rules, regulations and procedures ► Report to the Council, Legal and Technical Commission and ISA members, as well as other competent international organizations and other concerned sub-regional, regional and global organizations ► Issue a general notification of an incident upon receipt of notification from a contractor ► Issue immediate temporary measures to be performed by the contractor to prevent, contain and minimize the incident ► On-going monitoring of developments concerning the incident ► Issue a request to the sponsoring State to ensure the contractor provides the required guarantee ► Directing and supervising an inspectorate on the basis of mechanisms established by the Council
ISA Council	► Issue emergency orders at its discretion which override the Secretary-General's temporary measures ► Take necessary practical measures to prevent, contain and minimize the incident in the event the contractor fails to act ► Suspend or terminate the contract on the basis of serious, persistent and willful violations ► Establish mechanisms for the operation of an inspectorate
ISA Legal and Technical Commission	► Issue recommendations to the Council
Sponsoring State	► Review monitoring reports provided by the contractor for compliance with its national legislation ► Ensure the contractor provides a guarantee to the Council ► Exercise due diligence to ensure contractor upholds the terms of its contract

According to Article 162 (2)(z) UNCLOS, the Council is required to '*establish appropriate mechanisms for directing and supervising a staff of inspectors who shall inspect activities in the Area to determine whether this Part, the rules, regulations and procedures of the Authority and the terms and conditions of any contract with the Authority are being complied with*.' Section 14.1 (a-b) of the standard clauses for exploration contracts further spells out the functions of this inspectorate to '*monitor the contractor's compliance with the terms and conditions of this contract and the Regulations*' and '*monitor the effects of such activities on the marine environment*'. The Secretary-General is responsible for directing and supervising the inspectorate according to Section 14 of the standard clauses.

Despite the fact that the effectiveness of both monitoring and emergency orders under the Exploration Regulations relies on an inspectorate to ensure compliance, no such inspectorate has yet been established. This is an extraordinary deficit in the Exploration Regulations and may be attributable to the formulation used in Article 153 (5) UNCLOS in this regard: '*the Authority shall have the right to inspect all installations in the Area used in connection with activities in the Area*'. This provision fails to establish a corresponding obligation on the part of the Authority to conduct inspections and restricts the right to 'all installations in the Area' – that is the 'seabed and ocean floor and subsoil thereof, beyond the limits of national jurisdiction' according to Article 1 (1) UNCLOS. In the absence of a functioning ISA inspectorate, the effectiveness of monitoring and emergency orders relies on self-reporting by the contractor, discretionary and reactive action by the Council, and the enforcement of contractual obligations by the sponsoring State in its national legal system in accordance with Annex III, Article 4 (4) UNCLOS and its right to terminate sponsorship in accordance with Section 20 of the standard clauses.[380] This division of responsibilities between the ISA and the sponsoring State is clearly inadequate for achieving effective environmental protection during exploration.

4.2.5 Potential changes in the Draft Exploitation Regulations

Although the Draft Exploitation Regulations continue a cooperative approach to the division of responsibilities *pro forma*, it becomes apparent on closer examination that would, in practice, lead to a general reduction in the responsibility and accountability of the Authority for activities in the Area and significant gaps in effective protection which would become the ultimate responsibility of sponsoring States. This arguably fails to uphold the Authority's fundamental responsibility to 'organize and control activities in the Area' established in Article 153 (1) and 157 (1) UNCLOS.

The Draft Exploitation Regulations place emphasis first and foremost on the application process and the approval of exploitation licenses, but given the fact that these licenses are to be granted for an initial period of up to 30 years in accordance with Draft Regulation 13, the actual operation of the regime is given surprisingly little attention. Comparison of the procedures for monitoring and emergency orders in the Exploration Regulations and Draft Exploitation Regulations reveals some radical changes in approach that could further weaken the capacity of the regime to ensure effective environmental protection. It might even be argued in general that the document's receptor-based approach to environmental protection is a *de facto* smokescreen for the urgent need on the part of all potential actors in deep seabed mining to undertake a source-focused approach to the prevention of environmental damage as required in Article 196 (1) UNCLOS: 'States shall take all measures necessary to prevent, reduce and control pollution of the marine environment resulting from the use of technologies under their jurisdiction or control…'

[380] According to Regulation 34 (2), coastal States also have a right to notify the Secretary-General concerning serious harm or threat of serious harm from activities in the Area, however this is restricted to the marine environment under their jurisdiction or sovereignty.

4.2.6 Monitoring as a bureaucratic act rather than a fundamental environmental protection responsibility

In regard to monitoring, Draft Regulation 23 (5) of the Draft Exploitation Regulations provides that contractors shall implement and carry out monitoring in accordance with the Environmental Management and Monitoring Plan approved by the LTC as part of the plan of work for exploitation and after the cessation of activities in accordance with the final Closure Plan on the basis of Draft Regulation 25. The contractor is required to submit a review of its environmental performance in the second, fifth and tenth years after beginning commercial production according to Draft Regulation 24, which is then reviewed by the Secretary-General and made public. Finally, Draft Exploitation Regulation 24 (2) requires the contractor to obtain an '*independent assessment of its compliance with its Environmental Management and Monitoring Plan and the state of its Environmental Management System*' which would, in practice, represent a performance audit from a company standpoint but cannot be considered a compliance mechanism for environmental performance in general as it is intended to review internal industrial processes rather than regulatory requirements.

In contrast to the Exploration Regulations, no specific responsibility is established for the sponsoring State in the monitoring process beyond the general obligation on the part of sponsoring States to ensure compliance. Following the requirements established in UNCLOS and the Advisory Opinion, this places considerable responsibility on sponsoring States to enact appropriate procedures to ensure environmental protection in their national law and creates exactly the conditions for the emergence of 'sponsoring States of convenience' feared in the Advisory Opinion. This can further be seen in Annex VII – Environmental Management and Monitoring Plan which places in subparagraph (g) even the implementation of adaptive management under the responsibility of the contractor and sponsoring State. Such an approach makes a regional approach to monitoring, which can only be effectively be achieved through broader inter-State cooperation, legally unsupported.

4.2.7 From 'emergency orders' to an approved emergency response and contingency plan

As in the Exploration Regulations, the contractor is required to immediately notify the Secretary-General of an incident -- defined as '*a situation where activities in the Area result in … serious harm to the marine environment or…a situation in which such serious harm to the marine environment is a reasonably foreseeable consequence of the situation*' -- in accordance with Draft Regulation 40 (2) and immediately implement its Emergency Response and Contingency Plan as well as any other necessary measures. The Secretary-General may also issue instructions similar to the temporary measures foreseen under the Exploration Regulations. In the event the contractor fails to comply with its approved plan, Draft Regulation 40 (3) requires the Secretary-General to report non-compliance to the sponsoring State or flag State for '*consideration of the institution of legal proceedings under national law*'. Further, Draft Regulation 41 places the responsibility for notifying all regulatory authorities on the contractor rather than on the Secretary-General as was provided in the Exploration Regulations.

There is no indication how the Secretary-General would effectively and reliably establish non-compliance in such a situation. While Part XI of the Draft Exploitation Regulations does provide for inspections, the focus of the relevant provisions is on inspectors' powers ('*An Inspector may, for the purposes of monitoring or enforcing compliance…*') rather than setting out specific responsibilities and obligations to be upheld by an inspectorate. Draft Regulation 87, for example, gives the inspector powers to issue instructions in the event of a threat of serious harm to the marine environment which may include the suspension of mining activities, conditions for the continuation of mining activities and requirements for the contractor to undertake specific measures within a set time period. Inspectors' instructions, however, lapse after 7 days which significantly limits their potential effectiveness. After inspectors' instructions have lapsed, the Secretary-General may begin to exercise powers under Draft Regulation 89. Needless to say, an inspectorate has not been established which renders these provisions irrelevant in practice.

Under Draft Regulation 89, the Secretary-General is authorized to issue compliance notes to contractors when violations of ISA rules or contractual obligations may have occurred and require the contractor to take remedial action to ensure compliance. A compliance notice includes a requirement on the part of the contractor to take remedial action to ensure compliance within a specified time period and, for specific violations, a monetary penalty. After allowing the contractor to make representations, the Secretary-General can confirm, modify or withdraw the compliance notice. In the event a contractor fails to comply with a compliance notice, the Authority may suspend or terminate the exploitation contract at its discretion according to Draft Regulation 89 (5).

In fundamental contrast to the Exploration Regulations, Draft Regulation 90 does not require the ISA to undertake remedial action in the event of non-compliance by the contractor. Instead, the Authority '*may carry out any remedial works or take such measures as it considers reasonably necessary to prevent or mitigate the effects or potential effects of a Contractor's failure in complying with the terms and conditions of an exploitation contract*' in accordance with Draft Regulation 90 (1). In this event, '*the actual and reasonable costs and expenses incurred by the Authority in taking that action are a debt due to the Authority from the Contractor*' following Draft Regulation 90 (2) rather than through a guarantee provided by the contractor prior to beginning operations as in the Exploration Regulations. While not explicitly stated, Draft Regulation 90 can be argued to implicitly create an obligation on the part of the sponsoring State to perform remedial action itself if the contractor fails to do so and the ISA decides against taking action. This is then confirmed in Draft Regulation 91 which sets out the specific responsibility of sponsoring States to ensure the compliance of contractors, including for emergency orders issued by the Council to prevent serious harm to the marine environment under Article 162 (2)(w).

There are a number of issues with the approach proposed in the Draft Exploitation Regulations. First, a notable consolidation of executive powers in the office of the Secretary-General is apparent, as well as an expansion of the office into the area of compliance. The review mechanism provided in Draft Regulation 92 (3) clearly demonstrates this: '*Any request for a review under this regulation shall be made to the Secretary-General who shall cause the matter to be investigated as he considers appropriate.*' This power would allow the Secretary-General to decline a review request at his discretion without recourse to another decision-making body. This expansion of powers may not be compatible with the original intentions of Article 166 (3) UNCLOS where the Secretary-General is foreseen as the 'chief administrative officer' while the Council was foreseen in Article 162 (1) as the executive organ.

Second, a comparison of Draft Regulations 90 and 91 and the division of responsibilities between the ISA and sponsoring States reveals an attribution of discretionary powers to the Authority ('the Authority may…', 'if the Authority…') while sponsoring States 'shall…take all necessary measures to secure compliance by Contractors whom they have sponsored…' which squarely places responsibility on sponsoring States. Finally, implementation of any measures by the Authority in the event of non-compliance on the basis of Draft Regulation 90 would also require the Authority to have a considerable operating budget as it would no longer have access to a performance guarantee provided by the contractor prior to beginning operations in order to ensure the Authority has the necessary resources to take action as required under the Exploration Regulations.

4.2.8 An urgent need for transparency and public participation mechanisms

A further effect of the procedures foreseen in the Draft Exploitation Regulations is the elimination of a duty on the part of the Secretary-General to issue a general notification of an incident reported by a contractor as well as issuing a notification to all ISA members and any potentially concerned international and regional organizations as established in the Exploration Regulations. This is of particular concern as, although cooperation between States, public participation, transparency and access to information are only procedural obligations, they serve at the same time to legitimize and improve the quality of decisions[381] and enable other actors to contribute to environmental protection. If incidents no longer must be generally notified and compliance notices are subject to the discretion of the Secretary-General and communicated only with sponsoring States, the mechanism for collective pressure from States Parties to ensure compliance by all actors foreseen in Article 139 (1) UNCLOS is rendered obsolete. This provision notably provides that '*States Parties*' – that is, all States as opposed to sponsoring States -- '*shall have the responsibility to ensure that activities in the Area, whether carried out by States Parties, or state enterprises or natural or juridical persons which possess the nationality of States Parties or are effectively controlled by them or their nationals, shall be carried out in conformity with this Part*.' If the procedures foreseen in the Draft Exploitation Regulations are adopted, independent science and civil society would play an absolutely essential role in ensuring compliance in the absence of other external control mechanisms but would be profoundly hindered in taking on this role by the limited access to information foreseen in the draft.

4.2.9 Diffusion of the ISA's responsibility

In general, a comparison of the two instruments shows that the Draft Exploitation Regulations shift a number of obligations from the purview of the ISA to sponsoring States and bring the sponsoring State much more actively to the forefront in ensuring compliance both procedurally and substantively. A notable example of this is found in Annex V – Environmental Impact Statement Template, Section 2 under which applicants provide a list of all legal instruments, both domestic and international, applying to the plan of work contained in the application for an exploitation license:

- '…legislation, regulation or guidelines that apply to the management or regulation of seabed mining in the Area, including how the proposed operation will comply with these…'
- '…any other legislation, policy or regulations that do not necessarily apply specifically to seabed mining or the environment, but may be relevant to the proposal (e.g. shipping regulations, etc.)'
- '…international agreements applicable to the operation, such as the United nations Convention on the Law of the Sea (UNCLOS), the Convention on Biological Diversity (CBD), the International Maritime Organization (IMO) suite of environmental and safety conventions including the Safety of life at Sea (SOLAS) Convention, the International Convention for the Prevention of Pollution from Ships (MARPOL), the London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention), etc.'.

Further, in Annex VI Emergency Response and Contingency Plan, it is noted that the plan will be further developed under the Exploitation Regulations and *'in conjunction with other international organizations, sponsoring States and other entities with relevant jurisdictional competence as regards specific components of the plan.*" This indicates that other forms of State jurisdiction – particularly flag State jurisdiction – are envisaged as an essential part of the deep seabed mining regime.

These provisions underline the fundamental role of States in protecting the marine environment from 'activities in the Area' and could potentially suggest a diffusion of responsibility away from the ISA in the Draft Exploitation Regulations. This calls into question how Article 153 (4) UNCLOS under which it is provided that '*the Authority shall exercise such control over activities in the Area as is necessary for the purpose of securing compliance…'* and *'States Parties shall assist the Authority by taking all measures necessary to ensure such compliance…'* is intended to operate in practice if the sponsoring State is considered legally subordinate to the ISA but is in practice responsible for ensuring the compliance of

[381] Patricia Birnie, Alan Boyle, Catherine Redgwell (2009) International Law & the Environment. Oxford University Press: Oxford, 123.

its sponsored contractor.[382] In light of the Advisory Opinion's observation that the sponsoring State's obligation '*to ensure is not an obligation to achieve, in each and every case, the result that the sponsored contractor complies with the aforementioned obligations… this obligation may be characterized as an obligation 'of conduct' and not 'of result', and as an obligation of 'due diligence*''.[383] Consequently, it must be examined whether the approach taken in the Draft Exploitation Regulations is ultimately capable of achieving effective environmental protection at all. Furthermore, it must also be examined whether this division of responsibilities upholds the obligation of the ISA to act on behalf of mankind as a whole as provided in Article 137 (2) UNCLOS when the central obligation for ensuring compliance is performed by States.

4.2.10 Draft Exploitation Regulations and the issue of State capacity for implementation

Irrespective of how the division of responsibilities between the ISA and sponsoring States is ultimately defined, ensuring that the institutions of both sponsoring States and the ISA are capable of executing their responsibilities in an effective and appropriate manner in practice is as fundamental to environmental protection as developing good regulation. If the sponsoring State becomes the default guarantor of environmental protection in the deep seabed mining regime as foreseen in the Draft Exploitation Regulations, the issue of national capacity will become an even more critical factor in ensuring effective environmental protection. It has frequently been observed that national capacity is often a neglected part of many international environmental regimes[384]. It should also be noted here that capacity is not just an issue for developing countries. As emphasized in Agenda 21, the need to strengthen national capacities in order to achieve sustainable development is shared by all countries.[385]

The Advisory Opinion has already referred to the issue of 'sponsoring States of convenience', where contractors from highly industrialized countries evade more stringent environmental protection requirements by relocating to developing countries[386]. Although the ISA has engaged in some degree of training and capacity-building with contractors it has not examined the capacity of the sponsoring State to ensure that the contractor upholds its obligations. At the 23rd session of the Council, the Secretary-General presented a list of the sponsoring States' relevant national laws, regulations and administrative measures concerning deep seabed mining[387], however no further analysis of the adequacy of these instruments was made. It is notable that the Draft Exploitation Regulations fail to consider the initial stage of the application process for exploitation altogether. The decision of a State to sponsor establishes that State as the initial gatekeeper in the application process, which is a critical stage in environmental protection and directly related to the State's duty to prevent environmental damage which is also at the core of the Principle 15 formulation of the precautionary principle held up as on the general principles applicable to environmental management in Draft Regulation 17. In particular, no criteria have been established in the draft for evaluating the State's qualifications to serve as sponsor.

[382] Advisory Opinion, para. 102.

[383] Advisory Opinion, para. 110.

[384] Martin Jänicke (2002) The Political System's Capacity for Environmental Policy: The Framework for Comparison. In: Helmut Weidner and Martin Jänicke (eds.) Capacity Building in National Environmental Policy: A Comparitive Study of 17 Countries. Springer: Berlin,

[385] United Nations Conference on Environment and Development (1992) Agenda 21. UN Doc. A/Conf.151/26 (Vol. III) of 14 August 1992, Chapter 37.1.

[386] Advisory Opinion, para. 159.

[387] International Seabed Authority/Council (2017) Laws, regulations and administrative measures adopted by sponsoring States and other members of the International Seabed Authority with respect to the activities in the Area. Report of the secretary-General on the status of national legislation relating to deep seabed mining and related matters. Doc. ISBA/23/C/6 of 1 June 2017.

4.2.11 Conclusions

- The division of responsibilities between the ISA and sponsoring States for the protection of the marine environment from the effects of deep seabed mining is dynamic and not clear-cut.
- How the ISA's competences are ultimately defined in light of the interpretation of 'activities in the Area' directly determines which responsibilities fall under the purview of sponsoring States and which are jointly held.
- The ISA's 'evolutionary approach' to developing specialized regulation for deep seabed mining and its avoidance of being 'over-prescriptive' could lead to an under-regulation of environmental matters.
- States, as the 'guardians' of international environmental law, are required to fill gaps in all areas that are not sufficiently regulated by the ISA using other sources of environmental protection obligations including Part XII UNCLOS.
- Effective environmental protection requires both well-drafted, comprehensive regulation, as well as sufficient capacity on the part of the ISA and sponsoring States to implement the corresponding obligations.
- The lack of a functioning inspectorate endangers environmental protection under the Exploration Regulations.

4.2.12 Recommendations

Recommendations

- Clearly define the division of responsibilities between all actors and Identify all activities where the ISA and sponsoring States have shared or joint responsibilities. Establish formal procedures and criteria to ensure effective cooperation.
- Address institutional weaknesses within the ISA for upholding specific obligations, including the lack of an existing inspectorate or environmental organ. Develop a memorandum of understanding with the IMO to ensure that inspections may be conducted on all vessels engaged in activities in the Area and are not restricted to 'installations in the Area'.
- Develop a formal procedure for sponsoring States as part of their due diligence obligations to notify the ISA of areas where their legal systems and institutional capacity for upholding their obligations may fail to uphold the minimum standard.
- Develop ISA capacity-building programs not just for contractors but also for sponsoring States to ensure that they have the regulatory and institutional capacity to uphold the obligations connected with sponsorship.
- Understand transparency and public participation as mechanisms for enhancing capacity and due diligence.

Developing the exploitation regulations:

- Ensure that the division of responsibilities between the ISA, sponsoring States and contractors are clearly defined and ensure that formal procedures and criteria for cooperation have been created in areas of joint responsibility.
- Ensure that the Draft Exploitation Regulations clearly establish the ISA's responsibility to conduct inspections and not just the discretionary rights of its inspectors ('may'). Also ensure that inspections are not spatially restricted to 'installations in the Area' but may be conducted on all vessels involved in activities in the Area.
- Ensure that checks and balances are built into the Draft Exploitation Regulations to provide internal controls over the exercise of powers by the organs of the ISA and increase accountability.

- Ensure that failure to protect and preserve the marine environment is specifically named as grounds for compliance notices, as well as the suspension and termination of contracts.
- Clarify mechanisms for transparency, public participation and access to information in order to create external mechanisms for ensuring the accountability and effective operations of the ISA.
- Establish criteria for States to fulfill in order to qualify as sponsors, emphasizing their gatekeeper function at the application stage as well as their on-going environmental obligations also derived from other international legal instruments.

4.3 Regulation of mining tests

4.3.1 Current state of regulation concerning mining tests

Mining tests, initially component tests, are already scheduled to begin in 2018, despite the fact that the ecosystem dynamics of and consequences of human impacts on the previously untouched deep seabed are little understood and barely researched. Compounding this, testing, by nature, occurs when developers have the least understanding of the reliability and performance of their equipment and have had no opportunity to test potential mitigation or emergency response measures to address potential system and process failures. In this light, it is particularly urgent that an effective system of environmental controls is in place, which expands with the scale of testing and its potential environmental impacts and facilitates early regulatory intervention to prevent environmental harm. This represents a shift from the original focus on feasibility toward an understanding of the testing process as a critical risk management measure. The results of mining tests are essential to all potential actors in deep seabed mining for different reasons, whether contractors, sponsoring States or the ISA itself. It is therefore essential that the regulation of mining tests is comprehensively overhauled for the exploration phase and that all new regulation in development for exploitation and environmental management ensures that decisions concerning whether or not to pursue deep seabed mining at commercial scale are made on the basis of comprehensive and credible information on its environmental impacts and their likely consequences.

A number of legal issues become apparent when examining the current regulation of mining tests. First, testing is rarely mentioned in UNCLOS or the Implementing Agreement and when it is mentioned, the terminology is highly inconsistent. It should also be noted that the term 'pilot mining test' is not used at all in relation to legal obligations, although it is frequently used by contractors involved in the development of mining technologies. The following terms have all been used in this regard without the creation of suitable criteria for determining exactly which technical processes are being addressed:

- 'testing of mining systems' (Annex III, Article 17 (2)(c));
- 'testing of recovery systems' (Exploration Regulations);
- 'testing of equipment' (Annex III, Article 17 (2)(g), Exploration Regulations);
- 'testing of plant' (Annex III, Article 17 (2)(g));
- 'testing of processing facilities' (Annex III, Article 17 (2)(c)) und Exploration Regulations);
- 'testing of transportation systems' (Exploration Regulations).

An additional issue is that UNCLOS also further differentiates tests of equipment and processes according to their scale, referring to small-, medium- and commercial-scale mining technologies in the Area. Depending on how provisions concerning the duration of 'exploration' and 'exploitation' in Annex III, Article 17 (b)(ii) and (iii) UNCLOS are interpreted, these distinctions may have consequences both for the extent to which commercial-scale equipment and processes may be tested without an approved plan of work for exploitation and for the extent of testing upon which decisions to proceed with commercial production and corresponding environmental protection measures would be made. These provisions specify that:

- 'Exploration should be of sufficient duration to permit a thorough survey of the specific area, the design and construction of mining equipment for the area and the design and construction of small and medium-size processing plants for the purpose of testing mining and processing systems.'
- 'Exploitation should be of sufficient duration to permit commercial extraction of minerals of the area and should include a reasonable time period for construction of commercial-scale

mining and processing systems, during which period commercial production should not be required.'

This distinction between different scales is further reflected in Annex III, Article 17 (2)(c) regarding performance requirements which provides that '*construction of large-scale mining and processing systems cannot be initiated until after the termination of the exploration stage and the commencement of the exploitation stage*'.

Despite the importance of the definition, there has been no activity within the ISA to develop objective criteria for determining the scale of equipment, systems and testing processes, which is essential for determining when different regulatory steps would occur during mining tests. Although it would seem logical that scale would refer to the physical area and depth of the seabed affected during testing, the approach originally foreseen by UNCLOS for determining scale is based objectively on the quantity of minerals extracted and the progress toward the realization of commercial production that quantity represents and subjectively on the intentions of the contractor to engage in commercial production.

This underlines that regulation of mining tests is clearly technology- rather than environment-oriented which requires the use of different legal tools in order to ensure environmental protection such as a requirement to use best available techniques (BAT). Although UNCLOS refers to the '*state of the art of technology then available for seabed mining*' in Annex III, Art. 17 (2)(a) as one of the objective criteria, alongside the physical characteristics of the area, for determining appropriate areas for exploration, the ISA has also not developed rules, regulations or guidelines in this regard:

> *'The Authority shall determine the appropriate size of areas for exploration which may be up to twice as large as those for exploitation in order to permit intensive exploration operations. The size of area shall be calculated to satisfy the requirements of article 8 of this Annex on reservation of areas as well as stated production requirements consistent with article 151 in accordance with the terms of the contract taking into account the state of the art of technology then available for seabed mining and the relevant physical characteristics of the areas. Areas shall be neither smaller nor larger than are necessary to satisfy this objective.' (Annex III, Art. 17 (2)(a))*

Another issue in the current regulation of mining tests is whether an obligation on the part of the contractor to conduct tests exists at all. Although it contains references to testing, UNCLOS does not contain an explicit legal obligation for contractors holding exploration or exploitation licenses to actually conduct tests prior to applying for an exploitation license. Nonetheless, all subsequent Regulations and Draft Regulations refer to various forms of testing as foreseeable activities in a plan of work for exploration or exploitation, suggesting that an implicit obligation to engage in testing may exist. However, given restrictions in UNCLOS concerning the scale of equipment, it is unclear which tests are required or may be conducted at a given point in time and whether the allowable tests would in fact deliver meaningful information for the decision-making process. Further, if an obligation to use best available techniques is deemed to exist, this could implicitly create an obligation for contractors to engage in continual testing during their operations in order to evaluate and improve their equipment and processes.

4.3.2 Testing under the Exploration Regulations

The Exploration Regulations make only limited reference to testing: Regulation 1 (3)(b) includes 'the use and testing of recovery systems and equipment, processing facilities and transportation systems' in its definition of 'exploration' while Regulation 33 (8) concerning emergency orders requires the contractor 'prior to the commencement of testing of collecting systems and processing operations … to provide the Council with a guarantee of its financial and technical capabilities to comply promptly with emergency orders or to assure that the Council can take such emergency measures'. Finally, in Section

10.1 (b) of Annex IV's standard clauses for exploration contract, the Exploration Regulations require the contractor to include information in its annual reports to the Secretary-General on 'the equipment used to carry out the exploration work, including the results of tests conducted of proposed mining technologies, but not equipment design data.'

The Legal and Technical Commission has also issued additional legally non-binding recommendations to contractors for the assessment of the possible environmental impacts arising from exploration for marine minerals in the Area[388], which contain extensive guidance on testing. Para. 19 (c) provides an important recommendation that the 'testing of collection systems and equipment' requires '*prior environmental impact assessment, as well as an environmental monitoring programme to be carried out during and after the specific activity*.' This recommendation is positive from the standpoint of environmental protection in that it requires a prior EIA for one form of testing, however the restriction to collection systems and equipment is inadequate in light of the reference to processing in para. 15 (c)(iii). The EIA is to be submitted to the Secretary-General at least one year prior to beginning the activity according to para. 20 and environmental monitoring data from before, during and after test mining from both the mining site and comparable reference sites are required in para. 21. It can be assumed based on the Advisory Opinion that this EIA would be conducted according to the laws of the sponsoring State as part of its due diligence obligation.

The recommendations provide both useful clarifications and further ambiguities concerning the scale, scope and purpose of mining tests. Para. 7 states that '*the nature of the environmental considerations associated with test mining depends on the type of mining technology used to extract the minerals and on the scale of the operation (i.e. the number of tons extracted per annum per region)*', however it does not provide further criteria how that definition of scale would be applied in practice. Para. 23 states that:

> *'Mining tests may be conducted by contractors individually or collaboratively. In a mining test, all components of the mining system will be assembled and the entire process of test mining, lifting minerals to the ocean surface and discharge of tailings will be executed. For environmental assessments, this test phase should be monitored intensively, as should tests of any test-mining component. When mining tests have already been carried out, even if by another contractor, the knowledge gained through those tests should be applied, where appropriate, to ensure that unanswered questions are resolved by new investigations.'*

Despite the expansive scope of testing recommended under para. 23, para. 52 of the explanatory commentary then reduces the scope of testing to 'collecting systems', which alone cannot provide a sufficient basis for assessing the environmental implications of mining. The glossary of technical terms contained in Annex II, in contrast, defines 'test mining' as 'the use and testing of recovery systems and equipment'. As can be seen in these inconsistencies, the urgency of resolving the definitions of terms such as 'processing' and 'recovery' in light of the Advisory Opinion concerns even the non-binding instruments developed by the ISA. Due to these issues, it is currently impossible to establish the division of responsibilities between the ISA, sponsoring States and contractors in regard to testing which creates considerable difficulties for establishing clear regulatory or enforcement competences.

4.3.3 Testing in the Draft Exploitation Regulations

Weaknesses in the rules and procedures applicable to mining tests, particularly in regard to environmental impact assessments prior to testing, have been noted throughout the course of drafting

[388] International Seabed Authority, Legal and Technical Commission (2013) Recommendations for the guidance of contractors for the assessment of the possible environ mental impacts arising from exploration for marine minerals in the Area. Doc. ISBA/19/LTC/8 of 1 March 2013.

the Exploitation Regulations. And this, despite the clear understanding among stakeholders that the results of mining tests are critical – likely the 'primary inputs' – for determining the potential environmental impacts of commercial-scale mining. It is therefore urgent that the ultimate Exploitation Regulations define procedures and control mechanisms for mining tests in order to ensure that the findings from tests are fully taken into account in the decision-making process, both from technical and environmental standpoints, and are transparently handled and continually reviewed to define best available technologies for mining and foster continual improve in environmental performance.

The current Draft Exploitation Regulations refer to testing in several provisions, including the following definitions in Schedule 1:

> *'Exploration' and 'Exploration Activities'… means the searching for Resources in the Contract Area with exclusive rights, the analysis of such Resources, the use and testing of recovery systems and equipment, processing facilities and transportation systems and the carrying out of studies of the environmental, technical, economic, commercial and other appropriate factors that must be taken into account in Exploitation.*

> *'Commercial Production' shall be deemed to have begun where a Contractor engages in sustained large-scale recovery operations which yield a quantitiy of materials sufficient to indicate clearly that the principal purpose is large-scale production rather than production intended for information gathering, analysis or the testing of equipment or plant.'*

It is notable that testing is not mentioned in the definition of 'exploitation', which can be interpreted to mean that all testing is effectively part of the exploration phase and will have been concluded at the point of application for an exploitation license. The decision-making process concerning such applications is therefore limited to the environmental information available at that stage. Nonetheless, the definition of 'exploitation' includes 'construction … of mining, processing and transportation systems' which indicates that the technology development process is expected to be on-going.

The extent to which the Draft Exploitation Regulations foresee mining tests as a prerequisite for exploitation contracts is less clear, however. On the one hand, Draft Regulation 4 (3)(a) requires that a pre-feasibility study be prepared in accordance with Annex II and accompany an application for a plan of work. According to Annex II (1)(b), a pre-feasibility study serves to provide 'appropriate and sufficient information and data to assess the commercial and economic viability of the proposed Exploitation Activities' and must include in accordance with Annex II (2)(e) 'details of the equipment, methods and technology expected to be used in carrying out the proposed Plan of Work including the results of tests conducted and other relevant information about the characteristics of such technology, including processing and environmental safeguard and monitoring systems.' It can be concluded from these formulations that the Draft Exploitation Regulations currently do not consider potential environmental impacts as part of the assessment of commercial and economic viability, and through the use of the term 'technology expected to be used' allow for applications to be approved without all technologies having been completely tested.

Draft Regulation 29 (1)(a), on the other hand, specifies that a feasibility study (as opposed to a pre-feasibility study) be delivered to the Secretary General prior to the beginning of production, and in Draft Regulation 29 (2) that production may not begin until the feasibility study has been 'accepted' by the Authority. There is no further information in the current draft as to the difference between a pre-feasibility study and a feasibility study and it is therefore unclear what regulatory function 'acceptance by the Authority' would serve. It is also notable that there is no specific requirement that the test results submitted were obtained on location in the area subject of the exploration contract or exploitation application. This leaves open the possibility that testing could be conducted under laboratory conditions or in the field under very different environmental circumstances and still be submitted, which, although the results would potentially contribute useful information concerning technical feasibility, the outcomes would have little relevance for determining potential environmental impacts for the purposes of an EIA.

4.3.4 Areas where the current Draft Exploitation Regulations are weaker than the first draft

It is highly noteworthy that the current Draft Exploitation Regulations from August 2017 has actually removed a number of references to testing that existed in the first working draft of the Exploitation Regulations from July 2016. Annex VII, Section 1 (1.1.c) of the first working draft referred to 'production tests', defining these as '*those tests conducted by the Contractor during the development phase of Exploitation to assess the capacity of the mining equipment, as set out in the Mining Plan*'. Section 10.1 further referred to the '*conduct of the necessary Production Tests, including capacity tests, agreed to and in the period of time stipulated in the Mining Plan*' as '*development obligations*', implying an obligation to conduct testing '*prior to the commencement of Commercial Production*'. No explanation has been provided why the current draft has chosen to use less specific terminology and to eliminate definitions of specific types of tests which could eventually have helped clarify the scope, process and staging of tests. This decision may have been made to draw attention away from the fact that UNCLOS provides for two phases of exploitation – an interim/development phase and a commercial production phase – which could be interpreted to suggest that multiple decision-making stages were originally intended during the technology development process. A multi-stage approval process would considerably slow down a contractor's ability to commence commercial production and would therefore be unattractive to both contractors and the ISA itself.

It is also highly noteworthy that the current Draft Exploitation Regulations make no reference to a legal requirement for contractors to use best available techniques (BAT) despite the fact that this was extensively considered in the January 2017 Discussion Paper on Environmental Matters[389]. A legal requirement to use BAT – also referred to as 'state of the art of technology' – is already clearly established in Annex III, Article 17 (2)(a) UNCLOS. Although not specifically part of the testing process, BAT is a source-focused approach to environmental protection which is fundamentally interconnected with testing. Draft Regulation 8 (1) in the Discussion Paper proposed the inclusion of 'best available techniques' as part of the contractor's obligation to use best environmental practices during exploitation, which it defined in Schedule 1 as '*the latest stage of development, state of the art processes, of facilities or of methods of operation that indicate the practical suitability of a particular measure for the prevention, reduction and control of pollution and the protection of the marine environment from the harmful effects of exploitation activities*'. This obligation was then linked with Draft Regulation 8 (2) which requires that '*the development and application of environmental standards and protocols shall be continually reviewed in order that progressive improvements are made in the efficient and effective protection of the marine environment, including the reduction of pollution and waste at source…'* Draft Regulation 45 (1)(c) of the Discussion Paper further proposed an obligation on the part of the applicant to present 'evidence of Best Available Techniques' in its Environmental Management Plan, which logically would require systematic testing, analysis and comparison of results and a corresponding procedure and set of criteria for assessment by the ISA as part of the application process. It is also unclear here why this approach has not been taken up in the current Draft Exploitation Regulations as it represents a realistic mechanism for achieving higher standards of environmental performance.

[389] Developing a Regulatory Framework for Mineral Exploitation in the Area: A Discussion Paper on the development and drafting of Regulations on Exploitation for Mineral Resources in the Area (Environmental Matters). Tentative working draft, January 2017.

4.3.5 Conclusions

- Mining tests are currently poorly regulated and require urgent attention as equipment tests are scheduled to begin in 2018.
- Assumptions that mining tests will have little environmental impact must be challenged.
- There are indications that the current regulatory approach to testing does not reflect the multi-phase development and gradual scaling-up of technology originally foreseen in UNCLOS.

4.3.6 Recommendations

Recommendations

- Develop objective criteria and procedures for determining 'scale' in order to correctly implement the technological development approach set out in UNCLOS.
- Establish specific assessment requirements for mining tests taking place under the Exploration Regulations which correspond to the scale of the equipment and mining systems to be tested.
- Ensure that the results of mining tests are used for both environmental risk management and assessment of commercial and technical feasibility in the application process for exploitation licenses.
- Establish clear control obligations for sponsoring States over all testing activities irrespective of their scale, including prior EIA requirements for tests.
- Update the LTC recommendations to contractors applicable to test mining to ensure that all potential testing activities are consistently and comprehensively addressed.
- Developing the exploitation regulations:
- Ensure that contractors are required to conduct mining tests on all components, integrated systems and production processes at gradually increasing scales prior to beginning commercial production.
- Define specific requirements in the EIA process for integrating the results of mining tests and ensure that this information is considered environmental information for the purpose of transparency and participation.
- Incorporate a mechanism into the Draft Exploitation Regulations to ensure that the ISA receives sufficient information about tests in order to exercise effective control over the development of mining technologies and their environmental impacts.
- Include an obligation for contractors to use Best Available Techniques (BAT) in the Draft Exploitation Regulations and a corresponding obligation for the ISA to establish procedures for determining and revising BAT standards including an external review mechanism.

4.4 Conclusion

As deep seabed mining becomes an increasingly realistic proposition, it is of profound importance that the inadequacies of existing regulation are resolved so that effective environmental protection can be implemented and the technological development process can still be guided, and where necessary, restrained. Much remains to be done to clarify the division of responsibilities among the various actors, address potential gaps in the coverage of environmental protection measures and develop regulatory approaches for technology development which were left unaddressed during the drafting of UNCLOS. This section has considered three areas where considerable work is necessary, both in regard to the implementation of existing rules and regulations and the development of new rules and regulations in order to draw attention to issues that might not otherwise be discussed in more detail as the Draft Exploitation Regulations take shape. It is hoped that these findings have drawn attention to some relevant issues in this process and provide impulses toward resolving them.

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Annex 1

Mandate of the International Seabed Authority, ISA

The ISA is the organisation through which states parties 'organize and control' seabed mining activities in the Area (LOSC, article 153(1), 157; IA, annex section 1(1)). To fulfil its role, the ISA has the mandate to:

- administer the Area and its resources on behalf of mankind as a whole (LOSC, articles 137(2), 140, 153(1))
- give effect to the principle of common heritage of mankind, which includes the obligation to share the benefits of seabed mining, in particular with developing states (LOSC, articles 82, 140, 150(i))
- continuously develop the Area regime through adopting the Mining Code (LOSC, articles 137(2), 145, 160(2(f), 162(2)(o), 209, annex III article 17(1); IA, annex sections 1(5)(f)-(g), 1(5)(k), 1(15), 6(6))
- control access to minerals in the Area through a contractual system (LOSC, article 153(3), annex III articles 3 and 6; IA, annex sections 1(6))
- retain overall control of exploration and exploitation activities in the Area LOSC, articles 153(1), 157, annex III articles 3(4) and 4(6)(b); IA, annex section 1(1))
- ensure effective protection for the marine environment from harmful effects which may arise from seabed mining (LOSC, articles 145, 162(2)(w)-(x), 165(2)(d)-(h) and (k), annex III article 17(2)(f); IA, annex section 1(5)(g) and (k))
- promote and encourage the conduct of marine scientific research in the Area, and coordinate and disseminate the results (LOSC, article 143 ; IA, annex section 1(5)(h)-(i))
- ensure compliance with the regulatory framework (LOSC, articles 139, 153(4) and (5), 162(2)(a), (l), (u), and (z), 165(2)(m), 165(3))

Note: The ISA is not specifically required to ensure seabed mining takes place. However, the ISA is required to develop the detailed framework to regulate seabed mining, if and when it commences. This framework must balance seabed mining with the obligation, expressly require in the LOSC, to protect the marine environment from harmful effects of seabed mining (UNCLOS, article 145).

Annex 2

Table 5 Exploration licenses issued in national waters in the Pacific (as of September 2014)

Contractor	Date of entry into force of contract	Date of expiry of contract	General location of the exploration area under contract	Type	License	Depth	Area (km^2)
Nautilus Minerals	2011	2030	Solwara 1 project, Manus Basin; Papua New Guinea	SMS	Mining	1600	59
Nautilus Minerals Inc	Granted and under application		Papua New Guinea – Bismarck Sea (except Solwara 1)	SMS	Explorati on	1 030 – 2 590	10 630 (Granted); 8 146 (under appl.)
Nautilus Minerals	Granted and under application		Papua New Guinea – Woodlark Area	SMS	Explorati on		255 (Granted); 3 543 (under appl.)
Nautilus Minerals Inc	Under application		Papua New Guinea – New Ireland Arc	SMS	Explorati on	1 500 – 2 000	12788
Neptune Minerals	2012	2014	Papua New Guinea	SMS	Explorati on		2568
Nautilus Minerals Inc	19 July 2011	18 July 2014	Solomon Islands	SMS	Explorati on		39500
Bluewater Metals (Neptune Minerals subsidiary)	2007	2014	Solomon Islands	SMS	Explorati on		9840
Nautilus Minerals Inc	Granted, year unknown		Kingdom of Tonga	SMS	Explorati on	965 – 2 360	77 563 (granted); 131 878 (under appl.)
Neptune Minerals	2008	2014	Kingdom of Tonga	SMS	Explorati on		63949
Korean Institute of Ocean Science and Technology (KIOST)	2008	2014	Kingdom of Tonga	SMS	Explorati on		24500

Nautilus Minerals	2014	2016	Fiji		Explorati on		60370
Bluewater Metals (Neptune subsidiary)	2012	2014	Fiji	SMS	Explorati on		5012
Korean Institute of Ocean Science and Technology (KIOST)	2011		Fiji	SMS	Explorati on		
Nautilus Minerals Inc	Granted, year unknown		Vanuatu	SMS	Explorati on	1 000 – 3 000	2 768 (granted); 1 247 (under appl.)
Bismarck (Neptune subsidiary)	2011 & 2012	2014 & 2015	Vanuatu	SMS	Explorati on		10183
Neptune Minerals	Under application		Federated States of Micronesia	SMS	Explorati on		

Source of table: Ecorys, 2014. More detailed descriptions about the licensed projects can be found therein.

Table 6 Exploration licenses in the Area (as of June 2017, ISBA/23/C/7)

Contractor for exploration of polymetallic nodules in the Area	Date of entry into force	Date of expiry	Sponsoring State(s)	General location of the exploration area	Depth (m)	Area (km²)
Interoceanmetal Joint Organization	29 Mar 2001	28 Mar 2016	Bulgaria, Cuba, Czech Republic, Poland, Russian Federation and Slovakia	Clarion-Clipperton Fracture Zone	4000-5000	75000
Yuzhmorgeologiya	29 Mar 2001	28 Mar 2016	Russian Federation	Clarion-Clipperton Fracture Zone	5000	75000
Government of the Republic of Korea	27 Apr 2001	26 Apr 2016	-	Clarion-Clipperton Fracture Zone	3000-6000	75000
China Ocean Mineral Resources Research and Development Association	22 May 2001	21 May 2016	China	Clarion-Clipperton Fracture Zone	5000-5300	75000
Deep Ocean Resources Development Co. Ltd.	20 Jun 2001	19 Jun 2016	Japan	Clarion-Clipperton Fracture Zone	5000	75000
Institut français de recherche pour l'exploitation de la mer	20 Jun 2001	19 Jun 2016	France	Clarion-Clipperton Fracture Zone	5000	75000
Government of India	25 Mar 2002	24 Mar 2017	-	Central Indian Ocean Basin	5000-5700	150000
Federal Institute for Geosciences and Natural Resources of Germany	19 Jul 2006	18 Jul 2021	Germany	Clarion-Clipperton Fracture Zone	4200-4800	75000
Nauru Ocean Resources Inc.	22 Jul 2011	21 Jul 2026	Nauru	Clarion-Clipperton Fracture Zone (reserved area)	4000-5000	75000

Tonga Offshore Mining Limited	11 Jan 2012	10 Jan 2027	Tonga	Clarion-Clipperton Fracture Zone (reserved area)	5000	75000
Global Sea Mineral Resources NV	14 Jan 2013	3 Jan 2028	Belgium	Clarion-Clipperton Fracture Zone	5000	75000
UK Seabed Resources Ltd.	8 Feb 2013	7 Feb 2028	United Kingdom of Great Britain and Northern Ireland	Clarion-Clipperton Fracture Zone	4000	58000
Marawa Research and Exploration Ltd.	19 Jan 2015	18 Jan 2030	Kiribati	Clarion-Clipperton Fracture Zone (reserved area)	5000	75000
Ocean Mineral Singapore Pte Ltd.	Kingston on 15 January 2015, Singapore on 22 January 2015	21 Jan 2030	Singapore	Clarion-Clipperton Fracture Zone (reserved area)	4000-5000	58280
UK Seabed Resources Ltd.	29 March 2016	28 March 2031	United Kingdom of Great Britain and Northern Ireland	Clarion-Clipperton Fracture Zone	4800	75000
Cook Islands Investment Corporation	15 July 2016	14 July 2031	Cook Islands	Clarion-Clipperton Fracture Zone (reserved area)	5000	75000
China Minmetals Corporation	12 May 2017	11 May 2032	China	Clarion-Clipperton Fracture Zone (reserved area)		72740

Contractor for exploration of polymetallic sulphides in the Area	Date of entry into force	Date of expiry	Sponsoring State(s)	General location of the exploration area	Depth (m)	Area (km^2)

China Ocean Mineral Resources Research and Development Association	18 Nov 2011	17 Nov 2026	China	South-west Indian Ridge		10000
Government of the Russian Federation	29 Oct 2012	28 Oct 2027	-	Mid-Atlantic Ridge		10000
Government of the Republic of Korea	24 Jun 2014	23 Jun 2029	-	Central Indian Ocean		10000
Institut français de recherche pour l'exploitation de la mer	18 Nov 2014	17 Nov 2029	France	Mid-Atlantic Ridge	3400	10000
Government of India	26 Septembe r 2016	25 Septembe r 2031	-	Indian Ocean Ridge		10000
Federal Institute for Geosciences and Natural Resources of Germany	6 May 2015	5 May 2030	Germany	Central Indian Ridge and South- east Indian Ridge	3000	10000

Contractor for exploration of cobalt-rich ferromanganese crusts in the Area	Date of entry into force	Date of expiry	Sponsoring State(s)	General location of the exploration area	Depth (m)	Area (km^2)
Japan Oil, Gas and Metals National Corporation	27 Jan 2014	26 Jan 2029	Japan	Western Pacific Ocean	3000-4000	3000
China Ocean Mineral Resources Research and Development Association	29 Apr 2014	28 Apr 2029	China	Western Pacific Ocean	2000-2300	3000
Ministry of Natural Resources and Environment of the Russian Federation	10 Mar 2015	9 Mar 2030	-	Magellan Mountains in the Pacific Ocean	2000-2300	3000
Companhia de Pesquisa de Recursos Minerais S.A.	9 November 2015	8 Novembe r 2013	Brazil	Rio Grande Rise in the South Atlantic Ocean	1000-5000	3000
Government of the Republic of Korea	To be signed			East of the Northern Mariana Islands, Pacific		

Source of table: ISBA/213C/7

Annex 3

Table 7 Legal Obligations relating to the Conservation of Biodiversity

Instrument	Obligations
UNCLOS (obligations of states)	States have an unequivocal 'obligation to protect and preserve the marine environment' (art 192) and to 'protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life' (art. 194(5)). In formulating international rules and standards, states must take into account 'characteristic regional features' of marine environments (art. 197), which in the deep ocean context includes unique, slow-growing and largely unchartered ecosystems.
UNCLOS (obligations of the ISA)	Article 145 requires the ISA to take: 'necessary measures […] in accordance with this Convention with respect to activities in the Area to ensure effective protection for the marine environment from harmful effects which may arise from [activities in the Area].' The ISA must adopt rules, regulations and procedures, including for: • the prevention, reduction and control of pollution and other hazards; • the prevention, reduction and control of interference with the ecological balance of the marine environment; • the protection and conservation of the natural resources of the Area; and • the prevention of damage to the flora and fauna of the marine environment. The LTC has to make recommendations to the Council on 'the protection of the marine environment, taking into account the views of recognized experts in that field' (art. 165(2)(e)).
Convention on Biological Diversity, CBD	States parties are required to 'ensure that activities within their jurisdiction or control do not cause damage to the environment […] of areas beyond the limits of national jurisdiction' (art. 3). This obligation must be implemented consistently with the rights and obligations of states under UNCLOS (art. 22). In 2008, the CBD adopted criteria for the identification of ecologically or biologically significant areas (EBSA) beyond national jurisdiction (CBD, Marine and Coastal Biodiversity, UNEP/CBD/COP/DEC/IX/20 (9 October 2008), annex I).
Aichi Targets	Through the Aichi Biodiversity Targets, states committed to inter alia: • ensure sustainable production and consumption patterns to keep the impacts of use of natural resources well within safe ecological limits (Target 4) • reduce the rate of loss of natural habitats (Target 5) • achieve sustainable marine harvesting (Target 6) • conserve 10 percent of coastal and marine areas through protected areas, especially areas of particular importance for biodiversity and ecosystem services (Target 11) • restore and safeguard ecosystems that provide essential services, including services related to water (Target 14) • enhance ecosystem resilience and the contribution of biodiversity to carbon stocks (Target 15)

Rio+20	At the Rio+20 conference, states committed to: • protect, and restore, the health, productivity and resilience of oceans and marine ecosystems; • maintain their biodiversity, enabling their conservation and sustainable use for present and future generations; • effectively apply an ecosystem approach and the precautionary approach in the management, in accordance with international law, of activities having an impact on the marine environment, to deliver on all three dimensions of sustainable development. UNGA, The Future We Want, UN Doc A/Res/66/288 (27 July 2012, paragraph 158)
UN Sustainable Development Goals	The 2030 Agenda for Sustainable Development includes the following goals: • By 2030, achieve the sustainable management and efficient use of natural resources (goal 12.2) • By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse (goal 12.5); • By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans (goal 14.2); • By 2020, conserve at least 10 percent of coastal and marine areas, consistent with national and international law and based on the best available scientific information (goal 14.5); • Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in UNCLOS (goal 14.c). • Develop effective, accountable and transparent institutions at all levels (goal 16.5) • Ensure responsive, inclusive, participatory and representative decision- making at all levels (goal 16.7). UNGA, Transforming Our World: The 2030 Agenda for Sustainable Development, UN Doc No A/RES/70/1 (25 September 2015)

Annex 4

Almaty Guidelines under the Aarhus Convention

Based on the Almaty Guidelines on Promoting the Application of the Principles of the Aarhus Convention in International Forums (UNECE, 2005) the following best practice is recommended[390]:

Access by observers to all official documents, in a timely manner (Almaty Guidelines, para. 20);

1. Attendance at all meetings, including of subsidiary bodies (Almaty Guidelines, para. 29);
2. Observers should be allowed at all relevant stages of the decision-making process, subject to specific exclusions (Unless there is a reasonable basis to exclude such participation according to transparent and clearly stated standards that are made available, if possible, in advance. Almaty Guidelines, para. 29.);
3. The ability to make interventions (speak), (Almaty Guidelines para 34), under the control of the Chair. The Aarhus Convention specifically permits interventions from observers during debates on an agenda item – not only after interventions from States are exhausted. Rule 27 of the Convention's rules of procedure states that observers are entitled to seek to address meetings of the Parties under each agenda item and, having made such a request, will be included on the list of speakers. The Chair will in general call upon speakers in the order in which they signify their desire to speak, but may, at his or her discretion, decide to call upon representatives of Parties before observers.
4. The ability to circulate relevant documents (Almaty Guidelines, para. 34).
5. The Almaty Guidelines similarly state that participation of the public concerned should be as broad as possible, that each Party should encourage international forums to make available the agenda, drafts, agreed resolutions and reports in a timely manner, the public should be allowed at all relevant stages of the decision-making process, subject only to specific and transparent exclusions, and stress the entitlement to have access to all documents relevant to the decision-making process produced for the meetings, to circulate written statements and to speak at meetings.
6. Following Principle 10 of the Rio Declaration, the Rio+20 'Future We Want' outcome document stated that 'We need institutions at all levels that are effective, transparent, accountable and democratic.' Transparency was a recurring theme in the document, which underscored the importance of 'governments taking a leadership role in developing policies and strategies through an inclusive and transparent process.' The entire framework for sustainable development 'should be inclusive, transparent and effective.' That framework will 'enhance the participation and effective engagement of civil society and other relevant stakeholders in the relevant international fora and in this regard promote transparency and broad public participation and partnerships to implement sustainable development.' The Future We Want` stated that the institutional framework will '76 (g) promote the science-policy interface through inclusive, evidence-based and transparent scientific assessments'.

[390] summarised in https://www.isa.org.jm/sites/default/files/dscc.pdf

Annex 5

Excerpt from ISBA/19/C/17 Part VI

Confidentiality

Regulation 36

Confidentiality of data and information

1. Data and information submitted or transferred to the Authority or to any person participating in any activity or programme of the Authority pursuant to these Regulations or a contract issued under these Regulations, and designated by the contractor, in consultation with the Secretary-General, as being of a confidential nature, shall be considered confidential unless it is data and information which:

    k) Is generally known or publicly available from other sources;
    l) Has been previously made available by the owner to others without an obligation concerning its confidentiality; or
    m) Is already in the possession of the Authority with no obligation concerning its confidentiality.

2. Data and information that is necessary for the formulation by the Authority of rules, regulations and procedures concerning protection and preservation of the marine environment and safety, other than proprietary equipment design data, shall not be deemed confidential.
3. Confidential data and information may only be used by the Secretary-General and staff of the Secretariat, as authorized by the Secretary-General, and by the members of the Legal and Technical Commission as necessary for and relevant to the effective exercise of their powers and functions. The Secretary-General shall authorize access to such data and information only for limited use in connection with the functions and duties of the staff of the Secretariat and the functions and duties of the Legal and Technical Commission.
4. Ten years after the date of submission of confidential data and information to the Authority or the expiration of the contract for exploration, whichever is the later, and every five years thereafter, the Secretary-General and the contractor shall review such data and information to determine whether they should remain confidential. Such data and information shall remain confidential if the contractor establishes that there would be a substantial risk of serious and unfair economic prejudice if the data and information were to be released. No such data and information shall be released until the contractor has been accorded a reasonable opportunity to exhaust the judicial remedies available to it pursuant to Part XI, section 5, of the Convention.
5. If, at any time following the expiration of the contract for exploration, the contractor enters into a contract for exploitation in respect of any part of the exploration area, confidential data and information relating to that part of the area shall remain confidential in accordance with the contract for exploitation.
6. The contractor may at any time waive confidentiality of data and information.

Annex 6

Table 8 Recommendations for the guidance of contractors for the assessment of the possible environmental impacts arising from exploration for marine minerals in the Area, ISBA/19/LTC/8 (2013) and as yet unresolved issues

Topic	Requirement as in ISBA/19/LTC/8	unresolved issues
Environmental baseline and understanding	To obtain sufficient information from the exploration area to document the natural conditions that exist prior to test mining .... and make it possible to acquire the capability necessary to make accurate environmental impact predictions. (§ 13 ff)	Determination of what is sufficient information (spatial, temporal, quantitative and qualitative - biota and communities, etc)? Scope of models, verificaton
Monitoring programme	Environmental monitoring data are required prior to ... test mining at the mining site and at comparable reference sites (to be selected according to their environmental characteristics and faunal composition). (§ 21 ff)	No minimum time period prior and after the activity indicated. Site selection mechanism - should be transparent and standard for all contractors. Standard monitoring programme required to enable regional assessments. An operator-independent international monitoring and research programme should accompany any test mining in order to collect verifiable and regionally integratable data and knowledge.
All equipment built	In a mining test, all components of the mining system will be assembled and the entire process of test mining, lifting minerals to the ocean surface and discharge of tailings will be executed. (§ 23)	Scale of equipment and scale of impact undefined, yet predictions on commercial scale impacts shall be enabled.
Prior environmental impact assessment	To be submitted by the contractor to the Secretary-General at least one year before the activity takes place and at least three months in advance of the annual session of the Authority. (§ 20)	The EIA process and criteria is undefined. **No concrete feedback of information on environmental impacts** is required as part of a EIA process. The monitoring results, and any impact evaluations or scientific studies will become available to ISA via contractor Annual Reports (see below) - not available for ISA interventions or control as would be possible when part of EIA process.

Topic	Requirement as in ISBA/19/LTC/8	unresolved issues
Technical information	Data and information on the nature of the mining equipment, technological progress with mining system and processing (§ 12) and as in § 27, includes resource, equipment, test procedure and site-specific information. (§ 20)	Site selection mechanism undefined, equipment specifications subject to confidentiality clause.
Serious environmental harm	Each contractor should include ... a specification of the events that could cause suspension or modification of the activities owing to serious environmental harm ... (§ 28)	Serious environmental harm is undefined in the local, regional and global context
During the test, notification of Impact and Preservation reference areas	The impact reference area should be representative of the site to be mined in terms of environmental characteristics and the biota. The preservation reference area should be carefully located and large enough not to be affected by mining activities, including the effects from operational and discharge plumes. The reference site will be important in identifying natural variations in environmental conditions. Its species composition should be comparable to that of the test-mining area. (§ 26 d)	Long-term planning is required as a long-term local environmental baseline is required for PRZ and IRZ - one year monitoring is insufficient.
Reporting as part of annual reporting (ISBA/21/LTC/15)	Annex I, Part IV requests information on *environmental baseline studies (monitoring and assessment).* A. **Environmental Monitoring** 9. The contractor is also requested to provide: (a) A description of the objectives during the reporting period (intended, ongoing and completed); (b) Information on the technical equipment and methodologies used at depth, on board and in the laboratory (including analysis software); (c) The results produced (also summarized as graphic representations of data on which the results are based); (d) An interpretation of the findings, including comparisons with published data from other studies; (e) Information on physical oceanography (characteristics of water column and near-bed currents, including current speed and direction, temperatures, turbidity at different water depths, as well as any hydrodynamic modelling). Data should be linked to long-term mooring-based observations; (f) Information on chemical oceanography (characteristics of sea water, including pH value, dissolved oxygen, total alkalinity,	Information will be delivered as part of the Annual Reports - but this information is not available for specific impact assessment or recommendations on better technology. No assessment standards or agreed methodologies, and no mechanisms of control exist.

Topic	Requirement as in ISBA/19/LTC/8	unresolved issues
	nutrient concentrations, dissolved and particulate organic carbon, estimation of mass flux, heavy metals, trace elements and chlorophyll a); (g) Information on biological communities and biodiversity studies (including megafauna, macrofauna, meiofauna, microflora, nodule fauna, demersal scavengers an pelagic communities); (h) Information on ecosystem functioning (such as measures of bioturbation, stable isotopes and sediment community oxygen consumption). B. **Environmental Assessment** 10. The contractor is requested to provide: (a) **Information on the environmental impact of exploration activities including information on a monitoring programme before, during and after specific activities with the potential for causing serious harm**; (b) A statement that activities undertaken in the contract area in the year covered by the annual report have not caused serious harm and the evidence of how this has been determined; (c) Information on the environmental impact of test-mining activities as measured in the impact reference zones; (d) An assessment of statistical robustness/power, taking into account sample sizes, sample number and, for biological communities, the abundance of individual species (with evidence for statistical significance); (e) A gap analysis and future strategy to achieve the goals of the five-year programme of activities and the requirements contained in ISBA/19/LTC/8; (f) An examination of the recovery over time of seabed communities following disturbance experiments conducted on the sea floor; (g) An evaluation of the advantages and disadvantages of different sampling and analysis methods, including quality control; (h) A comparison of environmental results in similar areas to understand species ranges and dispersal on the scale of ocean basins.	

Topic	Requirement as in ISBA/19/LTC/8	unresolved issues
	Annex 1, Part V. *Mining tests and proposed mining technologies* 12. The contractor is requested to provide: (a) Data and information on the nature of the mining equipment designed and tested, where applicable, as well as data on the use of equipment not designed by the contractor; (b) A description of the equipment, the operations and the results of the mining tests; (c) A description of the nature and results of the experiments (where applicable); (d) With regard to mining technologies, information on the technological progress made by the contractor with its mining system (e.g. collectors, riser, production vessel or other) development programme; (e) With regard to processing technologies: (i) Information on the mineral processing and metallurgical testing and processing routes, for instance whether three metals, five metals, rare earth elements or other; (ii) Information on other methods.	

Annex 7

Outcome document of a workshop co-organised by IASS and UBA on 7 November 2017[391]:

Effective Implementation of Environmentally Responsible Deep Seabed Mining:

The Obligations of the Sponsoring State with Particular Attention to Germany and in Light of the Obligations of the Organs of the International Seabed Authority (ISA)

Potsdam, 7 November 2017

Outcome Document

On 7 November 2017, the German Environment Agency and the Institute for Advanced Sustainability Studies convened a transdisciplinary workshop in Potsdam to discuss the role of the sponsoring State in ensuring high standards of environmental protection in the conduct of deep seabed mining activities and taking into account the obligations of the organs of the ISA. The workshop had more than 30 participants including representatives of the German ministries responsible for different aspects of deep seabed mining by a German contractor, scientists from the Federal Institute for Geosciences and Natural Resources, academic researchers as well as NGO and stakeholder representatives.

Central outcomes of the workshop are:

Obligations of the sponsoring State and the ISA and its organs pursuant to the law of the sea (UNCLOS)

1) The obligations of sponsoring States are established in the United Nations Convention on the Law of the Sea (UNCLOS) and were interpreted and concretised in the International Tribunal on the Law of the Sea Seabed Dispute Chamber’s 2011 Advisory Opinion.

2) The purpose of sponsorship is to create a balance between the responsibilities of the State and private actors to ensure jurisdiction and control as well as to limit the State’s liability.

3) The due diligence obligation of the sponsoring State is an obligation of conduct, rather than an obligation of result. The sponsoring State is not residually liable.

4) The sponsoring State has a “responsibility to ensure’ to the utmost and to the best of its abilities that the contractor upholds its responsibilities, and is further responsible for ensuring that the measures it enacts are risk-adequate. The due diligence obligations of a sponsoring State are thus more stringent than those of a flag State established in international shipping regulations.

[391] This outcome document has been collectively produced by UBA and IASS colleagues.

5) Insufficient implementation of due diligence obligations in national law would trigger State responsibility for the actions in question. It is therefore of fundamental interest to the sponsoring State to ensure that its national legislation upholds these requirements.

6) In accordance with UNCLOS, the ISA has functional jurisdiction over "activities in the Area' and spatial jurisdiction over the Area itself. These jurisdictional limits also pertain to the obligations of sponsoring States. The scope of the term "activities in the Area' has not yet been legally resolved.

7) There are overlaps in the responsibilities of the ISA and sponsoring States, which may serve to strengthen the overarching legal framework.

Practical experience in Germany with the implementation on national and ISA level

8) To date only two German applications for sponsorship of exploration activities have been approved by Lower Saxony's State Office for Mining, Energy and Geology (LBEG). These concern manganese nodules in the Pacific Ocean (2006) and massive sulphides in the Indian Ocean (2013). Both applications were submitted by the Federal Institute for Geosciences and Natural Resources (BGR), an official government agency.

9) The focus of exploration is to determine topography, rigidity, resource density, metal composition, economic interest, biodiversity, geochemistry and bottom currents. Metallurgical processing is under development.

10) In accordance with Germany's implementation laws for deep seabed mining, the Federal Maritime and Hydrographic Agency (BSH) and the German Environment Agency (UBA) can issue a jointly agreed position statement in the decision-making process. Upon the agreement of the LBEG, the Federal Ministry for Economic Affairs, then forwards the sponsored application to the International Seabed Authority.

11) The public was not informed or included in the decision-making process concerning the two applications.

12) The LBEG has a legal mandate and responsibility to control the compliance of sponsored contractors with the terms of the contracts and plans of work concluded with the ISA. It is unclear, however, how control could be exercised in practice. The current exploration projects were conducted by the governmental body BGR and were not considered high-risk activities.

13) In the event the nature and scope of these projects change, inspections will become necessary. Despite the LBEG's legal mandate to conduct inspections, this would exceed its current capacities. It may be necessary to increase LBEG's inspection capacity in the future.

14) In April 2019, an initial equipment test is intended to be carried out by the Belgian company DEME (ISA contractor sponsored by Belgium) in the German and Belgian manganese nodule license areas.

15) The test will likely be scientifically accompanied by the European research project JPIO Mining Impact II which aims to monitor the environmental impacts of the equipment test in both test areas. A proposal has been submitted for a four-year project. Building on already available baseline data

obtained close to the test sites including pre-selected preservation and impact reference zones, further field sampling is planned for April/May 2018 and March 2019 in preparation for the test. A strong focus of the project will be the monitoring of plume development during and directly after the test. Biological monitoring, with particular emphasis on species recolonisation and recovery, is planned until the end of the German license period in 2021.

16) The equipment test carried out by DEME will involve 4-5 days of nodule collection with a hydraulic collector device from an area of 300x300 m and is anticipated to create a plume which settles onto the seafloor up to 2-3 km distance from the source. The total test area amounts to 0.09 km^2 which is the equivalent of 1/2000 of the size of an exploitation area estimated at 170 km^2/year. The collector to be tested is 4 m wide and is one-quarter the size of an industrial collector. It is expected to remove 10 cm of sediment at a speed of 0.5 m/s. It will mobilise and discharge ca. 300 tons of sediment per hour. The nodules will be picked up and then returned to the seafloor after ca. 100-m-long transects have been cleared. No material will be brought to the surface.

17) According to the LTC Guidelines for Contractors (ISBA/19/LTC/8), an assessment of possible environmental impacts (EIA) must be conducted prior to a.o. testing of collection systems and equipment. The EIA must be submitted to the Authority one year prior to the beginning of the test, however no guidance exists as to the formate for reporting. DEME, together with the BGR, will submit an EIA to the ISA by 1 April 2018.

18) Because the test was not listed as part of the original plan of work for exploration in 2006, the LBEG plans to conduct a supplementary review in cooperation with the BSH/UBA/BfN.

19) Access for the public or stakeholders to the EIA document and options for commenting were considered necessary (acc. to ITLOS Advisory Opinion and ESPOO Convention) and desireable by the participants. The practical implementation was the subject of debate, particularly due to time constraints and the unclear legal basis for these activities. A voluntary mechanism to facilitate participation was proposed.

Regulatory concepts to ensure high standards of environmental protection

Reflective regulation

20) There is an extreme knowledge gap concerning seabed ecosystems, environmental thresholds and the technologies necessary for both exploitation and monitoring. To address these uncertainties, institutional learning and dynamic, responsive regulation is necessary for effective implementation. It is essential that this regulation is designed to "learn" and continuously review environmental protection measures as scientific knowledge increases. That is meant by "Reflective Regulation"

21) The future Exploitation Regulations must include appropriate instruments ensuring reflective regulation.

22) The following regulatory mechanisms and measures should be applied: (1) test mining; (2) the obligation of contractors to comply with more stringent requirements as these become necessary (rather than "grandfathering" the mining practices and technologies contained in the original plan of

work); (3) the effective involvement of the public; (4) access to information and (5) active scientific knowledge management by ISA.

23) The precautionary approach requires that the standards and requirements established at the start of activities correspond with the level of risk and degree of uncertainty associated with potential environmental impacts. As knowledge increases, these standards and requirements can be adjusted accordingly.

Environmental Impact Assessment

24) The LTC 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" is currently under review.

25) All relevant actors should be included in the review process, not merely the contractors.

26) The recommended process for assessing environmental impacts has several significant deficits. These include: (1) the lack of public involvement; (2) the lack of environmental thresholds and assessment methodology; (3) the lack of criteria for sufficient baseline description; (4) the lack of valid criteria for the designation of IRZ and PRZs (although these are currently under development at the ISA); and (5) the absence of a clear monitoring concept. The development of minimum standards for a monitoring concept was proposed.

Test mining

27) Test mining is considered an essential instrument for overcoming existing knowledge gaps about ecosystems, environmental thresholds and appropriate exploitation technologies, as well as monitoring requirements and techniques.

28) Both UNCLOS and the Mining Code use different terminology to describe testing activities. It is therefore necessary to clearly define the terms used to regulate test mining in the Mining Code.

29) Moreover, test mining should be established as a prerequisite for an application for the approval of a plan of work for exploitation. Additional regulation of test mining is necessary concerning the procedural requirements for approving and conducting tests, as well as the disclosure of test results.

30) The LTC Guidance document for contractors (ISBA/19/LTC/8) requires that the environmental impacts of any disturbance in nodule areas exceeding 10,000 m^2 of seafloor are assessed prior to the conduct of tests. An assessment methodology and reporting format do not exist.

31) The legal requirements for test mining set by international law could be transposed into German law using a specific Verordnung (ordinance) adopted under Article 7 of the Meeresbodenbergbaugesetz (Seabed Mining Act).

Level playing field

32) Creating a level playing field is crucial for preventing the emergence of sponsoring States of

convenience.

33) 33) The standards which must be complied with by all sponsoring States derive from the regulations and recommendations adopted by the ISA. It is therefore essential that ambitious standards for environmental protection are established in the future Exploitation Regulations.

34) Germany will aim to further the development of high standards to ensure the best possible ecological safeguards for the deep sea and the oceans.

Division of responsibilities between the sponsoring State and the ISA

35) The division of responsibilities between the sponsoring State and ISA should be framed according to the following criteria:

   a. the attribution of responsibilities supports the implementation of substantive criteria;

   b. the division is clear and each area of responsibility is accountable;

   c. the respective organ has the required expertise;

   d. the attribution does not interfere with the general competence of the respective organ as foreseen in UNCLOS;

   e. the division upholds the ISA's central role as trustee over the Area and its resources on behalf of all mankind;

   f. cost-effectiveness is ensured.

36) The current draft Exploitation Regulations endow the Secretary General with decision-making powers. This may conflict with the facilitator role foreseen by UNCLOS.

37) The LTC plays a strong role in the decision-making process concerning the approval of a plan of work. It was discussed whether the influence of States, namely through the Council, should be strengthened.

38) It is problematic that the ISA is endowed with both legislative and executive powers. It should be discussed further whether a clear separation of powers is necessary and how this could be achieved.

39) The LTC's workload is likely to increase considerably if exploitation commences. It must be discussed whether additional organs or sub-organs to the LTC would enable the ISA to manage an increased workload.

Financial Instruments

40) Hidden subsidies in the institutional financing of the ISA Secretariat must be prevented. Appropriate fees should be paid by the contractors for ISA services.

41) Urgent attention must be paid to the development of a comprehensive liability regime.

42) Sufficient insurance cover and/or contributions to a liability fund could provide a basis for addressing significant damage. There are drawbacks to these concepts, however. First, liability serves to create an economic incentive to prevent damage. Insurance cover could interfere with this essential function. Second, not all damage to the marine environment can be remediated. In such situations, the availability of financial resources does not help. Third, States have already been reluctant to establish international liability funds in other industries such as oil and gas at least on international level.

Annex 8:

Pelagic communities of the open ocean and deep sea - risks from seabed mining

Report to IASS

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DER FORSCHUNG | DER LEHRE | DER BILDUNG

Cover image: Deep-sea jellyfish (helmet jelly, *Peryphylla peryphylla*) ©Solvin Zankl

Executive summary

The existence of large mineral resources in the deep sea of the oceans has been known for decades. Currently, five main types of deep-sea mineral deposits are considered which hold some potential for commercial exploitation: Ferromanganese (FeMn) nodules, seafloor massive sulfids (SMS), cobalt-rich ferromanganese (FeMn) crusts, metalliferous sediments in brine pools of the Red Sea, and phosphorite nodules. With the exception of the phosphorites, all these deposits occur mainly or exclusively at bathyal and abyssal depths. Although it has widely been acknowledged that deep-sea mining activities may affect also pelagic fauna, a possible impact is usually regarded as minor compared to benthic biota. In this study, we try to collate all available information which is important for evaluating the potential risks of deep seabed mining for pelagic communities.

Part I: Characteristics of the open-ocean and deep-sea pelagic realm

This chapter summarizes the basic structure and the processes which characterize the open-ocean pelagic realm, with a special focus on the deep sea, mirroring the current state of knowledge. It has to be kept in mind, however, that many pelagic components and their role in ecosystem functioning are still poorly or not at all known. For example, most studies have been strongly biased towards medium-sized hard-bodied zooplankton which are readily caught by nets.

- The pelagic biota comprise a wide variety of organisms from bacteria to mammals, with elements from nearly all known phyla. Phytoplankton usually are the primary producers. The faunal components include zooplankton, micronekton and nekton, distinguished by their size and degree of mobility.
- The pelagic realm is subdivided into different depth zones. The epipelagic zone (0-200 m) receives enough sunlight to support photosynthetic primary production. Zooplankton biomass and production are usually highest in this zone, and hydrographic conditions vary considerably. Although sunlight penetrates into the mesopelagic zone (200-1000 m) as well, it is not sufficient for primary production in that layer. Many mesopelagic species undergo diel vertical migrations, feeding in surface waters during the night and staying at depth during the day. In many areas, particularly at low latitudes, a marked oxygen minimum zone (OMZ) is present. The bathy-and abyssopelagic zones (1000-4000 and 4000-6000 m, respectively) are completely dark, except for bioluminescence. Hydrographic conditions are very stable, and particle load in the water column is very low. Due to resuspension and accumulation, particle concentrations often increase towards the bottom, forming the benthic nepheloid layer (BNL). Close to the sea floor, water flow decreases due to friction at the bottom and marks the benthic boundary layer (BBL).
- The deep-sea pelagic realm below 1000 m hosts one of the least known ecosystem components in the world. This applies to all aspects, including biodiversity and biogeography, life history, ecology and physiology. The available information suggests that deep-sea communities are usually dominated by K-strategic species, and their typical life strategies involve low metabolism, long life, slow growth rates, late maturity, and low fecundity. Due to the limited food supply, abundances and biomass are low, but recent studies suggest that the biodiversity is very high.
- The benthopelagic communities in the BBL differ markedly from the deep-sea pelagic fauna in the layers above and include species that are endemic to the near-bottom environment. The benthopelagic

nekton are composed of fishes and large, mobile invertebrates. Many species seem to be widely distributed or even cosmopolitan. The knowledge of the benthopelagic zooplankton is extremely poor. Copepods seem to be the most numerous members, and meroplanktonic larvae may form a substantial part of the community, but nothing is known about their biogeography and distributional ranges.

- Most of the energy in form of organic material which drives the food webs of the oceans is photosynthetically produced in the euphotic surface layers by phytoplankton. Hence, most deep-sea communities also depend on the surface derived organic matter. Primary productivity and pelagic biomass vary strongly between different oceanic regions, depending on light and nutrient availability. Spatial and temporal variability can be introduced by large- and mesoscale oceanic features. Central gyres are regions with very low productivity, whereas ridges, frontal systems, upwelling areas, seamounts and mesoscale eddies are often associated with enhanced productivity.
- Herbivorous zooplankton grazers are the intermediate link between phytoplankton and higher trophic levels. The structure of the surface ocean food chain, which ultimately affects also the export of organic matter to the deep ocean, depends on the size spectrum of the phytoplankton community. In eutrophic waters, the prevailing microphytoplankton are directly grazed upon by herbivorous crustaceans. Primary production in oligotrophic regions is dominated by nano- and picophytoplankton, and protists are the main primary consumers, which are then fed upon by larger zooplankton. The microbial loop is another important process particularly in oligotropic areas, channelling dissolved organic matter (DOM) via bacteria and microzooplankton into higher trophic levels.
- The export of the photosynthetically produced organic matter from the surface layer to depth is driven by the 'biological pump', which comprises five main pathways for the supply of energy to the layers below the euphotic zone: the steady rain of small organic particles, the episodic input of phytodetritus aggregates, the episodic input of large food falls, and diel or ontogenetic vertical migration. The fifth, but largely unknown pathway, involves dissolved organic matter. Most of the sinking POM is remineralised in the epipelagic or in the upper mesopelagic layers, and the food supply to the deeper living communities is further reduced as microbial decomposition, consumption by zooplankton and fish and repackaging of particulate and dissolved organic matter (POM and DOM) and final remineralisation continue during sinking. Consequently, the abundance and biomass of pelagic fauna decrease exponentially with depth.
- Food webs and energy flux at seamounts may be complicated by specific hydrodynamic conditions, eventually leading to advection, local retention and up- and downlift of nutrients, POM and biota. Food webs at hydrothermal vents rely to a large extent on chemoautotrophic production by bacteria, living usually as symbionts in benthic metazoans. Benthic and pelagic components are linked by, for example, direct predation and release of meroplanktonic larvae.
- Deep-sea benthic and benthopelagic communities may be directly coupled with the pelagic surface production via rapidly sinking phytodetritus aggregates and faecal pellets, large food falls, and, to a lesser extent, slowly sinking detritus, which usually is degraded in the water column. The knowledge about the processes which link the benthic and pelagic communities within the near-bottom water layer is extremely poor, and their quantification is currently not possible. Direct feeding interactions are known between some benthopelagic fishes and benthic infauna or epifauna, but information on possible feeding links between benthopelagic zooplankton and benthic fauna is largely missing.

Predators and scavengers in the BBL may modify and redistribute organic material, but the processes associated with this trophic transfer are poorly understood. The release of meroplanktonic larvae by benthic organisms is probably an important pathway linking benthos and pelagos in the BBL. Because seamounts provide various habitats for benthic deep-sea and shallow-water organisms at depths which usually host only pelagic fauna in the open ocean, they may act as hotspots for meroplanktonic larvae. Most residents of hydrothermal vents are benthic as adults, but they usually rely on free-living planktonic larvae for dispersal, and the vent sites may form another hotspot for meroplankton in the deep sea.

Part II: Potential impacts of deep-sea mining on pelagic and benthopelagic fauna

This part compiles possible effects of activities in conjunction with deep seabed mining on pelagic and benthopelagic organisms. No full-scale pilot mining has been performed to date, and not all mining effects described are based on direct scientific evidence; some can be inferred from small-scale disturbances or shallow water processes, and others remain speculative. The overall scale of effects cannot yet be determined, as most conclusions are based on qualitative observations. A total of 16 primary and secondary processes of deep seabed mining activities have been identified, which can potentially affect the pelagic environment:

- Removal of substrate
- Deposition of material
- Pre-processing of ore at the sea floor
- Removal of ambient water
- Generation of noise and light
- Compacting of bottom substrate
- Generation of operational sediment plumes
- Generation of discharge sediment plumes
- Alteration of habitat through substrate removal, sedimentation, deposition, compacting
- Destruction of benthic communities
- Alteration of near-bottom flow characteristics and turbulence
- Release of toxic compounds during extraction or in discharge plumes
- Acidification
- Release of nutrients
- Oxygen depletion
- Injection of water with different than ambient temperature Introduction of alien species or pathogenic material

Some of these processes are supposed to have only minor impacts on the pelagic and benthopelagic communities. Particularly the direct effects of substrate removal, deposition of material, pre-processing, compacting of substrate, acidification and alteration of near-bottom flow are probably negligible. All others will severely interfere with pelagic and benthopelagic fauna, at least locally. Some of the impacts will be directly lethal, but most will impair processes associated with feeding, growth and reproduction, which can ultimately lead to smaller standing stocks, altered communities and loss of biodiversity.

- The most problematic immediate effects of deep-sea mining operations are probably caused by the generation of operational and discharge sediment plumes, which can disperse over large areas.

Enhanced loads of inorganic and degraded organic particles may impair respiration, decrease food availability, cause higher energy expenditure, and suppress communication and feeding interactions based on bioluminescence and chemical cues. A discharge in the upper water column will further reduce primary production, reduce the foraging success of visual predators and affect the vertical flux of organic matter. The associated release of nutrients may locally enhance primary production and alter the composition of the phytoplankton community.

- Large volumes of water are required to pump the extracted ore to a surface vessel. Most of the animals living in this water mass are not able to avoid the suction flow and will be entrained and die subsequently. The water will be subject to warming in the upper water layers and during processing and, if released back into the bathy- or abyssopelagic zones, will impair the usually stenotherm animals which are adapted to an environment with cold and stable temperatures.
- The seafloor operations will be associated with the generation of light and noise in a dark and largely silent environment. Bright illumination may attract or deter fishes, irreversibly damage eyes, and mask the ecological function of bioluminescence. Similarly, noise may interfere with the natural use of sound or damage acoustic sensors.
- The mining operations and sedimenting plumes will directly destroy benthic communities and lead to persistent alterations of the habitat. The destruction of benthic fauna will induce changes in food supply, probably favouring scavengers for short periods, but generally reducing food availability for benthivores. Even if a recolonisation occurs, the benthic communities will be altered for long periods or even permanently. This will affect trophic pathways between the pelagic BBL community and the benthos and favour or discriminate against certain feeding interactions, and ultimately change the composition of the benthopelagic communities.
- Both the mining process and the discharge of sediment plumes are associated with the release of potentially toxic substances, such as heavy metals, into the environment. This will lead to enhanced mortality, inhibition of growth or lower reproductive rates in the affected communities. Bioaccumulation in highly mobile species at higher trophic levels may spread the effects to large areas.
- The ore extraction and tailings disposal may impose the release of anoxic sediments. If discharged in the OMZ, this would locally decrease oxygen concentrations further and lead to anoxic conditions, excluding most zooplankton and micronekton from this layer.

Part III: Knowledge gaps and recommendations for research

More than 90 % of the oceans' area is deeper than 200 m, and still nearly 85 % is deeper than 1000 m. Due to its vastness and inaccessibility, the deep sea is one of the least known ecosystems. This applies to both the pelagic and benthic compartments and particularly to the waters below 1000 m depth. The vastness and apparent lack of limits, however, does not mean that the deep ocean is a homogenous ecosystem, and we cannot exclude that even disturbances which affect small areas or volumes in relation to the total ocean, may have serious and far-reaching consequences. We identify here some knowledge gaps that should be addressed in order to better understand possible impacts of deep-sea mining on the deep-water pelagic fauna:

- Biodiversity and biogeography of deep-sea pelagic and benthopelagic communities.

  Still very little is known about the taxonomic and functional composition of pelagic communities in the deep sea and their spatial variation and connectivity. Due to the high sampling effort required, studies have been restricted to a few locations and cannot be generalised for larger ocean basins. A substantial fraction of the deep-sea pelagic community is not assessed with the currently available technology, for example very fragile gelatinous forms and very small zooplankton, although these might be particularly vulnerable to enhanced sediment loads. The obligate benthopelagic fauna within a few decimetres off the bottom is especially poorly known, but will probably be affected most by mining activities.

- Recommendations: Quantitative large volume sampling and taxonomic analysis (classic/genetic) of pelagic and benthopelagic communities, and comparison with the overlying water column. •
- Limitations: A complete species inventory will be impossible to achieve. Functional diversity will probably be restricted to very few traits and to more abundant species.

- Abundance, biomass and distribution of deep-sea pelagic and benthopelagic fauna.

Estimates of zooplankton abundance and biomass in the deep sea show generally low standing stocks. Results from the near-bottom layer are extremely rare and somewhat ambiguous. In all these studies, neither microzooplankton are considered nor gelatinous organisms. Quantitative estimates of benthopelagic nekton are rare, but indicate substantial geographic differences. •

- Recommendations: Quantitative sampling and enumeration of near-bottom nekton and zooplankton (including microzooplankton and gelatinous organisms), and comparison with overlying water columns. Special attention should be given to the distribution of zooplankton between the seafloor and 10 metres above bottom. •
- Limitations: Reliable estimates of abundance, biomass and distribution will not be possible for very rare and for most large, highly mobile species.

- Life history traits of deep-sea pelagic and benthopelagic fauna.

Apart from a few fish species, life history traits, such as longevity, fecundity, reproductive cycles, mate finding mechanisms and growth rates of deep-sea pelagic and benthopelagic organisms are practically unknown. •

- Recommendations: No methodology is currently available for uncovering life history traits in a substantial number of deep-sea key species. •
- Limitations: It is highly unlikely that much progress in the knowledge of deep-sea life history traits can be achieved in the near future.

- Near-bottom food web: Trophic relationships, metabolism, energy paths.

Studies addressing the trophic structure of deep-sea pelagic communities exist from a few locations, but usually do not include the obligate benthopelagic zooplankton. Studies of metabolic rates as a basis for energetic pathways in deep-sea food webs are extremely rare. •

- Recommendations: A high effort should be put on studies of deep-sea food webs including zooplankton, nekton, benthopelagic and benthic fauna, and should involve a combination of different analyses, including morphological identification of feeding types, stomach contents, stable isotope and fatty acid biomarkers, ETS and other enzyme activities, and direct respiration measurements. •
- Limitations: The position of rare species in the near-bottom food web and their contribution to the energy flux will remain unknown in most cases. A differential analysis of metabolic rates will be restricted to a few key organisms.

- Sensitivity of deep-sea pelagic fauna to enhanced particle loads.

  Pelagic animals within the sediment plumes will be exposed to enhanced (inorganic) particle concentrations, but nothing is known about possible effects.
  - Recommendations: In situ experiments should be carried out, which expose deep-sea pelagic filter and mucus net feeders along with gelatinous organisms to enhanced concentrations of inorganic particles and measure possible effects on physiological processes. •
  - Limitations: Experiments will be possible only for a few key species.
- Sensitivity of deep-sea pelagic fauna to toxic compounds, such as heavy metals.

  Heavy metals are known to impair a variety of physiological processes, resulting in lethal to sublethal effects in most biota. However, specific knowledge of effects on deep-sea fauna, which often show naturally enhanced levels of heavy metals, is lacking. •
  - Recommendations: In situ experiments should be carried out, which expose deep-sea pelagic fauna at different trophic levels to enhanced concentrations of heavy metals in water and food items and measure possible effects on physiological processes. •
  - Limitations: Experiments will be possible only for a few key species. Long-term sublethal effects will hardly be detectable.
- Temporal variability in larval release.

  The dynamics of reproduction in deep-sea communities are poorly known. The coupling with surface processes introduces variability into deep-sea communities and is likely to trigger episodic release of larvae and gametes in deep-sea benthic and pelagic fauna as well. •
  - Recommendations: In order to understand the dispersal capabilities of deep-sea benthic fauna, the occurrence of meroplanktonic larvae should be monitored in high temporal resolution, for example using optical or acoustic recording of the fauna close to the bottom. •
  - Limitations: Whereas larval release in locally aggregated assemblages, such as vent communities, can be monitored with a limited number of systems, direct observations of reproductive cycles in mobile and highly dispersed pelagic fauna can hardly be achieved.

Part IV: Recommendations for additions and changes to the ISA Consolidated Regulations and Recommendation on Prospecting and Exploration

Generally, the recommendations of the ISA LTC for baseline, environmental impact assessment (EIA) and monitoring studies during prospection and exploration request assessments not only of benthic, but also of pelagic communities. However, the recommendations remain unspecific in most cases. With a few exceptions, neither the target groups and parameters to be measured nor any methodological aspects are mentioned. Possible links between benthic and pelagic communities and their consequences for impact assessments are ignored. Study design concepts for the different deposit types are completely lacking. No comparisons with unaffected areas (reference stations) are requested.

Recommendations: Baseline studies prior to a disturbance and the monitoring studies should principally follow the same design. The sampling grid should be designed to represent the main abiotic and biotic features of the mining site and different grades of impact plus one or more reference station. A sufficient number of replicates has to ensure robust statistical analyses. The studies generally should include:

- Occurrence of marine mammals.
- Integrated assessments of Chl. a, primary production and phytoplankton size spectra.
- Composition, abundance and biomass of near-bottom zooplankton.
- Composition, abundance and biomass of BBL zooplankton (ca. 1 mab).
- Composition, abundance and biomass of BBL nekton (fishes and invertebrates).
- Additional measurements for food web analysis.
- Additional measurements for toxicology.

If the tailings are released in the water column, the following additional studies are required:

- Depth-stratified assessment of Chl. a, primary production, phytoplankton size spectra and taxonomic composition
- Depth-stratified assessment of composition, abundance and biomass of zooplankton in the water column at and below the discharge depth (down to the bottom), considering diel vertical migrations, if applicable.
- Depth-stratified assessment of composition, abundance and biomass of micronekton and nekton in the water column at and below the discharge depth, considering diel vertical migrations, if applicable.

Specific study designs are required at seamount and vent sites, considering the small-scale spatial and/or temporal variability in habitat and hydrographic conditions.