

Chapter 12

Assembling the Seabed: Pan-European and Interdisciplinary Advances in Understanding Seabed Mining



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Abstract This chapter deploys assemblage theory and thinking to bring together a unique set of insights on the seabed ranging from the ecological, to legal, practice to theoretical. It does so with a particular aim in mind: to *integrate* debates pertinent to understanding the frontier space of the sea floor. Whilst there are increasing calls for interdisciplinary integration in the marine sciences, combining the natural and social sciences research on the space of the seabed and its potential for mining tends to be siloed with work addressing component parts of such possible processes: ecosystem and ecosystem service aspects, legal dimensions, and geopolitical aspects, to name but a few. Whilst these contributions touch upon intersecting issues (society and environment; law and economics, and so on) they remained centered

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on particular disciplinary and scientific offerings to understanding the seabed and prospect of seabed mining. This chapter offers a thoroughly ‘joined up’ approach, which presents a prism through which to better understand the issues at stake in venturing to the new vertical frontiers of ocean extraction.

12.1 Introduction

Seabed mining is an extractive process, removing and retrieving resources from the seabed – the solid ‘surface’ that lies at the bottom of the ocean – otherwise known as the ‘ocean floor’ or ‘sea floor’. The mining happens on the very surface layer of the seabed which can be rich in mineral deposits such as copper, nickel, aluminum, manganese, zinc, lithium and cobalt (IUCN 2018). In respect of seabed mining, there is mining which may be described simply as ‘seabed mining’ and this may occur at any depth. For example, explorations and exploitations off the coast of Namibia are described as ‘seabed mining’ and exist within the territorial sea (12 nautical miles (nm)) and in the Exclusive Economic Zone (EEZ, up to 200 nm) from the West African country’s coast – but these deposits are not *deep*.¹ Other forms of seabed mining are explicitly named ‘deep-sea mining’ (or DSM) and this refers to “retrieving mineral deposits from the deep sea – the area of the ocean *below* 200m” (IUCN 2018, emphasis added). Spaces of possible extraction are located on and in the seabed in EEZs globally, as well as on and in the seabed beyond EEZs, on the

¹ Diamonds mined at around 130 m and exploration for phosphates is up to 300 m depth.

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continental shelf and in the ‘Area’ – the seabed beyond these zonal markers. This chapter is concerned with both seabed and deep-sea mining – in other words, the surface of the seabed – as a space of extraction.

The seabed has been long recognized as an ocean ‘frontier’ for exploration and exploitation (Zalik 2018). In an article in the *American Journal of International Law* in 1969, Louis Henkin noted the existence of an ‘untapped’ global extraction space under the liquid surface of the sea, stating that “a new environment of golden promise looms on the distant horizon” (Henkin 1969, 504). Some 50 years on, this ‘golden promise’ does indeed ‘loom’ large. As Matthew Taylor has recently noted, “the world’s oceans are facing a ‘new industrial frontier’ from a fledgling deep-sea mining industry as companies line up to extract metals and minerals from some of the most important ecosystems on the planet” (Taylor 2019, n.p). Indeed, the seabed holds ‘promise’ because it is a lucrative space that may provide access to valuable minerals that are now more difficult to access from terrestrial mining sites, where resources are depleting (IUCN 2018). Seabed mining opens-up a new space to retrieve minerals that are often needed in the production of today’s “high-tech applications such as smartphones and green technologies such as wind turbines, solar panels and electric storage batteries” (IUCN 2018). Yet, whilst there is huge economic benefits of the promise of such extraction, there is also a wide acknowledgement of the legal complexities of such activities at sea (especially in spaces beyond national jurisdiction); of the global challenges of enabling mining where it may be driven solely by profit and multinational corporations rather than local concerns; and where technologies, access and processes of extraction may impose irreversible harm to the seabed environment and ecosystems. To return to Henkin, then, there are many ‘looming’ issues in respect of seabed mining as it finally comes to fruition and into reality, as a new offshore industry, alongside the ‘extractive’ industries of fishing and the piping of oil and gas reserves.

Given this ‘looming’ issue, this chapter *assembles* a unique set of insights on the seabed ranging from the ecological, to societal, practice to theoretical. It does so with a particular aim in mind: to *integrate* debates pertinent to understanding the frontier space of the sea floor. Whilst there are increasing calls for interdisciplinary integration in the marine sciences, combining the natural and social sciences (see Markus et al. 2018) research on the space of the seabed and its potential for mining tends to be siloed with work addressing only component parts of such possible processes: legal dimensions (see Willaert 2020a, b), ecological aspects (see Simon-Lledó et al. 2019) societal perspectives (see Childs 2020; Zalik 2018). Whilst these contributions (and more) of course touch upon intersecting issues (society and environment; law and economics, and so on) they remained centered on particular disciplinary and scientific offerings to understanding the seabed and prospect of seabed mining. There is much value in these approaches but they can lack a more thoroughly ‘joined up’ approach, which presents a prism for better understanding the issues at stake in venturing to the new vertical frontiers of ocean space.

Recent work has attempted to ‘join up’ debates more concretely. For example, in a recent paper on traditional knowledge and seabed mining developments, Tilot et al. (2021) bring together indigenous and traditional knowledge with legal

understandings, ecological insights and contemporary politics to understand management futures for mining in the Pacific. The chapter builds on such integrative approaches and features a series of linked interventions – assembling a dialogue – which highlights how researchers are grappling with this ‘frontier space’ – legally, socio-economically, environmentally and geopolitically (see Koschinsky et al. 2018). This chapter offers – in one piece – a conversation on the *complexities* of seabed science and management, where the anthropogenic drivers, historic developments and future climate impacts as well as approaches for such an aim differ across space, and through the lenses of different disciplinary approaches demonstrating the necessity of such ‘joined-up’ thinking. That said, whilst highlighting contemporary research and approaches for understanding the seabed, it does not offer a definitive answer in how we manage such rich, varied, contentious sites, but rather aims to demonstrate the richness of combining such work to encourage further interdisciplinary endeavors as the march towards sustainable seabed mineral extraction continues afoot.

To achieve this aim, this chapter unfolds in the following way. It begins with an analytic consideration of ‘assemblage’ – a theoretical tool used for drawing together heterogeneous parts, into a ‘whole’ (DeLanda 2006). This approach makes it possible to assemble a set of disparate debates, which tend to remain separate in discussions about the seabed, and can create new modes of knowing and making sense of seabed governance issues. Following this framing, the chapter then ‘assembles’ a series of interventions, collating and linking these into the chapter as a whole² to enliven an understanding of the range of actors, issues, knowledges, techniques and practices that must combine to understand seabed and deep-sea mining, past present and future. In doing so, it aims to demonstrate the potential of combining numerous voices for an integrated understanding of the impacts of the development of the new industry. The chapter ends with a conclusion of future possibilities and required knowledge for deepening our understanding of the seabed.

12.2 Assembling Knowledge: Assembling the Seabed

Assemblage thinking or ‘theory’ is a mode of post-structural understanding, attuned to understanding the multiplicity of the world. It aims to provide a means of making sense of how phenomena are always emerging and ‘becoming’ (in other words, is never ‘finished’ but always in the making). As such, it is attuned to the ongoing

²The term ‘whole’ draws from work in assemblage theory which contends that multiple, heterogeneous ‘parts’ cohere together to form more or less territorialised ‘wholes’ - a complete picture of something for us to grasp. That said, the ‘whole’ is always open (and ever becoming) as other parts may be inserted or other parts may drop away as the assemblage comes together and apart over time. This chapter is a snapshot of seabed mining (a ‘whole’) configured of different parts: the ecological, political, economic etc. In 5 years times the picture of seabed mining may look quite different as certain parts hold fast or fall away, or new parts come to play an important role.

co-constitution of given issues, rather than presenting a situation, place, or politics as static, unchanging and complete. Moreover, rather than only allowing a dominant narrative in understanding a particular place, phenomenon or issue to be revealed, assemblage thinking enables scholars to consider the multiple, heterogeneous, seemingly separate, ‘parts’ (human and non-human actors, influences, discourses, environments) that ‘hold together’, making complexity known (DeLanda 2006). Indeed, key to assemblage is that there is a ‘pause’ – a moment of stability – at which a phenomenon and its parts ‘territorialise’ for us to assess it. However, it is always acknowledged that such an assemblage is always open, and could ‘deterritorialise’ and change in the future as new parts are added or detracted (a new stakeholder opinion, scientific finding, or policy, for example). As Dovey states, any assemblage comes “from flows becoming...which then produce relative points of stability”, only for that stability to be shaken as parts of a particular assemblage are ‘unplugged’ or different parts become ‘plugged in’. In sum, as Venn notes, assemblage allows a focus on “the dynamic character of interrelationships between heterogeneous elements” in the case of any given phenomena (2006, 107). It thus, arguably, can enable a more detailed, careful and critical consideration of the world.

For Deleuze and Guattari, the key ‘architects’ of assemblage thinking, we can think of virtually anything as an ‘assemblage’ – be it a person, animal, home (2004, 503–4), or as DeLanda shows, a city, or even something more intangible such as an ‘issue’ or ‘discourse’ (DeLanda 2006). Indeed, under the remit of ‘assemblage’ thinking, assemblage is a device that can be used for understanding almost any given topic that is emergent and complex. For example, scholars have used this framework for making sense of the ongoing construction of places (cities, streets, towns); for understanding social movements and protest; environmental justice regimes (Bickerstaff and Agyeman 2009) to a mode of thinking about the Blue Economy (Winder and LeHeron 2017). Accordingly, then, as Anderson and McFarlane note, “there is no single ‘correct’ way to deploy the term” (2011, 124) and it may be applied in a variety of contexts. The concept itself then, is and constantly re-becoming an assemblage.

Although seemingly abstract, the theory provides a useful framework for this chapter, in collating a series of insights about seabed mining to *integrate* debates than often remain siloed. Seabed mining can be understood as an issue – one that does not exist in and of itself – but that is *assembled* of emergent and evolving ‘parts’ (law, local communities, material resources, technology, economic and environmental concerns and so on) that come together to define it at any given moment. With this aim in mind, the chapter now assembles a series of voices and perspectives on seabed mining. We begin by drawing on definitional work that sets out what the seabed is – as a geographical space and site of potential governance and extraction, before highlighting why it is such an emergent zone of extraction and, hand-in-hand, of possible ecological harms. Our next logical step shifts us to ecosystem service dimensions, before we highlight to how these ‘parts’ assemble with the legal and geopolitical terrain of seabed mining potentials. In assembling these sections

into an integrated coherent ‘whole’ we also bring together different country perspectives from Aotearoa New Zealand to Papua New Guinea; from the seabed mining potentials in territorial waters to the deep sea (or the ‘Area’).³

12.3 Setting the Scene: Defining Who and What

Deep-sea mining (known as DSM), is currently being pursued by many industries and national governments. At the same time, it is being heatedly opposed-to by environmental and local groups who fear the unknown impacts and potential risks this activity can cause on the environment and the affect this may have on lives and livelihoods. Currently, regulations to manage DSM are being drafted by several countries as well as the International Seabed Authority (ISA), the body in charge of overseeing this process in the ‘Area’ – the seabed beyond national jurisdiction (see Van Dover 2011 and Wedding et al. 2015, on advances, possible impacts and regulatory frameworks related to seabed mining). However, in spite of this work, two fundamental questions remain largely underexplored. First, how, ontologically, do we understand what the seabed *is*, and secondly, who is the stakeholder to whom seabed issues relate? Who will profit and exploit, who will be impacted, who will take decisions and govern, and vitally – who is excluded?

These definitions are vital because how the seabed is defined influences governance in national and international settings and shapes regulations in innumerable ways. At the most basic level, in respect of defining the seabed, this space is regarded as either an extension of land (in which case seabed mining could be regulated by adapting terrestrial mining laws) or an area of ocean (in which case there is a greater need to consider a broader range of ecological impacts on, for instance, the water column and its users). Some governments have considered the seabed as an extension of land seeking inspiration in regulatory instruments for onshore mining activities. For example, Papua New Guinea, the country that is arguably most advanced in pursuing DSM, has issued permits based on an extension of onshore mining protocols that, for purposes of the seabed, redefine “land” as “the offshore area being the seabed underlying the territorial sea from the mean low water springs level of the sea to such depth as admits of exploration for or mining of minerals”. Other countries such as Japan, Canada, and several European Union members, will likely extend existing onshore mining regulations to the seabed to allow for seabed mining in areas of national jurisdiction. As a point of contrast, New Zealand has developed and applied specific regulations on seabed mining, the Exclusive Economic Zone and the Continental Shelf Act 2012, which rather than taking land as their reference point, place seabed mining within New Zealand’s overall marine

³The ‘Area’ refers to the zone of “seabed and ocean floor and the subsoil thereof, beyond the limits of national jurisdiction. The international seabed area represents around 50 per cent of the total area of the world’s oceans” (International Seabed Authority, n.d.) It is under the jurisdiction of the International Seabed Authority or ISA.

management strategy. Building on a recognition of the divisions within New Zealand's maritime space – the territorial sea, exclusive economic zone, and outer continental shelf – New Zealand mandates that when permitting seabed mining “the [Environmental Protection Authority] must take into account the...effects that may occur in New Zealand or in the waters above or beyond the continental shelf” (EEZ 2012). This understanding implies that models for best practice might come *less* from the onshore mining and *more* from forms of marine management used in other extractive industries such as Marine Protected Areas (MPAs).⁴ As we can see, then, the definition of the seabed ultimately matters how use, and governance, emerge.

Similarly, although there has been an increasing interest in, and attention to, ‘stakeholders’ – how they might engage in Environmental Impact Assessments and their limited participation (see Lallier and Maes 2016; Lodge et al. 2014; Jaeckel et al. 2017) – a careful analysis of *who* stakeholders are (and could be) in the first place, remains underexplored. For DSM, where people have different connections and dependencies to this contentious and inhabited space, it is crucial to develop a new understanding of who stakeholders are, and by default, who may be excluded from debates. Who is identified and recognized as having a legitimate connection or interest; who is included (or has access) in the drafting of the regulations; who is involved in decision-making if a project is to go ahead; who has had, in effect, meaningful participation in its governance? All these questions become more complex to answer when referring to activities in the ABNJ (Areas Beyond National Jurisdiction).

Turning again to New Zealand's regulations, the EEZ provided not only for a Māori Advisory Committee that can ‘advise’ and ‘comment on’ regulation changes, but also allows for the wider participation of stakeholders: ‘any person’ that the EPA considers to “have existing interests that may be affected by the application” can provide ‘submissions’ in favour or against a marine project. Other legislation, beyond New Zealand, has similar understandings of who a stakeholder ‘is’, but its implementation has been criticized. For instance, the Cook Islands’ Seabed Minerals Policy stated that “the entire nation and its people are the “community” affected by seabed mining activities and that related decisions are best-handled with participation of all concerned citizens, at the relevant level”. However, the Cook Islands Seabed Minerals Advisory Committee created for this endeavour has been criticized for a lack of representation and transparency. Accordingly, seeking inclusion of varied stakeholders does not ensure such representation manifests.

Regulations in other countries have a ‘fuzzy’ or incomplete understanding of what a stakeholder is. For Portugal, where seabed mineral exploration has started in the Azorean sea, the specific regulations developed in 2015 state that a “compulsory consultation” shall be carried out “of the municipalities in their respective areas of

⁴Although not traditionally regarded as extractive or as industries, MPAs do have these qualities, when, for example, we see them as geopolitical resources. In this context they allow sovereign states to extract security assets from the environment under the guise of conservation. Likewise, they can play into the hands of global discourses around environmental protection and extract resources from traditional and indigenous users in modes of neocolonialism.

territorial jurisdiction (...)” (Lei 54/2015 Portugal). Although stakeholders seem to be represented here through the municipalities and competent bodies, the extent of ‘territorial jurisdiction’ of these municipalities on marine areas and how exactly the stakeholders will be involved, is unclear. Other countries are still developing specific regulations for DSM. In the case of Namibia the new Minerals Policy draft made public in 2018 states that “the Government will ensure community participation through consultation before companies are allowed to commence metallurgical operations” however, it is unclear how ‘communities’ are to be defined in the context of the seabed or if ‘metallurgical’ (i.e. the extraction and modification of metals) applies to the seabed.

As such, at the start of any discussion of seabed or deep-sea mining, unpacking what the seabed is and who the stakeholders are, is not a purely academic or philosophical exercise, it is a *political decision* which may be influenced by various lobby groups. The political decision shapes outcomes for potential use, and governance. It is a key ‘part’ of understanding seabed mining. Specific definitions of the seabed are likely to influence governance in national and international settings, from what particular ministry is given lead regulatory authority, to the calculation of risk and the scope of Environmental Impact Assessments (EIA). Indeed, whilst it is vital to assemble the question of ‘what’ the seabed is, and ‘who’ it matters to, this must be held in the context of *why* it matters – its economic benefits in the short term, but the possible ecological harms in the long term. We next integrate this vital ‘part’ of understanding to our assemblage of seabed perspectives.

12.4 Socio-Economic Dimensions: Marine Ecosystem Services and Values of Deep-Sea Mining

The Ecosystem Services (ES) framework, linking the environment to human well-being, is important for sustainable management of the deep-sea, which could provide a quantitative basis for future practice of Marine Spatial Planning (MSP), a crucial ‘part’ of understanding emerging DSM regimes by recognizing various values, including economic values. Figure 12.1 shows how the ecosystem services framework can be incorporated into the various stages of MSP.

Le et al. (2017) identify, in detail, the ES that could potentially be affected by DSM in terms of polymetallic sulfide mining, ferromanganese crusts mining, polymetallic nodules mining and phosphorites mining. ES, when considering provisioning of fish catch, for example, may be affected by disrupted breeding grounds and nursery habitat, altered secondary production and trophic support, and dispersal connectivity. Pharmaceuticals and biomaterial provisioning ES will also be affected by the changes in biodiversity and metabolic activities. Regulating services will be impacted through many channels such as surface photosynthesis, chemosynthesis, carbon flux, bioturbation, bio-irrigation, aerobic methane oxidation, greenhouse gas

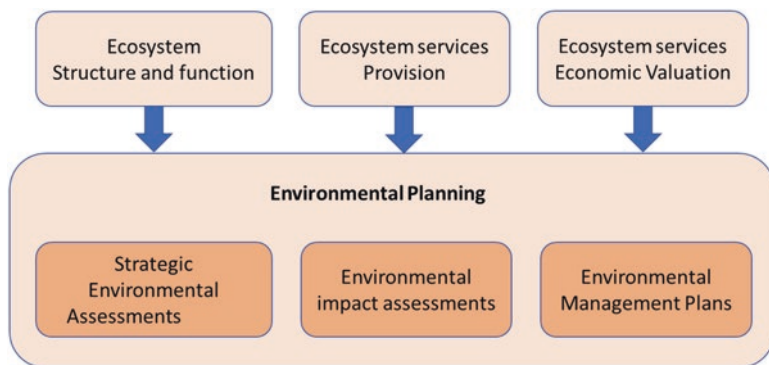


Fig. 12.1 Relationships among ecosystem services, their study and phases in environmental planning where ecosystem services can be incorporated. (Adapted from Le et al. 2017)

regulation, biological control of population and waste absorption. As noted already in this chapter, deep-sea mining will also affect the *cultural* ES that the deep-sea and seabed provides; such as the educational, aesthetic including arts, existence and stewardship values; often termed ‘non-use’ values.

As knowledge of deep-sea ecosystems and their dynamics is still limited, it has – to date – been difficult to connect the ecosystem function with the services they provide (Hanley et al. 2015), and it has been yet more difficult to quantify the impacts of deep-sea mining on the affected ES (Le and Sato 2013). If impacts could be quantified on provisioning services like lost fish catch, this can be valued using market prices. Impacts on regulating services can also be valued by market prices through the replacement costs approach, but it can be difficult to find a perfect substitute project that in theory could replace the loss in these ES. However, impacts on cultural ES can be very challenging to put an economic value on, as people are unfamiliar with these deep-sea, with ES and the long-term risk to these ES posed by DSM (Hanley et al. 2015). However, some environmental valuation studies have tried to address this issue.

For example, a Delphi based method was developed by Jobstvogt et al. (2014a) to communicate the ecological value of the deep-sea ecosystem. Jobstvogt et al. (2014b) conducted a Stated Preference (SP) survey in terms of a Choice Experiment (CE) to elicit households’ willingness-to-pay (WTP) for creating additional MPAs in the Scottish deep-sea in order to protect them from potential destructive impacts from, for example, DSM. Aanesen et al. (2015) and Sandorf et al. (2016) conducted CE surveys of Norwegian households’ WTP for extending the national MPAs for deep water, cold water corals (CWCs), including also the uncertainty of the ecological role of CWCs in their assessment. They experimented with different survey modes and different ways of presenting the ES of these unfamiliar public goods to the general public in order to improve the validity and reliability of these non-use values. These CWC valuation estimates were later included in a bioeconomic

fisheries model of destructive bottom trawl versus non-destructive coastal gear (Armstrong et al. 2017); that clearly showed the importance of incorporating impacts on cultural ES and their non-use value into economic analysis of extraction of natural resources.

The uncertain linkage between the deep-sea ecosystem, ecosystem services and their benefits to humans should not preclude the inclusion of ecosystem services and their economic values into strategic environmental impact analysis (SEA), monitoring systems and ecosystem based management. DSM has strong economic motivation but impacts on ecosystem services and their values to humans should also be considered in the economic analysis in order to support a sustainable development path. This is a crucial ‘part’ of understanding deep-sea mining.

Ecosystem Accounting (EA), a framework proposed by UN, views nature as an asset, and aims to incorporate the environmental assets into the system of national accounts (UN 2014). EA involves not only the physical terms of ecosystem such as ecosystem extent and condition, but also the supply and use of ecosystem services, and the monetary valuation of supply and use, as well as the periodic revision of asset values based on changes in predicted future flows of ecosystem services (UN 2017). Although marine ecosystem accounting is still in an early stage, EA is a potentially valuable ‘part’ to consider in seabed mining assemblages as it can enhance transparency in governance, and link stocks and flows of natural resources with a broad spectrum of ecosystem services and benefit values (Chen et al. 2020). In the context of DSM, EA could provide a flexible monitoring framework (Grimsrud et al. 2018) to support ecosystem-based management as it maps the changes in ecosystem extent, condition, or physical supply and use of the ES or changes in the economic value of the ES if there is sufficient knowledge to monetize the ES. The spatial focus of EA could highlight the different geographic impacts of DSM, helping to identify management hotspots and create MPAs, if needed. However, it has to be admitted that EA faces the similar challenge as those related to quantifying ES and ES values mentioned in the section above. Yet it is still a crucial arena of research and key ‘part’ of the assemblage in helping to make sense of the current ‘state of play’ in emergent seabed mining activities.

12.5 Tackling the Legal Perspectives: Insights from Law and Policies

Given the complexity previously described, the regulation of DSM, particularly in the Area Beyond National Jurisdiction, represents a unique challenge legally. From the perspective of the United Nations Convention on the Law of the Sea (UNCLOS), the seabed has garnered great attention, and this before any real activity has taken place (an unusual feat in maritime governance, to seek to govern a still largely unpracticed mining activity). Yet with the *exploitation phase* rapidly approaching, many interests are at stake and research on legal dimensions is highly relevant, not

only for academics and lawyers, but for all parties involved in exploration and exploitation of the continental shelf and the deep seabed. Moreover, future issues can be anticipated and remedied through thoughtful analysis of changes in international regulations and national legislation. By studying all the relevant legal sources, including the applicable conventions, the regulations, guidelines and standards of the International Seabed Authority, the national legislation of specific states, pertinent case law and authoritative literature, research can offer insights into a highly complex legal regime and how its implementation unfolds on the ground. Furthermore, research may fill the blanks and make a substantive contribution to the legal literature surrounding this topic by ‘zooming in’ on issues which have been largely neglected until now, such as the effective implementation of the status of common heritage of mankind, the interaction between the regimes of the deep seabed and the continental shelf and the differences between relevant national laws (Willaert 2020a).

Legal designation of the seabed began as early as 1970, with the Area and its mineral resources, declared as the ‘common heritage of mankind’ (sic). Since this point, the Area as well as seabed resources *within* national boundaries, have been the subject of regulation on the scales of national to international politics. Some research is, crucially, exploring the potential legal conflicts between DSM and the status of the seabed and its natural resources as the ‘common heritage’ of all (Willaert 2020b). The objective of this work is to find out if the current international legal framework and the national legislation of selected states fully respect the applicable legal principles linked to the common heritage of mankind (sic). As the research has observed, fairly quickly, the legal framework with regard to the deep seabed is not in a final state (see Hunter et al. 2018) and keeps progressing. As with any assemblage, it is in a state of ‘becoming’, and corrections and improvements can still be made.

But beyond this, what is at stake legally? With respect to activities in the area beyond national jurisdiction (short: the Area and high seas), mining practices are considered to comprise of the exploration and exploitation for three different types of minerals. These are polymetallic nodules, polymetallic sulphides, and cobalt-rich ferromanganese crusts. UNCLOS clearly stipulates that minerals of the Area cannot be subject to any sovereign claim by an individual state. As such, access to the resources is only possible through the regime designed by the UNCLOS and the regulations of the ISA. UNCLOS, which provides the general framework to govern deep seabed mining in the Area, confers upon the ISA the requisite mandate to actually develop all the necessary rules, regulations and procedures to administer the mineral resources of the Area. Accordingly, since its inception in 1994, the ISA has been working to this end. The ISA comprises of 168 Member States and is headquartered in Kingston, Jamaica. Member states of the ISA, all of whom are represented in the UN Assembly, meet annually. In recent years, the executive organ of the ISA, the Council, has been meeting twice a year (a sign of increasing demands for legal decision-making in respect of the seabed). It is noteworthy to mention that a number of non-Member States, most notably, the United States of America, regularly participates in the work of the Authority by attending annual sessions.

Regulations for the exploration of minerals have been in place since the year 2000, in the case of polymetallic nodules (amended in 2013), while exploration regulations for polymetallic sulphides were adopted in 2010, and the same for cobalt-rich ferromanganese crusts in 2012. Since 2014, the ISA has shifted its focus towards developing regulations to govern the exploitation of mineral resources. Instead of designing individual regulations for each type of minerals, the Member States have proceeded to develop one set of regulations that applies across the board (Willaert 2019).

One area that raises some significant questions when it comes to the exploitation of mineral resources is the harm that will be inflicted on the marine environment. Harm is another key 'part' or factor to be considered in an assemblage of understanding DSM and seabed mining per se. It is widely accepted that mining activities could cause irreparable harm on the marine environment and ecosystems at the mining site, and plumes that are generated from mining activities could spread well beyond the mining site, thereby disrupting surrounding ecosystems. In response to this, numerous Member States have called for the development of Regional Environmental Management Plans or REMPs. The prevailing view is that REMPs should be in place *before* any mining activity is permitted within a specific region. However, there is yet to be clear consensus on the actual legal force that REMPs actually connote. Like any assemblage, then, the legal and management provisions of mining remain emergent, ever in process.

One view is that REMPs are merely planning instruments that guide decision-making, while another view is that REMPs are binding instruments that instruct decision-making processes. If the latter view is adopted, this would mean that the ISA could actually reject exploitation applications on the basis that its approval would not conform with the goals and objectives of the applicable REMP. It is expected that some progress will be with respect to the legal force or effect of REMPs and the dynamics between REMPs and decision-making at the ISA. Similarly, discussions pertaining to the adoption of Standards and Guidelines that should apply to exploitation activities are also currently ongoing. The regulatory assemblage of DSM, then, is in an ever-changing and evolving state, which will be important for scholars and stakeholders to keep abreast of.

However, such instruments, and other regulative apparatus are not the only legal considerations that are a 'part' of making sense of seabed mining. Competent legal knowledge is also vital. An important area of research which arguably requires more detailed interrogation is the actual ability of the ISA to ensure the effective protection of the marine environment. From an institutional perspective, it appears that the ISA lacks the appropriate expertise in this regard. While it has an expert subsidiary body, known as the Legal and Technical Commission (LTC), a significant majority (80–90%) of the Commission's members are lawyers and geologists, who do not have environmental-related expertise. This is worrying, as the LTC is entrusted to make recommendations to the Council on environmental-related matters such as the design of appropriate regulations, the consideration of environmental impacts (including the need for emergency action), and whether or not to approve

environmental monitoring and management plans submitted by contractors. This workload is substantial for three experts. However, stakeholder input enables further deep-sea ecology expertise can be injected into the process. To add further, it should be noted that it is difficult for the Council to disagree with any recommendations made to it by the LTC, as this would require two-thirds majority of Council members present and voting in most cases.

Moreover, more clarity is needed with respect to the confidentiality of data related to DSM decision making by the ISA. On the one hand, contractors insist on the need to protect proprietary interests and by extension, can withhold data obtained. On the other hand, the Law of the Sea clearly states that all environmental data should be promptly released to the ISA. Environmental information, such as baseline data, and the analysis thereof, is essential for the ISA to take necessary measures to ensure the effective protection of the marine environment. As such, there is a crucial need to clarify which information can be deemed as confidential, and which information is essential for environmental-related measures and must be disclosed. Given the current developments in international environmental law and the status of the deep seabed and its resources as common heritage of mankind, public participation, which is closely linked to the topic of transparency, is also a hot issue.

Finally, two critical 'parts' that require greater attention from a legal perspective are the financial terms of exploitation contracts, and the appropriate mechanism for benefit sharing. With regards to the former, the ISA is currently taking steps to design a suitable method to calculate how payments that emerge from mining, should be made (and who they should be made to). As concerns the latter, efforts remain at a preliminary stage and are currently, as of writing this, elusive. It is anticipated that efforts to make some progress in the appropriate benefit-sharing mechanism will intensify in coming years (altering the assemblage of DSM) and the operationalization of the Enterprise, an organ through which the ISA can develop its own mining activities, will also play a vital role in providing benefits for 'mankind' as a whole. The chapter next turns to economic dimensions, particularly ecosystems services, in greater detail.

However, it should be noted that legal research on the seabed is challenging. It is highly likely that new developments, in the form of new agreements, regulations or changes to relevant national legislation, may occur during any given research period. However, these risks can be limited by closely observing recent evolutions and anticipating such changes, thereby ensuring that the research results do not lose their relevance if these developments eventually take place. Indeed, apart from studying the *existing* legal framework, it is very useful to focus on the law-making process of the International Seabed Authority by attending and observing the annual sessions of the ISA Council in order to enhance knowledge with regard to the future regulations on DSM and the topical issues under discussion. Under this remit, legal scholars are also integrating semi-structured expert interviews informed by the findings of the desk research. By interviewing a representative of each of these involved parties, such as environmental NGOs, scientists, commercial mining operators,

sponsoring states, developing states and the International Seabed Authority, the various points of contention are underlined, allowing for a better analysis of the different factors influencing stakeholder perceptions of the current legal framework and enabling a more accurate assessment of future policy changes.

12.6 Recognizing the (Geo)Political and Associated Socio-Cultural and Temporal Dimensions

Whilst this chapter has, so far, addressed the definitional, ecosystem services, economic and legal ‘parts’ that help us understand seabed mining, geo-politics is also crucial in this emergent industry and overlaps and converges (see Anderson 2012) with the parts introduced so far. Through an approach conceptually grounded at the interface of critical geography, political ecology and resource anthropology, research by Childs has been focusing on how the seabed has emerged as a new political *terrain* of struggle (see 2018, 2019, 2020). Moving beyond geopolitical approaches that understand the world largely in the narrow terms of interstate relations, this research instead seeks to understand the seabed as a space of politics produced by a relational congregation of socio-natural forces, considering 1) the temporalities of DSM (Childs 2018); 2) a corporate anthropology of a DSM firm and its strategies (Childs 2019); and 3) the impacts of DSM upon indigenous communities and the political potential of art to counter-narrate the seabed (Childs 2020). Shifting back to the earlier section on definitions, certainly, a vibrant, unstable and agentic seabed, that is in flux and changing, is seen as generative of DSM’s evolving geo-politics.

The seabed as a geopolitical concern has emerged where, in recent years, it has been re-imagined by industry and policy makers not as an inert edge of a politically insignificant watery volume, but as the latest ‘frontier’ of resource extraction. Various scripted by global capital as both a solution to global resource security and as a more sustainable alternative to the terrestrial mining industry, DSM has thus emerged as a new iteration of *spatial fix*. This ‘fix’ encompasses both a tendency to ‘sink money into physical objects’ (for example, ports, ships, deep-sea mining equipment) and a metaphorical ‘addiction’ to resource extraction (Brent et al. 2018: 3). In other words, for those who work DSM into the blue economy narrative, the seabed becomes a key geographical site for capital’s ongoing expansion.

Yet for all the spatially centered critiques that it provokes, DSM also invites us to think about the (geo)political effects of its unique *temporalities*. As Childs argues, temporal dimensions ‘may be projected forwards; DSM’s target metals and minerals have been constructed both historically and currently as ‘resources of the future’, global finance is courted by corporate pronouncements of DSM’s ‘resource potential’, ‘waste’ from the extractive process is included in predictions of environmental impact and so forth. But the temporal also engages with the geological time of deep-sea topographical formation; for example, where polymetallic sulphides form at

very different speeds to polymetallic nodules, or where the status of resources can be either materially altered by physical forces such as volcanism or through discursive shifts inspired by (human) knowledge production and commodification' (Childs 2018: 2). *Time* and *space* then, are vital parts to critically consider in understanding the politics of DSM.

Yet it is also vital to consider DSM as *social*. A geopolitical approach critiques the oft-understood domain of DSM as largely asocial (its industry proponents often describe it as having 'no human impact'). To date, there have been very few ethnographic studies of those affected by or invested in the activity. Childs has sought to partially address this gap by analyzing the emotional and affectual aspects of DSM upon communities in Papua New Guinea (PNG) situated closest to the world's first commercial DSM license. Using a range of participatory methods and creative practices, including drawing, sculpture and participatory theatre, these small-island communities sought to find an alternative vocabulary for making the seabed visible to DSM actors including the corporation, the PNG state and activist groups at local, national and global scales (Childs 2020). Building on earlier sections of the chapter – research on DSM is not only scientific but understanding the assemblage of the issue involves engaging with legal analysis, interviews and as demonstrated here, more novel methodologies. Indeed, creative practices, in particular, emerge as 'submerged perspectives' that seek to 'pierce through the entanglements of power' associated with blue growth and proclamations of 'sustainable' DSM and which seek to 'differently organize the meanings of social and political life' (Gomez-Barris 2017: 11 in Childs 2020: 7). In other words, they make possible a greater understanding of geopolitics in the context of DSM.

There is also a need to understand the political possibilities enabled by the deep-sea's unique materialities, not least in terms of the ways that these prefigure the legitimizing strategies of certain human actors to mine the seabed. For example, the Deep-Sea Mining Corporation frames DSM activity in a way quite specific to the deep-sea environments in which it operates. By engaging with the matter or materiality of deep-sea mining (for example, the violence and unruliness of its associated volcanism, and the temporalities of sulphide 'chimneys'), the DSM industry is able to position itself as a more sustainable version of mining than its terrestrial equivalent (Childs 2019), geopolitically legitimizing itself. Understanding geopolitical 'positioning' then, of this multinational and complex industry and its physical materialities are an important part of any seabed mining assemblage.

Finally, connecting studies of deep-sea mining to a broader turn in the social sciences towards 'critical ocean studies' (DeLoughrey 2019) is essential to understanding its place in the politics of the Anthropocene. This means taking the geophysical processes of the seabed and deep-water column as well as a broadened cast of political actors (including spirits and deep-sea fauna) seriously in understanding how DSM's politics is wrought. Such an approach can draw upon work that has urged us to think 'with' the ocean (Steinberg and Peters 2015; Peters and Steinberg 2019) and the still hidden (post)colonial histories that it reproduces (DeLoughrey 2017).

12.7 Endings, and Beginnings

This chapter has been ambitious in scope, assembling together a collection of perspectives and knowledges about seabed and more specifically DSM. Unlike other publications on the seabed – *which have largely tended to focus solely on single issues* – this chapter has deployed the post-structural theory of ‘assemblage’ – as a mode of bringing together disparate parts, territorializing them into one coherent whole – a multipart, complex and varied discussion of the issue of seabed mining. Each ‘part’ of the chapter – on definitions, legal dimensions, ecosystems services and values, to science communication and geopolitics – has aimed to demonstrate that DSM cannot be understood through only one approach, but requires a *conversation* and *collaboration* across fields of knowledge and academic disciplines, and across the many approaches of those disciplines (from quantitative modelling, to qualitative interview data to scientific findings).

Taking an ‘assemblage’ approach has enabled a chapter that pays attention not to one ‘master narrative’ of mining, but rather the many parts that constitute this global, underwater development. The ‘part’ focused on definition, raised the vital issue that seabed mining does not, or will not, emerge outside of how we define, know and understand what the seabed – as a space to ‘save’ or a space to ‘exploit’. Intersecting closely, the ‘part’ on socio-economic assessment identified the need to understand seabed ecology and measure potential harms. This must be done in situ with understanding ‘legal’ and ‘geopolitical’ parts of the story. Together our ‘prism’ has demonstrated the potential of assemblage in has enabling a perspective that identifies often overlooked or previously unrecognized dimensions of the issue. Indeed, assemblage theory encourages scholars to be critical in thinking through the many parts that make a ‘whole’ (whether they seem immediately important or not) which come together to form an understanding of an issue. It permits also, “an alternative account”, one rich in its diversity and attention to heterogeneous elements (in this case, law, geopolitics, science, governance, management) showing how they interrelate. However, our assembled analysis is not complete and further questions could be asked. Whilst the chapter touches on seabed mining in different areas – the ‘Area’ and within national jurisdiction, it would be beneficial to dig deeper and explore (as one Reviewer urged us to do): ‘how the assemblage of seabed mining under national jurisdiction differs from assemblage of seabed mining beyond national jurisdiction, if there is a difference, and if so why: which are the dominant parameters?’

Yet also crucial to assemblage is the acknowledgement, as noted at the start of the chapter, that any assemblage is always open, and could ‘deterritorialise’ and change in future as new parts are added or detracted. This chapter has ‘held together’ a set of ‘parts’ arising at one moment in time. In this sense, this chapter provides a certain sort of conclusion for how to think about and understand seabed mining. But the chapter also, with the knowledge that assemblages change and evolve – and that seabed assemblages, in particular, are a terrain of flux (physically, legally, and

beyond) – argues that this is just the beginning. Future studies of this emergent assemblage will be necessary in the future, and we hope they may take inspiration from our approach here.

Appendix: The Deep-Ocean Stewardship Initiative

The body of scientific literature relating to environmental aspects of DSM has exploded in the past few years with examples too numerous to cite here. Of course, this is excellent news for increasing scientific knowledge of the remote areas of the deep ocean that maybe targeted for mineral extraction. It provides far more information to work with to try to gauge potential impacts for those that inhabit our deep oceans and the effects on the important services they provided to the planet and its occupants. However, this wealth of information can be overwhelming in complexity for scientists who work in this field, let alone for other stakeholders who have alternative interests in this realm (however those stakeholders may be defined, see previous part).

In trying to grapple with this wealth of information, the Deep-Ocean Stewardship Initiative (DOSI) – consisting of mainly scientists but also lawyers, policy makers, economists, conservationists and industry experts from around the globe – help to collate, disseminate and translate the current scientific literature for all. DOSI network members work to advance deep-ocean science in UN and other intergovernmental policies as well as on a national level, and translate science into digestible information at all levels. This is a key occupation for this group who unite to advise on ecosystem-based management of resource use in the deep ocean (both within and beyond national jurisdiction), including on DSM.

As the industry is rapidly approaching the transition from exploration to exploitation in our world's oceans (see above), one of the current primary focus areas is to provide independent scientific advice to the ISA and other stakeholders on DSM issues, including the development of exploitation regulations for the Area. DOSI is in a unique position to be able to collate this knowledge and deliver it directly to policy makers, neither advocating for mining or opposing it. Moreover, the initiative has been an official observer at the ISA Annual Sessions since 2016, delivering scientific side-events and interventions to highlight environmental aspects of DSM, working with country delegates and other stakeholders and producing related policy briefs (for example on climate-change considerations, the importance of biodiversity assessment and monitoring, and strategic environmental goals and objectives).

The network also actively encourages and funds the engagement of a broad spectrum of scientists, including those from developing nations, as well as early career individual, in these activities. Capacity development is an important aspect of DOSI's work, especially where there may be unequal power relations between those who seek to extract and exploit resources, and those subject to such extraction and exploitation. Between the Annual Sessions, DOSI Minerals Working Group

members (which number around 175), contribute expert commentaries on the draft regulations and other ISA documents, produce peer-reviewed publications (for example, Tunnickliffe et al. 2018), reports and outreach materials, convene and attend workshops and meetings relating to environmental planning and management aspects of DSM, and have regular communications with the enormous flux of information coming from scientific papers and meetings. Proactive development and implementation of comprehensive management practices, frameworks and policies prior to the onset of commercial mining will ensure protection and preservation of the marine environment, whilst enabling the use of seabed mineral resources. This, however, requires a deep understanding of law, a vital part of the seabed mining ‘assemblage’.

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