UiT The Arctic University of Norway

Faculty of Law

Harvesting Geothermal Energy in the Area

The Environmental Management of Prospective Geothermal Energy

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1 Introduction

Climate change has grown into the biggest concern of the 21st century. Changes in temperatures are predicted to affect ocean health, biodiversity and consequently humanity.[1] At the heart of the climate change problem is the world's energy consumption, more precisely the consumption of non-renewable energy.[2]

The world is turning to the oceans to mitigate the effects of climate change through the development of energy resources at sea. These include, for example, tidal and current power, offshore solar and wind power, bioenergy from marine biomass as algae for instance, and ocean thermal energy conversion.[3] Most of the plans for energy development at sea will primarily take place on the water column or by using water. Yet, the water column is not the only maritime zone of interest to develop energy sources. The Area does also provide a ground for new opportunities but also remains largely unknown and unexplored.[4] The first interest shown in the deep seabed was for mineral resources. These are argued to be indispensable to build the infrastructure necessary to convert to renewable energies.[5] Their legal framework is currently under negotiation.

The Area may also provide ground for the development of a particular form of energy which is for the past five years increasingly being explored even if not envisaged to taking place in the

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[1] IPCC, Sixth Assessment Report, Chapter 9, Ocean, cryosphere and sea-level change (2021), available online: https://www.ipcc.ch/report/ar6/wg1/#FullReport, last accessed 27 August 2021.

[2] European Commission on causes of climate change, available online https://ec.europa.eu/clima/change/causes_en, last accessed 5 August 2021.

[3] M. das Neves, "Offshore Renewable Energy and the Law of the Sea" in E. Johansen, I.U. Jakobsen and S.V. Bush (eds.), *The Law of the Sea and Climate Change: Solutions and Constrains*, (Cambridge 2021) pp.206-233.

[4] H. Ginzky, P.A. Singh and T. Markus, "Strengthening the International Seabed Authority's knowledge-base: Addressing uncertainties to enhance decision-making" (2020) 144 *Marine Policy* 103823.

[5] C. Nugent, The Governance Challenge of Deep Seabed Mineral Mining [webinar], 2020, Renewable Natural Resources Foundation, available online https://rnrf.org/round-table-on- seabed-mineral-mining/.

near future: geothermal energy.[6] To date, only a few pilot projects are currently being implemented.[7] Still, the hot stream coming from the ocean crust and hydrothermal vents situated in the Area is of particular interest in the midst of increasing pressure to develop clean and renewable energy.

The few pilot projects currently implemented are situated in areas within national jurisdiction. Developing geothermal energy in an area beyond national jurisdiction raises challenging questions such as who the regulator of the activity will be and also how the activity will be environmentally and sustainably managed. The purpose of this master thesis is to contribute to a better understanding of key aspects concerning the legal regime applicable to geothermal activities in the Area, more specifically the regime for environmental and sustainable management of this very activity.

1.1 Research questions

In view of the above, the overarching research question of this thesis is: what environmental management strategy may be envisaged for the exploitation of geothermal energy in the Area?

In order to answer this overarching question, this thesis necessarily explores the following sub-questions:

- How does the United Nations Convention on the Law of the Sea (LOSC)[8] regulates the environmental management of geothermal energy in Areas Beyond National Jurisdiction? Can geothermal energy in the Area be incorporated under the International Sea Authority's (ISA) mandate?

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[6] In this thesis the author also uses the expressions geothermal activity or simply activity interchangeably. All of these refer to offshore geothermal activity being developed in areas beyond national jurisdiction.

[7] For a listed overview of geothermal projects see M. das Neves, "Offshore Renewable Energy and the Law of the Sea*", opt. cit.*, p.212.

[8] Adopted 10 December 1982, entered into force 16 November 1994, 1833 UNTS 397.

- What are the advantages of the express obligation to protect the marine environment under article 145 of the LOSC in the matters of geothermal energy in the Area?

- Can geothermal energy activities in the Area benefit from the environmental management continuously developed by the ISA?

- What impact may the Area-Based Management Tools strategy developed within the BBNJ framework have on the environmental management of geothermal energy in the Area?

1.2 Methodology

This research is primarily a legal doctrinal analysis based on the analysis and discussion of sources of international law as listed in Article 38 of ICJ Statute. The first and most prominent source is the LOSC, its articles related to environmental protection in general and specific articles related to the development of deep-sea resources under Part XI of the LOSC. Case Law as well as principles of law relevant in the context of environmental protection will be used throughout the research. The use of scientific literature explaining the process of geothermal harvesting as well as the deep-sea environment, especially hydrothermal vents are relevant to enable a subsequent informed legal analysis. The next paragraphs will address the methodology specifically tailored to individual themes answering the main question.

First, with regards to the first milestone which is to determine under which legal regime geothermal energy would fall. The first step is to decide whether a zonal approach or a resource-based approach is the most appropriate to decide upon the applicable legal regime. Following from this, a resource-based approach will be considered. Therefore, the next step is to determine whether the steam from the ocean crust and hydrothermal vent is a resource of the Area falling under the Common Heritage of Mankind. Article 133 is the fundamental source of this particular step. However, the uncertainty which pertains the material scope of application, requires a thorough analysis and interpretation of article 133 of the LOSC. Organic chemistry and geology literature will be used to help determine the ordinary meaning of the term “mineral

resource", whereas commentaries on article 133 from various authors will supplement the analysis.

Second, with regards to the environmental management, the first and foremost source is the LOSC once more. The general provisions regarding the protection of the environment but especially article 145 of the LOSC are going to provide the basis of environmental management. Hence, to complement the understanding of the legal instruments used as primary sources for this research, the first step is to engage with the language of these provisions and also to examine literature specifically addressing deep seabed mining. In a second step, this thesis analyses the ISA's management tools to assess to what extent they incorporate the precautionary and ecosystem approach. Special emphasis is going to be given to the ISA's secondary law in matters related to the environmental management as well as Area-Based Management Tools (ABMT). The last step of the thesis is to analyze the possible influence the International Legally Binding Agreement on Biodiversity Beyond National Jurisdiction (BBNJ) will have on the ISA in its design of ABMT. The BBNJ draft text as well as documents from the fourth preparatory commission and literature will provide the answers as to the degree of coordination of ABMT. The LOSC and literature will provide the answer as to whether the ISA's institutional arrangements provides enough flexibility to cooperate effectively with other organization to design coherent ABMT, especially with regards to its Areas of Particular Environmental Interest (APEIs).

1.3 Scope Delimitation

This thesis will exclusively address the harvesting of geothermal energy in the Area, meaning the hot steam from the ocean crust and hydrothermal vents. However, this research will not discuss the entire legal regime applicable to all the stages of geothermal energy in the Area as it would be beyond the scope of this thesis. This thesis will exclusively focus on the environmental management pertaining this new activity. This thesis being merely a master thesis it will be an inception to the components of the environmental management that can be expected and anticipated. Consequently, this research will not investigate in depth the environmental management of all maritime activities and determining common components of the management, neither will it deduce a management pattern that can be applied or adapted to

geothermal activities. Despite focusing on the ISA's regional environmental strategy, this research will only provide an overview of environmental tools due to the set length of the thesis.

1.4 Structure of the Thesis

Chapter 2 explains the different geothermal harvesting techniques developed so far. Following the explanation of the different harvesting techniques, this chapter explains the potential environmental impacts that can result from this activity.

Chapter 3 investigates which legal regime is applicable to geothermal activities in the Area. The chapter will decide whether a zonal approach or a resource-based approach is the most appropriate to determine which legal regime is the most likely to apply. Further, this chapter will also demonstrate that the hot steam from the ocean crust and hydrothermal vents may be understood as a "mineral resource" under article 133 of the LOSC.

Chapter 4 builds up on the two previous chapters and investigates the environmental management of "activities in the Area". After determining the extend of the ISA's jurisdiction for geothermal activities, this chapter will investigate how the ISA implements the precautionary and ecosystem approach while discharging its obligation under article 145 to 'ensure effective protection for the marine environment'. Then, the chapter will investigate key precautionary procedures to safeguard the environment from geothermal activities.

Chapter 5 will finalize the research and investigate how the regional environmental management designed by the ISA will accommodate the spatial conflict resulting from geothermal activities and mining activities taking place in the same areas. Then, this chapter will also explain how the legally binding instrument on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction currently being negotiated influences regional ABMT.

2 Geothermal Energy in the Area: harvesting methods and associated environmental impacts

Geothermal energy is harvested from two different energy sources: either the continental curst or hydrothermal vents.[9] Both energy sources are to be find on ocean ridges which are marking the boundaries between tectonic plates. The heat flow and thermal gradient is the most prominent on and around these ridges, reaching very high temperatures, which makes these areas optimal to harvest geothermal energy.[10] Offshore geothermal technologies have been increasingly developed and tested since the 2010's.[11] The technologies used for this come from the oil industry and are suitable to resist to the high temperatures which can be found in vents.[12] However, it is noteworthy that offshore geothermal energy is still at an experimental phase and there is no ongoing commercial offshore geothermal production. New technologies are also being developed to minimise the environmental impact which remains under-researched at present.

This chapter explains the different harvesting methods as well as the different installations required to transform and transport the energy. This is so for two reasons. The first is that different harvesting methods and installations may raise different environmental impacts, some more significant than others. The second reason is that the harvesting process involves different stages taking place in different maritime zones. This is fundamental for the discussion of who has the jurisdiction to regulate this activities and issue exploration and exploitation licenses. Consequently, it influences the environmental management.

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[9] For simplification purposes, the thesis also uses the term 'vents' in isolation. When this occur it should be understood as referring to hydrothermal vents.

[10] A. Banerjee, T. Chakraborty and V. Matsagar., "Evaluation of possibilities in geothermal energy extraction from oceanic crust using offshore wind turbine monopiles" (2018) 92 *Renewable and Sustainable Energy Reviews* 685-700.

[11] M. C Suárez-Arriaga, J. Bundschuh and F. Samaniego, "Assessment of submarine geothermal resources and development of tools to quantify their energy potentials for environmentally sustainable development" (2014) 83 *Journal of Cleaner Production* 21-32.

[12] F.B. Armani and D. Paltrinieri, "Perspectives of offshore geothermal energy in Italy" (2013) *The European Physical Journal Conferences*, p. 8.

2.1 The harvesting method per se and its reasonably assumed environmental impacts

The hydrothermal fluid is difficult to capture because it dissipates in the seawater immediately after it is ejected.[13] Therefore, the capture process is being carefully studied. The technology to capture the hydrothermal vent fluid varies. There are three possibilities to harvest geothermal energy in the Area. The first is to drill the oceanic crust, the second is to catch the steam emanating from hydrothermal vents by way of a heat pipe inserted into the hydrothermal vent chimney. The third possibility is a variation of the second. It involves a spiral structure to be installed on top of the hydrothermal vent.

First with regards to drilling methods, there are two possibilities. The first possibility is to drill vertically into the ocean crust next to the hydrothermal vent (see Annex I, Concept E).[14] The thermal gradient on the boundary of diverging tectonic plates is indeed ideal for geothermal harvesting.[15] The second possibility is to drill diagonally into the hydrothermal vent to access the heat reservoir (see Annex I, Concept A).[16] Both involve drilling into the ocean crust and therefore take place on and beneath the seafloor, meaning the Area. The lack of research results in a lack of information regarding the environmental impact of drilling but it nonetheless compromises the integrity of both, the hydrothermal vent, and its surroundings.

Still, an analogy with offshore hydrocarbons can be made. In addition to noise, the drilling results often in cutting piles to be deposited and accumulated near the rugs which will directly

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[13] Y. Xie, S-J Wu and C-J Yang, "Generation of electricity from deep-sea hydrothermal vents with a thermoelectric converter" (2016) 164 *Applied Energy*, p.621.

[14] J. Parada et al., "The deep sea energy park: Harvesting hydrothermal energy for seabed Exploration*"* in R.A. Shenoi, P.A. Wilson, S.S. Bennett (eds), *The LRET Collegium 2012 Series*, vol. 3, (University of Southampton) p.54.

[15] A. Banerjee, T. Chakraborty and V. Matsagar., "Evaluation of possibilities in geothermal energy extraction from oceanic crust using offshore wind turbine monopiles" *opt. cit*.

[16] J. Parada et al., *opt. cit.*

affect the benthos underneath.[17] The species richness is the most prominent next to the drilling site.[18] The cutting pile may therefore greatly affect ecosystem functions. Cutting piles are accumulated mixture of drilling mud, fluids and solids, rock fragments, sediment, and speciality chemicals. These cutting piles can disturb bottom dwelling animals[19] as well as contaminate the sediment and the surface water.[20] Environmental monitoring in offshore hydrocarbon exploitation within national jurisdiction shows that sediments are often contaminated with heavy metals.[21] However, it is uncertain whether in the relatively undisturbed deep sea this heavy metal contamination also applies. Consequently, less damaging options have been developed.

The possibility to insert a heat pipe in the hydrothermal vent chimney down to the well reservoir is being considered as a less invasive option compared to drilling (see Annex I, Concept D).[22] As the hydrothermal fluid is caught by the pipeline it would not be released into the environment or only a fraction would be released. Species rely on the transformation of sulphur compounds into energy to survive.[23] As sulphur compounds are caught by the pipeline it could be reasonably assumed that this chemical process cannot take place as long as the harvesting structure is in place. This would threaten the entire hydrothermal vent ecosystem. Despite research showing that life is still sustained on inactive hydrothermal vents, it is paramount to point out that the same research is emphasising that the species to be find in this ecosystem are

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[17] P.F. Kingston, "Impact of offshore oil production installations on the benthos of the North Sea" (1992) 49 *ICES Journal of Marine Science*, p.46.

[18] A. Chapman, V. Tunnicliffe and A.E. Bates, "Both rare and common species make unique contributions to functional diversity in an ecosystem unaffected by human activities" (2018) 24 *Diversity and Distributions* 568–578.

[19] K. Hossain, T. Koivurova and G. Zojer, "Understanding the Risks Associated with Offshore hydrocarbon Development" in E. Tedsen, S. Cavalieri and R.A. Kraemer (eds.), *Arctic Marine Governance: Opportunity for Transatlantic Cooperation*, (2013), p.169.

[20] S. Kark et al., "Emerging conservation challenges and prospects in an era of offshore hydrocarbon exploration and exploitation" (2015) 29(9) *Conservation Biology*, p.1575.

[21] E. Breuer et al., "A review of contaminant leaching from drill cuttings piles of the Northern and Central North Sea: A Review", (1999).

[22] F.B. Armani and D. Paltrinieri, *opt. cit.*, p.8.

[23] C. Smith, "Chemosynthesis in the deep-sea: life without the sun" (2012) 9 *Biogeosciences Discussions* 17037–17052.

completely different, thus resulting in a different ecosystem.[24] After being caught, the sulphur compounds are re-injected into the bottom water near the hydrothermal vent together with the seawater caught at the same time.[25] Further, Fisher et al. found that species use the heat of the diffuse flow coming from cracks in the hydrothermal vent.[26] Judging by the depth at which the pipeline is inserted into the hydrothermal vent chimney it may be assumed that it could at least limit the diffuse flow.[27] Despite this process being tested within the framework of the Marsili project, the environmental consequences remain unknown[28]. It can only be reasonably assumed that limiting the diffuse flow may result in an environmental impact yet the extend of such an impact can only be speculated upon.

Faced with these possible environmental consequences, a variation of this method has been developed. Instead of a strait pipeline being inserted vertically, a loop is being introduced into the hydrothermal vent chimney functioning as a close circuit (see Annex I, Concept C). Contrary to the strait pipeline, this method does not catch the hydrothermal fluid. Consequently, the fluid is released in the environment. Due to the hydrothermal fluid to dissipate immediately after being ejected from the vent, this method of harvesting directly from the inside of the vent may be considered the best method.[29]

However, these two methods present a common environmental risk. There is the strong possibility that the hydrothermal vent chimney needs to be prepared for the strait or loop pipeline to be inserted which may damage the hydrothermal vent chimney.[30] In addition,

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[24] J.B. Sylvan, B.M. Toner and K.J. Edwards, "Life and Death of Deep-Sea Vents: Bacterial Diversity and Ecosystem Succession on Inactive Hydrothermal Sulphides" (2012) 3(1) *mBio*.

[25] See the multiple examples marked in yellow in T. Prabowo et al. "A New Idea, The possibilities of offshore geothermal system in Indonesia marine volcanoes" (2017) 103(1) *IOP Conference Series Earth and Environmental Science* 012012.

[26] C.R. Fisher, K. Takai and N. Le Bris, "Hydrothermal Vent Ecosystems" (2017) 20(1) *Oceanography* 14- 23.

[27] F.B. Armani and D. Paltrinieri, "Perspectives of offshore geothermal energy in Italy", *opt. cit.*, p.18.

[28] The web page to the Marsili project is not found anymore. For more information about the project see *Ibid.*

[29] Y. Xie, S-J Wu and C-J Yang, "Generation of electricity from deep-sea hydrothermal vents with a thermoelectric converter", *opt. cit*., p.621.

[30] J. Parada et al., "The deep sea energy park: Harvesting hydrothermal energy for seabed Exploration*", opt. cit.,* p.54.

drilling the seafloor or the hydrothermal vent as well as inserting a pipeline into the hydrothermal vent are to various degrees disrupting the integrity of the vent. For these reasons a third possibility is being recently developed.

A third method to catch the energy is currently being developed by the IMPULSA project. This new method involves positioning a spiral structure in the water column above the hydrothermal vent which turns the hot steam into energy (see Annex II).[31] Contrary to the two previous methods, it would not compromise the integrity of the hydrothermal vent and it would let the hydrothermal vent fluid disseminate into the environment. This spiral structure developed by the IMPULSA project is designed to withstand pressure at a depth over 2000 meters and temperatures above 360 degrees Celsius.[32] As most of the Ocean Ridges are to be find at a depth of 2000 or 2500 meters and some are even situated at greater depth[33], it means that the spiral structure can be used to harvest geothermal energy in the deep sea. It is uncertain if this method will have an environmental impact. There is no research available and it is unknown whether the spiral structure would catch the heat and consequently cooling the steam on the long term.

2.2 The energy conversion and its environmental impacts

After being harvested, the hydrothermal fluid needs to be transformed into energy. The hydrothermal fluid consists of the pure steam, the sea water and the sulphur compounds. Only the hot steam is used and transformed into electricity. Consequently, the hydrothermal fluid needs to be separated. This stage of the transformation process is taking place by means of either a separator or a heat exchanger. The pure steam is then transferred to a power plant on land and transformed into electricity. It is also possible to design the power plant in such a manner that the separation process takes directly place on the power plant before being

[31] See Figure 2 in G. Hiriart et al., "Submarine Geothermics: Hydrothermal Vents and Electricity Generation" (2010) *Proceedings World Geothermal Congress*, p.3.

[32] *Ibid.,* p.2.

[33] *Ibid*.

transformed on the same structure. The only example of this possibility is the platform-based power plant.

All possibilities but one, require a structure to be laid on the seafloor and all may be expected to impair migration routes similar to offshore hydrocarbon exploitation structure.[34] The only exception is the platform-based power plant where the platform is floating on the sea surface above the energy source. The platform-based power plant is currently implemented in the Marsili project.[35] Still, it requires to be anchored on the seafloor.[36] Thus, the power plant is not expected to have a significant impact on the seafloor or the hydrothermal vent. However, because the structure would be subjected to wave impact and rapidly decreasing temperatures, research has developed technologies that would enable to submerge either the power plant itself or the intermediary structure.[37] Therefore, all other possibilities involve installing a structure directly on the seabed next to the energy source. The first possibility is to install the power plant itself on the seabed. The second is to construct the power plant on land and to install an intermediary structure on the seafloor next to the energy source. As of today, there are three "intermediary installations" possible. The first is a separator which separates the hydrothermal fluid and transports the pure steam onto land.[38] The second is a heat exchanger which is a technology currently tested by the IMPULSA project. [39] The third is to install a thermoelectricity power station, utilising the temperature difference between the hot hydrothermal fluid and the cold seawater.[40]

Research regarding the environmental impact of geothermal activities is scarce. Despite the lack of research and therefore information, the environmental impact of submerged structures

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[34] K. Hossain, T. Koivurova and G. Zojer, "Understanding the Risks Associated with Offshore hydrocarbon Development", *opt. cit.*, p.170.

[35] F.B. Armani and D. Paltrinieri, "Perspectives of offshore geothermal energy in Italy", *opt. cit*.

[36] *Ibid*.

[37] T. Prabowo et al. "A new idea: The possibilities of offshore geothermal system in Indonesia marine volcanoes", *opt. cit.,* p.11.

[38] B. Kárason et al., "Utilisation of offshore geothermal resources for power production" (2013) *Thirty-Eight Workshop on Geothermal Reservoir Engineering*, p.10.

[39] *Ibid.,*

[40] T. Prabowo et al., "A new idea: The possibilities of offshore geothermal system in Indonesia marine volcanoes" *opt. cit.,* p.12-13.

may be assumed to a certain extend and within reason. First, on the very location on which the submerged structure will be installed, it may be reasonably anticipated to have a serious impact on the benthos beneath in the same way as the cutting piles will for instance. Second, it may be reasonably assumed that, similarly to a nuclear power plant, the submerged structure will produce heat and be cooled by the surrounding water. The ambient bottom water temperatures may vary between less than 2 degrees and 40 degrees.[41] In the possibility for the ambient deep-sea water to act as cooling water, it is unknown whether or, to which extend the temperature of the bottom water would be above naturally occurring levels. Most species living on the hydrothermal vent wall or on the surrounding seafloor do not live entirely in near freezing temperatures.[42] They live in hotter temperature due to the diffuse flow emanating through cracks in the hydrothermal vent wall. Worms, for instance, prefer temperatures between 40 and 50 degrees but could also withstand much higher or much lower temperatures.[43] Therefore, it is uncertain whether these species will be impacted by a possible rise in temperature of the waters surrounding the submerged structure. Yet, literature emphasis that the known species represent only a fraction of the knowledge.[44] Thus, it could be that not all the species have this temperature resilience. Hence precaution should be exercised.

Whether the power plant is floating on the sea surface right above the energy source or whether it is installed on the seafloor next the energy source or else whether it is situated onshore and requires an intermediary structure, all the options available to harvest geothermal energy require either cables or pipelines to be laid on the seafloor to transport the energy. These cables or pipelines will be laid beyond as well as within national jurisdiction. If the cable departs from a power plant floating on the sea surface, then the cable would partially be situated in the water column and mainly situated on the seafloor. Cables are used to transport the already converted energy while pipelines are used to transport either the pure stream[45] or the working fluid.[46] Research highlighted that thermal loss may occur during the transport of the pure steam

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[41] C.R. Fisher, K. Takai, N. Le Bris, "Hydrothermal Vent Ecosystems", *opt. cit.*, p.17.

[42] *Ibid.,* p.21.

[43] *Ibid.,* pp. 20-21.

[44] See for instance *Ibid.,* p.17.

[45] B. Kárason et al., "Utilisation of offshore geothermal resources for power production" *opt. cit.* p. 10.

[46] The term 'working fluid" designates the water circulating in a close cycle within a pipe. The water will be transformed into steam due to the heat flow of the hydrothermal vent and then liquified in the cooler.

resulting in the steam to be liquified.[47] This finding equally applies to option involving the use of working fluid. Failing to consider this thermal loss may destabilise the pipeline structure[48] but it is unknown to which extend this could represent a risk for the environment. Kark et al. emphasis that the environmental effects of pipelines are understudied but at the same time emphasis in the known fact that pipelines are known to be pathways for invasive species.[49]

Kark et al. when identifying the potential environmental impact of harvesting offshore hydrocarbon and transferring the idea to the deep seabed, consider it hazardous due to the fragile environment.[50] Harvesting geothermal energy involves the same kind of infrastructure and sensibly the same harvesting process. Therefore, the same deduction can be made for geothermal energy. Beyond the potential environmental impact, this chapter showed that different harvesting methods as well as different stages of the harvesting process take place in different maritime zones. This results in the uncertainty regarding the legal regime under which the activity would fall. The next Chapter is therefore going to address this legal uncertainty.

3 Legal regime ruling geothermal energy in the Area

The scope of this thesis is offshore geothermal energy in Areas beyond National Jurisdiction (ABNJ). Two legal regimes rule ABNJ. These regimes are either the regime of the freedom of the High Seas or the regime of the Area. There is uncertainty as to which legal regime applies to the activity. This uncertainty arises due to two factors. The first is that the LOSC does not directly mention geothermal activities. The second, is that in addition to this, all harvesting methods take place in the Area as well as in the water column in various degrees, as shown in the previous chapter.

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[47] T. Prabowo et al. “A new idea: The possibilities of offshore geothermal system in Indonesia marine volcanoes”, *opt. cit.*, p.10.

[48] B. Kárason et al., *opt. cit*.

[49] S. Kark et al., “Emerging conservation challenges and prospects in an era of offshore hydrocarbon exploration and exploitation”, *opt. cit.*, p.1576.

[50] *Ibid*.

The first and foremost step is to establish under which legal regime geothermal energy falls. This step is paramount to the discussion and the cornerstone of this master thesis as it will decide who the regulator for the activity should be and thus influence the pertaining environmental management which is investigated in Chapter 4. Depending on the conclusion drawn in this chapter, some actors may have greater obligations/responsibilities to protect the marine environment from geothermal activities. If the Area regime applies, the ISA would regulate offshore geothermal activities. Article 87 of the LOSC is laying down the principles of the regime of the High Seas, specifying the activities that are ruled by this regime, while article 133 of the LOSC is laying the condition for the applicability of the regime of the Area. If the regime of the High Seas applies, Flag States would be the regulator of the activity.

Under the regime of the High Seas, States have the freedom to carry out activities provided that these are conducted with due regard for other legitimate activities, including activities in the Area.[51] These activities are the laying of submarine cable and construction of installation. With no further indication as to what an "installation" is, the construction of certain geothermal harvesting structures can be understood to fall under the regime of the High Seas.[52] Equally so does the laying of submarine pipelines and cables to transport the hydrothermal vent fluid or the energy ashore.[53] The Area sees the regime of the Common Heritage of Mankind to be applied when it comes to harvesting mineral resources.[54] There is some uncertainty as to the material scope of the term "mineral resource" and therefore as to whether geothermal energy could fall under the scope of the Common Heritage of Mankind and under the jurisdiction of the ISA.

To try to clear the uncertainty regarding the applicable legal regime, sub-chapter 3.1 will investigate whether the harvesting method will have an impact on the applicable regime, building up on a zonal approach that may be assumed to apply at first. As uncertainty remains, sub-chapter 3.2 will further develop on the resource-based approach. The inclusion or exclusion of the hot steam from the material scope of article 133 of the LOSC will finally establish the applicable regime to offshore geothermal energy.

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[51] LOSC, article 87(2).

[52] LOSC, article 87(1)(d).

[53] LOSC, article 87(1)(c).

[54] LOSC, article 133.

3.1 The freedom of the High Seas as the default legal regime

The main argument for the inclusion of offshore geothermal energy in the regime of the High Seas is based on a zonal approach, by analogy to Ocean Thermal Energy Conversion (OTEC). OTEC is a process to produce energy through the temperature difference in the water column.[55] It takes place exclusively in the water column of ABNJ. It has been shown in Chapter 2 that one of the geothermal harvesting methods is similar to OTEC in that it takes place exclusively in the water column. The plant is floating on the sea surface anchored to the seabed above the energy source. Nordquist et al. in their commentary of the Law of the Sea Convention exclude other ocean resources such as OTEC from the Area regime.[56] Scovazzi, in his commentary of the Law of the Sea Convention, extends Nordquist's argumentation relating to OTEC arguing that other ocean resources might be included in the regime of the High Seas since they don't take place in the Area.[57]

The analogy can only be made in relation to the harvesting method involving a floating power plant. However, the analogy stops when the harvesting method involves drilling and the insertion of pipeline into the ocean crust or the hydrothermal vent as the activity goes beyond the water column into the seabed and subsoil. Then an analogy with deep seabed mining can be made. The main aspect of seabed mining, meaning the mining itself, takes place on the seabed. The rest of the retrieving process takes places in the water column. A comprehensive illustration provided on the IUCN website shows that there is a variety of equipment involved such as a production support vessel floating on the sea surface above the mining source. Pipelines would be vertically departing from this vessel in the water column and tied to a

[55] Ocean Energy Europe on OTEC, available online: https://www.oceanenergy-europe.eu/ocean-energy/otec/, last accessed 22 July 2021.

[56] M.H. Nordquist, S.N. Nadan, S. Rosenne, *United Nations Convention on the Law of the Sea 1982: A Commentary*, vol. VI, (2002).

[57] T. Scovazzi in A. Proelss (ed.) *United Nations Convention on the Law of the Sea: A Commentary* (Beck 2017) p.939.

seafloor collector, which is collecting the mineral resource.[58] Yet, it is undisputed that harvesting mineral resources of the deep seabed falls under the regime of the Area. The mining process is identical to harvesting geothermal energy in the Area as all types of harvesting techniques will require support vessels, infrastructure in the water column as well as pipelines and cables on the seabed.

Currently the harvesting method associated with the use of a floating platform requires a pipeline to be inserted into the hydrothermal vent chimney.[59] However, it is not impossible that in the future, the technology is developed to adapt the IMPULSA spiral structure or an equivalent process to the platform power plant. Still, it remains that the resource harvested comes from the Area even if harvested in the water column. Elferink implicitly confirms that the zonal approach is impractical by stating that the subsoil of the deep seabed is torn between two regimes.[60]

The zonal approach to determine which legal regime is applicable does not seem to be the most appropriate approach. Especially the harvesting process of deep seabed minerals provides comparison basis for the foundation of a resource focused approach to determine the legal regime of offshore geothermal energy in ABNJ. This resource focus approach is further solidified by the International Tribunal for the Law of the Sea (ITLOS) in its 2011 advisory opinion on the Responsibilities and Obligations of States Sponsoring Persons and Entities with respect to activities in the Area.[61] The ITLOS constrains the term "activity in the Area", thus the applicability of the Area regime, to the resource harvested falling under article 133 of the LOSC. The Tribunal does not constrain "activities in the Area" to a specific resource such as polymetallic nodules.[62] Even though the tribunal mentions "minerals", it should not be taken in

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[58] IUCN on deep sea mining, available online https://www.iucn.org/resources/issues-briefs/deep-sea-mining, last accessed 22 July 2021.

[59] F.B. Armani and D. Paltrinieri, "Perspectives of offshore geothermal energy in Italy", *opt. cit.*

[60] A.G. Oude Elferink, "The Regime of the Area: Delineating the Scope of Application of the Common Heritage Principle and Freedom of the High Seas" (2007) 22(1) *The International Journal of Marine Coastal Law* 143-176.

[61] *Responsibilities and Obligations of States Sponsoring Persons and Entities with Respect to Activities in the Area*, Advisory Opinion of the Seabed Disputes Chamber of the International Tribunal for the Law of the Sea [Seabed Dispute Chamber, Advisory Opinion] (1 February 2011).

[62] *Ibid.*, at para 94.

its scientific understanding as it will be seen in the next chapter. The resource-based approach is also supported by the findings of Wang et Chang when identifying attributes of the Common Heritage of Mankind based on the attribute of the resource.[63] All this hints on the fact that the High Seas regime is only applicable to offshore geothermal activities in ABNJ by default in the eventuality that the Area regime does not apply.

3.2 The term "mineral resource" as a legal classification

The LOSC does not expressly include geothermal energy into Part XI. Article 133 of the LOSC establishes the scope of the ISA's mandate by identifying the resources it is to regulate. Article 133 reads as follows:

> For the purposes of this Part:
>
> (a) "resources" means all solid, liquid or gaseous *mineral resources* in situ in the Area at or beneath the seabed, *including* polymetallic nodules; (emphasis added)
>
> (b) resources, when recovered from the Area, are referred to as "minerals".

This provision is putting a special emphasis on polymetallic nodules but is not an exhaustive list. This implies that other non-living resources may be included in the ISA's mandate. However, due to the wording of article 133 referring to "mineral resources" and not "non-living resources", this inclusion seems to be on the condition that the resource is of mineral origin. Yet, there are also arguments that could nuance the material scope of the term "mineral resources" enabling the inclusion of geothermal energy in part XI.

Article 133 of the LOSC defines the term "resources" as all solid, liquid or gaseous *mineral resources* in situ including polymetallic nodules. The first step is to understand what a "mineral" is. A mineral is constituted of inorganic material. In other words, it has a mineral origin meaning a crystalline structure.[64] According to Nickel-Strunz's mineral classification,

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[63] C. Wang et Y-C. Chang, "A new interpretation of the common heritage of mankind in the context of the international law of the sea" (2020) 191 *Ocean & Coastal Management* 105191.

[64] M. Allaby, *A Dictionary of Geology and Earth Science* 4th edition (Oxford University Press 2013).

some resources with an organic origin may be classified as a mineral resource[65]; but these resources need to be recognised as such by the International Mineral Association. Hydrocarbons, for instance, which have an organic origin, are *not* a mineral resource on accounts of the scientific understanding.[66] Hence, resources which are classified as energy such as is the hot steam from hydrothermal vents, or the ocean crust also cannot be categorised as mineral resources. Hence following the ordinary meaning of the term "mineral resource", geothermal energy would be excluded from article 133.

In view of the above, this would entail for instance that hydrocarbons would similarly be excluded from the scope of application of article 133 of the LOSC. Yet, hydrocarbons are referred to by the ISA as a "non-solid mineral resource".[67] Also, as it will be explained below, the drafters of the LOSC considered hydrocarbons as a mineral. This hints that the term "mineral resource" has a legal meaning to it that goes beyond the scientific understanding. Whether the scope would be broad enough to include geothermal resource needs to be assessed by analysing the preparatory works relating to the negotiation of the LOSC. This analysis necessarily starts by examining the original definition of the term "mineral resource", as well as the note on the simplified version of this initial definition by the drafting Committee on its understanding of material scope of article 133. The initial definition reads as follows:

> "Mineral resources" means any of the following categorizations:
>
> (a) Liquid or gaseous substances such as petroleum, gas, condensate, helium, nitrogen, carbon dioxide, *water, steam; hot water*, and also sulphur and salt extracted in liquid form in solution; […][68]

This definition of "mineral resources" remained in the draft documents until the eighth negotiation session. The definition was then simplified to the current provision. Yet, the

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[65] Mindat.org, Hudson Institute of Mineralogy, available at: https://www.mindat.org/strunz.php?a=1, last accessed 5 August 2021.

[66] "Naturally occurring organic compound containing carbon and hydrogen. Hydrocarbons may be gaseous, solid, or liquid, and include natural gas, bitumen, and petroleum". M. Allaby, *A Dictionary of Geology and Earth Science* 5th edition (Oxford University Press 2020).

[67] ISA, Marine Mineral Resources Brochure, available online: https://isa.org.jm/files/files/documents/ia6_eng6.pdf, last accessed 22 July 2021.

[68] UNCLOS III, Informal Single Negotiating Text (Part I), UN Doc. A/CONF.62/WP.8/PART I (1975), OR IV, 137-138 (Article 1). Emphasis added by this author.

drafting Committee, in its recommended changes to article 133 of the LOSC, expressed that the term "mineral resources" should include other *non-living resources* emphasising on hydrocarbons.[69] First it is to be pointed out that this implies an unexhaustive list of resources to fall within the understanding of "mineral resources". Second, the drafting Committee, referred to hydrocarbons as mineral resources despite it having a an organic and not a mineral origin. The ISA refers to hydrocarbons as "non-solid mineral resource".[70] Hence, the drafting Committee's position seems to confirm that the term "mineral resources" must be understood as a legal term including the resources listed in the initial definition before it was simplified, including steam, water and hot water, meaning geothermal energy. What is more, the ISA hints at the possibility for it to recognise its jurisdiction over energy resources as it refers to methyl hydrate as a "non-metallic mineral resource".[71] Scovazzi in his commentary to article 133 also seems to balance in favour of including the initially listed resource in the material scope of the term "mineral resource".[72]

Elferink argues in favour of a resource-based approach. The author defends the view that resources deriving from within the subsoil, such as the water or steam from hydrothermal vents, are an integral part of the hydrothermal vent. Consequently, even once in the water column the resources should be viewed as resources of the Area falling under the Area regime.[73]

This paper acknowledges that whether geothermal energy falls under the Common Heritage of Mankind or the freedom of the High Seas is not clear cut. Geothermal activities will necessarily occur across different maritime zones. Hence, a coordination of both regimes and of management bodies with jurisdiction over different segments of the overall activity will likely be necessary, such as in the case of deep-sea mining in ABNJ. However, this author sustains that offshore geothermal energy predominantly falls under the regime of the Area and should

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[69] Report of the Chairman of the drafting Committee to the Plenary, Part XI (articles 133 – 146), A/CONF.62/L.67/add.16, 1981, p.3.

[70] ISA, Marine Mineral Resources Brochure, *opt. cit*.

[71] Methyl hydrate is a mixture of natural gas and water compressed into a solid, *ibid*.

[72] T. Scovazzi in A. Proelss (ed.) *United Nations Convention on the Law of the Sea: A Commentary*, *opt. cit.*, p.938.

[73] A.G. Oude Elferink, "The Regime of the Area: Delineating the Scope of Application of the Common Heritage Principle and Freedom of the High Seas", *opt. cit*.

therefore be primarily managed by the ISA. It is on this basis that the next chapter will proceed to focus on the ISA's environmental management.[74]

4 Environmental obligations of offshore geothermal energy as an activity in the Area

Chapter 3 has concluded that offshore geothermal energy in ABNJ fall under the ISA's mandate. Nevertheless, this does not entail that the entire geothermal activity process, from exploration and production in the Area to transmission and distribution to the shore, falls exclusively under the ISA's jurisdiction, nor that environmental management will take place exclusively under the purview of the ISA. Which part of the activity would be regulated by the ISA depends on the interpretation of the terms "activity in the Area". Parts of the activity which are not considered to be part of the "activity in the Area" will be falling under the general environmental provisions of the LOSC. Yet, parts of the activity which are considered to be an "activity in the Area" will, first and foremost be regulated by article 145 of the LOSC and by the secondary law of the ISA. A closer look at the ISA's specific secondary law and procedures relevant fir the purposes of environmental management will be developed in Chapter 5.

4.1 The extend of the ISA's jurisdiction in the environmental management of offshore geothermal activities

[74] This paper also agrees with the argument made by De La Fayette that the ISA should not be broadened to include *all* resources of the Area. L. A. de La Fayette, "Principles and Objectives Of The Legal Regime Governing Areas Beyond National Jurisdiction"— Commentary On Tullio Treves in A.G. Oude Elferink, E.J. Molenaar (eds.) *The International Legal Regime of Areas beyond National Jurisdiction: Current and Future Developments*, Series A: Modern International Law, Vol. 26.

Before developing the environmental obligations of actors involved in offshore geothermal energy, the first step is to understand which parts of the processes descried in Chapter 2 fall under the understanding of "activities in the Area".

The LOSC understands "activities in the Area" to include drilling, dredging, excavation, disposal of waste, construction and operation or maintenance of installations, pipelines and other devices related to such activities.[75] The Seabed Dispute Chamber in its 2011 advisory opinion clarifies that it is not the whole process that should be under the ISA's jurisdiction as some parts of the process does not qualify as being an "activity in the Area".[76] Broadly put, the *in situ* transportation of resources falls under the ISA's jurisdiction, while the *ex situ* transportation of the resource would fall under the jurisdiction of the flag State. Thus, the Seabed Dispute Chamber's understating of activities in the Area adapted to offshore geothermal energy in the Area would only encompass the pipelines to collect the steam, the separation of the pure steam from the wastewater and the minerals as well as the re-injection of the wastewater and minerals.[77] The ISA would therefore regulate geothermal energy up to the separator or the binary power plant.

However, the Seabed Dispute Chamber considers the transporting and processing of the resource to be excluded from the ISA's mandate. Both processes would therefore fall under the freedom of the High Seas. Consequently, the flag State would be in charge of the environmental management of the submarine cables relaying the infrastructure on the seabed to the shore and to the structure that is on shore. This would *a priori* exclude floating and submerged power plants from the ISA's mandate as these are designed to process the pure steam into energy before transporting the electricity to shore. Yet, the Seabed Dispute Chamber is making this conclusion in the context of deep seabed mining where the resource needs to be necessarily transported to the shore because it cannot be processed on board the ship.[78] Consequently, it is not unreasonable to assume that floating power plants such as implemented in the Marsili project and submerged power plant would fall under the ISA's jurisdiction but that the

[75] LOSC, article 145.

[76] Seabed Dispute Chamber, Advisory Opinion, *opt. cit.*, at paras 94-96.

[77] Adapted from *ibid.*, at para 95.

[78] *Ibid.*, at paras 87 and 95.

transportation of the processed steam or electricity would fall under the freedom of the High Seas.[79]

The extend of the ISA's jurisdiction will of course have a consequence on the rules, regulations and procedures adopted, which will be discussed in the following sub-chapter and Chapter. It also determines the extend of the sponsoring State's obligation in environmental matters. Sponsorship is referred to by the ITLOS as the "key element" in the expiration and exploitation of the resources of the Area.[80] Indeed, the provisions of the LOSC and associated instruments are only binding on the State parties, which is also recalled by the ITLOS.[81] Requiring a sponsorship ensures that key environmental measures and principles will be applicable to the contractor through the domestic legislation of its Sponsoring State.[82] This scheme would also be applicable to geothermal activities. As the domestic law of the sponsoring State has to meet the requirements of the LOSC and associated instruments, the contractors will have to meet environmental measures and requirements set within the ISA framework when exploring and exploiting the hot steam from ocean crust and hydrothermal vents.

Sponsoring States have a due diligence obligation to protect the environment by making sure that the contractor it is sponsoring complies with the environmental measures the ISA has adopted.[83] The Seabed Dispute Chamber held that the due diligence obligation evolves according to new knowledge and technologies.[84] This is embodying adaptive management as a means to implement the precautionary approach.[85] The Permanent Court of Arbitration in the Chagos case has given some clues as to how the due diligence obligation may be met but there

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[79] *Ibid.*, at para 96.

[80] *Ibid.*, at para 74.

[81] *Ibid.*, at para 75.

[82] LOSC, article 153(2)(b), sponsorship is based on nationality or effective control.

[83] Seabed Dispute Chamber, Advisory Opinion, *opt. cit.*, at para 118.

[84] *Ibid.*, at para 117.

[85] Adaptive management is not a legal concept, it is solely a form of management. Yet, the ISA is implementing adaptive management alongside the precautionary approach, the latter informing the first mentioned. Thus, the Authority is recognizing them as complementary concepts rather than alternatives. See N. Craik, "Implementing adaptive management in deep seabed mining: Legal and institutional challenges" (2020) 114 *Marine Policy*, p.5.

is no set procedure.[86] The ITLOS proceeds to give additional details as to how the due diligence obligation is to be met in the context of activities in the Area and in relation to environmental measures. The Tribunal notes that due diligence is proportionate to the *stage* of the activity and to the *resource*, prospected, explored or exploited.[87] The risk of geothermal activities are unknown, yet Van Dover expects it to be a moderate anthropogenic disturbance contrary to mining which the author expects to be a major anthropogenic disturbance.[88] Hence, the due diligence obligation in matters related to geothermal energy in the Area may be lesser than the due diligence obligation required in matters related to seabed mining. Following the ITLOS' Advisory Opinion, it is therefore likely that in the case of geothermal activities, the due diligence obligation will also be proportionate to the harvesting method. Indeed, methods involving drilling the ocean crust or the hydrothermal vents will require a higher due diligence obligation than the spiral structure of the IMPULSA project deployed above the vent.

4.2 Precautionary measures relating to geothermal activities in the Area

Activities in the Area, meaning the entire geothermal process except the laying of submarine pipelines and cables connecting to the shore as well as onshore power plant, fall under article 145 of the LOSC. The ISA would therefore need to take necessary measures to protect the environment from harmful effects, both potential and actual, arising from geothermal activities taking place in the Area.[89] The first part of this sub-chapter will address the threshold triggering the applicability of precautionary measures. The second part of this sub-chapter will focus on article 145 of the LOSC in practice.

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[86] *In the Matter of the Chagos Marine Protected Area Arbitration* (the Republic of Mauritius v. The United Kingdom of Great Britain and Northern Ireland), Award from the Permanent Court of Arbitration (18 March 2015).

[87] Seabed Dispute Chamber, Advisory Opinion, *opt. cit*., para 117.

[88] C.L. Van Dover, "Impacts of anthropogenic disturbances at deep-sea hydrothermal vent ecosystems: A review" (2014) 102 *Marine Environmental Research*, p.61.

[89] LOSC, article 145.

As hinted by Chapter 2, some geothermal energy exploration and production methods may be reasonably assumed to have at least a "significant impact" on the environment, such as drilling the ocean crust and hydrothermal vents, while some methods could be assumed to have less than a significant impact on the environment, such as the spiral structure designed for the IMPULSA project. So, is there a specific threshold requirement of environmental harm caused by geothermal activity in order to trigger ISA's obligation to adopt adequate environmental protection measures?

The LOSC in its article 145 obliges the ISA to protect the environment from "harmful effects".[90] "Harmful" means causing or likely to cause harm. Harm means to physically injure.[91] "Effect" means a change which is a result or consequence of an action.[92] Hence, "harmful effects" implies a multitude of different impact sources and what is more important a lack of threshold. Vöneky and Beck support this understanding, even emphasizing on the lack of threshold in their commentary of article 145.[93] Consequently, it can be argued that regardless of the harvesting method, appropriate protection and preservation measures need to be taken. These measures would admittedly be proportionate to the anticipated impact on the environment of the respective harvesting methods.

Although the LOSC did not specify any threshold the ITLOS set a low threshold in its advisory opinion. The Tribunal decided upon "plausible indications of potential risks".[94] But such a low threshold does not seem to be followed by the ISA.With regards to deep seabed mining, the activity needs to have "significant adverse change" on the marine environment to trigger the application of environmental measures.[95] The understanding of what "significant" means is not

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[90] LOSC, article 145. S. Vöneky and F. Beck point out that it is any effect not limited to pollution, see footnote infra.

[91] Definition by the Cambridge English Dictionary, online, available at: https://dictionary.cambridge.org/fr/dictionnaire/anglais/harmful, last accessed 5 August 2021.

[92] *Ibid.*, https://dictionary.cambridge.org/fr/dictionnaire/anglais/effect, last accessed 5 August 2021.

[93] S. Vöneky and F. Beck in A. Proelss (ed.) *United Nations Convention on the Law of the Sea: A Commentary* (Beck 2017) pp.1015-1016.

[94] Seabed Dispute Chamber, Advisory Opinion, *opt. cit.*, at para 13.

[95] ISA draft regulations on exploitation of mineral resources in the Area, ISBA/26/C/CRP.1, Kingston, Jamaica, 17 December 2019 [Draft Exploitation Regulations], p.140; ISA, *Decision of the Council of the International Seabed Authority relating to amendments to the Regulations on Prospecting and Exploration for Polymetallic Nodules in the Area and related matters* [Exploration Regulation for

commonly agreed upon. The ISA is to determine what it entails through its rules, regulations and procedures.[96] So far, the ISA has not determined this. At this stage, a necessary precision needs to be made with regards to the use of terminology by the ISA. The ISA employs the term of "serious harm" which is triggered by "significant change to the environment". However, the International Law Commission distinguishes the two qualifiers. "Significant" is less than "serious" or "substantial".[97] A confusion in terminology and therefore in the applicable threshold may arise. However, by accounts of the ISA secondary law, the threshold is set at "significant" and not "serious" harm.[98] This may be supported by the practice of the ISA which, according to Feichtner would point towards a low threshold.[99]

Vöneky and Beck support the argument that any kind of threshold has been willingly omitted in article 145 of the LOSC.[100] The authors further support this argument by pointing out that any treaty, including the LOSC itself in all other articles, use thresholds. Consequently, the ISA is not bound to maintain the same threshold for geothermal activities and may decide upon a lower threshold.

After identifying the threshold, the practical implementation of the precautionary approach can be analyzed. The precautionary approach is indeed implied in article 145 and expressly stated

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Polymetallic Nodules], ISBA/19/C/17 (2013), Regulation 1(3)(f); ISA, *Decision of the Assembly of the International Seabed Authority relating to the regulations on prospecting and exploration for polymetallic sulphides in the Area* [Exploration Regulation for Polymetallic Sulphides], ISBA/16/A/12/Rev.1 (2010), Regulation 1(3)(f); and ISA, *Decision of the Assembly of the International Seabed Authority relating to the Regulations on Prospecting and Exploration for Cobalt-rich Ferromanganese Crusts in the Area* [Exploration Regulation for Cobalt-rich Ferromanganese Crusts], ISBA/18/A/11 (2012), Regulation 1(3)(f).

[96] *Ibid.*,

[97] ILC, *draft article on prevention of transboundary harm from hazardous activities, with commentaries,* UN Doc A/5610 (2001).

[98] Draft Exploitation Regulations, *opt. cit.*, p. 140; Exploration Regulation for Polymetallic Nodules, ISBA/19/C/17, *opt. cit.*, Regulation 1(3)(f); Exploration Regulation for Polymetallic Sulphides, ISBA/16/A/12/Rev.1, *opt. cit.*, Regulation 1(3)(f); Exploration Regulation for Cobalt-rich Ferromanganese Crusts, ISBA/18/A/11, *opt. cit.*, Regulation 1(3)(f).

[99] I. Feichtner, "Contractor liability for environmental damage resulting from deep seabed mining activities in the area" (2020) 144 *Marine Policy* 103502.

[100] S. Vöneky and F. Beck in A. Proelss (ed.) *United Nations Convention on the Law of the Sea: A Commentary, opt. cit.*, p.1015-1016.

by the ITLOS in its advisory opinion.[101] The ISA expressly incorporates the precautionary approach in its secondary law. Consequently, this is transforming the precautionary approach into a binding obligation as part of the direct obligation to protect the marine environment from activities in the Area.[102] This opens the possibility for the ISA to precise what it understands under the precautionary approach for its industry. Until the ISA does so, the precautionary approach is to be understood as in in Principle 15 of the Rio declaration. Following from the ISA's practice it may be reasonably assumed that it will also include the express mentioning of the precautionary approach into rules, regulations and procedures relating to geothermal activities. Therefore, the precautionary approach will continue to be legally binding.

Still, this alone is not helpful to know what the obligation entails for the ISA. Jaeckel's findings offer complementary information on this issue. The precautionary approach is implemented on a practical level through the gathering of scientific data on the spatial and temporal scale, thus the conduct of scientific research; and through the assessment and monitoring of the activity.[103] When it comes to these aspects, the ISA discharges its obligations onto Contractors. Indeed, the Contractor is to conduct the scientific research, collect baseline data and assess the potential environmental impact of his project. If the Contractor fail their obligations, they are in breach of their contractual obligation and may be found liable.

The ISA is nonetheless developing the Environmental Assessments the Contractor will have to conduct. These assessments are the EIA and the Environmental Impact Statement (EIS). The purpose of the EIS "is to document and report the results of the EIA"[104] and was introduced during the current negotiations on the Exploitation Regulations. These Environmental Assessments are developed within the framework of the mining industry but can be transposed to geothermal activities.

Regarding the EIA, there is difficulty to know how it would contribute to protect and preserve the environment because specifications still need to be made. For the moment, neither is its

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[101] Seabed Dispute Chamber, Advisory Opinion, *opt. cit.*, at para 125.

[102] *Ibid.*, at para 126.

[103] A. Jaeckel, *The international seabed authority and the pre-cautionary principle: balancing deep seabed mineral mining and marine environmental protection* (Brill Nijhoff 2017), pp.158-159.

[104] Draft Exploitation Regulations, *opt. cit.*, draft Regulation 47(1).

content specified nor how it should be taken into account by the EIS.[105] Craik et al. also point out that there is a lack of identification of alternatives or the assessment of these, nor is there a reference to a "no action" alternative.[106] However, it is not required by international law to envisage a "no action" alternative which would therefore be a vanguard step.[107] Lily and Roady reflect that the Authority may rely on the Sponsoring State's national Environmental Impact Assessment procedure which would account for the fact that it hasn't taken any proactive step to detail its content.[108] This reasoning may also be behind the ISA's failing to harmonise guidelines as to what kind of data is required, resulting in individual contractors to submit different data, and the information they want.[109] Still Ma et al. point out that it is the lack of domestic legislation which is the main reason for poorly implemented EIA obligations.[110] As Doelle also highlighted, EIA developed at the international level would be based on domestic examples and their flaws.[111] Still a harmonised bases is needed and Craik advocates the generic elements common to EIA such as screening, scoping and participation should be

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[105] Australia, Comments on the Draft Regulations on Exploitation of Mineral Resources in the Area (ISBA/25/C/WP.1), Canberra, October 2019, p.2.

[106] N. Craik et al., *Sixth Report of the Code Project: EIA procedures in ISA Draft Exploitation Regulations*, A. Friedman and H. Lily (eds.), The Pew Charitable Trusts (2020), p.8.

[107] *Pulp Mills on the River Uruguay* (Argentina v. Uruguay), Judgment, I.C.J. Reports 2010, p. 14: EIA are of customary international law but no details as to the procedure is specified. The material scope of the EIA is at the discretion of the State.; *Pulp Mills on the River Uruguay* (sep. op. of Judge Cançado Trindade) and *Gabčíkovo-Nagymaros Project* (Hungary v. Slovakia), Judgment, I.C.J. Reports 1997, p. 7 (sep. op. of Vice president Weeramantry): there is a necessity to balance needs requiring to identify the "least worst" option even if this option means to pursue an activity in a sensible ecosystem. The possibility for a «no action» option is not even envisaged.

[108] H. Lily and S. Roady, "Sponsoring State Approaches to Liability Regimes for Environmental Damage Caused by Seabed Mining" in M.C Riberio, F. Loureiro Bastos, T. Henriksen (eds.) *Global Challenges and the Law of the Sea* (2020), p.343.

[109] H. Ginzky, P.A. Singh and T. Markus, "Strengthening the International Seabed Authority's knowledge-base: Addressing uncertainties to enhance decision-making", *opt. cit.*

[110] D. Ma et al., "Current legal regime for environmental impact assessment in areas beyond national jurisdiction and its future approaches", (2016) 56 *Environmental Impact Assessment Review*, p. 28.

[111] M. Doelle, Environmental Impact Assessment in the BBNJ Negotiations' [Webinar], Strathclyde Centre for Environmental Law and Governance (2021).

incorporated.[112] Doelle also advocates to applying a knowledge-based approach when it comes to Environmental Assessments.[113] The EIA remains project focused. It would a priori not take into account the cumulative impact geothermal activities may have with deep seabed mining. This aspect is addressed by the EIS.

The Environmental Impact Statement is intended to assess Environmental Effect and is to provide information corresponding to the scale and magnitude of the activity.[114] Environmental Effect means "any consequences in the Marine Environment arising from the conduct of Exploitation activities, whether positive, negative, direct, indirect, temporary or permanent, or cumulative effect arising over time or in combination with other mining impacts".[115] This assessment procedure is therefore adaptable to the type of activity that is implemented. In addition, some geothermal harvesting methods are expected to be less environmentally damaging than others. The EIS procedure would also adapt to the different harvesting methods. The EIS also requires to include information relating to impacts over a certain period of time. This would be particularly adapted to geothermal activities as in chapter 2 the possibility has been envisaged that there may be a possibility for impacts to appear over time. Indeed, catching the hot steam continuously, for instance, might cool the surrounding water. Further the EIS provides for demanding measures that are safeguarding the environment. If an Effect is not judged to be of significance by the applicant, they should be sufficient substantial information to justify such a conclusion.[116] Nonetheless, it remains that the EIS is also primarily project focused even if it takes into account the cumulative effect of the activity.

Current environmental assessments developed by the ISA are not assessing all activities in the Area holistically nor do they prioritise certain activities or harvesting methods in one area over another based on best available scientific evidence. Consequently, the ISA is currently developing Area-Based Management Tools (ABMT) designed at regional level to complete

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[112] N. Craik, "Environmental Assessment: A Comparative Legal Analysis" in J.E. Vinuales and E. Lees (eds) *The Oxford Handbook of Comparative Environmental Law* (2017).

[113] M. Doelle, Environmental Impact Assessment in the BBNJ Negotiations' [Webinar], *opt. cit*.

[114] Draft Exploitation Regulations, *opt. cit.*, draft Annex IV 1(b).

[115] *ibid.*, p.138.

[116] *ibid.*, draft Annex IV 1(b).

current EA. The next chapter will focus especially on the overarching ABMT: the Regional Environmental Management Plan (REMP).

5 Geothermal energy in the wider scope of the region they are implemented in

Area Based management Tools (ABMT) are widely recognised as environmental protection measures especially protecting biodiversity.[117] De Santos reminds that ABMTs should be tailored to the industry.[118] There is no definition of that term in the ISA's documents. The only legal definition is to be found in the draft BBNJ Agreement and means "a tool, including a marine protected area, for a geographically defined area through which one or several sectors or activities are managed with the aim of achieving particular conservation and sustainable use objectives".[119] This definition therefore includes a multitude of planning tools also involving protection measures implemented only for an established period of time over the year.

The ISA endeavours to develop ABMTs that will shift the focus from being activity specific, to the activities being put in the wider scope of the region they are taking place in. As mentioned in chapter 2, there is little known about the ecosystems of hydrothermal vents.[120] This knowledge gap is not specific to the geothermal industry. The lack of knowledge is also pointed out in the deep seabed mining industry where extensive research is conducted.[121] However, it remains that, in addition to this knowledge gap, research relating to geothermal energy in the Area is focusing on developing the necessary technology, not on the possible environmental

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[117] E.M. De Santo, "Implementing Challenges of Area-Based Management Tools (ABMT) for Biodiversity Beyond National Jurisdiction (BBNJ)" (2018) 97 *Marine Policy* 34-43.

[118] *Ibid.*,

[119] *Revised draft text of an agreement under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction* [Draft BBNJ Agreement], A/CONF.232/2020/3 (2019), draft article 1(3).

[120] R. Pedamallu et al., "Environmental Impacts of Offshore Geothermal Energy" (2018) *Geothermal Resource Council Annual Meeting & Conference,* Conference Paper.

[121] S. Bräger et al., "The current status of environmental requirements for deep seabed mining issued by the International Seabed Authority" (2020) 114 *Marine Policy* 103258.

impacts.[122] Even though extensive research is conducted on deep sea ecosystems and the impact of mining, the knowledge gap is considered important enough for some to argue for postponing exploitation. [123] Therefore, the application of the precautionary approach to geothermal activities is paramount.

The ISA within its environmental management implements the precautionary approach through a variety of measures including Areas of Particular Environmental Interest (APEI). In addition to the precautionary approach to protect the environment from activities in the Area, the ISA is also implementing an ecosystem-based approach to its management. On top of this, the ISA is also currently developing a regional environmental strategy put into practice by Regional Environmental Management Plans (REMP) as well as Environmental Assessments.[124] This is the inception to an integrated approach to planning activities in a given industry.

This Chapter will focus on the ISA's environmental strategy and the Area-Based Management Tools implemented within its strategy and see to which extend it is beneficial for geothermal energy. The research will focus on REMPs for their potential to coordinate activities in the Area at a regional scale and therefore also geothermal activities in the Area. Following this, this chapter will also address whether the current negotiations on ABMT withing the framework of the BBNJ negotiation will affect the ISA and a potential regulation of geothermal energy.

5.1 Geothermal activities and Regional Environmental Management Plans

The starting point of the ISA's regional environmental strategy is the development of [Regional] Environmental Management Plans. REMPs as such are developed within the framework of the draft Exploitation Regulations. They are suggested to take into account "marine spatial planning instruments such as the determination of Mining Areas, Areas of

[122] R. Pedamallu et al., "Environmental Impacts of Offshore Geothermal Energy", *opt. cit.*

[123] H. Ginzky et al., "Strengthening the International Seabed Authority's knowledge-base: Addressing uncertainties to enhance decision-making", *opt. cit*.

[124] A. Jaeckel, "An Environmental Management Strategy for the International Seabed Authority? The Legal Basis" (2015) 30(1) *The International Journal of Marine and Coastal Law* 102.

Particular Environmental Interests as well as Preservation Reference Zones".[125] Thus, Regional Environmental Management Plans may also be qualified as a Marine Spatial Planning Tools, organising activities within a designated area. These Management Plans aim to apply internationally accepted conservation tools[126] consistent with specific objectives established in a tailored manner to the region covered.[127]

The REMP is a tool to organize activities in the Area on a regional scale and tailor environmental measures to the very region according to the environmental characteristic of the region.[128] More specifically, the REMP is there to facilitate the Environmental Management System through Environmental Assessments and Marine Scientific Research amongst others.[129] Deep seabed mining and geothermal energy have a strong possibility to compete over the same space. REMPs would therefore be essential as it is precisely thought as a spatial planning tool that will lower the likelihood of conflicts between activities in the Area and environmental conservation matters at later stages.[130] To prevent these conflicts Environmental Assessments and Marine Scientific Research are key. The REMP framework would enable to collect and share scientific information relating to an entire region and allow to priorities the implementation of an activity in one space rather than another according to the characteristic of the ecosystem. Geothermal energy being expected to have a lesser impact than deep seabed mining, it could be implemented where the ecosystem is more fragile. The REMP also proposes to support the collaboration regarding Environmental Impact Assessments. encouraging this collaboration would contribute to the sharing of Best Available Techniques as encouraged by Ruiz-Larrea.[131] Further it could also encourage to develop *peu-à-peu* regionally focused

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[125] Draft Exploitation Regulations, *opt. cit.*, draft Regulation 44bis(2).

[126] ISA, *Environmental Management Plan for the Clarion-Clipperton* Zone [Environmental Management Plan for the CCZ], ISBA/17/LTC/7 (2011), at para 36(a).

[127] H. Ginzky et al., "Strengthening the International Seabed Authority's knowledge-base: Addressing uncertainties to enhance decision-making", *opt. cit*.

[128] ISA, *Guidance to facilitate the development of Regional Environmental Management Plans* (2019), p.13.

[129] *Ibid.*, p.14.

[130] *Ibid.*, p.22

[131] M. Ruiz-Larrea, Report Launch: Assuring Environmental Compliance in Deep Sea Mining [webinar], PEW Charitable Trust and Resolve, 2020, available online: https://www.resolve.ngo/site-dsm/workshop-on-enhancing-stakeholder-participation-and-transparency-in-the-isa-process.htm.

Environmental Assessments or at least Strategic Environmental Assessments. This would shift the focus of a project-based assessment to taking into account the cumulative environmental impacts of all Activities in the Area, including geothermal energy. This would increase spatial precision as stated by the ISA as an objective.[132]

However, the adoption of REMP in the draft Exploitation Regulations is uncertain such is their material scope. It is therefore uncertain whether the management of geothermal activities would be eventually influenced by this ABMT. As of now, there is no obligation for a Regional Environmental Management Plan to be implemented before an activity is approved.[133] For Willaert, the optional character of the REMPS is incompatible with the obligation of adequate protection set by article 145 of the LSOC.[134] Jaeckel also elaborates further on this optional character, emphasising that it is undermining the precautionary approach.[135] However, the concern that REMPs are currently only optional, is equally shared by the Council of the ISA which emphasises on the necessary of REMPs to fulfil the purpose of Article 145 UNCLOS, ensuring an effective protection even if they are not directly addressed in Part XI UNCLOS.[136] Despite being in essence optional, the ISA has, via its secondary law, designed on a voluntary basis an Environmental Management Plan for the Clarion-Clipperton Zone, both as a "spatial management tool"[137] and as a "conservation management tool".[138] The Environmental Management Plan is referred to as the first Regional Environmental Management Plan to ever be implemented. Therefore, it may be deduced that REMPs have become part of the ISA's management strategy and will certainly be implemented even if not legally required. This is

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[132] ISA, *Guidance to facilitate the development of REMPs, opt. cit.*, p.21.

[133] H. Ginzky et al., "Strengthening the International Seabed Authority's knowledge-base: Addressing uncertainties to enhance decision-making", *opt. cit*.

[134] K. Willaert, "Effective Protection of the Marine Environment and Equitable Benefit Sharing in the Area: Empty Promises or Feasible Goals?" (2020) 51(2) *Ocean Development & International Law* 182.

[135] A. Jaeckel, *The international seabed authority and the pre-cautionary principle: balancing deep seabed mineral mining and marine environmental protection*, *opt. cit.*, p.190.

[136] ISA, *Decision of the Council relating to an environmental management plan for the Clarion-Clipperton Zone* [Decision of the Council on the EMP for the CCZ], ISBA/18/C/22 (2012), p.1.

[137] Environmental Management Plan for the CCZ, ISBA/17/LTC/7, *opt. cit.*, at para 21.

[138] *ibid.*, at para 36(b).

supported by Jaeckel's finding that even if precautionary measures are not incorporated into the secondary law, the ISA is implementing them in practice.[139]

As of now, it is suggested in the draft Exploitation Regulation that the Regional Environmental Management Plan shall take into account cumulative effects if appropriate[140] and that these shall not exceed the thresholds set by the Regional Environmental Management Plan.[141] There is no strategy in place to assess Cumulative impacts.[142] This is undermining the practical implementation of the practical approach.[143] In addition to this, cumulative impacts are hard to conduct in the matter of mineral resources in the Area. There is a great variety of variables to consider such as fishing and the laying of cables as examples amongst others.[144] The poor knowledge of the deep-sea also contributes to the challenging nature of the assessment of cumulative consequences.[145] The cumulative impact needs to be assessed in a case-by-case basis given the particular environment and the variety of uncertainties.[146] The ISA will decide upon what is considered "appropriate" as well as the threshold for cumulative impact. The draft Regulations suggest that is should include all relevant activities[147], thus including the whole geothermal process falling under the term "activities in the Area".

REMPs would enable an enhanced ecosystem approach, with a comprehensive understanding as it is scaled to the Region. In addition to implementing an ecosystem approach, the REMP would apply the precautionary approach through designing Areas of Particular Environmental Interest. These are areas within which no activities shall take place. Designed as a network

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[139] A. Jaeckel, *The international seabed authority and the pre-cautionary principle: balancing deep seabed mineral mining and marine environmental protection*, *opt. cit.*, p.190.

[140] Draft Exploitation Regulations, *opt. cit.*, draft Regulation 44bis(2).

[141] *ibid.*, draft Regulation 20(6)(bbis).

[142] C.L. Van Dover, "Tighten regulations on deep-sea mining" (2011) 470(7332) *Nature* 33.

[143] A. Jaeckel, *The international seabed authority and the pre-cautionary principle: balancing deep seabed mineral mining and marine environmental protection*, *opt. cit.*, p.191.

[144] R. Grogan, Report Launch: Assuring Environmental Compliance in Deep Sea Mining [webinar], PEW Charitable Trust and Resolve, 2020, available online: https://www.resolve.ngo/site-dsm/workshop-on-enhancing-stakeholder-participation-and-transparency-in-the-isa-process.htm.

[145] Z. Da Ros et al., "The deep sea: The new frontier for ecological restoration" (2019) 108 *Marine Policy* 3.

[146] C.L. Van Dover, "*Tighten regulations on deep-sea mining*", *opt. cit.*, p.33.

[147] Draft Exploitation Regulations, *opt. cit.*, draft Regulation 13(4)(e).

within the framework of the REMP, APEIs for geothermal activities could be designed in coordination with APEIs designed for mining activities. APEIs are flexibly designed so as to modify their location[148] in accordance with the precautionary approach.[149] Their designation is also made on a provisional basis.[150] If the ISA permanently protects these areas, it will set a major precedent in marine management in areas beyond national jurisdiction.[151] Concepts have been identified by the Legal and Technical Commission that are to be taken into account such as the spatial variation of faunal communities within the management area[152], the size of Areas of Particular Environmental Interest it comprises, the flexibility in design and size based on improved information[153] herewith insisting once more on the exigency for the management of the Area to be in accordance with Best Available Environmental Information, echoing the aim to develop adaptative management complementing the precautionary approach.

5.2 The inception of administrative coordination of ABMT

The ISA has the capacity to develop sector specific rules, regulations and procedures to geothermal energy, and at the same time to coordinate environmental measures with those implemented for deep seabed mining activities. This is the result of the ISA's environmental strategy but also first and foremost because it has jurisdiction over geothermal and mining resources. Outside the ISA framework, the cross sectorial coordination in the design of ABMT and other environmental measures is not provided for. Cooperation schemes in the form of MoU exist between the ISA and other bodies, such as the IMO[154], The Cable Protection

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[148] Environmental Management Plan for the CCZ, ISBA/17/LTC/7, *opt. cit.*, at para 30.

[149] *ibid.*, at para 31.

[150] Decision of the Council on the EMP for the CCZ, ISBA/18/C/22, *opt. cit.*, at para 1.

[151] L.M Wedding et al., "From principles to practice: a spatial approach to systematic conservation planning in the deep sea" (2013) 280(1773) *Proceedings of the Royal Society B: Biological Sciences* 7.

[152] Environmental Management Plan for the CCZ, ISBA/17/LTC/7, *opt. cit.*, at para 23.

[153] *ibid.*, at para 30.

[154] Agreement of Cooperation between the International Maritime Organization (IMO) and the International Seabed Authority (ISA), available online: https://isa.org.jm/files/documents/EN/Regs/IMO.pdf, 22 July 2021.

Committee[155] and OSPAR.[156] But these MoU eventually don't coordinate the design ABMT or ensure the compatibility of environmental measures sometimes implemented in a same area. In light of the commercial exploitation of genetic material in ABNJ, including therefore the Area, taking place in the very near future, the idea of a more holistic approach to the implementation of ABMT has emerged. Geothermal energy sources are also hosting exceptional and dense biodiversity; especially hydrothermal vents are found to be hotspots of biodiversity.[157] The commercial exploitation of genetic resource would lead three resources, regulated by two different bodies to be in immediate conflict. Depending on the method used to exploit geothermal energy and its impact on the environment reasonably assumed in chapter 2, the harvesting of genetic resource may coexist with difficulty with geothermal energy.

The need for some level of coordination is acknowledged and eventually addressed as one of the four pillars of the BBNJ negotiations. However, the level of coordination is uncertain. On the one hand there are talks about the compatibility of measures, while on the other a more in-depth coordination is considered.[158] However, compatibility does not necessarily entail coordination. Compatibility only means that Area Based Management Tools should not contradict or undermine an Area Based Management Tool designed by another sector. Therefore, it does not entail harmonisation. This is also affirmed by draft article 15 which says that ABMT under the BBNJ should only complement measures designated under relevant legal instruments.[159] It seems therefore that ABMT relating to geothermal energy will have priority over ABMT relating to genetic resources. However, the term "complementary" leaves open a variety of practical questions, but one in particular: whether the institutional settings are suitable for an effective cooperation in the design of coherent ABMT. The relationship with existing

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[155] Memorandum of understanding between the International Cable Protection Committee and the International Seabed Authority, available online: https://isa.org.jm/files/documents/EN/Regs/MOU-ICPC.pdf, 22 July 2021.

[156] Memorandum of understanding between the OSPAR Commission and the International Seabed Authority, available online: https://isa.org.jm/files/documents/EN/Regs/MOU-OSPAR.pdf, 22 July 2021.

[157] J. Le, L. Levin and R. Carson, "Incorporating ecosystem services into environmental management of deep-seabed mining" (2017) 137 *Deep Sea Research Part II: Topical Studies in Oceanography* 490-491.

[158] *Ibid.*, p.11.

[159] Draft BBNJ Agreement, A/CONF.232/2020/3, *opt. cit.*, draft article 15(1)(b)(i).

instruments is still uncertain but it is very likely that it should be without prejudice to already existing instruments' respective mandate.[160] Hence, the focus will remain on the ISA in this sub-chapter. The success of the coordination is based on two aspects. First the internal organisation of the ISA and to which extend it focuses on environmental matters, and second, the criteria used for the design of Area-Based Management Tools.

First with regards to the administrative aspect of coordination. The LOSC permits flexibility in the ISA's institutional organisation which can further the coordination of cross-sector Area-Based Management Tools. Pursuant to Article 162(2)(d) of the LOSC, the Council may create further sub-organs as it deems necessary. In the context of the draft Exploitation Regulation, stakeholders have built upon this provision to further the environmental obligation of the ISA. Ginzky et al. on the other hand suggest the creation of an Ad hoc expert Committee entrusted to develop and review Regional Environmental Management Plans with the Legal and Technical Commission retaining its responsibilities.[161] However, the authors also point out that article 162(2)(d) of the LOSC also enables for the establishment of a permanent advisory body, with the Legal and Technical Commission retaining some of its responsibilities. Such body may also review Environmental Plans.[162] Murphy recommends creating an Environmental Committee on equal footing to the Legal and Technical Commission relieving the latter from the environmental aspects.[163] Murphy also recommends creating alongside the Environmental Committee a full-time Environmental Department within the Secretariat which will be in charge of environmental policy making.[164] It should be an independent body and therefore little influenced by other bodies within the Authority.[165] According to Willaert the implementation and organisation of the procedure to create a supporting Committee to the LTC or an

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[160] *Ibid.*, draft article 15(1)(a).

[161] H. Ginzky et al., "Strengthening the International Seabed Authority's knowledge-base: Addressing uncertainties to enhance decision-making", *opt. cit.*, p.9.

[162] *Ibid.*,

[163] K. Murphy, Report Launch: Assuring Environmental Compliance in Deep Sea Mining [webinar], 2020, The PEW Charitable Trust and Resolve, available online https://www.resolve.ngo/site-dsm/workshop-on-enhancing- stakeholder-participation-and-transparency-in-the-isa-process.htm

[164] K. Murphy Assuring Environmental Compliance in Deep-Sea Mining: Lessons from Industry and Regulators, *Report prepared for the PEW charitable Trust* (2020) p. 28.

[165] *Ibid.,* p.36-37

Environmental Department is challenging.[166] This institutional re-arrangement in favour of a strong environmental management is not yet in place but it is not unreasonable to envisage its implementation. These institutional arrangements dedicated exclusively to environmental matters are perfectly adapted to coordinate associated conservation measures as envisaged by the draft BNNJ.[167]

Second, with regards to the criteria for the design of Areas of Particular Environmental Interest, the ISA bases itself on criteria developed by other sectors. For instance, it bases its understanding of "vulnerable marine ecosystems" on the Food and Agriculture Organisation.[168] The ISA applies "generally accepted and widely applied principles for the design of marine protected area networks". [169] These scientific criteria are those developed by the CBD.[170] Some criteria have not been incorporated because of the lack of information.[171] The ISA is taking criteria that are also implemented in other industries. These criteria are also recommended to be taken into account for the identification of areas requiring protection by the draft BBNJ Agreement.[172] Indeed, the BBNJ Agreement lists in its Annex I all the criteria that may be taken into account as indicative criteria.[173] Amongst these criteria are those to be find in the CBD such as uniqueness, rarity, vulnerability, fragility, sensitivity, biological diversity, representativeness.[174] Further criteria such as Ecological connectivity and/or coherence[175], important ecological processes occurring therein[176] and the special importance of the species found therein[177] are also listed. These put a big emphasis on the ecosystem approach and the

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[166] K. Willaert, "Effective Protection of the Marine Environment and Equitable Benefit Sharing in the Area: Empty Promises or Feasible Goals?", *opt. cit.*, p.182.

[167] Draft BBNJ Agreement, A/CONF.232/2020/3, *opt. cit.*, draft article 15(3).

[168] Environmental Management Plan for the CCZ, ISBA/17/LTC/7, *opt. cit.*, at para 27(a).

[169] *Ibid.*, at para 26.

[170] Conference of the Parties to the Convention on Biological Diversity, decision IX/20, annex II, Bonn; Germany, 9 October 2008 [CBD decision COP IX/20].

[171] Environmental Management Plan for the CCZ, ISBA/17/LTC/7, *opt. cit.*, at para 29.

[172] Draft BBNJ Agreement, A/CONF.232/2020/3, *opt. cit.*, draft article 16(2).

[173] *Ibid.*, draft article 16(3).

[174] *Ibid.*, draft Annex I(a), (b), (f) – (j).

[175] *Ibid.*, draft Annex I(m).

[176] *Ibid.*, draft Annex I(n).

[177] *Ibid.*, draft Annex I(d).

ecological function of certain deep-sea ecosystems while acknowledging that ecosystems are connected and do not function in isolation.

This chapter has shown that the ISA has the capacity to develop the coordination of environmental measures in matters related to geothermal activities with environmental measures in matters related to biological resources. Further, there is a certain homogeneity in the criteria used to design protective areas, yet the understanding of each criterion may be a challenge. The BBNJ Agreement may, depending on the outcome of the negotiations, provide for the possibility for the criteria listed in Annex I to be further developed.[178] This will provide for more homogeneity and therefore may influence the regulation of geothermal energy eventually. In the end, the main challenge would not be to agree upon criteria but rather the communication between the different organisation to have a coherent implementation of measures.

6 Conclusion

This research focused on the environmental management of geothermal activities in the Area. The following paragraphs will summarise the answers to the questions.

The research has at the very beginning focused on the harvesting methods of geothermal energy and determined that the harvesting methods would not have an impact on the legal regime applicable. A zonal approach has been dismissed in favour of a resource-based approach. The research found that the steam from hydrothermal vents or the ocean crust can be considered as a resource of the Area falling under the Common Heritage of Mankind. Hence the activity to harvesting geothermal energy in the Area can be incorporated under the ISA's mandate. However, the research also reveals that the laying of submarine cables connecting the structure installed on the High Seas or the seabed to the shore is excluded from the ISA's jurisdiction due to its exclusion from the term "activity in the Area".

[178] *Ibid.*, draft article 16(4).

Even if the harvesting method does not influence the legal regime applicable, it may influence the threshold triggering protection and preservation measures. The extend of the environmental impacts is uncertain and precaution should therefore prevail. The applicability of article 145 and the lack of threshold mentioned has the advantage that protection and preservation measures would still be implemented even if the activity is thought to have less than a significant impact. However, the ISA has in its secondary law relating to deep seabed mining decided upon a threshold. This threshold is "significant harm". This does not necessarily mean that the ISA will decide upon the same threshold for geothermal energy. Yet, if it does so it will certainty lead to more permissive environmental regulation.

Once the threshold is set, tools need to be developed for an adequate environmental management. The ISA's institutional functioning provides for a strong environmental management that could welcome the management of geothermal energy. Its regional environmental management could set the appropriate basic framework to regulate geothermal energy, provided that it materially adapts it to the specific needs and challenges of geothermal activities. The negotiating BBNJ Agreement, if adopted, will influence ISA protection measures such as APEIs. The ISA does not develop a specific understanding on the concept or terms it uses such as "vulnerable ecosystems" or "precautionary approach" for instance. It takes onboard the understanding of other industries. Still, the cooperation and coordination of protective measures with other ABMT may eventually influence the regulation of geothermal energy. The possibility for the ISA to re-arrange its institutional functioning to integrate subsidiary bodies specifically created for the environmental matters would be a strong asset to coordinate effectively ABMT including APEIs with other environmental tools developed within other industries. It remains that within the ISA's framework, the coordination of activities in the Area and the establishment of coordinated environmental measures such as APEIs are not provided for. The draft Exploitation Regulation may provide the inception of such a possibility via the mentioning of taking into account cumulative impacts. However, a procedure within the ISA should address this specifically. This is the suggestion of this thesis further elaborated bellow.

6.1 Suggestions for a holistic management approach of activities in the Area in light of prospective geothermal activities

When it comes to the environmental management of geothermal energy in the Area, this thesis suggests for activities in the Area to be taken into account holistically in a single tool when considered to be implemented. This way, their implementation would reflect an integrated Marine Spatial Planning strategy for the industry. The ISA has already provided for the inception of such a possibility through its Regional Environmental Management Strategy. Such a sectorial implemented marine spatial planning could be done through a Regional Environmental Assessment (REA). This idea originally has been developed by Doelle and Sanders in light of the BBNJ negotiations and the growing possibility to exploit genetic resources in ABNJ.[179] However, it may also be very interesting for activities in the Area. As of now and for any sector, Environmental Assessment procedures are project focused. The ISA's EIA and Environmental Impact Statement (EIS) are also project focused even if they are suggested to take into account cumulative impacts. Yet, especially in light of geothermal activities, the protection of the environment could be improved if the activities of a whole sector are implemented in an integrated manner.

The REA developed by Doelle and Sanders is designed to identify priorities and limits when it comes to implementing activities, identifying alternatives to an activity including the possibility for a "no proceed" possibility in favour of another activity. The REA should be carried out with a focus on the Sustainable Development Goals, identifying different scenarios and being tightly linked to the planning process. The proposal by Doelle and Sanders envisions the REA to be holistic and provide for the organisation of all activities taking place in a specific region. In matters related to activities in the Area, this concept could be incorporated into the ISA's regional environmental strategy and into the REMP framework to manage in an integrated manage all activities in the Area in a designated region. Developing a REA withing the ISA

[179] M. Doelle and G. Sander, "Next Generation Environmental Assessment in the Emerging High Seas Regime? An Evaluation of the State of the Negotiations" (2020) 35(3) *The International Journal of Marine and Coastal Law* 498-532.

would enhance the ecosystem approach and further an integrated management and planning process.

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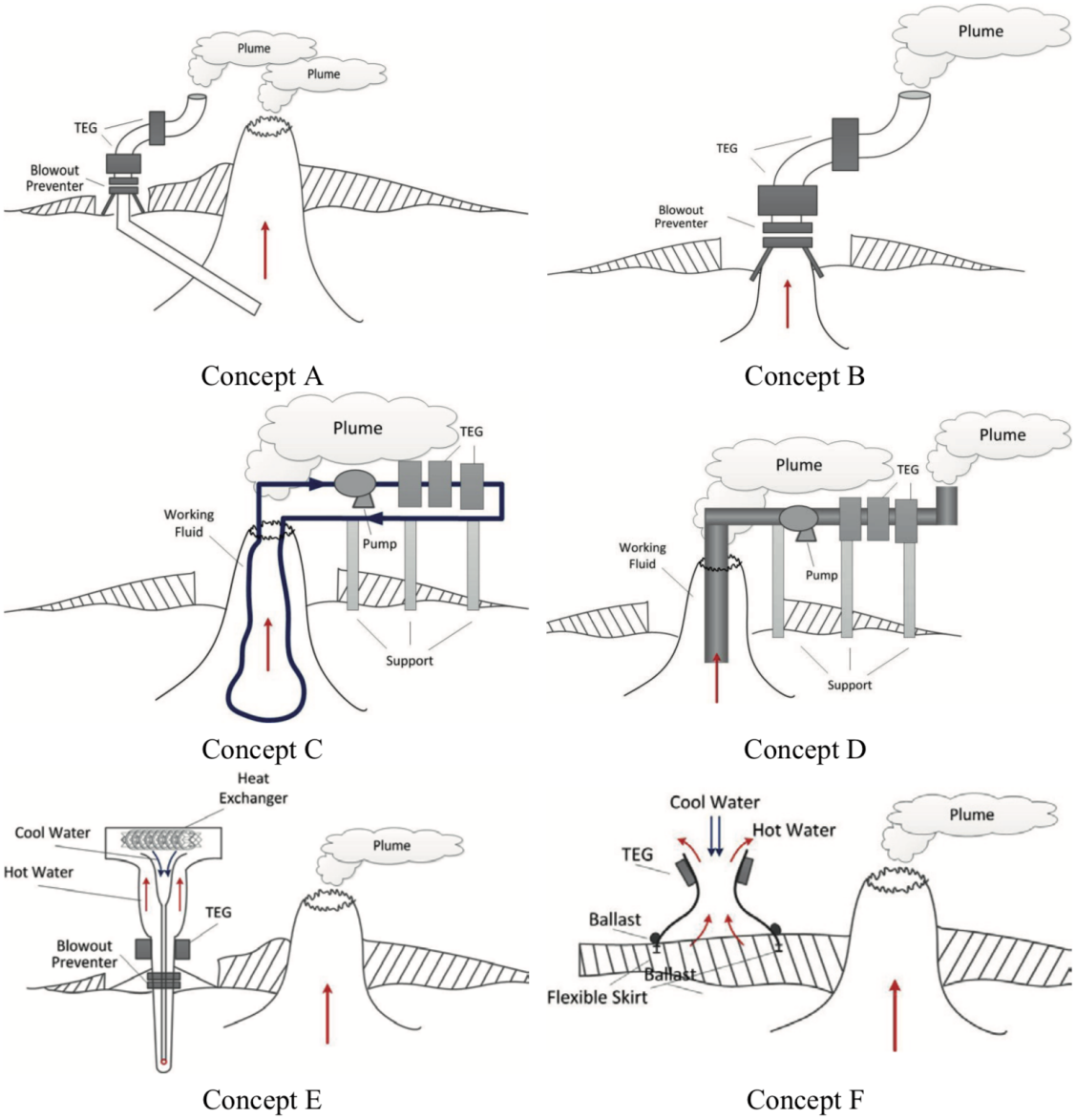
Annex I



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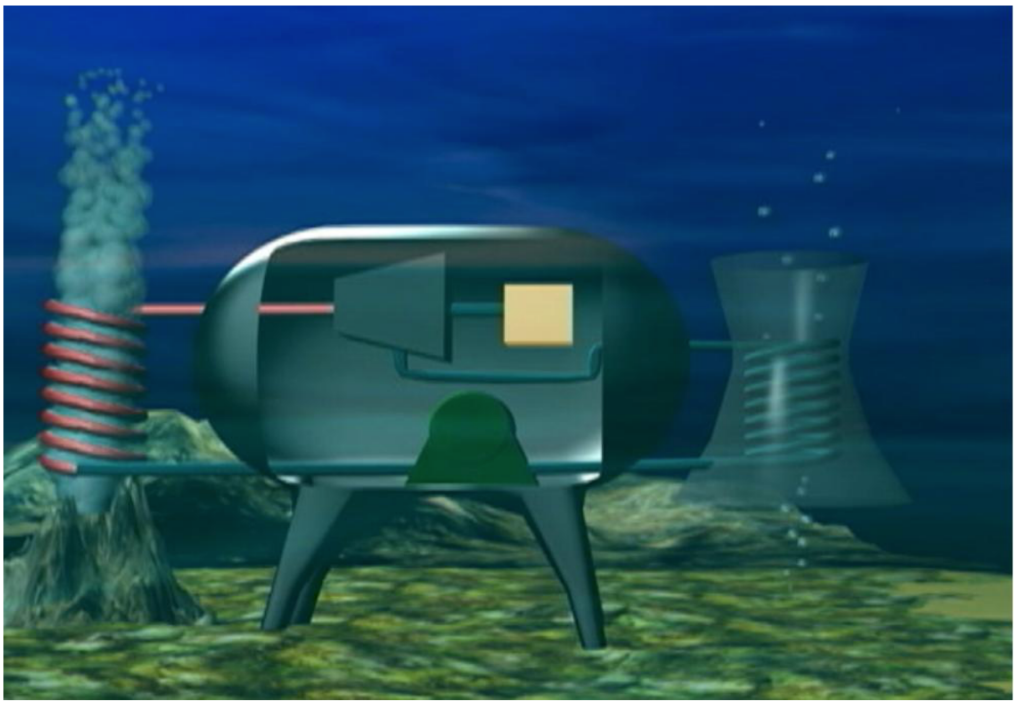
Annex II



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