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Mind the gap and close it: Regulating greenhouse gas emissions from deep-sea mining in the Area

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1. Introduction

The dual pressures of increasing global demand for metals and the declining metal content of known terrestrial mines have contributed to the recent interest in deep-sea mining (DSM). Deep-sea mineral deposits – manganese nodules, ferromanganese crusts, and seafloor massive sulfides – contain valuable metals that could, like terrestrially sourced metals, be used in a variety of goods ranging from smartphones to electric vehicles and renewable energy technologies ¹.

Marine mineral resources are found in two jurisdictionally disparate locations on the seabed. Those located on the continental and extended continental shelf of a coastal State fall under national jurisdiction, which means that the coastal State has sovereign rights to explore and exploit them in accordance with its domestic legislation and environmental policies. Deposits located on the international seabed, commonly known as ‘the Area’, are considered the ‘Common Heritage of Mankind’ (UNCLOS, Article 136). These deposits can be accessed through the International Seabed Authority (ISA) by three categories of actors: States, entities sponsored by States, and ‘the Enterprise’ (UNCLOS, Article 153). The Enterprise, which exists on paper but is not yet operational, will be the ISA’s independent mining entity that will enable most developing countries to participate directly in mineral-related activities in the Area in line with the Common Heritage of Mankind principle ². As of October 2023, the ISA has awarded a total of 31 exploration contracts, 19 of which cover the exploration for manganese nodules ³. Exploitation activities in the Area have not yet begun for several reasons, including ongoing negotiations on exploitation regulations, ongoing technological development, and potentially limited economic viability. However, the invocation of a treaty provision by the Republic of Nauru in 2021 resulted in a renewed sense of urgency⁴—for both the ISA, to accelerate the development of exploitation regulations, and the opponents of DSM who seek to impose a pause or moratorium⁵. In any case, there seems to be a broad understanding that exploitation activities, if and when they are allowed to commence, must be comprehensively regulated by the ISA and such operations must remain within the limits of acceptable environmental parameters as determined by its Member States.

At the exploitation stage, DSM will consist of three types of activities: (1) the seafloor evacuation, lifting, and shipboard pre-processing of the minerals (‘mining’ or ‘extraction’); (2) the bulk-carrier transportation of the recovered minerals from the mine site to shore (‘transport’); and (3) the metallurgical treatment of the marine minerals on land (‘processing’) ^{6–8}. These three types of activities are vastly different in terms of their geographic, environmental, and legal settings, but they each will be highly energy-intensive and will predominantly rely on fossil fuels, at least for the foreseeable future ^{9–12}.

Since exploitation operations have not yet begun, one can only approximate the ensuing GHG emissions (see Heinrich et al. ⁹ for estimates based on different mining and transportation scenarios). Even without knowing the precise amount of GHG emissions, two facts remain: first, like all fossil-fuel-based activities, deep-sea mining in the Area will contribute to climate change; and second, these GHG emissions are not yet covered and accounted for by any specific regulatory framework. Indeed, a recent study commissioned by the ISA acknowledges the existence of “a regulatory gap with respect to air emissions from [mining activities] in the Area” ¹³. However, the ISA has not taken any meaningful steps to close this gap and seems unlikely to do so in a comprehensive manner unless pressured to act, for instance, through the exploitation regulations (provided a textual proposal is

made during the negotiations, e.g., through a champion state, and there is sufficient support from member states to do more than pay mere lip service).

With specific reference to the ‘mining’ component of DSM and the GHG emission resulting therefrom, it would appear that three separate regimes could be applicable: (1) the climate regime, consisting of climate-related treaties and institutions, such as the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement (PA); (2) the shipping regime, which comprises shipping-related treaties and institutions, like the International Maritime Organization (IMO) and the International Convention for the Prevention of Pollution from Ships (MARPOL); or (3) the DSM regime, which includes DSM-related treaties and institutions, such as the United Nations Convention on the Law of the Sea (UNCLOS), the corresponding 1994 Agreement relating to the Implementation of Part XI of UNCLOS (1994 IA), and the ISA.

With commercial DSM in the Area on the horizon and the imminent threat of climate change in mind, this regulatory gap urgently needs to be closed. Thus, this article seeks to answer two questions:

- 1) Which regulatory regime(s)/fora should regulate DSM-related GHG emissions?
- 2) Which policy instruments (i.e. tools or measures) should be implemented to regulate DSM-related GHG emissions under the selected regime?

Following this introduction, we briefly introduce some general considerations with a view to evaluating regimes and instruments in international law, which become relevant whenever new environmental problems or conflicts emerge and need to be regulated. We then discuss three regimes and their suitability for covering GHG emissions arising from DSM in the Area. Following this, we present several instruments (here used interchangeably with “tools” or “measures”), which can be implemented to regulate or mitigate GHG emissions under the chosen regime. Finally, we conclude with some observations and recommendations.

2. Regime and instrument choices: A general overview

The selection and design of specific measures or sets of measures to regulate environmental problems in environmental law and policy has received considerable academic attention, both nationally and internationally (“instrument choice”).^{14–21} Insufficient attention has been afforded to the circumstances and standards that dictate the selection of the international regime that will oversee emerging and yet unregulated concerns (“regime choice”)^{18,22}, and even less on how these two choices are interlinked. This section provides a general overview on regime and instrument choice, while the following two sections will respectively discuss them in detail in the context of DSM in the Area.

2.1 Regime choice

In general, regime choices are to be made when new conflicts emerge and call for regulation. Under international law, the situation is somewhat unique. International treaties are usually developed in response to specific issues. States give their consent only to the very specific set of rules that they have negotiated in this regard. Where new issues emerge, they usually do not fall within the remit of these precisely and often narrowly constructed agreements. Some treaties, however, are drafted more openly and serve as umbrella or framework conventions. For example, UNCLOS aims to “settle (...), all issues relating to the law of the sea” (UNCLOS, preamble para 1). But even these general treaties assume that more specific regulations exist or will be developed outside their own frameworks)²³. This does not mean, however, that these new or emerging issues are entirely unregulated. In practice, lawyers, who are primarily responsible for drafting and negotiating international treaties, consider which treaties provide norms that are – at least to some extent - relevant for the newly emerging activities or technologies. Where they conclude that existing laws do

not fully resolve these new or emerging issues, lawyers assume there is a regulatory gap²⁴ and work towards closing it. Closing such regulatory gaps may be achieved either by amending an existing treaty or developing a new one. The first step in this process is the regime choice, i.e. choosing an existing or new treaty as the forum to address the issue.

States typically base their regime choices on a variety of considerations²², many of which are difficult to assess and measure. For example, negotiations often take place behind closed doors, motives are often rather vague, overlapping or even conflicting, and State leaders may be influenced by day-to-day politics that might change after national elections. However, this does not mean that choices are made in the absence of strategic, legal, economic, or pragmatic rationales. We argue that three legal criteria are important when making regime decisions, i.e. a treaty's scope, its level of readiness, and its effectiveness. All three are elaborated in the next sections.

A treaty's scope defines to whom, to what, and where an agreement should be applied, i.e. the personal, substantive, and geographical ambit. The underlying question lawyers will address in their debates is whether the legal, instrumental, and organizational ambit of an existing agreement can be applied to the new issue. Answering this question is far from simple, given that the existing treaty has been negotiated and agreed upon by a specific group of States under specific historical and political circumstances. The legal and practical implications of applying an 'old' treaty to a 'new issue' can thus be substantial and may evoke many reservations by the different States involved, particularly by those who are not party to the candidate agreement. However, where a new or emerging issue resembles issue(s) already regulated under a specific treaty and all concerned States consent, integrating a new issue into an existing regime may be relatively easy. In addition, where treaty scopes are drafted using open-ended or broad language, States might not even have to adapt the treaty, thereby avoiding potentially cumbersome amendment procedures. In case integration is not achievable, a new agreement would need to be developed. Simply put, the legal scope of existing agreements will be an important factor when making regime choices.

Structural and institutional *readiness* refers to the regulatory and organizational effort that would be required to govern the new issue under an existing treaty. Some treaties may already have principles, rules, precedents, and organizational structures that are well suited for addressing the emerging problem. In these cases, regulatory effort would be minimal, and the readiness level would be high, which may facilitate quick and decisive action by the parties to address the new or emerging problem. In contrast, where no such structures exist, regulatory effort would be high and the readiness level would be low, thus the advantage in selecting the existing treaty over negotiating a new one would be marginal. Under these circumstances, the parties might decide to refrain from addressing the new, emerging issue and instead suggest incorporating it into a different or even a new treaty.

Lastly, the *effectiveness* of laws, in general, and international treaties, in particular, has been conceptualized in various ways^{25,26}. In broad terms, we understand the effectiveness of international regimes as the degree to which they can direct and influence the behavior of relevant actors (i.e. particularly States, but indirectly, also non-state actors) to address and solve specific problems. Several factors inside and outside an agreement can contribute to a treaty's effectiveness. Internal elements could include a system for distributing benefits and burdens, clear reporting and monitoring requirements, implementation support mechanisms (administrative, technical, and financial), enforcement measures, and a mechanism for preventing evasion (leakage) by subjecting parties to similar obligations. Whether a treaty effectively functions or not influences States' decision on whether it is a suitable instrument for governing an emerging issue.

2.2 Instrument choices

The question of instrument choice focuses on determining the most suitable tool or measure to solve a particular problem. While most scholars discuss the functioning of specific instruments in a particular context, some develop more general ideas about the characteristics, mechanics, and advantages and disadvantages of different types of approaches. Before we discuss the suitability of various instruments potentially suitable for regulating DSM-related GHG emissions, we want to highlight two general observations:

First, the relevance of instrument choice differs greatly between national and international law. Since most international treaties depend on State Parties to implement regulations, they usually leave the choice of instrument to them. Driesen¹⁴ aptly speaks of the “instrumental agnosticism” of international treaties in this regard. In many cases, treaties only suggest or encourage the use of certain measures over others, allowing State Parties to choose those which are compatible with their legal traditions, political landscapes, and administrative capacities. Particularly younger agreements like the Paris Agreement (PA) focus on setting common goals or aims rather than on prescribing the specific measures to achieve them.

Second, regime and instrument choices can affect or influence each other. Regime choice, on the one hand, is often based on considerations regarding instruments that already exist within specific agreements. Instrument choice, on the other hand, is determined to some extent by the pre-existing content and design of the selected forum. Where existing agreements are chosen to govern an emerging issue, their current set of instruments and institutional practices will be an important factor for any approach to governing a new issue. Conversely, parties may select an instrument they deem the most appropriate to govern the new issue, which may in turn influence the regime choice.

Here, we consider three instrument options to be relevant in the GHG context: informational measures, command-and-control instruments, and market-based mechanisms.

Informational measures are undertaken to educate diverse stakeholders about the environmental impact or performance of goods, services, industrial processes and the like, with the intention of promoting informed decision-making and sustainable choices. Informational measures fall into two general categories: either authorities and governments provide information, such as historical data on impacts, or require information, for example, companies might be obligated to produce environmental impact assessments, emission reports, and other information and data about their activities¹⁸. The underlying assumption is that people or companies pollute because either they are unaware of the environmental impacts, or the lack of transparency enables them to pollute with impunity. Once information is released, polluters can be held accountable by governments as well as by other stakeholders, such as NGOs, shareholders, or the public. By themselves, informational measures are considered marginally effective, because they do not sanction polluters. However, as part of a policy package, they can increase the effectiveness of other types of instruments (e.g. reporting requirements to monitor compliance with regulations or track progress).^{18,27}

Command-and-control instruments are clear-cut rules imposed top-down by an authority or regulator “to mandate or prohibit specific behaviors.”⁵⁶ These very direct instruments typically complement informational measures and can range from monitoring and inspection obligations to sanctioning measures for cases of non-compliance^{28,29}. The most common command-and-control instruments are technical, process-related, or performance standards. Technical and process standards prescribe the use of specific technologies and/or procedures. Performance standards usually require companies to achieve set goals, e.g. emission limits.^{18,27,28}

Market-based mechanisms are generally considered more effective than informational or command-and-control measures³⁰, because they place an economic cost on emissions and this incentivizes actors to reduce emissions. Market-based instruments are considered the best method for capturing “externalities”, which are the environmental damages that are not fully captured in the market price

of a commodity. For example, the price of gasoline does not capture the costs associated with addressing the environmental damage caused by gasoline vehicles, such as air pollution (the cost of air pollution-related hospital visits, for example, are borne by other actors). The most common market-based mechanisms include climate levies, carbon crediting schemes, and emissions trading programs, all of which can impose costs on pollution or for emissions.³¹

The simplest of the market-based mechanisms are climate levies, also known as carbon taxes, which charge a fee for every unit of carbon a company produces. Levies are effective because they give companies, which generally like to reduce costs, a financial incentive to reduce their emissions. The levies must be adjusted over time (to keep pace with inflation) and must be painful enough that the effort required by the companies to reduce emissions is worth it.^{19, 32} The downside of carbon levies/taxes, however, is that regulators have very little influence over the level of emissions reduction. If companies decide they would rather pollute and pay the tax than invest in changing their behavior, then emissions will not be reduced. Another market-based mechanism, carbon crediting schemes, let polluters purchase carbon credits, which is an allowance to produce a certain number of emissions. Carbon credit schemes can also take the form of offsets, by which pollution in one area is credited or “offset” with impact reductions in other areas³⁵ (such as offsetting air travel emissions by planting a tree). Whether carbon offsetting can be considered truly effective in terms of reducing GHG emissions is, however, contested^{31,32} as some polluters may consider it an easy out.

The third and perhaps most effective but more complex market-based mechanism is an emissions trading program, also known as a cap-and-trade system. The EU Emissions Trading System is a prime example. In a cap-and-trade system, a group (for example, the EU Member States) sets a limit on the overall emissions the group is allowed to produce. Each member is allotted a certain number of emissions, and these “carbon allowances” can be either auctioned or distributed. The participants can then trade allowances¹⁸, with benefits accruing to the those who produce less emissions. With trading schemes, regulators can have more certainty about the level of emissions produced by the group.³⁰

3. Regulating GHG emissions from DSM: Regime choice

In the following section, we briefly introduce the three treaty regimes that, directly or indirectly, are most closely related either to deep-sea mining or to capturing GHG emissions. Their potential suitability for regulating GHG emissions from deep-sea mining will be based on the three aforementioned factors: *scope*, *readiness*, and *effectiveness*.

3.1. The climate regime

The foundation of the climate regime is the UNFCCC and, although the regime’s scope is not explicitly defined, its general main objective is to “stabiliz[e] greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system” (UNFCCC, Article 2). From 2005 to 2020, the Kyoto Protocol operationalized the UNFCCC and established binding emission limits for developed (Annex I) countries (Kyoto Protocol, Article 3) for either one or both of its two commitment periods (2005-2012 and 2012-2020). The Paris Agreement (effective as of 2016), in contrast, allows countries (developed and developing) to submit their own nationally determined contributions (NDCs) for avoiding and reducing GHG-emissions (PA, Article 4(2)). This means that each country can set its own targets and thus differentiation is allowed. But countries are expected to fulfill their NDC goals, and the PA requires each country to provide progress updates and national GHG inventory reports (PA, Article 13 (7)(a) and (b)) as well as periodic global stocktakes (PA, Article 14(1)).

Scope: In terms of scope, neither the UNFCCC, the Kyoto Protocol, the Paris Agreement, nor any document issued by State Parties (or bodies created by these agreements) refers to the term ‘deep-sea mining’. This includes the Guidelines for National Greenhouse Gas Inventories, last amended in 2006, which to this day contain “the most recent scientific methodologies available to estimate GHG emissions by sources and removals by sinks of GHGs” (FCCC/SBSTA/2009/3 para. 98), as well as a list of sectors and activities considered relevant in the context of climate change mitigation.

Readiness: In principle, the UNFCCC and its related treaties provide legal instruments and procedures for all types of GHG emissions. There are rules as well as organizational and procedural structures in place, such as regular global stocktakes, to monitor progress towards meeting the convention’s goal of stabilizing GHG emission levels in the atmosphere. Against this background, the regulatory effort required to incorporate GHG emissions from DSM in the Area would appear, at least *prima facie*, to be rather minimal. However, the UNFCCC and its related treaties strongly rely on their State Parties to select, implement, and enforce emission reduction targets and mitigation measures, which means that emissions need to be unambiguously allocated to individual countries to be regulated. While this is straightforward for most activities, it is considerably more challenging for transnational activities, especially those carried out in areas beyond national jurisdiction^{33–35}.

The Parties to the UNFCCC previously encountered this issue in the mid-1990s, when they attempted to regulate GHG emissions from international shipping. After contemplating several allocation options—including the allocation of emissions in proportion to the State Parties’ national emission inventories; the allocation to the departure and/or destination country of the vessels, passengers, or cargo; or to the vessel’s flag State or bunker fuel supplier (FCCC/SBSTA/1996/9/Add.2) - the Parties decided that none of the proposed options were feasible. Instead, they agreed to pass responsibility for regulating such emissions to the UN’s sectoral organization for international shipping, the IMO. This decision was later confirmed in the KP (Article 2.2). The PA, then, does not mention international shipping at all anymore, which has been interpreted as re-emphasizing the role of the IMO in mitigating the sector’s GHG emissions³⁶. Following a similar logic, the Parties to the UNFCCC placed responsibility for regulating international aviation emissions with the International Civil Aviation Organization (ICAO). In sum, both examples indicate that Parties to the climate regime are not inclined to regulate emissions from economic activities that are transnational or fully or partly located in areas beyond national jurisdiction, particularly when they can be housed under sectoral regulations.

Effectiveness: With their broad scopes, the UNFCCC and the PA provide common definitions, establish basic institutional frames, ensure transparency and accountability, and define overarching policy objectives and measures to track their contracting Parties’ progress towards meeting those objectives. The PA also provides a complementary transparency mechanism with measurement, reporting and verification requirements. However, to a large extent, the treaties leave it to their contracting Parties to select, implement, and enforce *specific* climate change mitigation measures. Hence, the State Parties of the UNFCCC and the PA would only have limited power to jointly direct and control the implementation of specific measures through individual parties, which most likely would be necessary to account for emissions from deep-sea mining.

Overall evaluation: GHG emissions resulting from DSM in the Area are exactly the type of emissions that treaties under the climate regime aim to regulate. It is important to bear in mind that the list of sectors included in the 2006 Guidelines is not exhaustive and member States are free to decide for themselves how they intend to achieve their self-imposed GHG reduction targets. In the context of DSM, the allocation of emissions would likely be considerably less complex than for international shipping, due to the smaller and thus more manageable number of operations and the ease with which actors involved in the activity can be identified (e.g., the contractors, the Sponsoring States, or the flag States). Nevertheless, without significant political will of the parties to the climate regime to regulate GHG emissions from a transnational activity such as DSM, unilateral or voluntary measures

by individual member States would result in low effectiveness given the absence of binding goals and enforcement measures. Finally, because each country can set its own targets, the possibility exists that actors could attempt to evade stringent regulation by re-locating to or, in the case of DSM, associating with countries with less stringent regulations.

3.2. The shipping regime

The IMO, established in 1948, is the UN's specialized organization for ensuring the safety of international shipping and protecting the marine environment from vessel-based pollution³⁷. The latter aspect is particularly covered under MARPOL^a, which presently consists of six technical annexes focusing on different types of pollution. Initially Annex VI ('air pollution') concentrated mainly on sulfur oxide and nitrogen oxide emissions, but now also includes regulations for GHG emissions (following the adoption of 'Resolution 8 on CO₂ emissions from ships'). In addition, over the past ten years, the IMO has adopted several climate-related mitigation measures, including the Energy Efficiency Design Index, the Ship Energy Efficiency Management Plan, the Energy Efficiency Operational Index, and a complementary mandatory fuel data collection system⁹.

Scope: The Parties to MARPOL have considered and unequivocally ruled out covering DSM-related GHG emissions. In fact, MARPOL explicitly states that none of its provisions on GHG emissions apply to "emissions associated solely and directly with the treatment, handling or storage of seabed minerals", and "GHG emissions from diesel engines [...] solely dedicated to [their] exploration, exploitation, and associated processing" (MARPOL, Annex VI, Regulation 19(c) and (d)).

Readiness: The shipping regime is a sectoral regime, which primarily aims at promoting international navigation, but it also has a clear environmental objective through MARPOL. The GHG-related instruments established by MARPOL, including the Energy Efficiency Design Index are, however, not directly applicable to DSM (MEPC.203(62), MEPC.1/Circ684), because they were designed for moving rather than stationary vessels. To target the unique characteristics of DSM vessels, the Parties to MARPOL would have to create and agree on an entirely new set of mitigation measures.

Effectiveness: Within the shipping regime, flag States are supposed to "exercise [their] jurisdiction and control in administrative, technical and social matters over ships" (UNCLOS, Article 94(1)) and are typically responsible for enforcing regulations set forth in UNCLOS and the IMO conventions, including MARPOL. However, because of the trend to register ships with so-called open registries—which often offer "reduced regulatory burdens, lowered registration costs, and expedited certification" (in order to maintain a competitive advantage)—flag State implementation and enforcement have been complemented by Port State Control, which allows port States to verify that ships at their ports comply with international regulations (Watterson et al. 2020: 1; see also Chen 2021). In the DSM context, regulation potentially could be evaded if DSM vessels register in a country with less stringent regulation. Moreover, the Port State Control system would only be applicable to a small number of DSM vessels, because the platform-type DSM vessels will likely remain at sea for extended periods of time and only enter port every few years for maintenance³⁹.

Overall evaluation: The shipping regime generally seems to be a suitable forum candidate for governing GHG emissions arising from DSM in the Area. It is already broadly applicable to a large number of States, including many of those interested in DSM. Likewise, its system of Flag and Port State Control could theoretically provide a solid administrative structure. However, due to the unique characteristics of the DSM sector, it is questionable whether control mechanisms for

^a Protocol of 1978 relating to the International Convention for the Prevention of Pollution from Ships, 1973. 1340 UNTS 61.

designed for shipping would have the desired effect. Similarly, the inapplicability of the established mitigation measures makes a direct integration of DSM into the existing framework impossible. The decisive factor, however, seems to be the formal rejection of regulating DSM-related emissions. While this theoretically could be overcome, it would likely be a lengthy and onerous process. Furthermore, developing entirely new standards under MARPOL to accommodate a comparatively small number of DSM vessels might be considered an unreasonable effort.

3.3. The deep-sea mining regime

DSM in the Area is regulated under Part XI of UNCLOS and the corresponding 1994 IA. Specifically, UNCLOS established the ISA to develop, implement, and enforce a legal framework that regulates mineral exploration and exploitation in the Area, and, at the same time, ensures the effective protection of the marine environment from the harmful effects of these activities. Furthermore, in instances where States choose to sponsor entities wishing to conduct mining activities in the Area, UNCLOS obligates the Sponsoring States to ensure that their entities comply with the terms of their contracts and the provisions of international law, as well as with the relevant national and international requirements stipulated by the Sponsoring State(s) (UNCLOS, Article 139 (1) and ITLOS 2011).

Scope: UNCLOS takes an extremely wide approach and thus can be referred to as an umbrella agreement. Until now, it has never explicitly attempted to regulate GHG emissions, although some argue that GHG emissions technically could be covered under article 212, which addresses pollution from or through the atmosphere⁴¹⁻⁴³. Under such an interpretation, UNCLOS would then consider GHG emissions as 'pollution to the marine environment' as defined under article 1 therein. Consequently, the ISA arguably possesses the mandate to regulate DSM emissions from activities in the Area pursuant to article 145, which obligates the ISA to take all necessary measures to ensure the effective protection of the marine environment, including to adopt rules, regulations and procedures for 'the prevention, reduction and control of pollution and other hazards to the marine environment', from the harmful effects of mining activities. In this case, regulation would be all encompassing and thereby include GHG emissions arising from DSM. In contrast to the UNFCCC, the ISA has previously mentioned GHG emissions - albeit very briefly and in broad terms. For example, they have been mentioned in the ISA's 'Discussion Paper on the Development and drafting of Regulations on exploitation for mineral resources in the Area ('Environmental matters)', and in the version of the draft regulations for exploitation from 2019 (ISBA/25/C/WP.1) but without any clear intention to regulate GHG emissions or incorporate concrete measures to do so in practice. In fact, GHG emissions have hardly ever come up during any of the negotiations of the regulations at the ISA (which have been ongoing since 2019).

Readiness: The DSM regime is a sectoral regime, which aims to regulate and control deep-sea mining in the Area. At the same time, the ISA also has a strong environmental protection responsibility, which requires it to protect the marine environment from harmful effects caused by the exploration for or exploitation of marine mineral resources in the Area. Given the absence of a pre-determined approach to mitigate these emissions, the Parties to the ISA would be completely flexible (within reason) and could implement any environmental conservation or mitigation measures they deem necessary and appropriate. Moreover, as discussed above, the ISA's responsibility to ensure the effective protection of the marine environment from the harmful effects of mining activities under article 145, and other responsibilities such as to ensure that mining activities are carried out for the benefit of humankind, would support the argument that member states cannot neglect this issue and must take positive measures to regulate GHG emissions from the activities that the ISA permits.

Effectiveness: While UNCLOS is a comprehensive regime, the ISA operates mainly under its specific provision on DSM. The ISA is a somewhat unique sectoral organization or administration, which exercises both legislative and executive functions, and is also equipped with a dispute settlement

mechanism for States and private actors involved in the exploration and exploitation of mineral resources in the Area ⁴⁴. In terms of enforcement, UNCLOS Annex III, article 18, provides for warnings, monetary penalties, suspension or termination (in certain circumstances) as potential compliance measures for the ISA. Indeed, ongoing negotiations on the exploitation regulations are expanding on these powers in terms of inspection, compliance and enforcement. Lastly, UNCLOS and consequently also the ISA place great value on applying the same regulations to all countries to prevent the formation of so-called 'Sponsoring States of convenience,' which ensures that regulations cannot be evaded by basing mining companies in less stringent countries. In practice, it remains to be seen how effective (and proactive) sponsoring states would be in assisting the ISA in terms of securing contractor compliance and enforcement (from an overall perspective, let alone on GHG emissions), as some states may have more capacity or motivation to do so than others. Conversely, sponsoring states can choose to impose more stringent requirements on the entities that they decide to sponsor than the ISA requires, and some may be willing to require sponsored entities to commit to certain emissions reduction targets as a pre-condition to sponsorship (and be prepared to take proportionate enforcement measures where necessary).

Overall evaluation: The DSM regime has sufficient scope to regulate GHG emissions arising from activities in the Area owing to the broad scope of its enabling treaty, UNCLOS. Because of its unique ability to exercise control over mining contractors and its ability to secure compliance and enforce regulations, the ISA could create a level playing field by imposing similar GHG-focused obligations on all mining entities (and thus avoid any leakage). Action against contractors could be taken directly under the domestic legal systems of their Sponsoring States, as well as against Sponsoring States in case wrongdoing could be attributed to them under international law. Moreover, although the ISA could in theory do so, it seems unlikely at this stage that there would be sufficient political will at the ISA to make GHG emissions a core element when evaluating and determining mining applications and using this as a basis for rejection. In sum, the ISA does not seem to face any legal obstacles to regulating DSM-related GHG emissions as part of its environmental mandate. However, despite some vague signs that the ISA is aware that GHG emissions should be part of its regulatory efforts, it is still very far from actively addressing the issue or implementing any concrete measures.

3.4. Forum choice – analysis

In theory, all three regimes are capable of regulating DSM-related GHG emissions. In practice, however, only the climate regime and the DSM regime could initiate a timely negotiation process. In contrast, the shipping regime would first require a formal modification of MARPOL Annex VI, which would require considerable time and effort as well as substantial political will. We thus believe it is unlikely to happen. Moreover, substantial political will would be required to integrate the regulation of DSM-related GHG emissions into the climate regime. However, it seems doubtful that the Parties to UNFCCC would suddenly be eager to regulate an activity carried out in areas beyond national jurisdiction—they already refrained from doing so for shipping and aviation. Moreover, due to the broad scope of the climate regime, which covers myriad activities in virtually all countries, it is questionable whether an emerging activity like DSM, which might only involve a small number of countries, will draw sufficient attention to move it to the top of the agenda. Furthermore, because the PA allows individual countries to determine their own emission reduction targets and strategies, the regime's regulatory reach is limited, and countries might not specifically target DSM-related GHG emissions.

In contrast to the climate regime, emissions under UNCLOS could be directly tied to the 'owner' of the activity. The regime's narrow focus on deep-sea mining and the absence of a pre-existing approach to climate change mitigation would give the Parties to the ISA considerable flexibility in selecting suitable sector-specific mitigation measures. The ISA's more direct regulatory reach could

be considered an additional advantage, although there is still considerable room for improvement when it comes to the operationalization of its enforcement abilities. Lastly, the ISA's equal application of regulation coupled with the direct contractual relationships between the contractor, (the sponsoring State), and the ISA, could ensure the creation of a level playing field and thereby minimize the risk of evasion. Taking all arguments into account, we conclude that the ISA would be best suited to regulate GHG emissions arising from deep-sea mining in the Area.

4. Instrument choice

From a policy perspective, a mixture of options derived from all three types of instruments (i.e. tools/measures) could help achieve the desired outcome of adequately regulating GHG-emissions from DSM in the Area. Hence, while the three types of measures will be discussed individually, the ISA should consider imposing a complementary combination.

4.1. Informational measures

With respect to informational measures, the ISA could require the inclusion of anticipated GHG emissions in publicly shared environmental impact assessments (EIAs) (more likely as a descriptive rather than a decisive criterion in the permitting process) that prospective contractors must submit to the ISA when applying for exploitation contracts as well as for certain activities during exploration. EIAs already feature as a component of the DSM regime^{45,46} and the ISA is currently elaborating this process. Moreover, as GHG emissions are part of the suggested template for future Environmental Impact Statements, the ISA could consider including GHG emissions in the draft exploitation regulations and corresponding environmental assessments and monitoring programs. The ISA could also require contractors to submit information on their GHG emissions in their annual reports, which would increase accountability and allow monitoring of the sector's overall contribution to climate change. Another option would be the establishment of a fuel consumption data collection system, similar to the IMO's (see section 3.2), to either calculate the release of emissions per mining vessel or operation, and/or monitor the sectors' GHG emissions and track progress.

4.2. Command-and-control measures

In addition to informational measures, the ISA should consider imposing several command-and-control measures. It is already anticipated that the exploitation regulations that are currently being developed will include standards and guidelines⁴⁷. While standards generally would be legally binding for the contractors, the guidelines would be recommendations. The ISA is also currently in the process of developing environmental thresholds for toxicity, turbidity and settling of resuspended sediments, and underwater noise and light pollution, and could decide to establish a working group to develop thresholds for GHG emissions (whether binding or voluntary). To be more concrete, the ISA could, for example, prescribe the installation of particularly efficient ship engines or the use of specific fuel types to reduce the GHGs emitted by vessels. With respect to performance standards, the ISA could adopt an Energy Efficiency Design Index similar to MARPOL's (but modified for DSM's stationary vessels). While this would be environmentally effective, it might not present the most cost-effective solution for contractors. Indeed, an unintended effect of regulators picking technologies is that it discourages private companies from pursuing technological innovation. More cost effective would be for the ISA to set performance standards or prescribe emission limits and allow contractors to decide how to comply.

4.3. Market-based measures

Finally, and in addition to the above, the ISA could pursue market-based mechanisms such as establishing an emissions trading scheme. At first glance, a trading scheme dedicated to DSM in the Area would seem impractical as the sector will likely involve relatively few actors. Integrating DSM-

related emissions into an existing trading program would be challenging, for example, it is unlikely that all actors would be eligible for the same cap-and-trade program (the largest program is the EU's and only EU Member States can participate). A carbon tax would be simpler to administer than a trading scheme but would require the ISA to levy and collect such taxes, which is typically undertaken by sovereign States. Although the ISA has the power to collect royalties from contractors based on their mining operations, a key topic under the ongoing exploitation negotiations, UNCLOS does not specify other forms of taxation that the ISA could impose, and it would appear to be a rather heavy lift for the ISA to execute a stand-alone form of carbon taxation at this stage. More plausibly, the ISA could utilize its ability to introduce incentives (under UNCLOS article 13, Annex III as well as the 1994 Agreement) for contractors to motivate them to go beyond any regulatory obligations. In a sense, such incentives would function as a quasi-tax break by reducing royalty payments in exchange for enhanced environmental performance, i.e. reduction of GHG emissions. A significant additional advantage for the ISA would be the ensuing revenue stream, which could be used for the benefit of all⁴⁸, for example, to support environmental and climate remediation. A tax would also afford polluters some cost certainty. But the tax would have to be sufficiently high to spur efficiency and conservation.

In terms of carbon crediting, the ISA could, for example, require contractors to offset a portion of their GHG emissions or motivate them to voluntarily offset their GHG emissions beyond a specific limit by offering some sort of financial incentive for model behavior. A coordinated approach supervised by the ISA would likely also reduce the administrative costs associated with the measure as no individual actor would have to engage with carbon markets directly³¹. However, although contractors might find a carbon offsetting approach attractive, it carries the risk that it might be considered a permission slip to emit (which is why it is contested, as discussed earlier).

4.4. Instrument choice - analysis

In sum, the ISA would have considerable flexibility in selecting suitable mitigation measures to minimize GHG emissions caused by deep-sea mining in the Area. In practice, though, the ISA's approach would largely depend on the agreement of the State Parties, who might resist the more onerous measures. Obtaining consensus on the imposition of informational measures might be relatively easy, especially if these are limited to broadening the knowledge base and do not entail hard consequences. However, informational measures alone are a rather weak tool for mitigating GHG emissions; they are more suitable as a complement to more stringent measures. Command-and-control measures would likely be more effective and provide the ISA with direct control over the sector's GHG emissions. They could be easily incorporated into the standards and guidelines currently being drafted by the ISA. To develop a suitable approach, the ISA could approximate the standards implemented by MARPOL, although these would have to be adapted to DSM vessels.

The development of market-based mechanisms under the DSM regime would likely be challenging but might be more effective at mitigating emissions than informational or command-and-control mechanisms. However, designing a sector-specific emissions trading scheme would seem to be impracticable while carbon offsetting schemes might be inefficient. Despite the advantages of carbon taxes—which include administrative ease and cost certainty for contractors—gaining acceptance from ISA member States may be difficult at this stage, although in contrast, the introduction of financial incentives might be more appealing. All in all, this topic urgently needs to be explored in greater detail. Further studies should involve the thorough evaluation of possible policy instruments in the DSM context, for instance, based on criteria such as environmental effectiveness, cost-effectiveness, fairness, and institutional feasibility, which have been applied by the IPCC to evaluate the suitability of climate change mitigation measures²⁷.

5. Conclusion

Once deep-sea mining occurs on a commercial scale, substantial amounts of GHG emissions will be released. It is therefore imperative that DSM-related GHG emissions are regulated through the implementation of environmentally effective, economical, fair, and practical measures. Regulating such emissions is not only necessary from an environmental perspective but may, in fact, be in the interest of the contractors. Energy efficiency measures can, for example, positively affect operational costs, which are substantial for DSM operations. Furthermore, emission reduction strategies may improve companies' reputations and lead to increased investor trust. The latter is particularly important considering that DSM is an emerging industry that needs significant investments^{49,50}. Many funding organizations, financial institutions, and other investors increasingly include environmental considerations in their selection criteria⁵¹⁻⁵³.

The ISA appears to be the appropriate forum to regulate DSM-related GHG emissions as it could implement a harmonized and targeted approach that would apply equally to all actors. As a sectoral organization, it would have a large degree of flexibility in choosing regulatory measures. Indeed, the ISA could not only develop, implement, and enforce GHG emission regulations but also cover other air pollutants arising from deep-sea mining activities. As such, the ISA could offer a 'one-stop-shop' solution for all DSM impacts.

Even if the ISA would be the most suitable forum for regulating GHG emissions from DSM in the Area, decisions at the ISA ultimately lie in the hands of its member States and they have not prioritized such regulation. However, GHG emissions from mining activities in the Area were covered in a recent ISA technical study, which should provide some additional impetus for the ISA to act. Based on recent practice, however, the ISA appears to be very cautious about extending its regulatory outreach to matters beyond those explicitly prescribed by UNCLOS⁵⁴ and has been fairly passive, that is, it tends to allow contractors to take the lead as well as to self-regulate.

The present negotiations of the exploitation regulations present a window of opportunity to close this gap and we recommend that the regulation of GHG emissions from DSM activities in the Area be made a priority for the ISA. For example, the issue could be given to the ISA's Legal and Technical Commission as a priority matter. A technical study could be commissioned to assess GHG emissions from activities in the Area, particularly with respect to the excavation, lifting, and shipboard processing of the marine minerals. Such a study could provide an in-depth evaluation of the applicability and, more importantly, the costs and benefits of implementing and enforcing potential policy instruments. This exercise would allow member States to negotiate and agree on how best to regulate GHG emissions from activities in the Area, including the introduction of concrete measures in the exploitation regulations or through standards and guidelines. This initiative could eventually be taken forward, if member states agree to make GHG emissions a priority issue, through the establishment of an expert working group to deal with GHG emissions and develop appropriate thresholds.

The member States of the ISA, which are all contracting Parties to UNCLOS, might also consider putting the issue of GHG emissions on the agenda of the meeting of the State Parties to UNCLOS (SPLOS), which is the forum for discussing all aspects of the law of the sea and UNCLOS. In this respect, it is important to note that the Parties to UNCLOS also are, by and large, Parties to the UNFCCC and its instruments and, consequently, bound to reduce GHG emissions in order to avoid catastrophic global warming. Finally, the ISA could also consider entering a memorandum of understanding with the UNFCCC Secretariat, whereby the ISA could require contractors to publish their annual emissions, and then report on those emissions that are attributable to the individual sponsoring states that are also contracting parties to the UNFCCC. This could be done with a view to

encourage those states to take steps to reducing those emissions under the UNFCCC and PA processes, although sponsoring states might not be so receptive to this notion of naming and shaming.

Whatever the next steps are, it is paramount that GHG emissions from deep-sea mining be regulated. A particular regime must be identified and assume responsibility. Whether it is the ISA, which is our recommendation, or another regime, the process should begin as soon as possible. Considering that the commercial exploitation of marine mineral resources could start within the next few years and that the vessels and equipment are being customized or specifically built for this purpose, the time to discuss suitable climate change mitigation measures is now. It would indeed be a missed opportunity if the ISA fails to address this topic in its Mining Code while negotiating the exploitation regulations, which would leave DSM in the Area as a source of unregulated GHG emissions.

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