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1 Introduction

In 2019, the Intergovernmental Panel on Climate Change (ipcc) highlighted the cryosphere’s fundamental role in redistributing “natural and anthropogenic carbon dioxide (co2) and heat.”[[1]](#footnote-1) However, several decades after the negotiation of the 1992 United Nations Convention Framework Convention on Climate Change (unfccc), “anthropogenic emissions of greenhouse gases are the highest in history.”[[2]](#footnote-2) Even if the 2015 Paris Agreement is fully implemented, it will most likely not prevent the ongoing warming of the Arctic Ocean.[[3]](#footnote-3) Thus, ice loss and retreat will continue.[[4]](#footnote-4) This scenario may bring solar radiation management (srm) techniques to the fore. srm is a category of geoengineering[[5]](#footnote-5) that includes various techniques. srm aims to increase the Earth’s albedo, i.e., capacity to reflect solar radiation, and therefore decrease “global average temperatures”.[[6]](#footnote-6) srm has no impact on emissions per se, so while lower average temperatures may contribute to sustaining ice sheets and snow patterns, it has no effect on other detrimental effects of increasing co2 emissions, including ocean acidification.

The political, technical, environmental, and ethical questions of traditional srm techniques, e.g., stratospheric aerosol injection, have been extensively discussed. However, in recent years, novel ice management techniques have been claimed to be different from traditional srm techniques since the former are regionally constrained and potentially reversible. These techniques have even been compared to reforestation,[[7]](#footnote-7) but critics also highlight the potential risks of such techniques.

In general, the literature points out four risks about geoengineering that have been roughly labelled as, i.e., moral hazard, ‘slippery slope,’ international conflict escalation and governance trap. The moral hazard risk indicates that mitigation efforts would diminish if technology became a cheaper and ‘simpler’ alternative for counteracting climate change.[[8]](#footnote-8) Slippery slope refers to two related problems. One is that control of technologies will lead to decision biases and then inexorably to deployment. The second is technology lock-ins, where one is obliged to continue deployment for extended periods (mainly of srm techniques) because a sudden termination could lead to rapid temperature increases.[[9]](#footnote-9) International conflict escalation may result from research following the path of least resistance, e.g., in States with lax or inexistent regulation or rogue research and deployment.[[10]](#footnote-10) Finally, the governance trap refers to multiple regulatory structures within institutions pursuing a particular objective that may incidentally claim jurisdiction over geoengineering.[[11]](#footnote-11) Historically, instead of triggering a governance negotiation process, these risks have cast a shadow over geoengineering research, leading to governance stagnation.

In this chapter, we analyse geoengineering research governance of the marine environment, emphasising novel ice-management techniques in the Arctic Ocean. We will utilise the four risks outlined in this discussion, demonstrating why geoengineering research is heading towards a governance trap. There is currently no comprehensive legal regulation on geoengineering research in the marine environment. The common international policy standpoint appears to be ‘governance before deployment.’[[12]](#footnote-12) We argue, however, that comprehensive ‘governance before research’ is also required, something that is currently missing. The unclos general legal framework and the 1996 Protocol to the 1972 London Convention on dumping do not adequately address the particular geoengineering research’ risks. Thus, the international community should negotiate a multilateral governance framework concerning geoengineering research. This framework can, later on, be complemented by a technique-by-technique approach regulation.

The rest of the chapter is structured as follows: Section 2 briefly introduces ice management research. Section 3 provides an overview of ice management techniques and the Arctic marine environment and describes why Arctic ice management research has local, regional, and global legal implications. Section 4 discusses law as a risk co-creator. Section 5 examines the legal framework applicable to ice management research. Section 6 evaluates the fragmented governance structure and suggests the negotiation of a multilateral framework. In Section 7, the authors present the conclusions.

2 Setting the Scene: Ice Management Research

Novel srm techniques to preserve ice in the polar regions, including the Arctic Ocean, are also called ‘ice management’ or ‘ice interventions.’ This labelling appears to imply that while specific srm techniques, e.g., stratospheric aerosol injections, could have unknown risks and severe global consequences, some techniques could be regionally deployed, and their repercussions would also be regional.[[13]](#footnote-13) The terminology could also denote that ice management or other interventions are different from geoengineering because their deployment is less risky. In the words of Desch and others, ice management could be categorised as geoengineering if used “to increase summer sea ice and therefore increase the albedo in the Arctic, but the primary goal is to restore the Arctic sea ice to its state before anthropogenic climate change.”[[14]](#footnote-14) Bodansky and Hunt make a similar argument, i.e., “Arctic interventions differ in important respects. They are closer in kind to conventional mitigation and adaptation and should be evaluated in similar terms.”[[15]](#footnote-15) Independently of the nuances that researchers use to categorise their research, all these techniques are catalogued in this chapter as srm techniques.

srm research includes both activities and technology. Research activities comprise modelling and laboratory experiments[[16]](#footnote-16) and field experimentation at small, medium and large scales. Field research is particularly controversial since it may be categorised as deployment. srm *technology* is defined as material entities, e.g., machines, tools, apparatus, and immaterial entities such as processes that purposely intend to modify the Earth’s climate. When used with this particular intention, material entities of technology become relevant from a governance perspective. Overall, geoengineering technology is not always innovative, but the novelty could lie in its application. Rebelo (in this volume) discusses in-depth the risks associated with technology innovation.

Ice management techniques are a case in point where ordinary technology is used, such as pumps and glass particles,[[17]](#footnote-17) but its potential use to modify the climate is what brings this technology into the realm of geoengineering. The technological challenges ice management faces concern the geographical scale the technology needs to cover and the deployment under the harsh Arctic weather.[[18]](#footnote-18)

3 Ice Management in the Arctic Ocean

Preserving the ice of the Arctic Ocean has both local and global repercussions. The polar regions uptake and redistribute “natural and anthropogenic carbon dioxide (co2) and heat.”[[19]](#footnote-19) With rising temperatures, the ice of the Arctic Ocean is diminishing both in thickness and extent, which endangers its capacity to regulate the Earth’s climate. For example, ice retreat increases the absorption of solar radiation, triggering further ice loss.[[20]](#footnote-20) Besides, declining permafrost will contribute to greenhouse gas emissions in the future.[[21]](#footnote-21) The global consequences include sea-level rise, ocean circulation variation in the North Sea, changes in weather patterns “in lower latitudes, even influencing Southeast Asian monsoons.”[[22]](#footnote-22) From a local perspective, climate change dramatically disrupts the arctic marine environment, including coastal erosion, redistribution of species, algae blooms and changes in ecosystems.[[23]](#footnote-23) Certainly, a warming Arctic Ocean will no longer be a remote and isolated environment. In fact, its current changes have already had ripple effects across the world.[[24]](#footnote-24)

3.1 Ice Management Techniques

This section presents the novel srm techniques that could potentially save the ice of the Arctic Ocean.[[25]](#footnote-25) Focusing on srm in the Arctic Ocean comes with the realisation that mitigation efforts, i.e., gradual reduction of greenhouse gas emissions, will most likely not prevent, at least until mid-century, the ongoing warming of the Arctic Ocean and the continuous ice loss and retreat. Consequently, it is worth exploring whether law could enable srm research in this area or not.

3.1.1 Arctic Marine Cloud Brightening

Marine cloud brightening enhances the reflection of clouds’ solar radiation. Dispersing seawater over the ocean increases “cloud droplet concentration … and thus cloud albedo.”[[26]](#footnote-26) In other words, it intends to make clouds whiter to decrease the absorption of solar radiation. This technique is presented as a regional alternative to preserve ice in the Arctic Ocean and therefore, some studies suggest that a potential deployment could be regionally constrained.[[27]](#footnote-27) Latham and others even argue that marine cloud brightening could “weaken hurricanes and reduce coral bleaching.”[[28]](#footnote-28) In the event of unforeseen consequences, the deployment could be terminated and after a few days, the seawater droplets would “rain or settle out of the atmosphere.”[[29]](#footnote-29) The main challenge is devising the technology (pumps, vessels, aircraft) to disperse the necessary seawater droplets. Whether marine cloud brightening could be, in fact, regionally constrained is a matter of controversy. Uncertainties remain concerning large-scale changes in weather patterns, ocean currents[[30]](#footnote-30) and ozone depletion.[[31]](#footnote-31)

3.1.2 Flooding – Refreezing

In 2017, Desch and others claimed that Arctic sea ice could be increased during winter by using wind-powered pumps to spray seawater on “the top surface of the ice.”[[32]](#footnote-32) Once in contact with the ice, pumped water will freeze and Arctic sea ice will thicken while the melting rate during the summer will decrease.[[33]](#footnote-33) The challenge to pump the amount of water required is considerable under extreme weather conditions.[[34]](#footnote-34) This technique is presented as benign since its ambition is to restore historical ice sea levels and in this regard, Bodansky and Hunt consider it similar to reforestation.[[35]](#footnote-35) Even if unintended consequences were to occur, those would be localised and probably feasible to revert.

Nonetheless, Desch and others also highlight that changes in precipitation patterns, effects on “frequency of mid-latitude storms,” and ecosystem alteration (due to significant deployment of wind-powered pumps) remain to be scrutinised. Miller and others raise serious concerns about the apparent innocuous nature of this technique. They explain the chemistry of ice and snow and how the natural ice formation process and melting result in the “exchange of materials with both the atmosphere and underlying water.”[[36]](#footnote-36) This natural process is not replicated when water is pumped on the top of the ice surface. This technique could “alter the … chemical characteristics of the ice with consequences for the biogeochemistry and ecology of the sea ice, the ocean and the atmosphere.”[[37]](#footnote-37)

3.1.3 Arctic Ocean Albedo Enhancement

In 2018, Field and others proposed preserving Arctic sea ice through *reversible and local* geoengineering.[[38]](#footnote-38) The authors propose to apply glass particles to sea ice. The particles will increase the reflectivity of solar radiation to restore historical ice levels.[[39]](#footnote-39) The technique is presented as benign because its deployment seems to have negligible effects on fish and birds.[[40]](#footnote-40) However, it remains to be answered how these particles will behave in the marine environment (sinking, floating and dissolving rate), their potential marine pollution effect, and the impacts on marine ecosystems.[[41]](#footnote-41) According to Field and others, the “optimal vehicle for deployment must combine long travel range, durable construction, and immense cargo volume due to the packing density of the material.”[[42]](#footnote-42) Miller and others emphasise possible changes in atmospheric chemistry caused by glass particles, particularly halogen and sulphur compounds.[[43]](#footnote-43)

3.2 Arctic Ice Management: A Global Issue

srm techniques were recognised as an international law matter from the outset due to its regional and global environmental risks.[[44]](#footnote-44) Arctic ice management techniques are presented as reversible and localised. The previous section highlighted ice management techniques’ potential regional and global risks from a natural science perspective. Although the local setting, the Arctic is not regionally constrained. The Arctic is foremost a political construction[[45]](#footnote-45) and from a political and legal perspective, it is an international region.

Defining the Arctic is not without controversy. [Figure 2.1](#CBML_ch02_fig_001) shows that the Arctic’s natural boundaries, including the marine environment, are subject to several delimitations. Characteristics such as temperature, i.e., 10°C July isotherm;[[46]](#footnote-46) the presence of permafrost; and treeline,[[47]](#footnote-47) have been used to describe different ‘natural’ boundaries of the Arctic. Today, the most accepted spatial delimitation comprises “terrestrial and marine areas north of the Arctic Circle (66°32’N), and north of 62°N in Asia and 60°N in North America, modified to include the marine areas north of the Aleutian chain, Hudson Bay, and parts of the North Atlantic Ocean including the Labrador Sea.”[[48]](#footnote-48) This regional delimitation ([Figure 2.1](#CBML_ch02_fig_001) purple line) includes eight States, i.e., Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, United States of America (U.S.).

The Arctic marine environment comprises areas within the national jurisdiction of five Arctic coastal States (i.e., Canada, Denmark, Norway, Russia, United States of America) and areas beyond national jurisdiction (i.e., the high seas and the areas) where all of the international community has vested interests, rights and obligations. Potential geoengineering research and governance must carefully consider these jurisdictional features.

Figure 2.1 Here

Figure 2.1. This figure is found at amap, Chapter 2: Physical/Geographical Characteristics of the Arctic in amap Assessment Report: Arctic Pollution Issues. Arctic Monitoring and Assessment Programme (amap), Oslo, 1998. The Arctic as defined by temperature (yellow line), the Arctic marine environment (blue line), the Arctic circle (dotted line) and the assessment area of the Arctic Council working group Arctic Monitoring & Assessment Programme (amap). amap’s geographical coverage intends to incorporate several definitions of the Arctic.

This section has illustrated the issue of climate geoengineering as a global problem within a local setting. While geoengineering aims to mitigate the global issue of climate change, it is a concrete measure that will be conducted in a specific physical location. From a legal perspective, this physical location has national, regional and global connotations. Thus, this chapter operates under an assumption that there is an additional value in examining the practice of geoengineering in such a local setting, rather than just as an abstract concept.

4 The Role of Law in the Risk Governance of Geoengineering Research

As has been demonstrated above, geoengineering is a risky business. Geoengineering governance thus holds great potential for future scenarios. This also follows from the theoretical perspective of risk governance that this chapter draws from, namely, understanding risk as constructive. Risks are not merely something pre-existing that should be handled upon discovery.[[49]](#footnote-49) This perhaps becomes even clearer in the context of the risk that is the centre of attention here: climate change. As we witness the legacy of earlier choices, we are forced to consider the consequences of current and future actions. This is illustrated to the extreme in so-called risk/risk scenarios or “clashes of precaution”, such as geoengineering.[[50]](#footnote-50) Geoengineering is an excellent example of how, when addressing one of the most profound risks to today’s society, climate change, technological development is still often posed as the answer. This reasoning comprises the inherent paradox that technological development also contributes to the current state of affairs regarding the climate, disclosing the dual nature of technology. It thus becomes clear that technology can mitigate as well as trigger new risks, all while at the same time changing the perception of socially accepted risks.[[51]](#footnote-51) With this in mind, we argue that risk governance in the case of geoengineering research needs to focus on how to mitigate existing and future risks and prioritise and choose between different risks. The result of this exercise will be of utmost relevance for future risk scenarios.

On the same note, Corry argues that mere visions of geoengineering help “to constitute the climate as a directly governable entity in certain ways” and thus have consequences on their own.[[52]](#footnote-52) In this chapter, we pick up from this and argue that international law holds the same potential, as it plays a significant role in shaping those visions through the governance of the associated risks. Consequently, law is seen as a co-creator of risk. These “legal imaginaries of the future” help establish a preferred interpretation of an issue and promote alternative visions.[[53]](#footnote-53) This approach also responds well to the shift in international law from *ex-post* regulation towards proactive governance.[[54]](#footnote-54)

As mentioned above, srm techniques comprise research and deployment, both of which require governance structures. The example of srm research, as opposed to deployment, interacts well with the theoretical approach. Thus, this delimitation is also a methodological choice. Our ambition is to make the constructiveness of risk visible. By focusing on this prior activity, which is needed to make deployment possible, it becomes clear how risk governance is not about managing existing risks but rather about shaping the future. The future existence/non-existence of geoengineering deployment and its consequences will be directly affected by the existence/non-existence of geoengineering research.[[55]](#footnote-55) Drawing on Sheila Jasanoff, geoengineering research is the songline that needs to be sung to pave the way for deployment.[[56]](#footnote-56) As pointed out by, i.e., Catriona McKinnon, the geoengineering community is already tuning up and thus, so should law.[[57]](#footnote-57)

Before moving on to the regulatory framework, something should be said about the precautionary principle. The principle is the basis of contemporary environmental regulation and risk governance is closely connected to it.[[58]](#footnote-58) In the case of geoengineering research, the precautionary principle can be used as an argument in favour of or against geoengineering research.[[59]](#footnote-59) Both lines of reasoning have also been carefully examined and advocated in the scientific community.[[60]](#footnote-60) Therefore, the precautionary principle does not provide the ‘right answer’ on whether geoengineering research should or should not be allowed.[[61]](#footnote-61) If used as a magic formula, it could conceal the political agenda of geoengineering, making geoengineering research seem objective and neutral when several circumstances connected to geoengineering relate to different values. For example, in the Arctic environment, where this chapter is situated, the interests of the local indigenous population may well collide with the international geoengineering agenda.[[62]](#footnote-62) Although no experiments have yet taken place in the Arctic marine environment, researchers conducted a field experiment concerning Arctic marine cloud brightening on a shallow lake in Barrow, Alaska. Although the researchers claimed they had the permissions to conduct such experiments, Arctic local community members were critical and argued they had no knowledge about the activities taking place in Barrow.[[63]](#footnote-63) Thus, geoengineering research governance should be mindful of this and resist a solely technical framing of the issue.[[64]](#footnote-64) Domestic authorisation processes should include environmental, social, and economic considerations and public participation processes. Public participation weighs stakeholders’ interests and elicits their local knowledge to devise criteria concerning the research legitimacy, the management and oversight structures.[[65]](#footnote-65)

5 Ice Management Research and the Law of the Sea: Current Regulatory Framework

This section analyses the current legal framework applicable to ice management research in the Arctic Ocean. From a regulatory perspective, the Arctic Ocean is governed by unclos. All Arctic coastal States except the U.S. are parties to this Convention. However, the U.S. is bound to customary law, including customs codified or that have emerged from unclos. In several forums, the U.S. refers to the law of the sea as the relevant legal framework[[66]](#footnote-66) to regulate the Arctic Ocean. In the Ilulissat Declaration, Arctic Coastal States affirmed:

the law of the sea provides for important rights and obligations concerning the delineation of the outer limits of the continental shelf, *the protection of the marine environment*, including ice-covered areas, freedom of navigation, *marine scientific research*, and other uses of the sea. We remain committed to this legal framework and to the orderly settlement of any possible overlapping claims. (emphasis ours)[[67]](#footnote-67)

Additionally, in 2017, Arctic States, including the U.S., adopted a treaty on Enhancing International Arctic Scientific Cooperation.[[68]](#footnote-68) The preamble recognises unclos, Part xiii, on marine scientific research as the relevant legal framework. Additionally, article 6 explicitly requires scientific applications to be processed in a manner consistent with unclos.

unclos does not explicitly regulate ice management research. However, Part xiii provides a general framework governing marine scientific research in areas within and outside national jurisdiction. An amendment (not in force) to the London Protocol explicitly regulates ocean fertilisation, a cdr technique.

unclos strives to balance individual and community interests. In principle, ice management research is not prohibited and its legality must be analysed in the light of the specific maritime zone, the jurisdictional rights and obligations of States and the provisions concerning marine environmental protection. Customary law principles, such as the no-harm rule, cooperation, and the seas’ peaceful use, are also endorsed in the provisions to conduct marine scientific research.[[69]](#footnote-69) Any marine scientific research must follow unclos’ general principles prescribed in articles 238–241. According to unclos, marine scientific research is a right to be exercised in accordance with its jurisdictional framework. It is not, however, an absolute right.[[70]](#footnote-70) Its exercise is subject to several conditions prescribed in Article 240. For instance, marine scientific research cannot ‘unjustifiably’ interfere with other uses of the sea, e.g., shipping or fishing and must be exercised “in compliance with all … regulations … for the protection and preservation of the marine environment.”[[71]](#footnote-71) These principles impose limitations on the exercise of marine scientific research. Article 240 also intertwines marine scientific research with Part xii on the protection of the marine environment. The latter becomes a valuable framework to evaluate ice management research. It is important to note that several global and regional treaties and soft law instruments amplify Part xii. Such instruments deal, for example, with marine pollution prevention, such as the London Convention and its Protocol or with the conservation of marine biological diversity. Such treaties may qualify or impose further conditions on marine geoengineering research.

5.1 unclos Jurisdictional Framework

5.1.1 Areas within National Jurisdiction

Internal waters are subject to the full sovereignty of the Arctic coastal States[[72]](#footnote-72) and are assimilated to land territory. International law imposes almost no restriction on the management of domestic environments. The most significant limitation on sovereignty concerns transboundary harm enshrined in the no-harm rule. This customary law principle imposes the duty to prevent significant “harm to the territory of other States and to collaborate in preserving the environment beyond national boundaries.”[[73]](#footnote-73) So, as long as ice management research has no significant transboundary effects and is conducted in light of unclos’ Part xii, coastal States have the sovereign right to legislate the matter as they please. No field ice management experiments have taken place in the Arctic marine environment. While researching Arctic Ocean albedo enhancement, Field and others conducted small field experiments within domestic environments, i.e., lakes, in Canada and the United States. One particular field experiment was conducted in the Arctic on a shallow lake in Barrow, Alaska.[[74]](#footnote-74)

In the territorial sea, Arctic coastal States also enjoy sovereignty subject to one limitation, i.e., the right of innocent passage. Coastal States have the exclusive right to regulate marine scientific research.[[75]](#footnote-75) Arctic Ocean albedo enhancement and Arctic marine cloud brightening may require ships to disperse glass particles or seawater droplets. Ships carrying out research or survey activities do not fall into the meaning of innocent passage and are subject to Arctic coastal State’s jurisdiction. As in internal waters, ice management research could be treated as a municipal law as long research has no significant transboundary effects. Coastal States “have the exclusive right to regulate, authorise and conduct marine scientific research.”[[76]](#footnote-76) Flooding requires building wind-driven pumps. Coastal States have jurisdiction over those installations.[[77]](#footnote-77) If building these structures is allowed, Arctic coastal States have the right to request ships to avoid certain parts of the territorial sea to protect the pumps and safeguard the marine scientific research.[[78]](#footnote-78) However, States are also obliged to provide alternative routes where ships can exercise their innocent passage right.[[79]](#footnote-79)

In the Exclusive Economic Zone (eez) and continental shelf, Arctic coastal States have sovereign rights over natural resources and have the jurisdictional right to regulate marine scientific research and jurisdiction over marine environmental protection. Other States enjoy, among others, the right of navigation and the right to conduct marine scientific research “with the consent of the coastal State.”[[80]](#footnote-80) In principle, ice management research cannot hamper freedom of navigation by making passage impossible or subject to restrictions (previous notification). Overall, coastal States enjoy a significant degree of discretion concerning the authorisation and regulation of marine scientific research. The limitations are the rights enjoyed by other States, e.g., navigation and the obligations concerning the marine environment.

Concerning ice management research, Field and others consider the Fram Strait to be a feasible location to conduct field albedo enhancement experiments.[[81]](#footnote-81) The waters forming such Strait are mainly territorial waters and eez of both Denmark and Norway, and the authorisations of these coastal States are required. The discretion arguably lessens if States or international organisations intend to conduct marine scientific research in the eez of another State. According to Article 246(3), ‘in normal circumstances’[[82]](#footnote-82) coastal States *must not uphold consent* to States or international organisations if these subjects intend to conduct research for “peaceful purposes and in order to increase scientific knowledge of the marine environment for the benefit of all mankind.” According to Scott, this phrase relates to ‘pure’ scientific research,[[83]](#footnote-83) which has “a privileged position in the presumption that coastal States will normally consent to research carried out in their exclusive economic zones or on their continental shelves.”[[84]](#footnote-84) It appears that ice management research is not subject to Article 246(3) because it does not primarily intend to increase ‘scientific knowledge of the marine environment’ rather than increase scientific knowledge to counteract climate change effects. Therefore, coastal States preserve their discretion to uphold consent. The right to uphold consent to conduct marine scientific research by third States or international organisations remains if the proposed research includes the activities detailed in Article 246(5). Particularly relevant for ice management research is the right to uphold consent if the research includes introducing harmful substances into the marine environment. Arctic Ocean albedo enhancement considers introducing glass particles on the ocean’s surface that could arguably constitute a harmful substance. Miller and others discuss the possible negative consequences of introducing glass particles for the biogeochemistry of marine ecosystems.[[85]](#footnote-85)

5.1.2 Areas outside National Jurisdiction

Marine scientific research is a freedom of the high seas.[[86]](#footnote-86) Apart from the general framework established in unclos Part xiii, Article 87(2) of unclos provides that freedoms of the high seas must be exercised “with due regard for the interests of other States in their exercise of the freedom of the high seas.” For ice management research, this implies a case-by-case analysis of the proposed activity, its scale and location. This information shall be used to assess whether the research unjustifiably interferes with other uses of the high seas. According to Article 143(1), in the Area, there is also a right to conduct marine scientific research “exclusively for peaceful purposes and for the benefit of mankind as a whole” and in accordance with unclos Part xiii.[[87]](#footnote-87) Article 143(1) relates to ‘pure’ research, which at this stage covers the ice management techniques presented in this chapter. The International Seabed Authority (isa) does not have a ‘general competence’ to regulate marine scientific research in the Area.[[88]](#footnote-88) It appears that States parties to unclos enjoy a high degree of discretion to allow ‘pure’ geoengineering techniques. Each State party must assess whether such research complies with Part xii and xiii of unclos. No field ice management research has yet taken place on the high seas or the area of the Arctic Ocean.

5.1.3 Agreement on Enhancing International Arctic Scientific Cooperation

This agreement implements unclos’s obligations to promote international cooperation and create favourable conditions for integrating scientific efforts to conduct marine scientific research.[[89]](#footnote-89) The third preambular paragraph reiterates the “urgent need for increased actions to mitigate and adapt to climate change”, and the preamble is telling since it recognises that earth climate and the oceans are interdependent. According to article 1, scientific activities “means efforts to advance understanding of the Arctic through scientific research, monitoring and assessment.” Such broad formulation coupled includes ice management research. In fact, the Agreement could inadvertently facilitate geoengineering research.

The agreement has no bearing on the jurisdictional framework previously discussed.[[90]](#footnote-90) The aim is to expedite decision-making procedures in accordance with the jurisdictional competences of the parties. Parties are obliged to develop legal and administrative procedures to facilitate the processes to allow researchers[[91]](#footnote-91) access to research areas (e.g., visas, clearances), infrastructure, facilities, and data.[[92]](#footnote-92) States are obliged to promote education and foster the training of future Arctic researchers.[[93]](#footnote-93) Research areas include zones within national jurisdiction identified by the parties in Annex I of the Agreement and areas beyond national jurisdiction.

5.2 The London Protocol

The permissive framework to conduct marine scientific research that we have previously discussed is not *per se* a shortcoming of unclos. This treaty is not an isolated instrument; it is an ‘umbrella treaty’ because it bridges several conventions concluded before and after its adoption.[[94]](#footnote-94) One of these instruments is the 1996 London Protocol to the 1972 London Convention on dumping, which explicitly regulates marine geoengineering (research and deployment). The Protocol applies to all maritime zones, other than internal waters.[[95]](#footnote-95)

In 2013, the State parties to the 1996 London Protocol on dumping adopted the following marine geoengineering definition:

deliberate intervention in the marine environment to manipulate natural processes, including to counteract anthropogenic climate change and/or its impacts, and that has the potential to result in deleterious effects, especially where those effects may be widespread, long lasting or severe[[96]](#footnote-96) (not in force)

This definition arguably includes ice management techniques. Since the ocean is an important carbon sink, ocean-related geoengineering has initially focused on carbon dioxide removal (cdr), particularly ocean fertilisation techniques, while little progress has been made concerning srm techniques.[[97]](#footnote-97) The Protocol also includes the following Article 6(bis)(1):

[c]ontracting Parties shall not allow the placement of matter into the sea from vessels, aircraft, platforms or other man-made structures at sea for marine geoengineering activities listed in annex 4, unless the listing provides that the activity of the subcategory of an activity may be authorised under a permit. (not in force)

This broad formulation indicates that the current regulatory trend in the law of the sea concerns the restriction of marine geoengineering activities. Two conditions qualify this general restriction. First, the Article refers to activities involving ‘placement of matter *into* the sea.’ Second, the restricted geoengineering activities are those established in Annex 4, i.e., ocean fertilisation.[[98]](#footnote-98) None of the ice management techniques discussed in this chapter relate to ocean fertilisation.

Of course, in the future, more geoengineering techniques could be included in Annex 4. Consequently, Article 6 (bis)(1) could be relevant for ice management. It is not without controversy whether ice management techniques qualify as ‘placement of matter into the sea.’ Introducing glass particles in the ocean surface for enhancing Arctic albedo falls within the scope of Article 6(bis)(1). Whether flooding and Arctic marine clouding brightening are within this Article’s scope is subject to debate. First, both techniques intend to use seawater. One can argue that ‘sea water’ is considered ‘matter’ for the purposes of this Article since the water is placed for marine geoengineering purposes. While flooding intends to place under seawater into the top surface of ice-covered areas in the Arctic Ocean, Arctic marine clouding brightening does not place matter into the water column. Seawater particles are intended to seed marine stratocumulus clouds.[[99]](#footnote-99) If the phrase ‘into the sea’ encompasses the water column and seabed of the marine environment, the atmosphere above the water column would be excluded.[[100]](#footnote-100) The London Protocol defines sea as “all marine waters … as well as the seabed and the subsoil thereof; it does not include sub-seabed repositories accessed only from land.” From this definition, it appears that Arctic marine clouding brightening would not be subject to Article 6(bis)(1).

One could also argue that the restriction refers to both deployment and research, but this is not the case. It refers exclusively to ocean fertilisation deployment. Annex 4 prescribes that ‘legitimate scientific research is allowed subject to a permit.’ To this end, Annex 5 includes an assessment framework for marine geoengineering research. This general framework is complemented by a specific risk assessment framework for scientific research involving ocean fertilisation adopted in 2010.[[101]](#footnote-101) The framework assessment in Annex 5 is a first step towards establishing conditions that qualify ‘legitimate scientific research.’ It establishes, among others, the objectives and purpose of research, consultation, assessment and risk management. Annex V puts ‘pure’ scientific research into a privileged position by demanding no “financial and/or economic gain arising directly from the experiment or the outcomes.”[[102]](#footnote-102)

6 Governance Structure: Current Trends and Future Outlook

6.1 The Governing Trap: A Permissive Framework for Conducting Ice Management Research

unclos provides a permissive framework where ice management research is easily accommodated and, therefore, engaging in geoengineering research is to a great degree a matter of discretion and ethics.[[103]](#footnote-103) Such discretion extends from the labelling of the research as geoengineering or something else (e.g., atmospheric studies, ice management), to the description of the scale, i.e., small, medium, large, to the risk assessment, to the appraisal of whether such research complies with Part xii and xiii of unclos. It also inevitably leads to an *ex-post-facto* evaluation to determine whether States complied with their obligations related to cooperation and protection of the marine environment.

It also leads to reactive regulation, as in the ocean fertilisation case, where regulatory efforts were triggered after research activities fuelled an international outcry.[[104]](#footnote-104) A further by-product of reactive regulation is a fragmented regulatory response. Once again, ocean fertilisation is a case in point. This fragmented regulatory response paves the way toward the ‘governance trap’ where multiple organisations partially govern geoengineering research with little coordination and overlapping mandates. The ice management techniques described in this chapter could be subject to multiple regimes, including, for example, the law of the sea (marine pollution in particular), Convention on Long-Range Transboundary Air Pollution, the Convention for the Protection of the Ozone Layer and its protocol and the Convention on Biological Diversity.[[105]](#footnote-105) The result will be regulatory fragmentation and overlapping.

Fragmentation constrains regulatory effectiveness. Even if the amendment to the London Protocol enters into force, its success will be limited. This Convention has only 53 State parties[[106]](#footnote-106) and the amendment will enter into force after two-thirds of the parties deposit their acceptance. About dumping, Article 210(6) of unclos prescribes that “national laws, regulations and measures shall be no less effective in preventing, reducing and controlling such pollution than the global rules and standards.” Due to the limited number of parties, the protocol still does not qualify as ‘global rules and standards.’ Scott even argues that legitimate geoengineering research relates to the “placement of matter for a purpose other than the mere disposal thereof.”[[107]](#footnote-107) Therefore, Article 210(6)[[108]](#footnote-108) is not applicable because this placement cannot be legally considered as dumping.

In accordance with 21.3 of the London Protocol and the principle *pacta tertiis nec nocent nec prosunt*, the amendment will only bind the accepting parties. Only six States (Estonia, Finland, Germany, Netherlands, Norway and United Kingdom) have accepted it.[[109]](#footnote-109) Under the general umbrella of unclos, non-state parties to the London Protocol can accommodate as ‘legal’ geoengineering research. In the Arctic Ocean, the effectiveness of this amendment will be even lower since two Arctic Coastal States, i.e., The United States of America and Russia, are not parties to the London Protocol.

Piecemeal regulation and non-consensus negotiations amplify regulatory fragmentation. The London Protocol amendment was apparently adopted by consensus. However, disagreements expressed by the parties were not addressed in the proposed text.[[110]](#footnote-110) Such disagreements may explain why the amendment has yet to enter into force. A majority rule approach to treaty negotiation could have negative consequences. For example, in the case of marine geoengineering, if dissatisfied, State parties have treaty law measures to circumvent the amendment. Parties could withdraw the Protocol and enter into a subsequent agreement.[[111]](#footnote-111) Overall, following this example of ice management techniques, to be successful and avoid an international conflict escalation and governance trap, the governance of geoengineering research requires a consensus approach.[[112]](#footnote-112) Consensus mitigates fragmentation and allows smooth legal development. This will be further explored in the following section.

6.2 Towards a Multilateral Governing Framework

If climate change reaches a point where srm geoengineering deployment will be inescapable, as some researchers contend,[[113]](#footnote-113) we need to establish an international research agenda setting the objectives, priorities, coordination mechanisms for funding, transfer of technology, and public participation processes. Solid scientific evidence is the only basis to assess whether geoengineering is feasible, effective, and safe. Some would argue that a research moratorium is the best governance alternative.[[114]](#footnote-114) This could be the case and such a decision must be taken by consensus at the international level since the most pressing question is related to geoengineering ethics,[[115]](#footnote-115) i.e., whether humankind should engage in geoengineering and the mechanism to manage risks that will emerge. If research is the gate to future deployment, its governance cannot be left to a piecemeal approach. Thus, we argue for *consensus* multilateral negotiations to adopt a framework geoengineering treaty.

A starting point to this multilateral negotiation is adopting an umbrella convention to flesh out shared values. The Convention should also create two treaty organs or organisations: one in charge of coordination and one in charge of research development oversight. One organisation/treaty organ should be in charge of developing cooperation mechanisms between the existing international organisations, both global and regional, that could eventually claim jurisdiction over geoengineering research. In practice, the existing regulatory and institutional framework can govern geoengineering research if coordination and common work agendas are established.[[116]](#footnote-116)

The second organisation/treaty organ should be similar to the Intergovernmental Panel on Climate Change (ipcc), with the capacity to provide policymakers with state-of-the-art scientific reports on the risks and opportunities of geoengineering techniques. Finally, the proposed framework treaty should be complemented by a technique-by-technique regulation because current scientific knowledge on climate geoengineering shows that there is no one size fits all governance response to geoengineering. cdr and srm are categories representing an initial effort to differentiate their characteristics and risks involved. However, cdr and srm include a range of techniques, each deserving particular regulation. Technique-by technique regulation may be adopted within the framework of existing legal regimes. The adoption of ocean fertilisation regulation under the London Protocol is a case in point.

Groundwork to build this umbrella Convention already exists. From an environmental perspective, Annex V of the London Protocol is a valuable starting point to define ‘legitimate geoengineering research.’ From a soft law perspective, researchers and scientific groups alike have put forward guiding principles concerning geoengineering. The most relevant are the Oxford Principles on geoengineering research,[[117]](#footnote-117) the Tollgate Principles,[[118]](#footnote-118) and the Asilomar Principles.[[119]](#footnote-119)

Scientists from the Royal Society and academics developed the Oxford Principles, which the Science and Technology Committee of the United Kingdom House of Common endorsed with certain modifications.[[120]](#footnote-120) The principles are:

1) geoengineering to be regulated as a public good;

2) public participation in geoengineering decision-making;

3) disclosure of geoengineering research and open publication of results;

4) independent assessment of impacts; and

5) Governance before deployment.[[121]](#footnote-121)

The Tollgate Principles highlight the geoengineering ethic’s dimension and they give substantive content to each Oxford principle. Particularly relevant for our discussion is recognising that governance before research is a necessary component of governance before deployment. Especially field research, on many occasions, depending on the scale, is no different from geoengineering deployment.[[122]](#footnote-122) Burger and Gundlach also argue that “research is unlikely to advance steadily without adequate governance”.[[123]](#footnote-123)

The Asilomar principles result from a conference where leading experts from academia, governmental and non-governmental organisations meet to discuss the future of geoengineering. These principles follow to some extent the Oxford principles:

1) Promoting collective benefit;

2) Establishing responsibility and liability;

3) Open and cooperative research;

4) Iterative evaluation and assessment; and

5) Public involvement and consent.[[124]](#footnote-124)

As Reynolds comments, these principles represent a self-regulatory approach.[[125]](#footnote-125) They are an attempt to make geoengineering research visible to policymakers. In other words, these principles aim to trigger a formal regulatory response. As such, they can certainly be used as a stepping-stone to build a common set of values for research governance.

A multilateral negotiation also needs to address essential questions of the moral hazard risk, i.e., whether geoengineering is, in fact, humanity’s last resort or should be seen as complementary to mitigation and adaptation endeavours.[[126]](#footnote-126) A crucial subject is the establishment of boundaries between laboratory and field experimentation and the meaning of small, medium, and large-scale field experimentation. This is relevant to elucidate if field experimentation will be allowed or subject to a moratorium (maybe large-scale field experimentation could be considered close to deployment rather than research).

Without a multilateral framework for geoengineering research, regionalism is an alternative worth exploring, especially concerning the Arctic marine environment. The Arctic Council is the leading regional organisation able to govern geoengineering research. The mandate of the Arctic Council is to promote cooperation and coordination “among Artic States, indigenous communities and other Arctic inhabitants on common Arctic issues, in particular issues of sustainable development and environmental protection of the Arctic.”[[127]](#footnote-127) The reference to *common issues* could easily accommodate geoengineering research.[[128]](#footnote-128) Additionally, the working and expert groups of the Arctic Council are active in the development of Arctic science scientific data collection, analysis, and outreach activities by making available summaries of their work to policymaking bodies.

The Royal Society pointed out the need to address geoengineering in a broader ethical, social, legal, and political frame rather than limiting its governance to a purely technical and scientific matter.[[129]](#footnote-129) The tripartite structure of the Arctic Council is particularly valuable to situate geoengineering research governance in this broader context. The organisation comprises eight States, six indigenous permanent participants and observers (i.e., non-Arctic States, intergovernmental and inter-parliamentary organisations, and ngo s).[[130]](#footnote-130) This structure transforms the Arctic Council into a platform that accommodates diverse or even conflicting interests of States and actors, including international organisations, indigenous communities, industry representatives, and civil organisation society. The organisation possesses inbuilt flexibility to engage actors from local to global, private and public. The possibility to engage a wide array of actors counteracts regulatory fragmentation to some extent.

The Arctic Council can map the legal regimes applicable to the Arctic marine environment and the authorities with potential jurisdiction over geoengineering research. Suppose such authorities, e.g., the Conference of the Parties to the London Convention or the Convention on Biological Diversity, enact regulation on geoengineering research. In that case, the Arctic Council can advise member States on the alternatives to implement and enforce such regulations in a coordinated matter.

A strength of the Arctic Council and its working groups is the adoption of numerous scientific reports in areas concerning the oceans, pollution, biodiversity, climate with an Arctic focus.[[131]](#footnote-131) With geoengineering research, the Arctic Council can serve a similar purpose. That endeavour would highlight the regional opportunities and risks of geoengineering and provide input to decision-making. The law-making capacity of the Arctic Council is, however, limited.[[132]](#footnote-132) Although the competence of the Arctic Council includes enacting soft law and even “new binding legal instruments”,[[133]](#footnote-133) there is a persistent ‘low commitment level’ of the member States to the Arctic Council to allow the institution to transition to a treaty-based organisation with a permanent budget.[[134]](#footnote-134)

7 Conclusions: Let the Genie out of the Bottle?

Scientific evidence indicates that the Arctic marine environment will continue to warm during the following decades, even in the most promising climate change mitigation scenario. The result will be the loss of ice both in thickness and extent. Preserving the Arctic ice is of paramount importance for global climate regulation and preserving marine Arctic ecosystems. Recent scientific research advances the possibility to deploy geoengineering techniques to restore Arctic sea ice to its historical levels. Ice management is argued to be reversible and its consequences regionally constrained, but sceptical views already confront these bold affirmations.

Overall, geoengineering research is happening. The genie is already out of the bottle. Exposing the risks of geoengineering, i.e., moral risk, slippery slope, governance trap, and international conflict escalation, does not automatically deter further research. We argue that international law is a co-creator of risk and not a passive recipient of scientific and policy developments and must take this role seriously. Currently, it is not comprehensively addressing geoengineering research governance. This inaction is already shaping the future, not only of research but also of deployment. From a regulatory perspective, the future now includes a permissive and discretionary framework that easily accommodates geoengineering research. This risk governance is heading towards a governance trap, i.e., ex-post evaluation of research, reactive regulation, regulatory fragmentation, and multiple institutions claiming jurisdiction.

In the absence of multilateral research governance, we argue that the Arctic Council should take a leading coordinator role concerning geoengineering research in the Arctic. In this scenario, and considering the structure of the Arctic Council, the future of geoengineering research will not be exclusively informed from a technocratic perspective but rather a broader social, economic and political context of the region.

Finally, we argue for a multilateral treaty negotiated by consensus and for the establishment of an organisation similar to the Intergovernmental Panel on Climate Change (ipcc). By establishing the common values of what geoengineering research should entail, law will either enable the path towards or ward off a climate engineering revolution.

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figure 2.1 Arctic boundaries

Note: ibid.

1. Intergovernmental Panel on Climate Change (ipcc) ‘*The Ocean and Cryosphere in a Changing Climate’* (24 September 2019) 3. [↑](#footnote-ref-1)
2. Intergovernmental Panel on Climate Change (ipcc) ‘*Climate Change 2014 Synthesis Report: Summary for Policymakers’* (2014) 2. [↑](#footnote-ref-2)
3. Arctic Monitoring and Assessment Programme (amap) ‘*Snow, Water, Ice and Permafrost in the Arctic: Summary for Policy-makers’* (2017) 8. [↑](#footnote-ref-3)
4. Importantly, it does not mean however that mitigation efforts are meaningless. Substantial reduction of emission will stabilize the Arctic. Nonetheless, “the changes underway in the Arctic are expected to continue through at least mid-century, substantial global reductions in net greenhouse gas emissions can begin to stabilize some trends (albeit at higher levels than today) after that.” ibid 6. [↑](#footnote-ref-4)
5. Also known as climate engineering, refers to the “deliberate large-scale intervention in the Earth’s climate system to moderate global warming.” The Royal Society ‘*Geoengineering the Climate: Science, Governance and Uncertainty*’ (September 2009) ix. [↑](#footnote-ref-5)
6. “Various techniques have been proposed to produce this effect; these involve brightening the Earth’s surface, introducing reflective matter into the atmosphere, or inserting light scattering material in space between the Sun and the Earth.” ibid ix and 23. [↑](#footnote-ref-6)
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8. The first proponent of the moral hazard was Stephen Schneider, ‘Geoengineering: Could – or Should – We Do It?’ (1996) 33 Climate Change 291. [↑](#footnote-ref-8)
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10. Albert Lin, ‘The Missing Pieces of Geoengineering Research Governance’ (2016) 6 Minnesota Law Review 2509. Michael Burger and Justin Gundlach, ‘Research Governance’ in Michael Gerrard and Tracy Hester (eds), *Climate Engineering and the Law: Regulation and Liability for Solar Radiation Management and Carbon Dioxide Removal* (cup 2018). [↑](#footnote-ref-10)
11. Burger and Gundlach (n 11) 280–281. [↑](#footnote-ref-11)
12. “There is a broad consensus on several basic points pertaining to the relationship between climate engineering research and its governance. First, governance should precede deployment of climate engineering technology even if governance does not precede all research.” Ibid 269. [↑](#footnote-ref-12)
13. Steven Desch and others, ‘Arctic Ice Management’ (2017) 5 Earth’s Future 107, 112. Bodansky and Hunt (n 8) ‘596. [↑](#footnote-ref-13)
14. Desch and others, (n 14) 111 -112. See also, L. Field and others, ‘Increasing Arctic Sea Ice Albedo Using Localized Reversible Geoengineering’ (2018) Earth’s Future. S. Tilmes and others, ‘Can regional climate engineering save the summer Arctic sea ice?’ (2014) 41 Geophysical Research Letters 880. Lisa Miller and others, ‘Implication of Sea Ice Management for Arctic Biogeochemistry’ (2020) 101 eos . [↑](#footnote-ref-14)
15. Bodansky and Hunt (n 8) 596. [↑](#footnote-ref-15)
16. Modeling and laboratory studies pose little to no risk of impact to the climate, environment, or society, and so new governance mechanisms are not likely to be needed. Asilomar Scientific Organizing Committee, *The Asilomar Conference: Recommendations on Principles for Research intoClimate Engineering Techniques* (November 2010) 18 . [↑](#footnote-ref-16)
17. *Infra* Section 2.1. [↑](#footnote-ref-17)
18. Desch and others (n 14) 121. [↑](#footnote-ref-18)
19. ipcc, *The Ocean and Cryosphere in a Changing Climate* (n 1) 3. [↑](#footnote-ref-19)
20. Donald Perovich and others, ‘Sunlight, water, and ice: Extreme Arctic sea ice melt during the summer of 2007’ (2008) 35 Geophysical Research Letters 1. [↑](#footnote-ref-20)
21. amap (n 3) 5. Susan Natali and others, ‘Large loss of CO2 in winter observed across the northern permafrost region’ (November 2019) 9 Nature Climate Change 852. [↑](#footnote-ref-21)
22. amap (n 3) 3–6. [↑](#footnote-ref-22)
23. O.A. Anisimov and others, ‘Polar regions (Arctic and Antarctic) Climate Change 2007: Impacts, Adaptation and Vulnerability’ in M.L Parry and others (eds), *Climate Change 2007: Impacts, Adaptation and Vulnerability Contribution of Working Group ii to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (cup 2007) 665. [↑](#footnote-ref-23)
24. “The Arctic is bearing the brunt of global warming, and these effects have the potential to trigger a series of tipping points, which, in turn, scientists worry, could irreversibly alter the balance of the earth’s system, at least as it prevailed during the last 10,000 years of the Holocene.” Klaus Dodds and Mark Nuttall, *The Arctic: What Everyone Needs to Know®* (oup 2019) 203. [↑](#footnote-ref-24)
25. Consequently, traditional srm techniques, such as space-based reflectors and stratospheric aerosols injection, are outside the scope of this chapter. Carbon dioxide removal (cdr) techniques are also excluded from this chapter. [↑](#footnote-ref-25)
26. John Latham and others, ‘Marine cloud brightening: regional applications’ (2014) 372 Philosophical Transactions of the Royal Society A 1 2. [↑](#footnote-ref-26)
27. Latham and others mention that marine cloud brightening “differs from some other srm strategies in that it could in principle also be deployed on a much less than global scale, thus offering a range of regional applications.” ibid 3. According to Desch “Sulfate aerosols would effectively block sunlight, but with considerable negative side effects; a more environmentally benign mechanism would seem to be the technique of marine cloud brightening, by which cloud cover is increased by introduction of cloud condensation nuclei into the lower atmosphere” Desch and others,’ (n 14) 112. [↑](#footnote-ref-27)
28. Latham and others (n 27) 1. [↑](#footnote-ref-28)
29. The Royal Society (n 5) 28. [↑](#footnote-ref-29)
30. ibid 28. [↑](#footnote-ref-30)
31. Hannah Horowitz and others, ‘Effects of Sea Salt Aerosol Emissions for Marine Cloud Brightening on Atmospheric Chemistry: Implications for Radiative Forcing’ (2020) 47 Geophysical Research Letters 1. [↑](#footnote-ref-31)
32. Desch and others, (n 14) 112. [↑](#footnote-ref-32)
33. ibid 112–116. [↑](#footnote-ref-33)
34. ibid. [↑](#footnote-ref-34)
35. Bodansky and Hunt, (n 8) 608. [↑](#footnote-ref-35)
36. Miller and others (n 15) 2. [↑](#footnote-ref-36)
37. ibid. [↑](#footnote-ref-37)
38. Field and others, (n 15) 897. [↑](#footnote-ref-38)
39. ibid 882. [↑](#footnote-ref-39)
40. ibid 883. [↑](#footnote-ref-40)
41. ibid 900. [↑](#footnote-ref-41)
42. ibid. [↑](#footnote-ref-42)
43. Miller and others (n 15) 4. [↑](#footnote-ref-43)
44. Joshua Horton and Jesse Reynolds, ‘The International Politics of Climate Engineering: A Review and Prospectus for International Relations’ (2016) 18 International Studies Review 438–440. [↑](#footnote-ref-44)
45. On the history about the transformation of the Arctic into a distinctive region see Douglas Nord, *The Arctic Council: Governance within the Far North* (Routledge 2016). [↑](#footnote-ref-45)
46. Janine Murray, ‘Physical/Geographical Characteristics of the Arctic’ in Arctic Monitoring and Assessment Programme amap, *Assessment Report: Arctic Pollution Issues* (1998) 9. [↑](#footnote-ref-46)
47. ibid 9–10. [↑](#footnote-ref-47)
48. ibid 10. [↑](#footnote-ref-48)
49. Risk is a verb rather than a noun. Following this, risk governance is about “rearticulating the collapsed future of late modernity,” which then is decisive for the following course of action. Gerda Reith, ‘Uncertain Times: The Notion of ‘Risk’ and the Development of Modernity’ (2004) 13 Time & Society 383, 398. [↑](#footnote-ref-49)
50. Grant Wilson, ‘Minimizing Global Catastrophic and Existential Risks from Emerging Technologies Through International Law’ (2013) 31 Virginia Environmental Law Journal 307, 359. Floor M. Fleurke, ‘Catastrophic Climate Change, Precaution, and the Risk/Risk Dilemma’ in W. G. Werner, R. Rayfuse and Monika Ambrus (eds), *Risk and the Regulation of Uncertainty in International Law* (oup 2017). Rosemary Rayfuse and Shirley V. Scott, ‘Mapping the impact of climate change on international law’ in Rosemary Rayfuse and Shirley V. Scott (eds), *International law in the era of climate change* (Edward Elgar 2012) 19–20. [↑](#footnote-ref-50)
51. As is also explored by Rosemary Rayfuse, ‘Public International Law and the Regulation of Emerging Technologies’ in Roger Brownsword, Eloise Scotford and Karen Yeung (eds), *The Oxford Handbook of Law, Regulation and Technology* (oup 2017). [↑](#footnote-ref-51)
52. Olaf Corry, ‘Globalising the Arctic Climate: Geoengineering and the Emerging Global Polity’ in Kathrin Keil and Sebastian Knecht (eds), *Governing Arctic Change: Global Perspective* (Palgrave Macmillan 2017), 66. [↑](#footnote-ref-52)
53. W. G. Werner, Rosemary Rayfuse and Monika Ambrus, ‘Risk and International Law’ in W. G. Werner, Rosemary Rayfuse and Monika Ambrus (eds), *Risk and the Regulation of Uncertainty in International Law* (oup 2017), 5–6. [↑](#footnote-ref-53)
54. Rayfuse (n 53) 500–501. [↑](#footnote-ref-54)
55. This division between governance of research versus deployment have been made by many before. See e.g. Lin, ‘The Missing Pieces of Geoengineering Research Governance’ (n 11) 2546; McKinnon (n 10) 445–450. Lisa Dilling and Rachel Hauser, ‘Governing geoengineering research: why, when and how?’ (2013) 121 Climatic Change 1. Jennie Stephens and Kevin Surprise, ‘The hidden injustices of advancing solar geoengineering research’ (2020) 3 Global Sustainability. Jane Flegal and Aarti Gupta, ‘Evoking equity as a rationale for solar geoengineering research? Scrutinizing emerging expert visions of equity’ (2018) 18 International Environmental Agreements: Politics, Law and Economics 45. who all specifically argue for or focus on governance of geoengineering research. [↑](#footnote-ref-55)
56. Sheila Jasanoff, ‘The Songlines of Risk’ (1999) 8 Environmental Values 135. Jasanoff refers to Bruce Chatwin, *The Songlines* (Vintage 1998). [↑](#footnote-ref-56)
57. McKinnon (n 10) 442. See also Cinnamon Carlarne, ‘Arctic dreams and geoengineering wishes: the collateral damage of climate change’ (2011) 49 Columbia journal of transnational law 637. [↑](#footnote-ref-57)
58. The principle is commonly considered to be a part of customary international law, which binds all states notwithstanding any treaty, Rayfuse(n 53) 512. “Although omitted as an explicit principle within unclos itself, the precautionary approach has evolved within both treaty law and custom to provide a fundamental component of the decision-making process in the context of activities likely to have a significant detrimental impact on the marine environment, and this has been confirmed by the International Court of Justice (icj) and the Seabed Disputes Chamber of the International Tribunal for the Law of the Sea (itlos).” Karen Scott, ‘Mind the Gap: Marine Geoengineering and the Law of the Sea’ in Robert Beckman and others (eds), *High Seas Governance: Gaps and Challenges* (Brill/Nijhoff 2018) 44. [↑](#footnote-ref-58)
59. This duality is also demonstrated by e.g. Fleurke (n 52) 200; Elizabeth Tedsen and Gesa Homann, ‘Implementing the Precautionary Principle for Climate Engineering Special Issue on Climate Change Geoengineering (Part I)’ (2013) 2013 Carbon & Climate Law Review 90. Karen Scott, ‘International Law in the Anthropocene: Responding to the Geoengineering Challenge’ (2013) 34 Michigan Journal of International Law 309. [↑](#footnote-ref-59)
60. See for example Philomene Verlaan, ‘Geo-Engineering, the Law of the Sea, and Climate Change Thematic Focus: Climate Change and the Law of the Sea’ (2009) Carbon & Climate L Rev 446. Jesse Reynolds and Floor Fleurke, ‘Climate Engineering Research: A Precautionary Response to Climate Change’ (2013) 2 Carbon & Climate Law Review 101. Kerstin Güssow and others, ‘Ocean iron fertilization: Why further research is needed’ (2010) 34 Marine Policy 911. [↑](#footnote-ref-60)
61. See also Fleurke (n 52) 203. [↑](#footnote-ref-61)
62. Corry (n 54) 71. [↑](#footnote-ref-62)
63. Dru Jay, ‘Arctic Geoengineering Experiment is Dangerous, Lacks Community Consent: Inupiaq Organizer’ *Geoengineering Monitor* <www.geoengineeringmonitor.org/2019/02/arctic-geoengineering-experiment-is-dangerous-lacks-community-consent-inupiaq-organizer/> accessed 22 October 2021. [↑](#footnote-ref-63)
64. The Royal Society (n 5) xi. See also Flegal and Gupta (n 57) 56. [↑](#footnote-ref-64)
65. Asilomar Scientific Organizing Committee (n 17) 9. Science and Technology Committee, *The Regulation of Geoengineering* (House of Commons 18 March 2010). Stephen Gardiner and Augustin Fragnière, ‘The Tollgate Principles for the Governance of Geoengineering: Moving Beyond the Oxford Principles to an Ethically More Robust Approach’ (2018) 21 Ethics, Policy & Environment 143. Rob Bellamy, Javier Lezaun and James Palmer, ‘Public Perceptions Of Geoengineering Research Governance: An Experimental Deliberative Approach’ (2017) 45 Global Environmental Change 194. Engineering National Academies of Sciences, and Medicine, *Reflecting Sunlight: Recommendations for Solar Geoengineering Research and Research Governance* (The National Academies Press 2021). [↑](#footnote-ref-65)
66. Megan Campbell, *United States Arctic Ocean Management & the Law of the Sea Convention* (oceans 2008). It is important to notice, that this paper was written reflecting the author’s opinion and “do not necessarily reflect the views of noaa, doc or the U.S. Government.”. [↑](#footnote-ref-66)
67. Arctic Ocean Conference, *Ilulissat Declaration* (Greenland 28 May 2008). retrieved from <https://cil.nus.edu.sg/wp-content/uploads/2017/07/2008-Ilulissat-Declaration.pdf> accessed 22 October 2021. [↑](#footnote-ref-67)
68. Agreement on Enhancing International Arctic Scientific Cooperation (adopted 11 May 2017, entered into force 23 May 2018) <https://oaarchive.arctic-council.org/handle/11374/1916 archive> accessed 22 October 2021. [↑](#footnote-ref-68)
69. United Nations Convention on the Law of the Sea (adopted 10 December 1982, entered into force 16 November 1994) 1833 unts 397 (unclos) arts 240(a), 242, 243. [↑](#footnote-ref-69)
70. Myron H. Nordquist and others (eds), *United Nations Convention on the Law of the Sea 1982: A Commentary*, vol iv (Martinus Nijhoff Publishers. 1991) 455. [↑](#footnote-ref-70)
71. unclos (n 71) art 240(c) (d). [↑](#footnote-ref-71)
72. There is only one exception, according to unclos (n 71) Article 8.2.: “[w]here the establishment of a straight baseline in accordance with the method set forth in article 7 has the effect of enclosing as internal waters areas which had not previously been considered as such, a right of innocent passage as provided in this Convention shall exist in those waters.”. [↑](#footnote-ref-72)
73. Gabriela Argüello, *Marine Pollution, Shipping Waste and International Law* (Routledge Research in International Environmental Law, Routledge 2019) 37. See also *Trail Smelter (Canada v United States),* 3 riaa 716 (1938 and 1941) and the *Lac Lanoux Arbitration (France v Spain)*, 24 ilr 101 (1957). [↑](#footnote-ref-73)
74. Field and others (n 15) 883–888. [↑](#footnote-ref-74)
75. unclos (n 71) art 17. [↑](#footnote-ref-75)
76. ibid art 245. [↑](#footnote-ref-76)
77. ibid art 258. [↑](#footnote-ref-77)
78. ibid art 21(1)(c)(g). [↑](#footnote-ref-78)
79. ibid arts 24 and 245. [↑](#footnote-ref-79)
80. ibid arts 56, 77 and 246. [↑](#footnote-ref-80)
81. Field and others (n 15) 889. [↑](#footnote-ref-81)
82. “Normal circumstances” may exist in spite of the absence of diplomatic relations between the coastal State and the researching State” unclos (n 71) arts 56, 77 and 246. [↑](#footnote-ref-82)
83. “The concept of marine scientific research usually covers two types of research, namely, ‘fundamental or ‘pure’ research and ‘applied’ or ‘resources-oriented research” Yoshifumi Tanaka, *The International Law of the Sea* (3 edn, cup 2018) 434. [↑](#footnote-ref-83)
84. Karen Scott, *Not an Intractable Challenge: Geoengineering MSR in ABNJ* (Brill/Nijhoff 2021) 198. [↑](#footnote-ref-84)
85. Miller and others (n 15) 1–6. [↑](#footnote-ref-85)
86. unclos (n 71) art 87(1)(f). [↑](#footnote-ref-86)
87. ibid art 143. [↑](#footnote-ref-87)
88. Donald Rothwell and Tim Stephens, *The International Law of the Sea* (2 edn, Hart Publishing Ltd 2016) 361. [↑](#footnote-ref-88)
89. unclos (n 71) arts 242(1) and 243. [↑](#footnote-ref-89)
90. art 16 of the Agreement (n 70) prescribes: “Nothing in this Agreement shall be construed as altering the rights or obligations of any Party under other relevant international agreements or international law.” [↑](#footnote-ref-90)
91. art 1 of the Agreement (n 70) refer to researchers as participants who are defined as: “Parties’ scientific and technological departments and agencies, research centers, universities and colleges, and contractors, grantees and other partners acting with or on behalf of any Party or Parties, involved in Scientific Activities under this Agreement.”. [↑](#footnote-ref-91)
92. ibid arts 5, 6, and 7. [↑](#footnote-ref-92)
93. ibid art 8. [↑](#footnote-ref-93)
94. Alan Boyle, ‘Reflections on the Treaty as a Law Making Instrument’ in Akexander Orakhelashvili and Sarah Williams (eds), *40 Years of the Vienna Convention on the Law of Treaties* (British Institute of International and Comparative Law 2000) 9. [↑](#footnote-ref-94)
95. Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (adopted 7 November 1996, entered into force 24 March 2006) 36 i.l.m. 7 (1997) (London Protocol) art 1(7). [↑](#footnote-ref-95)
96. art 5 bis. Eight Meeting of the Contracting Parties to the 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, *Annex iv: Resolution LP. 4(8) on the Amendment to the London Protocol to Regulate the Placement of Matter for Ocean Fertilization and other Marine Geoengineering Activities* (18 October 2013). The amendments are not in force yet. [↑](#footnote-ref-96)
97. Scott, *Not an Intractable Challenge: Geoengineering MSR in ABNJ* (n 86). 194. [↑](#footnote-ref-97)
98. This is cdr technique defined in Annex 4 (1)(1) of the amendment (n 98) as “any activity undertaken by humans with the principal intention of stimulating primary productivity in the oceans. Ocean fertilization does not include conventional aquaculture or mariculture or the creation of artificial reef.” [↑](#footnote-ref-98)
99. Latham and others (n 27) 2. [↑](#footnote-ref-99)
100. Whether the atmosphere above the water column is part of the marine environment is controversial. According to Harrison, “several proposals advanced during the negotiation process included the air space above the water column within the definition of the *marine environment,* although none of them were adopted … even if one accepts that unclos ‘does not address directly the problem of pollution of the atmosphere itself,’ it explicitly covers ‘pollution of the marine environment from or through the atmosphere,’ thereby recognizing the complex interactions between the atmosphere and the oceans.” James Harrison, *Saving the Oceans through Law: The International Legal Framework for the Protection of the Marine Environment* (oup 2017) 24. [↑](#footnote-ref-100)
101. Fifth Meeting of the Contracting Parties to the London Protocol, *Resolution LC-LP.2(2010) on the Assessment Framework for Scientific Research Involving Ocean Fertilization* (14 October 2010). The assessment framework for marine geoengineering research when adopted in 2010 is not binding. Article 6(bis)(2) prescribes: Contracting Parties shall adopt administrative or legislative measures to ensure that the issuance of permits and permit conditions comply with provisions of annex 5 and takes into account any Specific Assessment Framework developed for an activity and adopted by the Meeting of the Contracting Parties. Verlaan explains that the 2010 assessment framework “will be legally binding when the amendments to the LP enter into force.” Philomene Verlaan, ‘London Convention and London Protocol: New Regulation of Marine Geo-engineering and Ocean Fertilization’ (2013) 28 Marine and Coastal Law 729. [↑](#footnote-ref-101)
102. Eight Meeting of the Contracting Parties to the 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (n 98). [↑](#footnote-ref-102)
103. Scott, *Not an Intractable Challenge: Geoengineering MSR in ABNJ* (n 86). [↑](#footnote-ref-103)
104. Zach Horton, ‘Going Rogue or Becoming Salmon? Geoengineering narratives in Haida GWAII’ (2017) 97 Cultural Critique 128. [↑](#footnote-ref-104)
105. Convention on Long Range Transboundary Air Pollution (adopted 13 November 1979 entered into force 16 March 1983) 1302 unts 217. United Nations Convention on the Law of the Sea (adopted 1o December 1982 entered into force 1 November 1994) 1833 unts 397. Vienna Convention for the Protection of the Ozone Layer (adopted 22 March 1985 entered into force 22 September 1988) 1513 unts 293. Montreal Protocol on Substances that Deplete the Ozone Layer (adopted 16 September 1987 entered into force 1 January 1989) 1522 unts 3. Convention on Biological Diversity (adopted 5 June 1992 entered into force 29 December 1993) 1760 unts 79. [↑](#footnote-ref-105)
106. International Maritime Organization (imo), *Status of IMO Treaties: Comprehensive information on the status of multilateral Conventions and instruments in respect of which the International Maritime Organization or its Secretary-General performs depositary or other functions* (15 September 2020) 555. [↑](#footnote-ref-106)
107. unclos (n 71) art 1(5)(b.ii). [↑](#footnote-ref-107)
108. Scott, *Not an Intractable Challenge: Geoengineering MSR in ABNJ* (n 86) 201–202. [↑](#footnote-ref-108)
109. imo (n 108) 560. [↑](#footnote-ref-109)
110. Japan for example, stated that “it feared some fishing aspects could be inadvertently regulated by this amendment. While not wishing to stand in the way of consensus, Japan stressed that fisheries are an important issue from a Japanese perspective … and it was consequently concerned that the amendment might not be accepted” cop to the London Protocol, *lc 35/15 Report of the Thirty-Fifth Consultative Meeting and the Eighth Meeting of Contracting Parties to the London Protocol* (14–18 October 2013) 4.13. [↑](#footnote-ref-110)
111. Vienna Convention on the Law of Treaties (adopted 23 May 1969, entered into force 27 January 1980) UN Doc.A/Conf.39/27, 1155, unts 331, 8 ilm 679 art 41 . In theory States parties could potentially modify or suspend the treaty or parts of it, but these alternatives are not without difficulty. Treaty modification and suspension must fulfill the requirements of articles 41, 42 and 43 of the Vienna Convention. When making such appraisal, one must consider that the London Protocol is not an isolated instrument regulating exclusively the relations of the parties. It must be analyzed in the light of unclos and other treaties dealing with marine pollution since they are interconnected. Concerning the interconnection of treaty law see Joost Pauwelyn, ‘Bridging Fragmentation and Unity: International Law as a Universe of Inter-Connected Islands’ (2004) 25 Michigan Journal of International Law 903. [↑](#footnote-ref-111)
112. Sophie Gambardella, ‘The Stormy Emergence of Geoengineering in the International Law of the Sea’ (2019) 13 Carbon & Climate Law Review: cclr 122 129, who criticizes a “strong decline of multilateralism” and the “political stalemates”. [↑](#footnote-ref-112)
113. Rob Bellamy and Peter Healey, ‘‘Slippery slope’ or ‘uphill struggle’? Broadening out expert scenarios of climate engineering research and development’ (2018) 83 Environmental Science and Policy 1. [↑](#footnote-ref-113)
114. Timm Betz and Barbara Koremenos, ‘Monitoring Processes’ in Jacob Katz Cogan, Ian Hurd and Ian Johnstone (eds), *The Oxford Handbook of International Organizations* (oup 2016). [↑](#footnote-ref-114)
115. Gardiner and Fragnière (n 67) 143. [↑](#footnote-ref-115)
116. See eg, Scott, ‘International Law in the Anthropocene: Responding to the Geoengineering Challenge’ who proposes a geoengineering protocol to the 1992 UNFCC. For further reflections of governance options, see also Daniel Bodansky, ‘The who, what, and wherefore of geoengineering governance’ (2013) 121 Climatic Change 539. [↑](#footnote-ref-116)
117. The Oxford Principles are published in <www.geoengineering.ox.ac.uk/www.geoengineering.ox.ac.uk/oxford-principles/principles/index.html> accessed 12 November 2020. [↑](#footnote-ref-117)
118. Gardiner and Fragnière (n 67). [↑](#footnote-ref-118)
119. Asilomar Scientific Organizing Committee (n 17). [↑](#footnote-ref-119)
120. Science and Technology Committee (n 67). [↑](#footnote-ref-120)
121. The Oxford Principles (n 119). [↑](#footnote-ref-121)
122. Gardiner and Fragnière (n 67) 159–161. [↑](#footnote-ref-122)
123. Burger and Gundlach (n 11) 265. [↑](#footnote-ref-123)
124. Asilomar Scientific Organizing Committee (n 17) 9. [↑](#footnote-ref-124)
125. Jesse Reynolds, ‘Solar geoengineering to reduce climate change: a review of governance proposals’ (2019) 475 Proceedings of the Royal Society A 1 2. [↑](#footnote-ref-125)
126. Horton and Reynolds (n 44). [↑](#footnote-ref-126)
127. Ottawa Declaration, *Declaration on the Establishment of the Arctic Council* (September 19 1996) art 1(a). [↑](#footnote-ref-127)
128. Bjørnar Egede-Nissen and Henry Venema, *Desperate Times, Desperate Measures: Advancing the geoengineering debate at the Arctic Council* (International Institute for Sustainable Development (iisd) (2009). [↑](#footnote-ref-128)
129. The Royal Society (n 5)d xi. [↑](#footnote-ref-129)
130. Nord (n 46) Ch 2. [↑](#footnote-ref-130)
131. The work of the Arctic Council can be consulted at its webpage <https://arctic-council.org/en/> accessed 12 November 2020. [↑](#footnote-ref-131)
132. For further reflections on the capacity and potential of the Council to act relating to geoengineering, see Jane Long, ‘A Prognosis, and Perhaps a Plan, for Geoengineering Governance’ (2013) 7 Carbon & Climate Law Review: cclr 177. [↑](#footnote-ref-132)
133. ‘Framework for the Strengthening the Arctic Council’ in Senior Arctic Officials (sao) Report to Ministers. Nuuk, (Greenland, May 2011). [↑](#footnote-ref-133)
134. Timo Koivurova, ‘Limits and possibilities of the Arctic Council in a rapidly changing scene of Arctic governance’ (2010) 46 Polar Record 146, 148. [↑](#footnote-ref-134)