TIME FOR A NEW INTERNATIONAL LEGAL REGIME FOR OCEAN FERTILIZATION IN THE HIGH SEAS?

Glen Jeffries

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ABBREVIATIONS

AMAP	Arctic Monitoring and Assessment Programme
CBD	Convention on Biological Diversity
COP	Conference of the Parties
CO_2	Carbon dioxide
DOALOS	Division for Ocean Affairs and the Law of the Sea at the United Nations
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
FAO	Food & Agriculture Organization of the United Nations
GRGP	Geoengineering Research Governance Project
G77	The Group of 77
ICJ	International Court of Justice
IEA	International Energy Agency
ILBI	International legally binding instrument
ILM	International Legal Materials
IMO	International Maritime Organization
IPCC	Intergovernmental Panel on Climate Change
LC	London Convention
LC-LP	London Convention and London Protocol, jointly
LOSB	Law of the Sea Bulletin
LOSC	United Nations Convention on the Law of the Sea
LP	Protocol to London Convention
NASA	National Aeronautics & Space Administration
NGO	Non-governmental organisation
PCA	Permanent Court of Arbitration
PrepComm	Preparatory Committee established by UN Resolution 69/292
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UNGA	United Nations General Assembly
UNTS	United Nations Treaty Series
USTS	United States Treaty Series
WWF	World Wide Fund for Nature

CHAPTER A: INTRODUCTION

1. OBJECTIVE OF THE THESIS

The objective of the thesis is to answer the question of whether it is time for a new international legal regime in respect of ocean fertilization in the high seas. This question can only be answered by combining a detailed assessment of the current international legal regime for ocean fertilization with an analysis of potential additions and alternatives.

In the opinion of the author, such a review is timely for a number of reasons. First, ocean fertilization is on the global agenda: scientists continue to evaluate ocean fertilization in the context of combatting climate change,[1] and commerce continues to commit resources to it.[2] Secondly, the bulk of the published academic literature on this topic pre-dates a significant amendment to the law in this particular area from 2014[3] and a key international agreement in the wider field of combatting climate change (the Paris Agreement[4]). Thirdly, the United Nations General Assembly (UNGA) is presently in the process of "develop[ing] an international legally binding instrument […] on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction".[5] The focus of any such international legally binding instrument would include the high seas and therefore such an instrument could, and perhaps should, as shall be discussed in Chapter F below, regulate ocean fertilization in the high seas. It was commented nearly 10 years ago that "ocean fertili[z]ation[6] presents serious challenges for the law of the sea": those challenges continue to date and therefore ocean fertilization remains a fertile topic for legal analysis in 2017.[7]

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[1] See n 46 and accompanying text for further detail. Also, D Biello, "Farm the Oceans to Help Stop Global Warming", *Slate*, 16 November 2016, available at http://www.slate.com/articles/technology/future_tense/2016/11/how_dumping_iron_in_the_ocean_can_help_fight_climate_change.html (accessed 9 July 2017).

[2] G Omand, "Controversial Haida Gwaii ocean fertilizing experiment pitched to Chile", *CBC News* 24 April 2016, available at http://www.cbc.ca/news/canada/british-columbia/haida-gwaii-ocean-fertalizing-chile-1.3550783 (accessed 15 July 2017); J Tollefson, "Iron-dumping ocean experiment sparks controversy", *Nature* 23 May 2017, available at https://www.nature.com/news/iron-dumping-ocean-experiment-sparks-controversy-1.22031 (accessed 14 July 2017).

[3] See Chapter C, Section 2.2 for further detail.

[4] Paris Agreement (adopted 7 December 2015, entered into force 4 November 2016), available at http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf (accessed 14 July 2017).

[5] UN General Assembly Resolution 69/292, A/RES/69/292, adopted 19 June 2015, available at https://documents-dds-ny.un.org/doc/UNDOC/GEN/N15/187/55/PDF/N1518755.pdf?OpenElement (accessed 14 July 2017), [1].

[6] Fertilization will be spelled with a 'z' throughout for consistency. The 'z' spelling is typically favoured by international documents in which the term is used.

[7] R Rayfuse *et al.*, "Ocean Fertilisation and Climate Change: The Need to Regulate Emerging High Seas Uses", *The International Journal of Marine and Coastal Law* 23 (2008) 297, 300.

2. STRUCTURE OF THE THESIS

The thesis is structured in seven Chapters. In broad terms, Chapters A–C are descriptive. Chapters D–G, which form the focus of the thesis, develop the author's own arguments and assessment.

This introductory Chapter A explains the objective of the thesis (Section 1 above), presents the legal sources and methodology used (Section 3 below), and provides comment on the scope of the thesis (Section 4).

Chapter B begins by explaining the global context – a world with a changed and changing climate – (Section 1) before defining and explaining what is meant more broadly by geoengineering (Section 2) and more specifically by ocean fertilization (Section 3).

Chapter C is split into two Sections. Section 1 will provide a review of the current international law that applies in generality to ocean fertilization. Section 2 will provide a review of the current international law that specifically deals with ocean fertilization.

Having considered the current international legal regime for ocean fertilization in Chapter C, Chapter D will then identify and discuss the problems with that regime in detail.

Chapter E will review the various improvements and alternatives to the current international legal regime of ocean fertilization in the high seas suggested by a range of parties and argue why, in this author's opinion, each is not likely to be sufficient to solve those problems identified in Chapter D.

Chapter F will then introduce the author's own proposal for a new legal regime for ocean fertilization in the high seas.

The final Chapter, Chapter G, will contain some conclusions.

3. LEGAL SOURCES & METHODOLOGY

3.1 LEGAL SOURCES

Article 38 of the Statute of the International Court of Justice (ICJ)[8] is "generally regarded as a complete statement of the sources of international law".[9] Article 38(1) makes reference to "international conventions […]; international custom […]; the general principles of law recognized by civilized nations; [and] judicial decisions and the teachings of the most highly qualified publicists". The thesis considers each of these sources. Additionally, the thesis uses as sources: examples of State practice, examples of actions by non-State actors (for example, commerce), scientific reports, and non-State (for example, NGO and intergovernmental forum) policy documents.

3.2 LEGAL METHODOLOGY

The thesis applies the following legal methodologies: (i) legal interpretation of international law agreements guided by the rules established in Section 3 of the Vienna Convention on the Law of Treaties;[10] (ii) analysis of the development of international law agreements and their process of evolution after entry into force; (iii) case study; (iv) analysis of the interaction between different areas of international law (for example, law of the sea and environmental law); and, (v) an analysis of different options *de lege ferenda*.

4. SCOPE OF THE THESIS

The scope of the thesis is limited to the international legal regime for ocean fertilization in the high seas as that term is defined in Article 86 of the United Nations Convention on the Law of the Sea (LOSC),[11] *i.e.*, "all parts of the sea that are not included in the exclusive economic zone, in the territorial sea or in the internal waters of a State, or in the archipelagic waters of an archipelagic State". The basis for this limitation of scope is that ocean fertilization activities to date have typically taken place on the high seas; it is thought that ocean fertilization may have the most effective results on the open oceans;[12] and an assessment of ocean fertilization activity taking place in areas under national

[8] Statute of the ICJ (adopted 26 June 1945; entered into force 24 October 1945), USTS 993.
[9] I Brownlie, *Principles of Public International Law* (OUP Great Britain 2008), 5.
[10] Vienna Convention on the Law of Treaties (adopted 23 May 1969; entered into force 27 January 1980), 1155 UNTS 331.
[11] United Nations Convention on the Law of the Sea (adopted 10 December 1982; entered into force 16 November 1994), 1833 UNTS 397. High seas will not be capitalised in this thesis as it is not capitalised in the LOSC. Article references in this thesis are to the LOSC unless otherwise identified.
[12] For a more detailed discussion of this point see n 46 & 47 and accompanying text.

jurisdiction would require consideration not only of international law but also any applicable domestic regulation and a comparative study of this type would go beyond the scope of a thesis of this length.

Domestic legislation will not be evaluated in any detail. Nor will ocean fertilization be considered in the context of military or hostile use.

Each of the topics discussed in Chapter B – climate change, geoengineering and ocean fertilization – have been explained elsewhere in great depth. Accordingly, Chapter B does not attempt to be exhaustive in its account. It does, however, explain all the terms and issues which are necessary for the discussions in the chapters that follow. Pinpoint references for further reading beyond the detail required for the purposes of this thesis will be provided in the footnotes for interested readers.

CHAPTER B: OCEAN FERTILIZATION

It's really cold outside, they are calling it a major freeze, weeks ahead of normal. Man, we could use a big fat dose of global warming!

Donald J Trump, October 2015[13]

1. SETTING THE SCENE IN THE ANTHROPOCENE

In 2008, the Intergovernmental Panel on Climate Change (IPCC) reported that evidence for a changing of the climate was "unequivocal": air and ocean temperatures across the globe were increasing, snow and ice was melting, and sea levels were rising.[14] In 2015, the Parties to the United Nations Framework Convention on Climate Change (UNFCCC)[15] reiterated "the need for an effective and progressive response to the urgent threat of climate change".[16] And earlier this year, a report by a Working Group of the Arctic Council, the Arctic Monitoring and Assessment Programme (AMAP), remarked that "[c]limate change in the Arctic has continued at a rapid pace".[17] The evidence for continued climate change at both a global and regional level is unequivocal.

The majority opinion is that humankind has contributed, is currently contributing, and will contribute in the future to climate change. For example, climate change is defined in the UNFCCC as "a change of climate which is attributed directly or indirectly to human activity".[18] Put simply, "humankind has become a global geological force in its own right".[19] The Anthropocene – a term that was first

[13] Donald J Trump, Twitter, 19 October 2015, available at https://twitter.com/realDonaldTrump/status/656100109386674176 (accessed 9 July 2017).
[14] IPCC, "Climate Change 2007: Synthesis Report" (2008), available at https://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm (accessed 9 July 2017), 2.
[15] United Nations Framework Convention on Climate Change (adopted 9 May 1992; entered into force 21 March 1994), 1771 UNTS 107.
[16] Paris Agreement, Preamble.
[17] AMAP, "Snow, Water, Ice and Permafrost. Summary for Policy-makers. Arctic Monitoring and Assessment Programme" (25 April 2017), available at www.amap.no (accessed 15 July 2017), 3.
[18] UNFCCC, Art 1(2).
[19] W Steffen *et al.*, "The Anthropocene: Conceptual and Historical Perspectives", *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 369 no. 1938 (2011) 842, 843.

popularised in 2000[20] but has since become widely appropriated by both academia and the media – situates humankind at the very centre of these changes "in geology and ecology".[21]

The consequences – predicted and realised – of climate change have been discussed and documented extensively. Article 1(1) of the UNFCCC provides a general definition for the "[a]dverse effects of climate change": famine, biodiversity losses, water scarcity, flooding, security issues, ocean acidification can be seen as just some examples of these adverse effects.[22] The IPCC has said that the "net damage costs of climate change are likely to be significant".[23] The World Wide Fund for Nature (WWF) is less guarded in the language of its evaluation: "[c]limate change poses a fundamental threat to everything we love".[24]

Accordingly, and unsurprisingly, States have attempted to combat the urgent threat of climate change through a variety of mitigation and adaptation activities. The Paris Agreement is just one more recent example in this attempt. This thesis is not the place to comment on the relative successes and failures of those attempts in any detail other than to note that in November 2016 the International Energy Agency (IEA) concluded that even if all State parties to the Paris Agreement meet their pledged targets, this combined effort "would only limit the rise in average global temperatures to 2.7 (degrees Celsius) by 2100".[25] The warming of the globe appears here to stay.

Karen Scott wrote in 2013 that because of the continued adverse effects of climate change:

> it is consequently hardly surprising that individuals and – increasingly – states, deeply concerned about the consequences of climate change, are beginning to explore other mitigation strategies […]. The most radical of those alternatives, symbolic of the Anthropocene, is *geoengineering*.[26]

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[20] By P Crutzen and E Stoermer in an article called "The 'Anthropocene'" in the May 2000 newsletter of the International Geosphere-Biosphere Programme, available at http://www.igbp.net/download/18.316f18321323470177580001401/1376383088452/NL41.pdf (accessed 9 July 2017), 17.
[21] *Ibid.*
[22] See for further examples of consequences: G Wilson "Murky Waters: Ambiguous International Law for Ocean Fertilization and Other Geoengineering", *Texas International Law Journal* (2014) 49 507, 518–519; and K N Scott, "International Law in the Anthropocene: Responding to the Geoengineering Challenge", (2013) 34 *Michigan Journal of International Law* 309, 311–312, 314.
[23] IPCC, n 14, 69.
[24] WWF, "Changing Climate Change", available at http://wwf.panda.org/what_we_do/footprint/climate_carbon_energy/ (accessed 9 July 2017).
[25] IEA, "World Energy Outlook", available at http://www.iea.org/newsroom/news/2016/november/world-energy-outlook-2016.html (accessed 15 July 2017).
[26] Scott, n 22, 318 (emphasis added).

2. GEOENGINEERING

Geoengineering has been defined by the Royal Society as "deliberate large-scale intervention in the Earth's climate system, in order to moderate global warming" [27] and by the IPCC as "a broad set of methods and technologies that aim to deliberately alter the climate system in order to alleviate the impacts of climate change".[28] There is no single definition of the term geoengineering but definitions invariably make explicit – as the Royal Society and IPCC have – the component requirements of "scale and intent".[29] Without such qualification, everything, of course, *could* be considered geoengineering: from ornamental gardening to "inadvertent" climate changing activities such as burning fossil fuels and cutting down forests.[30]

Geoengineering is "seriously discuss[ed] as part of the solution to climate change",[31] and its "journey from the fringes to the mainstream of the scientific and policy debate on climate change", which began in the mid-1960s, continues to this day.[32] It remains highly controversial: there are doubts regarding the scientific and economic efficacy of geoengineering techniques,[33] and the ethical considerations and moral hazard posed by utilisation of such options.[34]

Geoengineering techniques that have been discussed to date include, but are certainly not limited to, stratospheric aerosol injection,[35] building wind turbines in the Arctic to pump water to thicken and

[27] Royal Society, "Geoengineering the Climate: Science, Governance and Uncertainty" (2009), available at https://royalsociety.org/~/media/Royal_Society_Content/policy/publications/2009/8693.pdf (accessed 15 July 2017), ix.
[28] IPCC Expert Meeting on Geoengineering, 20–22 June 2011, Meeting Report, available at https://www.ipcc.ch/pdf/supporting-material/EM_GeoE_Meeting_Report_final.pdf (accessed 15 July 2017).
[29] D W Keith, "Geoengineering the Climate: History and Prospect", *Annual Review of Energy & the Environment* 25 (2000) 245, 247.
[30] D Bodansky, "May we engineer the climate?", *Climactic Change* 33 (1996) 309, 309; and *ibid.*
[31] M Branson, "A Green Herring: How Current Ocean Fertilization Regulation Distracts from Geoengineering Research", 54 *Santa Clara Law Review* (2014) 163, 164. See also Scott n 22, 311: "geoengineering has become a serious contender for inclusion within the climate change mitigation toolbox".
[32] Scott, n 22, 320.
[33] This will be discussed in the context of ocean fertilization specifically in Section 3 of this Chapter below. More generally, see Keith, n 29, 269–275; Scott, n 22, 320; and "The Case for Engineering our Way to a Cooler Arctic", Arctic Deeply, 12 April 2017, available at https://www.newsdeeply.com/arctic/articles/2017/04/12/the-case-for-geoengineering-our-way-to-a-cooler-arctic (accessed 15 July 2017), *passim*.
[34] Wilson, n 22, 524–525; Scott, n 22, 354; Keith, n 29, 277–278.
[35] J Reynolds, "International Law and Climate Engineering", T Hester & M B Gerrard (eds) *Climate Engineering and the Law: Regulation and Liability for Solar Radiation Management and Carbon Dioxide Removal* (Cambridge University Press, forthcoming).

preserve sea ice,[36] and painting the Andes mountain range white.[37] Ocean fertilization is clearly recognised as one form of geoengineering particular to the marine environment.[38]

3. OCEAN FERTILIZATION

The objective of ocean fertilization is "to increase CO_2 uptake by marine biological processes […] in sufficient quantity to achieve a climatically significant reduction in atmospheric levels" of carbon dioxide (CO_2).[39] In essence[40] this is done by drawing down CO_2 from the atmosphere to the ocean by adding nutrients – often, but not always, iron[41] – to the oceans. These added nutrients stimulate the growth of phytoplankton. The phytoplankton then in turn absorb CO_2. When the phytoplankton are eaten by other organisms or die, their carbon-filled bodies fall to the ocean bed and thereby sequester the carbon there.[42] This is a natural, continuous and ongoing process – the oceans are the planet's largest natural reservoir of carbon dioxide[43] – but ocean fertilization attempts to *accelerate* this cycle.[44]

Various methodologies for introducing the nutrients have been attempted and proposed, including the *in situ* supply of nutrients from vessels and the transfer of nutrients by pipes from the ocean depths to the ocean surface and from land to sea.[45]

As mentioned above, to date, ocean fertilization activities – both commercial and those conducted by scientists[46] – have typically taken place on the high seas, and it is thought that ocean fertilization may have the most effective results on the open oceans.[47]

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[36] Arctic Deeply, n 33.
[37] C Sestanovich, "Painting the Andes White", *Foreign Policy*, 17 June 2010, available at http://foreignpolicy.com/2010/06/17/painting-the-andes-white/ (accessed 15 July 2017).
[38] See, for example, Keith, n 29, 266; Scott, n 22, 323.
[39] P Williamson *et al.*, "Ocean Fertilization for Geoengineering: A Review of Effectiveness, Environmental Impacts and Emerging Governance", 90 *Process Safety & Environmental Protection* (2012) 475, 476.
[40] For a more complete description of the science of ocean fertilization see C Roberts, *Ocean of Life: How our Seas are Changing* (Penguin London 2012), 251–253.
[41] Wilson, n 22, 515–516; Branson, n 31, 169.
[42] Branson, n 31, 168.
[43] Secretariat of the Convention on Biological Diversity, "Scientific Synthesis of the Impacts of Ocean Fertilization on Marine Biodiversity" (2009), available at https://www.cbd.int/doc/publications/cbd-ts-45-en.pdf (accessed 15 July 2017).
[44] Wilson, n 22, 511.
[45] *Ibid.*, 516; Branson, n 31, 169–170; Scott, n 22, 325.
[46] By 2014, 13 ocean fertilization experiments had been conducted by scientists (Branson, n 31, 183). For commercial ocean fertilization activities see, for example, Haida Salmon Restoration Corporation discussed in Section 2.4 of Chapter D, and Oceaneos (website available at http://oceaneos.org/, accessed 15 July 2017; also Tollefson, n 2) for a commercial organisation in operation at time of writing.
[47] R Abate & A Greenlee, "Sowing Seeds Uncertain: Ocean Iron Fertilization, Climate Change, and the International Environmental Law Framework", 27 *Pace Environmental Law Review* (2010) 555, 559; M Eick, "A Navigational System for Uncharted Waters: The London Convention and London Protocol's Assessment Framework on Ocean Iron

Ocean fertilization – both its "promises and perils"[48] – remains highly controversial. Some point to its apparent cost efficiency; some argue it is economically unattractive.[49] Some view the secondary effects – both the known and the still unknown – as deeply troublesome.[50] Some laud the "relative simplicity" of the technique,[51] while others posit that history has already demonstrated this accessibility to be a huge concern, evidenced by a number of individuals having already undertaken or attempted to undertake ocean fertilization.[52] Many point out that the science is "vague, inconclusive and inconsistent" [53] and the experiments carried out to date "have precluded a clear assessment of the export and fate of the extra carbon [sequestered in the ocean bed]"[54]. In short, the 2008 comment by Rayfuse *et al.* that "no internationally agreed mechanism exists to assess and verify the efficacy of ocean fertili[z]ation"[55] applies as equally in 2017.

Having situated climate change, geoengineering and ocean fertilization within its modern, global context, it is now apposite in the following chapter, Chapter C, to consider the current international legal regime that applies to ocean fertilization.

Fertilization", 46 *Tulsa International Law Review* (2010) 351, 362; Güssow, n 54, 915. One commercial enterprise notes that ocean fertilization takes place on the high seas for "operational reasons", Climos, "Climos Code of Conduct for Ocean Fertilization Projects" (27 September 2007), available at http://www.climos.com/standards/codeofconduct.pdf (accessed 14 July 2017).

[48] Abate & Greenlee, n 47, 559.

[49] Wilson, n 22, 511–512. Branson, n 31, 170–171 argues that the biggest financial obstacle may simply be acquiring a ship suited for high seas sailing.

[50] Wilson, n 22, 526–527; Branson, n 31, 171–172; Rayfuse *et al.*, n 7, 305–306.

[51] Branson, n 31, 170.

[52] See, for example, M Specter, "The First Geo-Vigilante", *New Yorker*, 18 October 2012, available at http://www.newyorker.com/news/news-desk/the-first-geo-vigilante (accessed 15 July 2017).

[53] Rayfuse *et al.*, n 7, 325. Also see Scott, n 22, 323.

[54] K Güssow *et al.*, "Ocean iron fertilization: Why further research is needed", *Marine Policy* 34 (2010) 911, 912. Also Branson, n 31, 171 and Wilson, n 22, 522.

[55] Rayfuse *et al.*, n 7, 299.

CHAPTER C: THE CURRENT LEGAL REGIME

[Ocean fertilization] does not take place in a regulatory Wild West or a legal black hole.
Karen Scott, 2013[56]

The international legal regime for ocean fertilization is comprised of a number of different albeit overlapping[57] spheres of international law, including: law of the sea, environmental law and climate change law. In addition to primary law – such as treaties – there is also relevant secondary law – for example, resolutions – deriving from international institutions working within these legal spheres. There are both global *and* regional international agreements *and* institutions that are relevant. Some of the applicable legal instruments and the provisions therein provide only a general framework within which ocean fertilization must be considered. Additionally, some legal instruments and the provisions therein provide for and deal specifically with ocean fertilization.

Accordingly, this Chapter C shall be organized in two sections. Section 1 will provide a review of the international law that applies in generality to ocean fertilization. Section 2 will provide a review of the law that specifically deals with ocean fertilization. Chapter C will not analyse the efficacy of the complete regime as that analysis will form Chapter D.

1. INTERNATIONAL LAW APPLYING GENERALLY TO OCEAN FERTILIZATION

The high seas are "open to all States" for "peaceful purposes".[58] However, these high seas freedoms may only be "exercised under the conditions laid down by [the LOSC] and by other rules of international law".[59] The following sub-sections will consider, first, the "conditions" laid down in the LOSC and, subsequently, the conditions laid down in "other rules of international law".

1.1 LOSC: PART XII

[56] Scott, n 22, 330.
[57] As Alan Boyle writes: "there is no magic in categorizations such as 'international environmental law', 'international trade law' […] 'the law of the sea' […] and so on. These are no more than convenient labels", A Boyle, "Relationship Between International Environmental Law and Other Branches of International Law", D Bodansky *et al.* (eds), *The Oxford Handbook of International Environmental Law* (OUP Oxford 2007) 125, 127.
[58] LOSC, Arts 87(1) & 88.
[59] LOSC, Art 87(1).

The framework for the protection and preservation of the marine environment – which is recognised in the Preamble of the LOSC as a key part of the overall objective of the LOSC to ensure a "legal order for the seas" – is found in Part XII of the LOSC. A number of the Articles in Part XII pertain in generality to ocean fertilization.

Article 192 stipulates that all States party to the LOSC have the obligation to protect and preserve the marine environment. This obligation applies to all ocean areas – including therefore the high seas – and a non-circumscribed range of activities – which would therefore include ocean fertilization.

In furtherance of this obligation, States are obliged to take, individually or jointly, all measures necessary to prevent, reduce and control "pollution" of the marine environment from any source.[60] Pollution is a term defined in Article 1(4) of the LOSC:

> The introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the seas, impairment of quality for use of sea water and reduction of amenities.

It is highly likely – but not absolutely certain (as shall be discussed in further detail in Chapter D below)[61] – that ocean fertilization activities would meet the criteria of pollution under the LOSC. For example, if iron is added *in situ* to the oceans, that iron is a substance which is likely to result in deleterious effects of the type listed in Article 1(4) introduced directly by man into the marine environment.[62]

States are required to take all measures to ensure that activities under their jurisdiction or control are conducted so as not cause damage by pollution to areas beyond those areas where they exercise their jurisdiction and control.[63] This provision reflects the approach of international law to 'respecting' the marine environment as confirmed by the ICJ in 1996 in *Legality of the Threat or Use of Nuclear*

[60] *Ibid.*, Art 194(1).
[61] See for further discussion Chapter D, Section 1.
[62] See n 50 and accompanying text for further discussion of the known and unknown "deleterious effects" of ocean fertilization.
[63] LOSC, Art 194(2).

Weapons.[64] This obligation is "part of the corpus of international law",[65] and it has been determined to be customary international law.[66] Accordingly, States undertaking ocean fertilization activities within their jurisdiction (for example, within their territorial sea or exclusive economic zone (EEZ)) have an obligation to ensure such activity respects the environment in those areas beyond its national jurisdiction (for example, the high seas). Similarly, States are under the same obligation with regards to those under their "control" (for example, a vessel flying the flag of the State on the high seas[67]). Because Articles 192 and 194 apply to a non-circumscribed range of activities, it is not relevant in the context of this thesis whether ocean fertilization does or does not constitute "marine scientific research" for the purposes of the LOSC: the Part XII obligations will apply in any case.[68]

States must take such measures to "deal with all sources of pollution of the marine environment" including: the release of toxic, harmful or noxious substances from land-based sources, from or through the atmosphere or by dumping, or from vessels, or from other installations and devices.[69] Accordingly, ocean fertilization activity taking place from all sources – be it land, vessels or installations and devices (such as pipes) – would be covered by this provision. Of particular relevance to ocean fertilization is the provision that refers in detail to one of these sources of marine pollution: "dumping". Pursuant to that provision, Article 210, States shall "adopt laws and regulations to prevent, reduce and control pollution of the marine environment by dumping".[70] These laws and regulations shall ensure that dumping is not carried out without a State's permission, and that these rules are enforced by a State "with regard to vessels flying its flag".[71] Additionally, these national laws and regulations shall be no less effective than the "global rules and standards" that States must "endeavour to establish [by] acting especially through competent international organizations or diplomatic conference".[72] Ocean fertilization within the specific context of dumping and Article 210 will be discussed in further detail in Section 2 below.

[64] The ICJ confirmed that there exists an obligation on States "to ensure that activities within their jurisdiction and control respect the environment of other States or of areas beyond national control", *Legality of the Threat or Use of Nuclear Weapons*, Advisory Opinion of 8 July 1996, [1996] ICJ Rep 226, [29].
[65] *Ibid.*
[66] Rayfuse *et al.*, n 7, 307. Customary international law can be defined as law "result[ing] from a general and consistent practice of states that they follow from a sense of legal obligation." (M Shaw, *International Law* (CUP Cambridge 2003), 80).
[67] LOSC, Art 92 provides a flag State with "exclusive jurisdiction" over vessels flying its flag in the high seas.
[68] If ocean fertilization is interpreted as a form of marine scientific research, obligations provided for in Part XIII of the LOSC which deals with marine scientific research would additionally apply – for example, Art 240(d).
[69] LOSC, Art 194(3).
[70] *Ibid.*, Art 210(1).
[71] *Ibid.*, Art 210(3) & 216(1)(b).
[72] *Ibid.*, Arts 210(6) & (4).

Article 195 provides that States shall, in taking measures to combat pollution of the marine environment, not "transfer damage or hazards from one area to another" or "transform one type of pollution into another". Moving CO_2 from the atmosphere to the ocean – the fundamental process in all ocean fertilization activity[73] – might likely be considered a transfer of damage or a hazard (*i.e.*, the hazard being the CO_2, because CO_2 is linked to climate change[74]) from one area (the atmosphere) to another area (the sea and seabed) and/or a transformation of one type of pollution into another (*i.e.*, atmospheric CO_2 to oceanic CO_2).

Further provisions in Part XII of the LOSC impose an obligation on States to cooperate on a global or regional basis for the protection and preservation of the marine environment[75] and to undertake environmental assessments and to communicate and cooperate in monitoring the risks and effects of activities that may cause harm to the marine environment.[76] Article 235(1) provides that "States are responsible for the fulfilment of their international obligations concerning the protection and preservation of the marine environment. They shall be liable in accordance with international law".

Not every State is a party to the LOSC: there are currently 168 parties.[77] However, it has been argued that the articles forming Part XII of the LOSC – *i.e.*, including each of the provisions discussed above – are widely considered part of customary international law.[78] Pursuant to such an interpretation, these provisions would therefore be binding on all States in any case.

Before focussing on ocean fertilization within the specific context of dumping and Article 210 in further detail in Section 2 below, the following sub-sections 1.2 and 1.3 look briefly at ocean fertilization within the general context of climate change law and regional oceans law.

1.2 CLIMATE CHANGE LAW: UNFCCC

The objective of the UNFCCC is to achieve the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate

[73] See Chapter B, Section 3.
[74] IPCC, n 14, 36.
[75] LOSC, Art 197.
[76] *Ibid.*, Arts 206 & 204.
[77] Chronological lists of ratifications of, accessions and successions to the LOSC, UN Division for Ocean Affairs and the Law of the Sea, http://www.un.org/depts/los/reference_files/chronological_lists_of_ratifications.htm (accessed 18 May 2017).
[78] R Churchill & V Lowe, *The Law of the Sea* (Manchester University Press Manchester 1999), 24.

system".[79] In pursuit of this objective, the Kyoto Protocol to the UNFCCC calls for the promotion of the research and implementation of "advanced and innovative environmentally sound technologies".[80] If ocean fertilization is interpreted to meet this criteria then the parties to the Kyoto Protocol to the UNFCCC are obliged to promote the research and implementation of ocean fertilization. However, perhaps for the reasons detailed in Section 3 of Chapter B, ocean fertilization has to date not considered been considered "environmentally sound" by the 197 parties to the UNFCCC in 2017.[81] For example, there is no mention of ocean fertilization in the Paris Agreement. Accordingly, such a provision has not yet taken effect with respect to ocean fertilization.

1.3 REGIONAL LAW

In addition to the LOSC, which applies to all ocean areas, there are regional international agreements relevant to activities in certain high seas areas. For example, ocean fertilization activity south of "60º South Latitude" is, in addition to the obligations provided for in the LOSC, subject to the provisions of the Antarctic Treaty.[82] A party to the Antarctic Treaty must give advance notice to all other parties of all expeditions taking place in waters south of 60º South Latitude "organized in or preceding from its territory".[83] Furthermore, the Protocol on Environmental Protection to the Antarctic Treaty[84] provides, *inter alia*, that the "protection of the Antarctic environment […] shall be [one of the] fundamental considerations in the planning and conduct of all activities".[85] These additional general requirements placed upon a State would apply in the context of ocean fertilization because these provisions apply to "all activities". There are currently 53 parties to the Antarctic Treaty.[86] It is for the reason that waters in the Antarctic have been specifically identified as potentially particularly suited to ocean fertilization[87] that this individual example of a regional agreement is discussed in this

[79] UNFCCC, Art 2.
[80] Kyoto Protocol to the United Nations Framework Convention on Climate Change (adopted 11 December 1997; entered into force 16 February 2005), 2303 UNTS 148, Art 2(1)(a)(iv).
[81] Status of Ratification of the UNFCCC, UNFCCC, http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php (accessed 18 May 2017).
[82] Antarctic Treaty (adopted 1 December 1959; entered into force 23 June 1961), 450 UNTS 169, Art VI.
[83] Antarctic Treaty, Art VII(5)(a).
[84] Protocol on Environmental Protection to the Antarctic Treaty (adopted 4 October 1991; entered into force 14 January 1998), 30 ILM 1455.
[85] *Ibid.*, Art 3(1).
[86] Parties, Secretariat of the Antarctic Treaty, https://www.ats.aq/devAS/ats_parties.aspx?lang=e (accessed 18 May 2017).
[87] Abate & Greenlee, n 47, 564.

paragraph, but there are a multitude of regional agreements across the globe with provisions that may have general application to ocean fertilization activity in specific high seas areas.[88]

1.4 SUMMARY

As two academics have termed it, the provisions discussed above "establish an essential framework"[89] and a "general frame of reference"[90] for how States are obliged to act in respect of ocean fertilization activity. The lukewarm adjectives "essential" and "general" are illuminating. As the Conference of the Parties (COP) to the Convention on Biological Diversity (CBD)[91] noted in 2012, this "essential" and "general" framework instituted "an incomplete basis for global regulation" of activities such as ocean fertilization.[92] It was thus deemed important to bolster the incomplete general framework with international law provisions specifically dealing with ocean fertilization. This process and the international legal regime that developed out of this process is considered in the following Section 2.

2. INTERNATIONAL LAW APPLYING SPECIFICALLY TO OCEAN FERTILIZATION

2.1 CBD

The objectives of the CBD are threefold: the conservation of biological diversity, the sustainable use of the components of biodiversity, and the fair and equitable sharing of benefits arising from the utilisation of genetic resources.[93] Article 4(b) of the CBD determines that its scope of application includes "processes and activities […] carried out [in areas] beyond the limits of national jurisdiction". Accordingly, ocean fertilization activity in the high seas is clearly included within its scope because it is an activity carried out in an area beyond the jurisdiction of a State (per the definition of high seas in Article 86 of the LOSC).

[88] The Division for Ocean Affairs and the Law of the Sea (DOALOS) at the UN has compiled an Indicative List of Regional Treaties the geographic scope of which includes specific high seas areas, available at http://www.un.org/depts/los/biodiversity/prepcom_files/Indicative_list_of_regional_treaties.pdf (accessed 16 July 2017).
[89] Scott, n 22, 313.
[90] Bodansky, n 30, 313.
[91] Convention on Biological Diversity (adopted 5 June 1992; entered into force 29 December 1993), 1760 UNTS 79.
[92] COP to the CBD, *Decision XI/20: Climate-Related Geoengineering*, UNEP/CBD/COP/DEC/XI/20, [11].
[93] CBD, Art 1.

Following the ninth meeting of the COP to the CBD in May 2008, Decision IX/16[94] was adopted. It contains the following paragraph with respect to ocean fertilization:

> [the COP] *requests* Parties and *urges* other Governments, in accordance with the precautionary approach, to ensure that ocean fertilization activities do not take place until there is an adequate scientific basis on which to justify such activities, including assessing associated risks, and a global, transparent and effective control and regulatory mechanism is in place for these activities; with the exception of small scale scientific research studies within coastal waters. Such studies should only be authorized if justified by the need to gather specific scientific data[95]

Decision IX/16 is not legally binding on the parties to the CBD (there are currently 196 parties to the CBD[96]) and, in any case, uses only "hortatory language".[97] However, importantly, Decision IX/16 also notes the "legal analysis [of ocean fertilization governance] occurring under the auspices"[98] of another legal instrument and "*[u]rges*"[99] parties to act in accordance with the outcome of that process. It is this process referred to by the COP that provides the most substantive international law dealing specifically with ocean fertilization. The following sub-section considers in detail that process and the international legal regime that developed from that process.

2.2 THE LONDON CONVENTION AND PROTOCOL

The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention or LC) and the Protocol to the London Convention (London Protocol or LP, jointly referred to as LC-LP)[100] stipulate that Contracting Parties shall "take all practicable steps to prevent the pollution of the sea by the dumping of waste and other matter".[101] The LC-LP forms the "global rules and standards" that States were obliged to establish by acting through a "competent international organization" (in this case the International Maritime Organization (IMO) which administers the LC-LP) in respect of dumping per Article 210 of the LOSC.[102]

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[94] COP to the CBD at Its Ninth Meeting, 19–30 May 2008, *IX/16 Biodiversity and Climate Change*, UNEP/CBD/COP/DEC/IX/16, 9 October 2008.
[95] *Ibid.*, [C.4].
[96] List of Parties, CBD, https://www.cbd.int/information/parties.shtml (accessed 18 May 2017).
[97] Güssow *et al.*, n 54, 915; Scott, n 22, 332.
[98] Decision IX/16, [C.4].
[99] *Ibid.*, [C.2].
[100] Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (adopted 29 December 1972; entered into force 30 August 1975), 1046 UNTS 138. 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 ILM 7.
[101] LC, Art I.
[102] See Section 1.1 above for further discussion of Art 210.

Dumping is defined in the LC as "any deliberate disposal at sea of wastes or other matter".[103] In turn, "wastes or other matter" are defined as "material and substance of any kind, form or description".[104] A list of those wastes or other matter that were *not* to be dumped was included as Annex I to the LC.[105] In 1996, following the adoption of the LP, Annex I was updated to function as a so-called "reverse list" of wastes or other matter that *may* be dumped.[106]

Dumping does *not* include: "disposal into the sea of wastes or other matter incidental to, or derived from […] normal operations" save for from sources whose normal operation is waste disposal or treatment; and "placement of matter for a purpose other than the mere disposal thereof, provided that such placement is not contrary to the aims of [the LC]".[107]

In 2007, following the announcement by a private commercial operation that it would be conducting ocean fertilization activity in the high seas offshore of the Galapagos Islands later that same year,[108] the Scientific Groups[109] of the LC-LP announced that they would scrutinize the issue of ocean fertilization.[110] Following this review, a Statement of Concern was released by the Scientific Groups that "knowledge about the effectiveness and potential environmental impacts [of ocean fertilization] currently was insufficient to justify large-scale operations", and that "any such operations [should] be evaluated carefully" by States to ensure such activity was not contrary to the aims of the LC-LP.[111] This Statement of Concern was endorsed by the Contracting Parties to the LC in December 2007,[112] when the Contracting Parties confirmed their belief "that the scope of work of the London Convention and Protocol included ocean fertilization".[113]

[103] LC, Art III(1)(a)(i).
[104] *Ibid.*, Art III(4).
[105] *Ibid.*, Art IV(1)(a).
[106] LP, Art 4(1)(a). See Wilson, n 22, 534.
[107] *Ibid.*, Art III(1)(b).
[108] See Rayfuse *et al.*, n 7, 299; Wilson, n 22, 548.
[109] The Scientific Groups are the bodies invited to collaborate and advise the Contracting Parties to the LC and LP on scientific matters pursuant to LC Art XIV(4)(b).
[110] IMO, Ocean Fertilization under the LC/LP, available at http://www.imo.org/en/OurWork/Environment/LCLP/EmergingIssues/geoengineering/OceanFertilizationDocumentRepository/OceanFertilization/Pages/default.aspx (accessed 19 July 2017).
[111] IMO Doc LC/SG 30/14.
[112] IMO Doc LC/29/17, 0.2.3.1.
[113] *Ibid.*, 0.2.3.2.

In 2008, the Contracting Parties adopted "Resolution LC-LP.1 (2008) On the Regulation of Ocean Fertilization" (Resolution LC-LP.1).[114] This resolution reaffirmed the belief that ocean fertilization fell within the scope of the LC-LP,[115] and provided a definition for ocean fertilization: "any activity undertaken by humans with the principle intention of stimulating primary productivity in the oceans", footnoting that "conventional aquaculture, or mariculture, or the creation of artificial reefs" fell outside of this definition.[116] Furthermore, Resolution LC-LP.1 stated that "in order to provide for legitimate scientific research" all potential ocean fertilization activity should be assessed on a "case-by-case basis using an assessment framework to be developed by the Scientific Groups" and that *only* activity complying with this assessment framework would *not* constitute dumping.[117] Ocean fertilization activity complying with the assessment framework would be considered as "placement" not contrary to the aims of the LC – *i.e.*, therefore not dumping, pursuant to the exception to the definition of dumping stated in Article III.1(b)(ii) of the LC – and would therefore be permitted.[118] In 2010, "Resolution LC-LP.2 On the Assessment Framework for Scientific Research Involving Ocean Fertilization" (Resolution LC-LP.2), which provided the "assessment framework", was adopted by the Contracting Parties.[119]

Neither resolution is legally binding on the Contracting Parties.[120] However, in 2013, legally-binding amendments to the LP – and only the LP, *i.e.*, not the LC – were adopted through "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" (Resolution LP.4(8)).[121] The amendments will enter into force after they are accepted by two-thirds of the Contracting Parties to the LP:[122] at the time of writing, Resolution LP.4(8) had not been accepted by the required number of parties.[123] The most important of the legally binding amendments to the LP for the purposes of this thesis are the incorporation of the definition of "ocean fertilization" adopted in Resolution LC-LP.1[124] and the provision stipulating that

[114] IMO Doc LC 30/16. Resolution LC-LP.1 is included at Annex 6.
[115] Resolution LC-LP.1, [1].
[116] *Ibid.*, [2].
[117] *Ibid.*, [3], [4] & [7].
[118] *Ibid.*, [8].
[119] IMO Doc LC 32/15. The Assessment Framework is included at Annex 6.
[120] Wilson, n 22, 539. Branson, n 31, 187 remarks that the non-binding nature of the resolutions ensured the "powerlessness" of the international legal framework for ocean fertilization at that time.
[121] IMO Doc LC 35/15. Resolution LP.4(8) is included at Annex 4.
[122] LP, Art 21(3).
[123] The most recent status update from the IMO is from January 2017: List of Conventions (as at 10 January 2017), IMO, available at http://www.imo.org/en/About/Conventions/StatusOfConventions/Documents/List%20of%20instruments.pdf (accessed 22 June 2017), 30. It is reported that as at April 2017, only one party had in fact accepted the amendments (see n 156).
[124] Resolution LP.4(8), Annex 4.1.1.

only ocean fertilization activities "constituting legitimate scientific research taking into account [the] specific assessment framework [*i.e.*, that adopted in Resolution LC-LP.2]" can be considered for a permit.[125] Ginzky and Frost argue that "when the amendments enter into force, there will, for the first time, be legally binding regulation of ocean fertilization in international law".[126] This is incorrect: as Section 1 of this present Chapter has detailed, ocean fertilization is regulated generally across a number of international law instruments. Rather, these amendments, when they enter into force (until that point they remain non-binding commitments), will be the first legally binding regulations *specific* to ocean fertilization.

Currently there are 87 parties to the LC and 48 parties to the LP. 36 States are parties to both the LC and LP; 51 States are parties to the LC only.[127] The LP supersedes the LC as between Contracting Parties to both legal instruments.[128]

Chapter C has described in some detail the *lex lata* international legal regime for ocean fertilization. The next chapter, Chapter D, marks the shifts from the descriptive assessment necessary in Chapters B and C into the author's own evaluation and argumentation, which will form the content of Chapters D–G. Chapter D will provide the authors' analysis of the various problems with the current regime.

[125] *Ibid.*, Annex 4.1.3.
[126] H Ginzky & R Frost, "Marine Geo-Engineering: Legally Binding Regulation under the London Protocol", *Carbon & Climate Law Review* 2 (2014) 82, 92.
[127] IMO, Parties to the London Convention and Protocol, available at http://www.imo.org/en/OurWork/Environment/LCLP/Documents/Parties%20to%20the%20London%20Convention%20and%20Protocol%20Dec%202016.pdf (accessed 19 May 2017).
[128] LP, Art 23.

CHAPTER D: PROBLEMS WITH THE CURRENT LEGAL REGIME

Give me half a tanker of iron, and I will give you an ice age

John Martin, July 1988[129]

As detailed above in Chapter C, the current international legal regime for ocean fertilization in the high seas is based on the pollution provisions of the LOSC in their general application to all activities under the jurisdiction or control of States and, additionally, legal instruments specifically dealing with one particular form of pollution – dumping – under whose scope ocean fertilization has been deemed to fall.

This Chapter will consider the problems of this legal regime. It is divided into three Sections. The first Section will consider the more conceptual problem of defining ocean fertilization in the context of pollution. Section 2 will look more specifically at the practical problems of the LC-LP regime. Section 3 will summarise the analysis by categorising those problems discussed in the previous two sections.

1. OCEAN FERTILIZATION & POLLUTION

1.1 IS OCEAN FERTILIZATION *ALWAYS* POLLUTION?

As explained in Section 1.1 of Chapter C, States have an obligation to "take all measures necessary" to prevent damage of the marine environment by pollution.[130] One form of pollution is pollution by dumping.[131] Ocean fertilization is regulated under the auspices of the dumping regime because it has been deemed to constitute a form of pollution by dumping.[132]

This sequence of logic is grounded in the idea that ocean fertilization activity constitutes pollution. If a form of ocean fertilization activity failed to meet the definition of pollution in Article 1(4) of the LOSC, then such an activity could not in turn be governed by the dumping regime because an activity which is not pollution cannot then be a particular form of pollution such as dumping. This would be

[129] John Martin, Lecture at the Woods Hole Oceanographic Institution, July 1988. Quoted in NASA's profile of John Martin, available at https://earthobservatory.nasa.gov/Features/Martin/ (accessed 15 July 2017).
[130] LOSC, Art 194(2).
[131] *Ibid.*, Art 194(3)(a).
[132] See n 115 and accompanying text.

problematic because, in such a scenario, ocean fertilization would not be governed by the provisions of Part XII that explicitly refer to pollution *or* the LC-LP regime.

And, indeed, the argument can be made that there might be instances where ocean fertilization activity may not meet the definitional requirements of pollution. Here, again, is the definition of pollution from the LOSC:

> The *introduction* by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the seas, impairment of quality for use of sea water and reduction of amenities.[133]

The crux is the concept of "introduction". If, for example, pipes are used in the water column to simply transfer nutrients already extant in the deeper ocean towards the surface is there any "introduction"? Karen Scott has argued that activity of this type would not constitute an introduction[134] and accordingly this particular form of ocean fertilization activity – a form which has indeed been proposed and tested[135] – would not be subject to the legal regime put in place to regulate ocean fertilization.

There are arguments to be made to refute Scott's conclusion, none of which is in itself fully convincing. Article 1(4) refers to the "marine environment", a term that is undefined in the LOSC. Can it be argued that the "marine environment" varies by water depth, *i.e.*, there is *a* marine environment at a 200-metre depth and *a* marine environment at a 1-metre depth? If so, then the transfer of nutrients from a 200-metre depth would be an introduction into a 1-metre depth marine environment. However, the LOSC does not in any of its provisions mention any such consideration of the layers of the water column – in fact, the phrase "water column" is only used once[136] and "depth" in the context of the water is only used in an absolute rather than a relative sense[137] (the LOSC does, however, recognise depth layers of the seafloor[138]). Furthermore, the term "ecosystem" – a term more likely to account for considerations of depth – is used elsewhere in the LOSC[139] but is not used in this Article. Finally, perhaps it could be

[133] LOSC, Art 1(4) (emphasis added).
[134] K N Scott, "Geoengineering and the marine environment", R Rayfuse (ed), *Research Handbook on International Marine Environmental Law* (Edward Elgar Cheltenham 2015) 451, 465.
[135] See further n 45.
[136] LOSC, Art 257.
[137] *Ibid.*, Arts 49(1), 60(3), 76(5) & 85.
[138] For example, the Preamble and Art 76(1) refer to the "seabed and subsoil".
[139] *Ibid.*, Art 194(5).

argued that the utilisation of pipes if not "directly" but "indirectly" introduces a substance – CO_2 – that is likely to result in deleterious effects.[140]

Therefore it is arguable that forms of ocean fertilization activity already under development are potentially not meeting the requirement of pollution for the purposes of the LOSC and accordingly are not subject to both the key Part XII provisions and the dumping regime. As noted in Section 3 of Chapter B, ocean fertilization is very much a technology still under development. A regime governing activity of this type should therefore "be responsive to the possibility of surprises over the lifecycle" of the technology.[141] It would appear that the regime is proving at least arguably unresponsive even in 2017 which is a worrisome augur for the future.

1.2 IS OCEAN FERTILIZATION *JUST* POLLUTION?

As noted in Section 2 of Chapter B, ocean fertilization is clearly considered in the context of climate change mitigation. However, as noted in Section 1.2 of the previous Chapter, ocean fertilization is not regulated in any meaningful way under the *climate change* regime. Rather, ocean fertilization is regulated under the *pollution* regime. There are problems in characterising and regulating ocean fertilization solely and exclusively under the pollution regime. These problems are best illustrated by a brief consideration of ocean fertilization in the context of the precautionary principle.

As the COP to the CBD noted in its Decision IX/16, one fundamental reason for limiting ocean fertilization activity at present is the obligation on States to act with precaution.[142] This thesis is not a suitable forum in which to debate *precisely* what is meant by precaution in international law – the debate branded ten years ago by one academic as a "Babylonian confusion"[143] still continues to this day[144] – but it is the forum to consider how precaution as "an integral component of modern

[140] By moving extant nutrients closer to the surface, CO_2 which would have stayed in the atmosphere is drawn down to the ocean. CO_2 is, of course, linked to climate change which has deleterious effects (see n 74).
[141] GRGP, "Draft Code of Conduct for Responsible Scientific Research involving Geoengineering" (May 2015), available at http://www.insis.ox.ac.uk/sites/default/files/insis/documents/media/an_exploration_of_a_code_of_conduct.pdf (accessed 14 June 2017), 4.
[142] Decision IX/16, [C.4].
[143] A Trouwborst, "The Precautionary Principle in General International Law: Combating the Babylonian Confusion", *Review of European Community & International Environmental Law* 16 (2) (2007), 185.
[144] A 2017 book on the principles of international environmental law notes that the debate is very much still alive: E Scotford, *Environmental Principles and the Evolution of Environmental Law* (Hart Oxford 2017), 58.

international environmental law"[145] might be interpreted and applied within the context of ocean fertilization as it is currently regulated.

The "most common articulation"[146] of precaution is that found in Principle 15 of the Rio Declaration on Environment and Development (Rio Declaration)[147] which provides that:

> [w]here there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

If it is argued that ocean fertilization threatens "serious or irreversible damage" – which as noted above is indeed argued by some[148] – then measures to prevent environmental degradation by such an activity may not be postponed on the basis that there is an absence of scientific certainty about that activity. There is most definitely an absence of scientific uncertainty in respect of ocean fertilization[149]. Therefore, with reference to the Assessment Framework under the LC-LP regime that limit the types of ocean fertilization activity that may take place, it can be argued that lack of full scientific certainty has therefore not postponed the implementation of measures to protect against the threat of ocean fertilization to the environment, *i.e.*, regulation of ocean fertilization is in accordance with the Rio Declaration's articulation of precaution.

However, the precaution language of the Rio Declaration is *also* incorporated *verbatim* in the UNFCCC.[150] If ocean fertilization is then argued to be *itself* a cost-effective measure that mitigates the effects of climate change – which as noted above is indeed argued by some[151] – then the Assessment Framework that limits the types of ocean fertilization activity that may take place may be said to in effect postpone a cost-effective measure to prevent environmental degradation. Precaution as it applies to ocean fertilization is evidently not so straightforward: both ocean fertilization proponents and detractors can argue precaution is on their side.

It is on account of this complexity that Güssow *et. al* argue that: "the precautionary principle ought to be used to balance the risks arising out of [ocean fertilization activities] with the potential advantages

[145] Scott, n 22, 341.
[146] *Ibid*.
[147] Rio Declaration on Environment & Development (adopted 14 June 1992), 31 ILM 874.
[148] See further n 50 and accompanying text.
[149] See further n 53 & 54 and accompanying text.
[150] UNFCCC, Art 3(3).
[151] See further n 49 and accompanying text.

relevant to the objectives of the UNFCCC".[152] Under the current regime there is not such a "balance" because ocean fertilization is regulated solely in terms of it being a form of pollution, *i.e.*, as a "risk". Consideration of ocean fertilization's "potential advantages to the objectives of the UNFCCC" is not provided for in its international regulation. Regulating ocean fertilization in this way masks the complex realities of the issues. This will likely cause practical problems for the current regime as those who consider and approach ocean fertilization within the context of climate change mitigation encounter – and can at least argue that they encounter – a regime ill-suited to their needs and the nuances of the issue.

2. PRACTICAL PROBLEMS WITH THE CURRENT LC-LP REGIME

2.1 PARTIES & PARTICIPATION

Only 48 States are parties to the LP.[153] This is a low number relative to the number of States party to the LOSC and UNFCCC (168 and 197, respectively).[154] Furthermore, for the amendments to the LP to become legally binding, only 32 of these 48 State parties must formally accept them.[155] It is largely unlikely that a regime potentially implemented with the support of only 32 States will be a widely accepted and workable regime on a global basis.

The legally binding amendments to the LP were adopted in 2013. Nearly four years later, the amendments are not in force, and as at April 2017, only one party State had formally accepted the amendments.[156] With such stark statistics, it is questionable whether the amendments will ever enter into force. Accordingly, this may remain a regime characterised by the "powerlessness" of non-binding commitments as, in theory at least, States provide only voluntary commitments to make reference to the Assessment Framework when considering permitting ocean fertilization activity.[157]

Furthermore, it may be argued that on account of the presence of a new and temporary delegation team from the USA at the negotiations of the amendments,[158] broad support from the USA – a State that has

[152] Güssow *et al.*, n 54, 916.
[153] n 127.
[154] n 77 & n 81.
[155] LP, Art 21(3).
[156] "Report of the International Conference: High Seas Governance: Gaps and Challenges", National University of Singapore, available at https://cil.nus.edu.sg/programmes-and-activities/past-events/high-seas-governance-gaps-and-challenges/ (accessed 21 July 2017).
[157] n 120.
[158] Ginzky & Frost, n 126, 95.

had vessels flying its flag ready to undertake ocean fertilization activities[159] and currently has a number of companies working on ocean fertilization technologies registered in its jurisdiction[160] – is not likely to be forthcoming. Branson also notes that a number of low-lying States that will be critically impacted by climate change and therefore *may* be more amenable to mitigation strategies of this nature are not parties to either the LC or LP.[161]

Of those States that are parties to the LC-LP, Wilson notes that in a 33-year period only 55.6% complied with the requirement to report dumping activities under their jurisdiction and control.[162] History, then, tells that there has been only limited compliance with the key provisions of the LC-LP which is naturally problematic for effective regulation. However, to balance this point, it is worth noting that one State, South Korea, has confirmed it will act in accordance with the non-binding Assessment Framework for a five-year ocean fertilization project that commenced in 2016.[163]

Even if it is "arguable"[164] that the LC-LP is binding on all States as the LC-LP are the "global rules and standards" of Article 210 (because Part XII of the LOSC, which includes Article 210, can be considered customary international law),[165] this is a "contentious"[166] assertion and, furthermore, it is "not clear" when, or perhaps more accurately if, the LP would in any case supersede the LC as customary law.[167]

In answer to the question of what can be done "to improve the prospects for responsible international consideration of climate engineering proposals", Bodansky had a simple formula in 1996: "get as many countries as possible involved as early as possible".[168] The LC-LP regime would not appear to demonstrate the characteristics of a regime of this type. Demonstrably the LC-LP is not a strong forum for international regulation through wide and committed participation.

2.2 RELIANCE ON FLAG STATE JURISDICTION

[159] The mooted 2007 Galapagos expedition initially involved a USA company with a vessel flying a USA flag (Branson, n 31, 189).
[160] For example, Atmocean, Inc.
[161] Branson, n 31, 190.
[162] Wilson, n 22, 545–546.
[163] IMO Doc LC/SG 40/INF.4.
[164] Rayfuse *et al.*, n 7, 311.
[165] See n 78.
[166] Rayfuse *et al.*, n 7, 317.
[167] Scott, n 22, 353.
[168] Bodansky, n 30, 320.

The LC-LP regime gives jurisdictional control to States in respect of: vessels or aircraft flying its flag;[169] vessels or aircraft loading dumping matter in its territory;[170] and vessels, aircraft or man-made structures believed to be engaged in dumping in areas within which it is entitled to exercise jurisdiction in accordance with international law (*e.g.*, its territorial sea or EEZ).[171] Accordingly, in the high seas, only the flag state is able to control dumping activities from a vessel.

As Ginzky & Frost note, it is therefore "relatively easy to circumvent the application" [172] of the LP with respect to ocean fertilization activity in the high seas. There are two ways to do this. First, by flying the flag of a non-party State to the LP. Secondly, by flying the flag of a party State that fails to enforce its LP obligations. This exact fact pattern has already been seen in practice.[173] This, of course, is not a problem unique to ocean fertilization, and much has been written elsewhere on the shortcomings of relying on flag state jurisdiction to control high seas activities particularly in the context of fisheries.[174]

Interestingly, as noted above, the LC-LP regime in the high seas only gives jurisdictional control to flag States over *vessels* and *aircraft* flying its flag. If there is no vessel or aircraft involved at the stage of enforcement – for example, pipes are being used to transfer nutrients from the deeper ocean towards the surface of the high seas – the LC-LP regime therefore would not apply. This could potentially be rather problematic. Without jurisdiction over activity of this nature, there is a lacuna in regulation because the dumping regime would not apply and only the more general provisions of Part XII of the LOSC would take effect.

2.3 THE ASSESSMENT FRAMEWORK

Some academics have argued that the requirements of the Assessment Framework are "likely to pose a serious, if not unrealizable, challenge for scientists".[175] For example, one criterion of the Assessment Framework is that "economic interests should not influence the design, conduct and/or outcomes of the proposed activity".[176] This is a broad requirement that may result in the exclusion of an operation

[169] LP, Art 10(1)(1).
[170] *Ibid.*, Art 10(1)(2).
[171] *Ibid.*, Art 10(1)(3).
[172] Ginzky & Frost, n 126, 93.
[173] The Planktos expedition in 2007 to Galapagos. For an account of the facts, see Rayfuse *et al.*, n 7, 319.
[174] For example, R Rayfuse *Non-flag State Enforcement in High Seas Fisheries* (Brill Leiden 2004), Chapters 1 & 2, *passim*; *ibid.*, 318–319.
[175] Güssow *et al.*, n 54, 915.
[176] Resolution LC-LP.2, 2.2.2.

that has, for example, sought funding for the research or intends to market its results in the future. This, one imagines, may exclude a significant proportion of scientific endeavours. Although the adoption of the Assessment Framework in 2010 removed some of the textual ambiguities in the non-binding Resolutions LC-LP.1 and LC-LP.2 and the CBD Decision IX/16 that proved in practice to be problematic,[177] clearly the Assessment Framework remains flawed in a number of respects. There is the concern that the current regime functions "at the expense of furthering scientific knowledge and rigorous debate" on ocean fertilization,[178] something which, despite the debate over the merits and drawbacks of ocean fertilization, is almost universally agreed upon as a "near-term priority".[179] In summary, the current regime "fail[s] to provide any incentives for an increase to the research desperately needed for accurate risk analysis".[180]

For example, it has been argued that the types of small-scale experiments likely to be permitted under the Assessment Framework "do not necessarily represent what would happen with larger-scale ocean-fertilization efforts" and, accordingly, the Assessment Framework is fundamentally misguided.[181]

Furthermore, as noted by Ginzky and Frost, the criteria established in the Assessment Framework set "a precedent in international law because, for the first time, the attributes of scientific research have been agreed upon in a legally binding instrument".[182] This, as the authors correctly note, is "innovative and groundbreaking."[183] Is an amendment to a protocol to a convention on dumping in the sea the appropriate forum to set down what is to be meant by "scientific research"? The LOSC, for example, provides no definition of the term "marine scientific research" and it remains a term still very much open for debate in both academia[184] and in the courts. In respect of the latter, in 2014 for example, the ICJ aptly demonstrated the complexities of establishing the "attributes of scientific research" in *Whaling in the Antarctic*.[185] The ICJ declined to offer a "general definition"[186] of scientific research as

[177] For a real-life account of these problems, see the LOHAFEX experiment in the Southern Ocean in 2009 discussed in Branson, n 31, 177–179.
[178] *Ibid.*, 167.
[179] A-M Hubert, "Draft Code of Conduct for Responsible Scientific Research involving Geoengineering: Executive Summary" (2016), available at http://wcm.ucalgary.ca/grgproject/files/grgproject/executive-summary-of-coc-for-responsible-geoeng-research.pdf (accessed 4 June 2017). Even those sceptical of ocean fertilization seem to agree that its efficacy, or lack thereof, will not be fully understood without further research taking place (Rayfuse *et al.*, n 7, 301–302). Scott is the outlier on this point, arguing that further scientific research might not yet be the way forward (n 22, 353).
[180] Branson, n 31, 180.
[181] Wilson, n 22, 522.
[182] Ginzky & Frost, n 126, 90.
[183] *Ibid.*
[184] For one introduction to the definitional debate, see Part 2 of T Stephens & D Rothwell, "Marine Scientific Research", D Rothwell *et al.* (eds), *The Oxford Handbook of the Law of the Sea* (OUP Oxford 2015) 559.
[185] *Whaling in the Antarctic* (Australia v. Japan: New Zealand intervening), Judgment, ICJ Reports 2014 226.
[186] *Ibid.*, [86].

it was to be interpreted in the context of a single international legal instrument, and a number of the judges[187] raised the issue of how appropriate it is for a court to ever make such a determination (Judge Yusuf concluding it to be a task that "befits scientists, not jurists"[188]). Ginzky & Frost – both of whom participated in the negotiations (as representatives for Germany and Australia respectively)[189] – confidently note that the whole process only took "about one year" and required "only one face to face meeting", while also commenting on the "fortuitous contributing factor to the rapid adoption of the amendments" being the absence of the usual delegation team from the USA.[190] In summary, it is rather easy to point out that the innovation of the Assessment Framework might not end up being groundbreaking after all if it finds little or no support.

The Assessment Framework presents impractical challenges to scientific research through the coupling of broad requirements on the one hand with specific requirements unsuited to the activity in question – and never seen before in international law – on the other. It is for these reasons that the Assessment Framework is likely to stymie scientific research and unlikely to receive the support of States.

2.4 THE DEFINITION OF OCEAN FERTILIZATION IN THE LC-LP

As explained above in Section 2.2 of Chapter C, a definition for ocean fertilization was first adopted in non-legally binding Resolution LC-LP.1 and this definition was subsequently used in the legally binding amendment to the LP. That definition is as follows:

> Ocean fertilization is any activity undertaken by humans with the principle intention of stimulating primary productivity in the oceans. Ocean fertilization does not include conventional aquaculture, or mariculture, or the creation of artificial reefs.[191]

Does this definition adequately cover all forms of ocean fertilization activity? A case study from 2012 demonstrates that it may not.

In July 2012, the Haida Salmon Restoration Corporation dumped 100 tons of iron sulphate – five times more iron sulphate than any previous experiment – into the Pacific Ocean off the coast of British

[187] *Ibid.,* Dissenting Opinion of Judge Owada, [25]; Dissenting Opinion of Judge Abrahams, [36]; Separate Opinion of Judge Xue, [15]; Separate Opinion of Judge Sebutinde, [9].
[188] *Ibid.,* Dissenting Opinion of Judge Yusuf, [44].
[189] Ginzky & Frost, n 126, 82.
[190] *Ibid.,* 95.
[191] n 116.

Columbia, Canada.[192] The "principle intention" of the activity was to stimulate primary productivity of plankton in order to directly boost salmon stocks in the area (because salmon feed on plankton, the logic was that more plankton would mean more salmon).[193] Accordingly, at least in name or "principle intention", this was therefore a *mariculture* activity. All mariculture activity is excluded from the definition of ocean fertilization (in contrast, only "conventional" aquaculture is excluded). Accordingly, activities that look like ocean fertilization but are branded mariculture activities – however non-conventional – may fall outside the scope of the regime. If an activity falls outside of the definition of ocean fertilization in the LC-LP it is not subject to the potentially binding Assessment Framework nor the non-binding Resolutions LC-LP.1 and LC-LP.2. As noted above in Section 1.1 of this Chapter, the regime should be responsive to future changes in the technology. A case study from 2012 sheds further doubt on how responsive the regime has been and might be in the future.

Interestingly, this would not have been an issue if the drafters of the definition had not included the first comma in the second sentence of the definition (*i.e.*, to instead read "does not include conventional aquaculture or mariculture"). Mass iron sulphate dumping would not (at least in 2012 or in 2017) be considered a conventional mariculture technique.

3. SUMMARY: THE SEVEN PROBLEMS

Before moving on to Chapter E, which will provide a review and evaluation of a number of proposals put forward by a range of academics and commercial institutions to improve the current regime, it is useful to categorise the problems with the current regime under a small number of headings. The problems identified in this Chapter can be grouped into the following seven headings:

(i) Certain types of ocean fertilization activity may not meet the LOSC definition of pollution and, accordingly, such activity would not be regulated by the Part XII pollution provisions or the dumping regime.

(ii) Ocean fertilization is currently not regulated pursuant to climate change mitigation legislation and is only regulated as a form of pollution which does not accurately reflect the status of ocean fertilization in 2017.

[192] For a fuller account of the Haida Salmon Restoration Corporation dumping see J Tollefson, "Ocean fertilization project off Canada sparks furore" *Nature* 23 October 2012, available at http://www.nature.com/news/ocean-fertilization-project-off-canada-sparks-furore-1.11631 (accessed 14 July 2017).
[193] Wilson, n 22, 529.

(iii) There are a limited number of States party to the LC and/or LP and non-parties may be deemed unlikely to support the amendment to the LP if it ever enters into force (which is not certain).

(iv) The current regime relies on flag state jurisdiction in the high seas which has historically proven inadequate in other high seas activities.

(v) The current regime may not apply to high seas ocean fertilization activity that takes place without the deployment of vessels or aircraft in the high seas.

(vi) The Assessment Framework is unworkable, misguided and inappropriately innovative.

(vii) Some ocean fertilization activities may not meet the LP definition of ocean fertilization and, accordingly, those activities would not be regulated pursuant to the legally binding amendments to the LP.

CHAPTER E: POSSIBLE ADDITIONS & ALTERNATIVES TO THE CURRENT REGIME

The international community should move quickly to address this lacuna.

Rosemary Rayfuse, Mark G Lawrence & Kristina M Gjerde, 2008[194]

In formulating their criticisms of the current international legal regime for ocean fertilization in the high seas, academics have often also advanced what they consider to be possible improvements or alternatives. Commerce, too, has offered a number of ideas for how to improve the current regime. This Chapter E will review the various improvements and alternatives suggested by the range of parties and argue why, in the author's opinion, they are not likely to be sufficient to eliminate the problems of the current regime. The subsequent Chapter, Chapter F, will then introduce the author's own proposal for a new legal regime for ocean fertilization in the high seas.

1. AMENDING THE LC-LP REGIME

Wilson argues that there are "several relatively simple steps" that may be taken within the current LC-LP regime to increase State reporting of dumping activity.[195] This was one of the issues with the LC-LP regime highlighted in Section 2.1 of Chapter D above.[196] Wilson's proposal is that one of these "steps" is for States to keep close track of the domestic and international trade of materials likely to be used in ocean fertilization and investigate that trade accordingly.[197] This is highly impractical: the materials likely to be used in ocean fertilization include iron and iron compounds, materials which are available in bulk at garden centres and online.[198] Furthermore, resolving the single issue of low reporting of dumping activity by States does not resolve the myriad other issues with the current legal regime discussed in Chapter D.

2. REGIONAL SOLUTIONS

Ocean fertilization might be regulated on a regional or subregional basis. For example, ocean fertilization activities in the Southern Ocean or Baltic Sea area might be exclusively considered under

[194] Rayfuse *et al.*, n 7, 326.
[195] Wilson, n 22, 548.
[196] n 162 and accompanying text.
[197] Wilson, n 22, 549.
[198] Branson, n 31, 170.

the Antarctic Treaty System and the Helsinki Convention,[199] respectively. However, there are a number of issues with such an approach.

To which regional or subregional organisations should such powers of regulation be given? For example, in the North-East Atlantic perhaps regulation of ocean fertilization would fall under the auspices of the OSPAR Convention?[200] After all, the mandate of the OSPAR Convention is to "address all sources of pollution".[201] However, as noted above in Section 1.2 of the previous Chapter, regulating ocean fertilization exclusively as a form of pollution is problematic: a regional or subregional regime of this type does not remove that underlying problem.

Furthermore, regional regulation may increase the likelihood of the development of 'areas of convenience' for ocean fertilization, *i.e.*, waters where ocean fertilization is less regulated and thus more attractive to those wishing to undertake ocean fertilization activity. Unlike fishing, where the activity is at least in part dictated by the presence or absence of stocks, ocean fertilization is not so limited by geography: even if a certain extant nutrient level is sought, this in all likelihood does not confine the areas available as restrictively as the presence or absence of concentrated fish stocks might.[202] This vastly increases the likelihood of areas of convenience developing with respect to ocean fertilization activity.

Finally, regional and subregional international agreements typically have relatively low membership – there are 53 parties to the Antarctic Treaty[203] and only 10 parties to the Helsinki Convention,[204] for example – and this creates an issue because the regional or subregional agreement rules and regulations do not apply to non-parties and thus non-parties have the potential to benefit disproportionately to parties to such an agreement. These so-called "free-rider" non-party States have been evidenced and commented on in the context of high seas fisheries where they have benefitted to the detriment of the States party to the agreement and, more generally, to the detriment of the efficacy of the agreement in question.[205]

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[199] Convention on the Protection of the Marine Environment of the Baltic Sea Area (adopted 9 April 1992; entered into force 17 January 2000), 2099 UNTS 197.
[200] Convention for the Protection of the Marine Environment of North-East Atlantic (adopted 22 September 1992; entered into force 25 March 1998), 23 LOSB 32.
[201] *Ibid.*, Preamble.
[202] Abate & Greenlee, n 47, 563–565, discuss the areas where ocean fertilization might be best suited in very wide geographic terms (*e.g.*, "middle latitudes", "Southern Ocean").
[203] n 86.
[204] Contracting Parties, Helsinki Convention, http://www.helcom.fi/about-us/contracting-parties/ (accessed 15 June 2017).
[205] Rayfuse, n 174, 34–35.

It is for each of these reasons that a regional or subregional regime would not remedy the problems with the current regime.

3. A NON-BINDING CODE OF CONDUCT

There have been proposals to implement non-binding codes of conduct for both geoengineering activities as a whole and also ocean fertilization on a standalone basis. The following two sub-sections will describe two such proposals, and the third sub-section will provide some conclusions on those proposals.

3.1 A GEOENGINEERING CODE OF CONDUCT

Ocean fertilization, as a single type of geoengineering, would clearly fall within the scope of a geoengineering code of conduct, unless explicitly excluded.

The Geoengineering Research Governance Project (GRGP) is an ongoing joint initiative of the University of Calgary, IASS-Potsdam and the University of Oxford, and its objective is "to analyse the changes required in governance and legal frameworks necessary to enable effective oversight in [the geoengineering] space in line with accepted principles" of international law.[206] In 2015, a working paper titled Draft Code of Conduct for Responsible Scientific Research involving Geoengineering (the Draft Code) was published.[207] The GRGP is ongoing: comments on the Draft Code were invited and the deadline for submissions of those was 30 April 2017.[208]

The introduction to the Draft Code explains that despite the current "normative overlaps"[209] of the current legal regime – mentioning specifically the overlaps in the context of ocean fertilization, noting that the CBD, LC-LP, UNFCCC, and LOSC all handle ocean fertilization in some way – the "existing law is too general, opaque [and] exhibits gaps",[210] criticisms which have similarly been raised in Chapter D above.

[206] University of Calgary, "Geoengineering Research Governance Project", available at http://www.ucalgary.ca/grgproject/ (accessed 5 July 2017).
[207] Draft Code, n 141.
[208] Information available at http://www.ucalgary.ca/grgproject/request-public-comments-1 (accessed 6 June 2017).
[209] Draft Code, n 141, 4.
[210] *Ibid.*, 5.

The Draft Code supports the implementation of an international instrument that "reaches beyond the traditional sphere of international law, in which States remain the principle actors, to involve other sectors of society"[211], including commerce, science and legal academia. It promotes wider participation in at least the drafting stage of the instrument.

There are two further aspects of the Draft Code particularly relevant to the topic of this thesis. First, the GRGP does not propose that further international laws are negotiated and implemented to solve the existing problems. Rather non-binding self-regulation is proposed on the basis that because at this stage not enough is known about the wide remit of geoengineering activities and their potential scope and hazards to adequately and prudently frame treaty negotiation,[212] governance of geoengineering must be "responsive to the possibility of surprises over the lifecycle of these technologies".[213] As it has been phrased by another academic, geoengineering in 2017 is a "moving target that is difficult to optimally regulate".[214] Secondly, the "*lex ferenda"* in the Draft Code – the term is used by the authors of the Draft Code[215] – is "the lowering of the threshold for procedural obligations to cover all scientific research involving geoengineering conducted in the open environment" (*i.e.,* not just scientific research that poses the risk of transboundary harm, for example).[216]

3.2 AN OCEAN FERTILIZATION CODE OF CONDUCT

In 2007, USA-based ocean fertilization company Climos proposed a voluntary Climos Code of Conduct specific to ocean fertilization.[217] The Climos Code of Conduct essentially "sets minimum environmental and operational standards for iron fertilization activities" and encourages broader inclusion of multiple stakeholders.[218] The Climos Code of Conduct remains in a draft form.

3.3 ANALYSIS

[211] *Ibid.,* 7.
[212] This same point is also raised elsewhere, *e.g.*, D G Victor, "On the Regulation of Geoengineering", 24 *Oxford Review of Economic Policy* (2008) 322, 325.
[213] Draft Code, 4.
[214] Wilson, n 22, 554.
[215] Draft Code, 8.
[216] *Ibid*.
[217] Climos, n 47.
[218] *Ibid.,* 1. It is not clear whether the Code of Conduct applies only to iron ocean fertilization or ocean fertilization more generally as the terms are used inconsistently in the document.

A geoengineering code of conduct is not practically feasible. Geoengineering viewed as a whole is a ragbag: some techniques are less developed than others and a regime that deals with all such technologies would inevitably be both vague[219] and unlikely to adequately deal with technology and technique changes. This is the first fundamental problem with a geoengineering instrument: the requirements to regulate will vary by geoengineering techniques. Ocean fertilization is not the same as painting the Andes white.

The second fundamental problem is that a return to a reliance on a non-binding regime is inherently a step backwards because Resolution LP.4(8) adopted binding commitments. Furthermore, self-regulation of the precise type proposed by the GRGP and Climos with respect to ocean fertilization – *i.e.*, the lowering of the threshold for procedural obligations for ocean fertilization to include all activity rather than just that which poses a certain threshold of risk – has already occurred because the Assessment Framework is the procedure the GRGP recommends and the "standards" Climos wanted to see. Accordingly, with respect to ocean fertilization, both proposals are outdated in this respect.

It is for these reasons that a non-binding geoengineering or ocean fertilization code is not the complete solution with respect to improving the current legal regime for ocean fertilization in the high seas. Such a code might be a positive development as an additional measure but it does not remedy the gaps identified in the current legal regime.

However, both the GRGP and Climos promote wider participation in the drafting of any such instrument to include not only State parties but also commerce, science and legal academia. I support this suggestion because, as noted in the previous Chapter,[220] one of the major weaknesses of the current regime derives from the narrow approach to the drafting of the Assessment Framework.

4. A PROTOCOL TO THE UNFCCC

Bodansky in 1996,[221] Lin in 2009,[222] Scott in 2013[223] and Branson in 2014[224] each in turn propose the adoption of a geoengineering protocol to the UNFCCC as a specific method for improving the

[219] Victor, n 212, 331
[220] Chapter D, Section 2.3.
[221] Bodansky, n 30, 318.
[222] A Lin, "Geoengineering Governance" *Issues in Legal Scholarship* Volume 8 Issue 3 (2009) 1, 22.
[223] Scott, n 22, 355.
[224] Branson, n 31, 191ff.

international legal regime of geoengineering. Regulation of ocean fertilization as a particular form of geoengineering would fall under such a protocol. Both Scott and Branson argue that because the UNFCCC has near-universal State membership, a COP and significant scientific, technical and financial structures in place, wide discussion, ratification and administration of any such protocol would ensure a strong regime.[225]

Scott envisages a protocol structured as a framework instrument of general principles and policies, devolving regulation-making to "the appropriate body" in respect of individual types of geoengineering activity.[226] Lin envisages a similar form of protocol where "decision making structures would be put in place to foster adaptive management" of the issue, *i.e.*, an organisation or body would be responsible for management on a case-by-case basis.[227] Bodansky and Branson do not expand in any detail on the format of the protocol they envisage.

However, there are a number of fundamental problems with a geoengineering protocol. Although Scott and Lin's suggestion to devolve decision making to the "appropriate body" for each geoengineering type largely removes the problem highlighted in Section 3 above of a vague treaty covering a ragbag of technologies, in the specific case of ocean fertilization, no such "appropriate body" actually exists. There is no obvious, existing international body to discharge the functions of regulating ocean fertilization in the high seas. The International Seabed Authority only organizes, carries out and controls activities on the seabed and this function does not extend to the water column of the high seas.[228] The IMO, the "competent international organization" in respect of the dumping regime,[229] does not have any function specifically in the context of climate change mitigation or the UNFCCC. The IMO describes itself as a "specialized agency with responsibility for the safety and security of shipping and the prevention of marine pollution by ships":[230] accordingly, climate change mitigation and ocean fertilization when not considered as a form of marine pollution is not within its remit. Therefore, there is no appropriate ocean fertilization body to which to devolve management. And it is highly unlikely that the creation of an ocean fertilization-specific international body would occur: there is simply insufficient attention on ocean fertilization at this time to envisage, in practical terms, a globally shared willingness to negotiate for a new institution pursuant to new legislation specifically on ocean

[225] *Ibid*, 191; Scott, n 22, 355.
[226] Scott, n 22, 356.
[227] Lin, n 222, 22.
[228] LOSC, Art 153(1).
[229] LOSC, Art 210(4).
[230] Introduction to IMO, IMO, http://www.imo.org/en/About/Pages/Default.aspx (accessed 15 July 2017).

fertilization. For these reasons, a protocol of this type is therefore a non-practical solution in the specific case of ocean fertilization.

Furthermore, moving the regulation of ocean fertilization from the pollution regime (*i.e.*, under Part XII of the LOSC and the LC-LP) to the climate change mitigation regime (*i.e.*, under the UNFCCC) does not remove the problem mentioned in the previous Chapter that ocean fertilization is inherently viewed as *both* a pollution and climate change issue. Nor, one might argue, is such a binary switch likely to happen.

More generally, the UNFCCC does not anywhere explicitly refer to geoengineering. Furthermore, certain geoengineering techniques that do not seek to stabilise greenhouse gas concentrations in the atmosphere[231] – which is the overarching objective of the UNFCCC[232] – arguably would not fall within the scope of the UNFCCC.[233] Therefore it is highly doubtful that a geoengineering protocol to the UNFCCC covering *all* geoengineering activities is even possible.

5. A BINDING TREATY

It has been argued that a legally binding comprehensive geoengineering treaty is one way forward.[234] Such a treaty would include ocean fertilization unless explicitly noted to the contrary. However, there are two fundamental problems with this proposal, each of which has also been discussed in the preceding Sections of this Chapter. First, geoengineering is a ragbag and an instrument providing exhaustive coverage would likely be vague and unable to respond to technological developments.[235] Secondly, there is no international body to discharge the functions of regulating ocean fertilization in the high seas.[236]

As far as the author is aware, only one academic article has proposed a treaty specifically dealing with ocean fertilization. Rayfuse *et al.* notes that because of the "inadequacies inherent in reliance on flag state jurisdiction" – discussed at Section 2.2 of the preceding Chapter – in the fisheries context, there have been a number of fisheries treaties "requiring [S]tates to regulate the high seas fishing and fishing-

[231] For example, techniques that deflect solar radiation in order to lower the earth's surface temperature, thereby seeking to address the negative impacts of climate change (see Scott, n 22, 326–329).
[232] See n 79 and accompanying text.
[233] A point also made by Scott, n 22, 330.
[234] For example, Wilson, n 22, 555.
[235] See n 219 and accompanying text.
[236] See n 228 & 229 and accompanying text.

related activities of their nationals, both individual and corporate, in addition to the activities of ships flying their flag".[237] Rayfuse *et al.* state that "the logic for regulating companies and individuals is equally compelling in the case of ocean fertili[z]ation".[238] This is an interesting proposal and would certainly go some way to resolve some of the issues associated with flag state jurisdiction on the high seas. But which organisation shall be responsible for developing such an instrument? The FAO is the global organisation responsible for fisheries and has taken a lead role in developing the types of treaties Rayfuse *et al.* are referencing. There is no such FAO-type organisation in respect of ocean fertilization. If the logic is compelling, then, unfortunately, the practical realities are dissuasive.

This Chapter E has discussed and evaluated a number of alternatives suggested by various parties to remedy the problems with the current international legal regime of ocean fertilization in the high seas. It is clear, however, that none of these suggestions provide a solution in 2017 to all seven of the problems identified in Chapter D. The following Chapter will introduce the author's own suggested solution and explain how it more effectively addresses each of the seven problems.

[237] Rayfuse *et al*, n 7, 320. These treaties are not explicitly referenced in the article but presumably the authors are referring to, *inter alia*, the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (adopted 24 November 1993; entered into force 24 April 2003), 2221 UNTS 120, developed under the auspices of the Food & Agriculture Organization of the United Nations (FAO).
[238] Rayfuse *et al*, n 7, 320.

CHAPTER F: A PROPOSAL FOR A NEW INTERNATIONAL LEGAL REGIME FOR OCEAN FERTILIZATION IN THE HIGH SEAS

Desiring by this new instrument to develop an effective regime of conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction

G77 & China[239]

1. A NEW LEGAL INSTRUMENT FOR THE HIGH SEAS

According to the Ocean Health Index, 64% of the ocean's surface and 95% of the ocean's volume is high seas,[240] and in these waters significant pressures on the marine ecosystems come from, *inter alia*, "pollution, overfishing, expanded shipping, marine mining, energy development, intensified aquaculture, as well as ocean warming and acidification".[241] This brief background demonstrates, in part,[242] the motivation for the resolution adopted by the UNGA in June 2015 in which it was decided to "develop an international legally binding instrument (ILBI) under the [LOSC] on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction".[243]

As explained by the DOALOS on its website:

> To that end, [DOALOS] decided to establish, prior to holding an intergovernmental conference, a Preparatory Committee [PrepComm], to make substantive recommendations to the General Assembly on the elements of a draft text of an international legally binding instrument under [the LOSC …] The [PrepComm] will start its work in 2016 and, by the end of 2017, report to the [UNGA] on its progress.[244]

[239] G77 & China proposal for Preambular Elements to the ILBI as quoted in the Non-Paper, n 245, 4.
[240] Ocean Health Index, "2014 High Seas Regional Assessment", available at http://www.oceanhealthindex.org/news/2014_highseas_assessment (accessed 16 July 2017).
[241] A-M Hubert, "UN General Assembly Resolution to develop a new legally binding instrument on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction" (17 August 2015), available at http://site.uit.no/jclos/files/2015/08/UN-General-Assembly-Resolution-to-develop-a-new-legally-binding-instrument-on-the-conservation-and-sustainable-use-of-marine-biological-diversity-of-areas-beyond-national-jurisdiction.pdf (accessed 16 July 2017).
[242] "Areas beyond national jurisdiction" does not refer solely to the high seas, of course. The ILBI will pertain to both the high seas and The Area (as defined in Art 1(1) of the LOSC), but the focus of the thesis and therefore the discussion in respect to the ILBI, is only the high seas.
[243] Resolution 69/292, n 5, [1]. For a more detailed narration of the events leading up to the 2015 resolution, see Hubert, n 241, section titled "A short summary of the process to date".
[244] DOALOS, http://www.un.org/depts/los/biodiversity/prepcom.htm (accessed 16 July 2017).

In advance of the third PrepComm meeting, held from 27 March–7 April 2017, the Chair of the PrepComm circulated a "Chair's non-paper on elements of a draft text of an international legally-binding instrument under the [LOSC] on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction" (Non-Paper).[245] The purpose of the Non-Paper was to provide a "reference document to assist delegations in their consideration of the issues", and it was an "attempt by the Chair at clustering the proposed elements and ideas [received from States and other participants] in a suggested structure".[246] In advance of the fourth PrepComm meeting in July 2017, a Programme of Work was circulated in which it was made clear that the agenda at that meeting would be the further "[d]evelopment of substantive recommendations on the elements of a draft text" of the ILBI.[247] At the time of the writing of this thesis, the Non-Paper remains the latest substantive document to be produced from this ongoing process. This Non-Paper contains a large number of those elements (the Non-Paper is longer than 100 pages) that will likely eventually form the elements of a draft to be submitted to the UNGA by the end of 2017.

2. OCEAN FERTILIZATION & THE NON-PAPER

There is no direct reference to ocean fertilization or geoengineering more generally in the Non-Paper. However other ancillary documents indicate that both have indeed featured in the PrepComm discussions. A report from a workshop held to "help governmental and nongovernmental delegations prepare for" the first PrepComm meeting contains a single reference to marine engineering: it is noted by the IMO delegation as "something that will be of increasing importance in the coming years".[248] The International Institute for Sustainable Development summary from the first PrepComm meeting reports that one country, Jamaica, made reference to ocean fertilization in respect of environmental impact assessments (EIA), and another country, the Philippines, made reference to marine geoengineering in respect of knowledge and capacity-building.[249] Furthermore, the Chair's overview

[245] Non-Paper, Chair of the PrepComm, 28 February 2017, available at http://www.un.org/depts/los/biodiversity/prepcom_files/Chair_non_paper.pdf (accessed 16 July 2017).
[246] *Ibid*., 1.
[247] Provisional Programme of Work: Fourth Session, PrepComm, 15 May 2017, available at http://www.un.org/ga/search/view_doc.asp?symbol=A/AC.287/2017/PC.4/L.2 (accessed 16 July 2017), Item 6.
[248] "Report of the BBNJ Workshop of the Centre for International Law, National University of Singapore, February 2016", Centre for International Law, National University of Singapore, available at https://cil.nus.edu.sg/wp/wp-content/uploads/2015/10/CIL-report-of-BBNJ-workshop-21-March-2016-final-2.pdf (accessed 21 July 2017).
[249] Earth Negotiations Bulletin, International Institute for Sustainable Development, "Summary of the First Session of the Preparatory Committee on Marine Biodiversity of Areas Beyond National Jurisdiction", Volume 25 Number 106, 11 April 2016, available at http://enb.iisd.org/vol25/enb25106e.html (accessed 16 July 2017).

of the third PrepComm meeting notes that examples of "advanced geoengineering" were provided in the context of the transfer of technology.[250]

It is a fair characterisation, then, that ocean fertilization has, to date, not appeared to be *explicitly* at the forefront of the PrepComm agenda. However, a more detailed look at the text of the Non-Paper demonstrates that it is clear that in one area of the Non-Paper in particular, ocean fertilization could – and this author argues *should* – find a natural home as a single component of a broader, integral facet of the Non-Paper. The next two Sections of this Chapter will, first, detail the author's proposal and, secondly, explain why that proposal successfully responds to each of the seven problems with the current regime identified in Chapter D.

3. OCEAN FERTILIZATION & THE NON-PAPER – MOVING FORWARD

It is important to make two preliminary points at this stage. It is clear that regulation of ocean fertilization in the high seas would fit within the broad scope of the objectives of the ILBI – *i.e.*, conservation and sustainable use in areas beyond national jurisdiction – howsoever those objectives are to be eventually defined.[251] Furthermore, it is made clear in the Explanatory Note to the Non-Paper that "the elements listed [in the Non-Paper] are not necessarily exhaustive and do not preclude consideration of matters not included" in future discussions.[252] Accordingly, it would not be too late to introduce discussion of the type proposed in this Chapter on the topic of ocean fertilization going forward.

The Non-Paper is organised in 12 parts with lettered sections and numbered sub-sections. EIAs are one of the topics in the "package"[253] of topics specified in the 2015 UNGA resolution as tools to help meet the overall objectives of the ILBI. Section E of Part III of the Non-Paper is titled "Environmental impact assessments". As discussed above,[254] EIAs are a requirement pursuant to Article 206 of the LOSC when:

> States have reasonable grounds for believing that planned activities under their jurisdiction or control may cause substantial pollution of or significant and harmful

[250] Chair's overview of the third session of the PrepComm, available at http://www.un.org/depts/los/biodiversity/prepcom_files/Chair_Overview.pdf (accessed 16 July 2017), 21.
[251] For example, see the broad objectives of the ILBI as they are variously drafted in the Non-Paper (*ibid.*, 12–14).
[252] Non-Paper, 1.
[253] Resolution 69/292, n 5, [2].
[254] Chapter C, Section 1.1.

> changes to the environment, they shall, as far as practicable, assess the potential effects of such activities on the marine environment and shall communicate reports of the results of such assessments

The importance of EIAs in the context of the overall objective of the ILBI is highlighted by a number of States and NGOs in the Non-Paper. For example, Norway comments that "the purpose of including provisions on EIAs in the [ILBI] must be to operationalize [the LOSC Article 206] duty".[255] To meet this goal, the Non-Paper provides a number of operationalising suggestions, including establishing scenarios for obligatory EIAs, and standardising the process for and content of EIAs.[256] It is the specific heading "Activities for which an EIA is required" – Sub-section 3 of Section E of Part III – that is most relevant for this thesis.

The Non-Paper reflects a variety of suggested approaches to regulating those activities for which an EIA should be required. These range from mandatory EIAs for all proposed high seas activities to mandatory EIAs only when a State exercises "effective control" (as opposed to activities "conducted by a vessel flying a State's flag").[257]

One particular suggestion, however, is raised by a significant number of States and NGOs – including New Zealand, USA, Norway, the G77 & China, and the High Seas Alliance[258] – and that is: "to provide a list of activities in an Annex that would always require an EIA […] When applying a list approach, it is important that the list be adaptable over time to reflect new and emerging uses".[259] It is the author's proposal that it is this suggestion – *i.e.*, an adaptable list that regulates those activities requiring EIAs at each and every instance – that should be the preferred option going forward in the ILBI discussions, with ocean fertilization featuring in such a list.

4. A ROBUST SOLUTION

It is now apposite to explain why, in the author's opinion, this is a robust solution to deal with each of the seven problems identified with the current legal regime for ocean fertilization in the high seas. Each of those problems will be considered in turn, after a few caveat remarks.

[255] Non-Paper, 63.
[256] *Ibid.*, Part III, Section E, Sub-sections 1, 3, 4 & 5.
[257] Suggestions by the Federated States of Micronesia and the USA, respectively. *Ibid*., 65.
[258] *Ibid.*, 65–67.
[259] *Ibid.*, 67.

4.1 CAVEATS

The Non-Paper, of course, provides only "elements of a draft text", and it is as yet unknown what proposals will make their way into the final ILBI. The author's analysis can only be based on those elements as they appear in the documents publicly available, although it should be noted that the author has given weight to specific elements which appear most frequently in the Non-Paper and have been cited as representing a common understanding or direction by the Chair.

The author is proposing that the ILBI, with respect to ocean fertilization, would explicitly override the current LC-LP regime for regulation of ocean fertilization in the high seas.[260]

The author is also working with the assumption that the ILBI will contain detailed provisions on EIAs. As noted above,[261] both the 2015 resolution and the Non-Paper provide every indication that this will indeed be the case.

Furthermore, although the PrepComm must report to the UNGA by the end of 2017, it is not clear how long it will subsequently take for the ILBI to be further considered, debated and eventually adopted: for example, the UNGA will only decide on a date for its first intergovernmental conference in September 2018.[262]

4.2 SOLVING THE SEVEN PROBLEMS

Certain types of ocean fertilization activity may not meet the LOSC definition of pollution and, accordingly, such activity would not be regulated by the Part XII pollution provisions or the dumping regime.

Specifying ocean fertilization as an activity that requires an EIA in all circumstances would remove the potentially thorny question of whether a particular form of ocean fertilization meets the definition of "pollution" for the purposes of the LOSC. Instead, the crux would simply be whether an activity

[260] The relationship between the requirements of the ILBI and requirements under existing legal instruments would need to be clearly determined. This point is highlighted in the general part of the Non-Paper and has been specifically raised with respect to EIAs by Japan (*ibid.*, 14–15 & 67).
[261] See n 253, 255 & 256 and accompanying text.
[262] Pew Charitable Trusts, "The Road to High Seas Conservation", 27 March 2017, available at http://www.pewtrusts.org/en/research-and-analysis/fact-sheets/2017/03/the-road-to-high-seas-conservation (accessed 21 July 2017).

constituted ocean fertilization as that term is defined in the ILBI (how to draft this definition will be discussed below). This simple solution would ensure a regime that can be responsive to changes in ocean fertilization technology – *i.e.*, one able to keep pace with the "moving target"[263] – by capturing all forms of such activity. In essence, the strictest approach can then be maintained while the science of ocean fertilization remains unclear, and the flexibility is there to remove ocean fertilization activity from any such list if that were to become desirable at some stage in the future.

Ocean fertilization is currently not regulated pursuant to climate change mitigation legislation and is only regulated as a form of pollution which does not accurately reflect the status of ocean fertilization in 2017.

By regulating ocean fertilization in a geographic context (*i.e.*, the high seas) within the wide remit of an ILBI that pertains broadly to conservation and sustainability, rather than the context of pollution or climate change explicitly, this intractable debate can be successfully sidestepped.

There are a limited number of States party to the LC and/or LP and non-parties may be deemed unlikely to support the amendment to the LP if it ever enters into force (which is not certain).

The ILBI is in marked contrast to the LC-LP. The importance of "secur[ing] the widest possible acceptance" of an ILBI was explicitly noted from the outset of the process, and the PrepComm is minded to "exhaust every effort to reach agreement on substantive matters by consensus".[264] The process is open to all States member to the UN, States party to the LOSC, and additionally "specialized agencies" and "observers", which has to date included NGOs, academics and scientists.[265] The ILBI shall be the result of a global, all-inclusive process: Bodansky's formula – "get as many countries as possible involved as early as possible"[266] – is embodied by the ILBI.

The current regime relies on flag state jurisdiction in the high seas which has historically proven inadequate in other high seas activities.

The problems associated with relying on flag state jurisdiction both generally and specifically in the context of EIAs are acknowledged in the Non-Paper. For example, the USA suggests there is in reality

[263] n 214.
[264] Resolution 69/292, n 5, [1(g) & (h)].
[265] *Ibid.*, [1(a)].
[266] See n 168 and accompanying text.

a practical distinction between activities under a State's jurisdiction or control and activities "simply" conducted by a vessel flying that State's flag, and a NGO proposes the incorporation of language from the Antarctic Treaty to bolster a State's capabilities to police high seas activities.[267]

However, crucially, the Non-Paper also indicates broad support for the formation of a new international institution pursuant to the ILBI with a decision-making forum, scientific forum, and secretariat,[268] with the provision of scientific advice and information-sharing included in its mandate.[269] An institution of this type is specifically designed to tackle the problems of reliance on flag state jurisdiction on the high seas and it would be extremely valuable to allow the regulation of ocean fertilization to benefit from such an institution. An institution of this type also contrasts with one of the major intractable problems identified in the suggestions by various parties to regulate ocean fertilization pursuant to a new UNFCCC protocol or geoengineering or ocean fertilization treaty, *i.e.*, there being no appropriate governing body for ocean fertilization on the high seas.[270] An institution specifically mandated and resourced with the purpose to govern and advise on activities such as ocean fertilization in the high seas – *i.e.*, an appropriate body – would thus be established pursuant to the ILBI regime.

The current regime may not apply to high seas ocean fertilization activity that takes place without the deployment of vessels or aircraft in the high seas.

This problem derives from the specific language used in the LC-LP regime. Accordingly, this problem would be removed by the transfer of regulation of ocean fertilization to the ILBI.

The Assessment Framework is unworkable, misguided and inappropriately innovative.

In contrast to the LC-LP regime Assessment Framework, the EIA process and framework established pursuant to the ILBI would be the result of a global, multilateral, inclusive negotiation, and, as noted above, would in turn likely be supported or governed by an institutional body with scientific and legal expertise. Furthermore, the implementation of an EIA general to all activities is more suited to a contextualised approach to ocean fertilization than an Assessment Framework capable only of

[267] Non-Paper, 65 & 67.
[268] The Chair notes that this is his understanding based on all proposals and suggestions received at *ibid.*, 94.
[269] The Chair notes that this is his understanding based on all proposals and suggestions received at *ibid.*, 93.
[270] See n 236 and accompanying text.

reviewing that single activity in isolation. In essence, the Assessment Framework – which is fundamentally a form of EIA in any case[271] – would be replaced by a superior EIA framework.

Some ocean fertilization activities may not meet the LP definition of ocean fertilization and, accordingly, those activities would not be regulated pursuant to the legally binding amendments to the LP.

This problem can be solved by amending the definition of ocean fertilization used in the LC-LP regime according to the single, simple drafting change suggested by the author in Section 2.4 of Chapter C (*i.e.*, the deletion of a comma) and including that amended definition in the ILBI. This would ensure a clear and broad definition that is capable of responding both to technology changes and activities with the widest variety of stated intentions.

[271] The Assessment Framework "provides a tool for assessing proposed activities on a case-by-case basis", and its first sections are titled "Initial Assessment" and "Environmental Assessment", IMO Doc LC 32/15, Annex 6, [1.2] & [1.3].

CHAPTER G: CONCLUSIONS

The objective of this thesis was to answer the question of whether it is time – now in 2017 – for a new international legal regime for ocean fertilization in the high seas.

The climate is changing and the world is warming, and to counter the deleterious effects of these changes, a variety of strategies have been and are being explored: geoengineering is just one of these strategies and ocean fertilization is just one form of geoengineering. The jury is still very much out regarding the efficacy of ocean fertilization as a climate change mitigation strategy and it remains in 2017 a controversial and fascinating topic for scientists, lawyers and the popular media.

The current regime for ocean fertilization in the high seas is comprised of the generally applicable norms of international environmental law found in the LOSC and, where specifically applicable, regional legal instruments, and the ocean fertilization-specific regulation of the "dumping" regime (a specific form of pollution in the LOSC regulated by IMO legislation). Chapter D reviewed this current regime in detail, and analysed the myriad flaws – both the conceptual and the practical – with that regime and grouped those flaws under seven headings.

This thesis is not an outlier in spotting those flaws. Both academics and commerce have also reached many of the same conclusions and, in response, have suggested a variety of amendments and alternatives to remedy the regime. However, in the author's opinion, as Chapter E explained, none of these proposals satisfactorily responds to each of the seven problems.

There is a better solution than the current flawed regime, and, furthermore, a better solution that is both timely and workable. As argued in Chapter F, ocean fertilization on the high seas would be better regulated by its incorporation within the EIA provisions of the ILBI specific to areas beyond national jurisdiction currently being negotiated. By including ocean fertilization within that EIA structure, each of the seven problems with the current regime highlighted in Chapter D would be removed. Ocean fertilization would thus be clearly regulated in an adaptive, well-supported and suitably scientific legal environment.

This thesis has been written at an opportune time: many academics writing on this topic have not had the opportunity to consider the relatively recent legally binding amendments to the dumping regime, the import of the Paris Agreement or, indeed, the ongoing negotiations of an ILBI under the auspices

of the UNGA. Furthermore, it is written at a moment when it is possible – and indeed *advisable* in the author's opinion – to anchor the discussion of alternatives and improvements to the current regime for ocean fertilization in the high seas in the context of the ongoing negotiations to draft a global ILBI to regulate the high seas of the future. Ocean fertilization has its place in these negotiations. It is indeed time for a new international legal regime for ocean fertilization in the high seas.

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