MARINE GEO-ENGINEERING: A NEW CHALLENGE FOR THE LAW OF THE SEA

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Australia New Zealand Society of International Law (ANZSIL) 18th Annual Conference: International Law in Second Decade of the 21st Century – Back to the Future or Business as Usual?
24 – 26 June 2010
Australian National University (ANU), Canberra, Australia

Abstract

In light of the apparent failure to agree to directly address climate change through emissions reductions, attention is increasingly focusing on alternative options to reduce the impacts of climate change. Some of these options involve engineering the earth to reduce the impact or affect of climate change; in particular, marine geo-engineering is seeking to explore ocean-based climate change mitigation measures. One of these options – the sub-seabed sequestration of carbon dioxide – has recently (and controversially) been addressed by the 1996 London Protocol to the 1972 London (Dumping) Convention. The parties to the 1996 Protocol have also asserted that this instrument has jurisdiction over ocean fertilization activities and are currently developing guidelines designed to permit fertilization for the purpose of science only. Neither sequestration nor fertilization fits entirely comfortably within the dumping regime, and it is clear that other geo-engineering schemes (such as those involving the deposit of devices into the ocean and the placement of dams across straits) will fall outside of the regulatory remit of these instruments.

This paper will explore the extent to which the law of the sea is capable of responding to the marine geo-engineering challenge, and whether the current regulatory tools provide the appropriate regulatory framework for proactive management of marine geo-engineering. This paper will conclude with an outline of a proposal for the development of a regime to regulate emerging climate change mitigation technologies. Whilst policy questions and general principles relating to geo-engineering are arguably best addressed within the regime established by the 1992 United Nations Framework Convention on Climate Change, detailed regulation and management of geo-engineering technologies is better suited to institutions and regimes that have specialist expertise in the area of the technology in question. The proposal developed in the final part of this paper attempts to address both these requirements.

Introduction

Over the last couple of days we have been exploring the theme of this conference within a variety of contexts. The essential question put to us by the Conference organizers is whether international law is in crisis and able only to react to events, or, more positively, whether it is able to proactively influence and guide action and decision-making. In this paper I intend to explore this question within a very particular context; marine geo-engineering. The term geo-engineering was coined by Cesare Marchetti in 1977 in connection with what he referred to as the CO_2 problem,[1] but more broadly, geo-engineering can be defined to mean "the intentional large scale manipulation of the environment."[2] The history of geo-engineering dates back to at least the 1840s when James Pollard Espy, the first US government meteorologist (and former lawyer) proposed burning vast areas of forest in order to create columns of heated air which, in his opinion would tripper precipitation.[3] Seeding clouds for the purpose of generating rainfall has been carried out since the late 1940s – and continues to be used today – and cloud seeding has also been used to lessen the intensity of hurricanes, to improve air quality and, less benignly, by the United States as so-called "weather warfare" in Vietnam.[4] In fact, concern that a very real "weather-warfare race" was developing between the US and the (then) USSR led directly to the negotiation and adoption of the UN Convention on the Prohibition of Military or any other Hostile Use of Environmental Modification Techniques (ENMOD) in 1976.[5] More recently, the term geo-engineering has become closely associated with climate change mitigation and its raison d'être – climate change mitigation – is now ubiquitously central to its modern definition. For example, the 2009 Royal Society Report (UK) on *Geoengineering the Climate: Science, Governance and Uncertainty* defines geo-engineering as "the deliberate large-scale manipulation of the planetary environment to counteract anthropogenic climate change."[6] The House of Commons' 2010 Report in the UK on *The Regulation of Geoengineering* similarly refers to "activities specifically and deliberately designed to effect a change in the global climate with the aim of minimizing or reversing anthropogenic climate change" in its definition of geo-engineering.[7]

Geo-engineering was first formally proposed as a means of addressing climate change in 1965 in a policy assessment provided to the US President Lyndon Johnson. In fact, geo-engineering was the only option given to President Johnson in this report; the reduction of emissions was not a suggested solution to a warming climate.[8] Until very recently geo-engineering was regarded as something as a fringe topic. It benefits from only a

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1 C. Marchetti, "On Geo-engineering and the CO_2 Problem" 1 (1977) *Climate Change* 59.

2 J. Virgo, "International governance of a possible geo-engineering intervention to combat climate change" 95 (2009) *Climate Change* 103.

3 James R. Flemming, "The Climate Engineers" 31 (2007) *The Wilson Quarterly* 46 – 60 at 51.

4 Ibid, at 55 – 56. For an engaging introduction to the history of geoengineering see David W. Keith, "Geoengineering the Climate: History and Prospect" 25 (2000) *Annu. Rev. Energy Environ.* 245 – 284. For a more in-depth study see Jeff Goodell, *How to Cool the Planet: Geoengineering and the Audacious Quest to Fix Earth's Climate* (Houghton Mifflin Harcourt: Boston) (2010). For a technical analysis of a number of different technologies see G. Bala, "Problems with geoengineering schemes to combat climate change" 96 (10 January 2009) *Current* Science 41 – 58; T. M. Lenton and N. E. Vaughn, "The radiative forcing potential of different climate geoengineering options" 9 (2009) *Atmos. Chem. Phys.* 5539 – 5561;

5 16 *ILM* 88 (1977) (in force 1978).

6 Royal Society, *Geoengineering the Climate: Science, Governance and Uncertainty* (2009) at 15.

7 House of Commons, Science and Technology Committee, *The Regulation of Geo-engineering* (5th Report of Session 2009 – 10) at 3.

8 David W. Keith, *op cit.* n. 4 at 254.

couple of paragraphs in the entire IPCC's Fourth Assessment Report released in 2007[9] and is not mentioned at all in the *Stern Review Report on the Economics of Climate Change* released by the British government in 2006.[10] David Victor has recently commented that the entire "scientific literature on the subject could be read during the course of a transatlantic flight".[11] (It is not apparent as to whether this is simply speculation on Victor's part or whether he proved his hypothesis over a particular journey!) The view that geo-enginneering is a fringe topic is however, undoubtedly changing. Two high profile reports released in 2003 in the United States by the Pentagon[12] and the National Research Council[13] both recommended that further research into geo-engineering as a climate change mitigation measure should be carried out. In the UK, the Royal Society published a report entitled *Geo-engineering the Climate: Science, Governance and Uncertainty* in September 2009[14] and two Parliamentary Committees have recently published reports on issues associated with geo-engineering.[15] At the international level, geo-engineering or, more particularly, one form of geo-engineering – ocean fertilization – is currently under serious consideration by the parties to at least two international instruments; the 1996 Protocol to the 1972 London (Dumping) Convention[16] and the 1992 Biodiversity Convention.[17] The upward trend of interest in geo-engineering as a climate change mitigation measure is likely to increase; the economics of geo-engineering are, as described recently by Scott Barrett: "incredible"[18] and thus potentially provide a cheap alternative to emissions reductions.

This inevitably creates a challenge for international law. To what extent can international law proactively manage these technologies as opposed to merely react and respond to ad hoc developments?

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[9] B. Metz *et al*, *Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press: Cambridge) (2007) at para 11.2.2.

[10] The full report is available online at: http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/stern_review_report.htm.

[11] David G. Victor *et al*, "The Geoengineering Option: A Last Resort Against Global Warming?" 88 (2009) *Foreign Affairs* 64 – 76 at 73.

[12] Peter Schwartz and Doug Randall, *An Abrupt Climate Change Scenario and its Implications for United States National Security* (October 2003) Available online at: http://www.edf.org/documents/3566_AbruptClimateChange.pdf

[13]National Research Council, *Critical Issues in Weather Modification Research* (Washington: The National Academies Press) (2003) available online at: http://www.nap.edu/catalog.php?record_id=10829#toc.

[14] The Royal Society, *Geo-engineering the Climate: Science, Governance and Uncertainty* (Policy Document 10/09) (2009) available online at: http://royalsociety.org/Geoengineering-the-climate/. For commentary on the Report see Geoff Brumfiel, "Climate Control Plans Scrutinized" 461 (September 2009) *Nature* 19; John A. Glaser, "Climate geo-engineering" 12 (2010) *Clean Techn Environ Policy* 91 – 95.

[15] House of Commons, Innovation, Universities, Science and Skills Committee, *Engineering: turning ideas into reality: Government Response to the Committee's Fourth Report* (Fifth Special Report of Session 2008 – 2009) (June 2009) available on line at: http://www.publications.parliament.uk/pa/cm200809/cmselect/cmdius/759/759.pdf; House of Commons Science and Technology Committee, *The Regulation of Geoengineering* (Fifth Report of Session 2009 – 2010) (March 2010) available online at: http://www.publications.parliament.uk/pa/cm200910/cmselect/cmsctech/221/221.pdf.

[16] 36 *ILM* 7 (1997) (in force 2006).

[17] 31 *ILM* 818 (1992) (in force 1993). Notably ocean fertilization has also received attention from the United Nations General Assembly in UNGA Resolution 62/215 *Oceans and the Law of the Sea* (2007) (para. 98) and UNGA Resolution 64/17 *Oceans and the Law of the Sea* (2009) (paras. 132 and 133). See also the 2009 *Report of the Secretary General on the Law of the Sea* (A/65/69, 2009) at para 86.

[18] Scott Barrett, "The Incredible Economics of Geo-engineering" 39 (2008) *Environ Resource Econ* 45 – 54 at 49.

Marine Geo-engineering: Options of Last Resort?

Geo-engineering for climate change mitigation purposes generally falls into one of two categories. First, those focused on solar radiation management or albedo enhancement such as injecting sulfur or other reflective particles into the atmosphere[19] or placing sunshades or strategically positioned mirrors in outer space.[20] Second, technologies designed to remove carbon dioxide from the atmosphere.

For the purposes of this paper, I will confine my discussion to technologies that exploit the marine environment for climate change mitigation purposes. The majority of technologies currently under consideration seek to use the oceans to change the balance of carbon dioxide between the atmosphere and the oceans (in practice to remove CO_2 from the atmosphere) rather than attempt to increase the reflectivity of the ocean through greater ice-cover or through placing reflective devices in the oceans.[21]

The oceans, as is well known, contain about 38,000 gigatonnes of carbon dioxide which represents 55 times the amount of carbon dioxide in the atmosphere and 20 times the carbon dioxide contained in the biosphere and soils.[22] Carbon dioxide is transferred from the surface of the ocean to deep waters by means of the biological and solubility pumps and ocean circulation. Scientists and, increasingly, engineers have postulated that if either or both of these pumps could be enhanced, in order to draw down greater quantities of carbon dioxide, this would in effect operate as a climate change mitigation measure. There are of course significant risks associated with increasing the level of carbon dioxide in the oceans including increased ocean acidity,[23] diminished phytoplankton productivity and damage to ecosystems.[24]

The marine geo-engineering method which has thus far received the greatest scientific and, consequently, regulatory attention, seeks to enhance the ocean's biological pump by so-called fertilization techniques.[25] This strategy exploits the fact that some ocean regions – most notably the Southern Ocean and the Equatorial Pacific – are relatively

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[19] Paul J. Crutzen, "Albedo Enhancement by Stratospheric Sulfur Injections: A Contribution to Resolve a Policy Dilemma?" 77 (2006) *Climatic Change* 211 – 210; Robert E. Dickinson, "Climate Engineering: A Review of Aerosol Approaches to Changing the Global Energy Balance" 33 (1996) *Climatic Research* 279 – 290; Alan Robock et al, "Regional climate responses to geoengineering with tropical and Arctic SO_2 injections" 113 (2008) *Journal of Geophysical Research* D16101. See also G. Bala *et al*, "Impact of geoengineering schemes on the global hydrological cycle" 105 (June 3 2008) *PNAS* 7664 – 7669; B. Govindasamy *et al*, "Impact of geoenginnering schemes on the terrestrial biosphere" 29 (2002) *Geophysical Research Letters* No. 22, 20-61, doi:10.1029/2002GL015911.

[20] C. R. McInnes, "Spaced-based geoengineering: challenges and requirements" 224 (2010) *Proc. IMechE Vol.224 Part C: J. Mechanical Engineering Science* 571 – 580.

[21] Nevertheless, the Royal Society in its 2009 Report on *Geo-engineering the Climate: Science, Governance and Uncertainty* noted that increasing the albedo or the reflectivity of the oceans could have a potentially significant beneficial effect on climate change. However, serious proposals for enhancing ocean albedo have yet to be made (p. 26).

[22] CBD, *Scientific Synthesis of the Impacts of Ocean Fertilization on Marine Biodiversity* (CBD Technical Series No. 45) (2009) at 11.

[23] H. Damon Matthews *et al*, "Sensitivity of ocean acidification to geoengineered climate stabilization" 36 (2009) *Geophysical Research Letters* L10706 doi: 10.1029/2009/GL037488.

[24] Tom Garrison, *Essentials of Oceanography* (5th edition) (Brooks/ Cole Cengage Learning: Belmont) (2009) at 379.

[25] See generally, A. Strong *et al*, "Ocean Fertilization: Science, Policy and Commerce" 22 (2009) *Oceanography* 236; Theme Section – "Implications of Large-scale Iron Fertilization of the Oceans" 364 (2008) Marine Ecology Progress Series 213 – 309.

unproductive. Within these regions biological production is limited by the low availability of one or more nutrients such as iron, nitrogen or phosphate. If the missing nutrient is added to the ocean then in theory this will facilitate an increase in the biological productivity in the region and, as a consequence, enhance the draw-down of carbon dioxide. As John Martin memorably put it in 1990: "Given me half a tanker of iron and I will give you an ice-age.[26] More than a dozen iron fertilization experiments have been carried out over the last decade mostly in the Southern Ocean.[27] The results of this research are inconclusive: it is not clear how large the fertilized area needs to be in order to draw down a meaningful quantity of CO_2[28] and it is uncertain as to how long the sequestration of CO_2 lasts for.[29] Moreover, this deliberate attempt to modify an ecosystem may well have negative impacts on the existing food chain of that ecosystem,[30] could potentially induce the growth of toxic algae[31] or the suffocation of that ecosystem or could even make climate change worse by leading to an increase in the release of methane and nitrous oxide.[32]

Other marine geo-engineering techniques which have been suggested include: the use of vertical ocean pipes to pump deep water to the surface in order to increase the supply to nutrients at the surface with a view to enhancing the biological pump[33]; crop residue oceanic permanent sequestration – the disposal of baled crop residues in the deep ocean[34]; so-called weathering techniques which seek to increase the alkalinity of the oceans in order to reduce acidification and enhance the solubility pump[35]; modification and enhancement of sea-ice designed to enhance down-welling ocean currents[36]; and the building of strategic dams in order to isolate key bodies of water such as the Arctic Ocean or the Mediterranean.[37]

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[26] "J. Martin, "Glacial – Interglacial Change: The Iron Hypothesis" 5 (1990) *Paleoceanography* 1 at 10.

[27] CBD, *Scientific Synthesis of the Impacts of Ocean Fertilization on Marine Biodiversity* (CBD Technical Series No. 45) (2009) at 24.

[28] K. Buesseler *et al*, "The Effects of Iron Fertilization on Carbon Sequestration in the Southern Ocean" 304 (2004) *Science* 417.

[29] S. Blain, "Effect of Natural Iron Fertilization on Carbon Sequestration in the Southern Ocean" 446 (2007) *Nature* 1070; P. Boyd *et al*, "A Mesocale Phytoplankton Bloom in the Polar Southern Ocean Stimulated by Iron Fertilization" 407 (2000) *Nature* 695; K. Caldeira and P. Duffy, "The Role of the Southern Ocean in Uptake and Storage of Anthropogenic Carbon Dioxide" 287 (2000) *Science* 620;

[30] A. Strong, "Ocean fertilization: time to move on" 461 (2009) *Nature* 347.

[31] Q. Schiermeier, "The Oresmen"421 (2003) *Nature* 109, 110.

[32] J. Furhman and D. Capone, "Possible Biogeochemical Consequences of Ocean Fertilization" 36 (1991) *Limnology & Oceanography* 1951; M. Lawrence, "Side-effects of Ocean Iron Fertilization" 297 (2002) *Science* 1993.

[33] See J. Lovelock and C. Rapley, "Ocean pipes could help the Earth to cure itself" *Nature* 449 (27 September 2007) 403; A. Yool *et al*, "Low efficiency of nutrient translocation for enhancing oceanic uptake of carbon dioxide" 114 (2009) *Journal of Geophysical Research* 114 C08009, oi:10.1029/2008JC004792.

[34] S. Strand and G. Benford, "Ocean Sequestration of Crop Residue Carbon: Recycling Fossil Fuel Carbon Back to Deep Sediments" 43 (2009) *Environ. Sci. Technol.* 1001.

[35] L. Harvey, "Mitigating the atmospheric CO_2 increase and ocean acidification by adding limestone powder to upwelling regions" 113 (2008) *Journal of Geophysical Research* 113; K. House *et al*, "Electrochemical Acceleration of Chemical Weathering as an Energetically Feasible Approach to Mitigating Anthropogenic Climate Change" 41 (2007) *Environ. Sci. Technol.* 8464; H. Kheshgi, "Sequestering Atmospheric Carbon Dioxide by Increasing Ocean Alkalinity" 20 (1995) 915.

[36] S. Zhou and P. C. Flynn, "Geoengineering Downwelling Ocean Currents: A Cost Assessment" 71 (2005) *Climate Change* 203.

[37] See for example R. Shutterhelm, *Diomede Crossroads: Saving the North Pole? Thoughts on Plausibility* available online at: http://www.cleverclimate.org/art/uploads/Diomede_Crossroads(1).pdf.

Governance Challenges

Before turning to the current legal framework it is helpful to identify some of the governance challenges which are associated with marine geo-engineering. There are undoubtedly many such challenges but I am going to content myself with six for the purposes of this paper.

First, all of these proposals are, in the words of the 2007 IPCC Report, largely speculative and unproven.[38] In contrast to techniques which focus on enhancing the Earth's albedo, marine geo-engineering technologies will potentially need a significant period of time to have an impact on global climate if, that is, they are capable of having such an impact. Moreover, the risks associated with these technologies are also unknown and could be significant. In short, the cure could be worse than the disease.

There is also the question as to how the development of these technologies relate to more traditional mitigation strategies and, most importantly emissions reduction. Although if they are to be used at all geo-engineering strategies should arguably form part of a wider portfolio of climate change mitigation strategies, there is a clear risk that they may in fact be viewed as an *alternative* to emissions reductions as, in effect, get-out-of-jail-free cards. The reluctance of the international community to take meaningful measures to reduce greenhouse gas emissions was publically demonstrated last December in Copenhagen and by the fact that global emissions are continuing to rise; at about 3 percent a year. The so-called moral-hazard argument is self-evident: if states or indeed individuals view these technologies as providing a quick fix they will feel no imperative to make the necessary life-style changes needed to address climate change in the longer term.

The third challenge is that many of these techniques are relatively cheap and can potentially be undertaken unilaterally by individual states or even companies or wealthy individuals.[39] Private corporations are already engaged in fertilization activities: the most well known are the US-based Climos[40] and Planktos although the latter company stopped operating in 2008. However, the Ocean Nourishment Corporation has recently conducted urea fertilization experiments in the Sulu Sea[41] and Atmocean – also a US venture – is experimenting with the use of wave driven pumps to transfer nutrient rich deep water to the surface.[42] Depending on the nature of the technology – and this issue is probably of greater concern to albedo enhancing technologies – states acting unilaterally and even individuals[43] have the potential capacity to unilaterally change our climate or otherwise re-engineer our environment.

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[38] B. Metz *et al*, *Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press: Cambridge) (2007) at para 11.2.2.

[39] See further Scott Barrett, "The Incredible Economics of Geoengineering" 39 (2008) *Environ Resource Econ* 45 - 54.

[40] Climos has plans to fertilize 40,000 square km of the Southern Ocean with iron for the sale of carbon offset credits. See Aaron Strong *et al*, "Ocean fertilization: time to move on" 461 (17 September 2009) *Nature* 347 – 348 at 348.

[41] J. Mayo-Ramsey, "Environmental, legal and social implications of ocean urea fertilization; Sulu Sea example" *Marine Policy* (2010) *in press*.

[42] R. Warner, "Preserving a Balanced Ocean: Regulating Climate Change Mitigation Activities in Marine Areas beyond National Jurisdiction" 14 (2007) *Australian International Law Journal* 99 at 104.

[43] For example, Bill Gates has apparently contributed US$4.5 million to geoengineering research over the last three years. See Clive Hamilton, *The Return of Dr Strangelove: The Politics of Climate Engineering as a Response to Global Warming* (June 2010) available online at: http://www.clivehamilton.net.au/cms/media/documents/articles/dr_strangeloves_return.pdf.

The fourth challenge focuses on the extent to which the risks presented by marine geo-engineering can be managed without stifling or inhibiting research altogether. All of these techniques are currently at the early stages of research or indeed represent no more than mere proposals. The safest way forward is obviously a moratorium on all marine geo-engineering technologies but, given the seriousness of the climate change threat, we arguably cannot afford to simply ignore these potential options. Concern over stifling research and innovation led the British House of Commons Science and Technology Committee in their 2010 report on *The Regulation of Geo-engineering* to deliberately exclude the precautionary principle from their proposed list of governance principles.[44]

The fifth challenge is managing the effects global and transboundary, intended and unintended of geo-engineering research and the actual deployment of such climate change mitigation technologies. Should the rules relating to state responsibility and civil liability apply in the event that negative consequences ensue? Some states are likely to benefit from climate change; how should their interests be represented in any governance regime?

And finally, and arguably, most importantly who or what should decide which if any of the geo-engineering options should be developed? Should technologies be developed on an ad hoc individual basis or do we need to take a more concerted or integrated approach?

The Current International Legal Framework[45]

Turning now to the international legal framework: there are very few examples of specific legal obligations which apply directly to marine geo-engineering activities – with the exception of Article 196(1) of the 1982 United Nations Convention on the Law of the Sea (UNCLOS). Nevertheless, UNCLOS provides for a range of rights and obligations which undoubtedly provide at least the bones of the framework for any governance regime. For the purposes of today's paper – in view of the time-constraints – I am not going to examine in detail this regime; I just intend to highlight in at least broad terms the types of obligations which are potentially applicable.

First, marine scientific research is undoubtedly a freedom of the high seas (Article 87(1)(f) of the 1982 UNCLOS). Moreover, a good case can be made for arguing that marine geo-engineering activities should likewise constitute a freedom of the high seas.[46] Nevertheless, high seas freedoms must be exercised with due regard for the interests of other states and in accordance with the provisions of UNCLOS. This is particularly

[44] House of Commons, Science and Technology Committee, *The Regulation of Geo-engineering* (5th Report of Session 2009 – 10) (UK)) at para. 86.

[45] See generally, A. Carlin, "Global Climate Change Control: Is there a better Strategy than Reducing Greenhouse Gas Emissions?" 155 (2007) *University of Pennsylvania Law Review* 1401; Daniel Bodansky, "May we engineer the climate?" 33 (1996) *Climate Change* 301 – 321;W. Davis, "What does Green Mean? Anthropogenic Climate Change, Geoengineering and International Law" 43 (2009) *Georgia Law Review* 901; J. Michaelson, "Geoengineering: A Climate Change Manhatten Project 17 (1988) *Stanford Environmental Law Journal* 73; Philomene Verlaan, "Geo-engineering, the Law of the Sea, and Climate Change" 4 (2009) *Carbon and Climate Law Review* 446 – 458; David G. Victor, "On the regulation of geo-engineering" 24 (2008) *Oxford Review of Economic Policy* 322 – 336; D. Victor *et al*, "The Geoengineering Option: A Law Resort Against Global Warming" 88 (2009) *Foreign Affairs* 64; J. Virgo, "International governance of a possible geoengineering intervention to combat climate change" 95 (2009) *Climate Change* 103.

[46] This is based on the prevailing view that unless an activity is specifically excluded by a rule of international law then it should be regarded as a high seas freedom. See R. R. Churchill and A. V. Lowe, *The Law of the Sea* (3rd edition) (Manchester University Press: Manchester) (1999) at 206.

important where technologies involve placing objects into the sea such as pipes which might hinder navigation and where fertilization activities have a negative impact on fish stocks and other biological resources which may impact upon the freedom of fishing. Similarly, although coastal states undoubtedly have exclusive jurisdiction in connection with both scientific research and, arguably, the exploitation of its waters for marine geo-engineering purposes (Article 56(1), UNCLOS) they too must exercise their rights with due regard to the rights of other states including the right of navigation (Article 56(2), UNCLOS). In particular, where international straits are concerned foreign vessels are able to exercise the right of transit passage or, at the very least non-suspendable innocent passage and this would appear to preclude mega-infrastructure projects such as the damming of straits.[47]

Second, marine scientific research must be carried out in accordance with Part XIII of UNCLOS and in particular, with the principles set out in Article 240 of the Convention which include regard for other users and the requirement to comply with Part XII of UNCLOS on marine environmental protection. Moreover, Article 245 provides for a number of principles related to the publication and dissemination of information connected to proposed major projects and the promotion of transfer of data, information and knowledge to developing states. Moreover, marine scientific research and indeed all activities taking place within the Area – that is on the seabed beyond the jurisdiction of states – must be undertaken for the benefit of mankind (Article 140 UNCLOS). Research activities taking place within the zones of coastal states are of course subject to the consent and control of that coastal state.[48]

In connection with scientific research involving ocean fertilization the parties to the 1996 Protocol to the 1972 London Convention are in the process of developing an Assessment Framework which will be modeled on the risk and Management framework adopted in 2006 for the geological sequestration of carbon dioxide. The Framework will require researchers to undertake an initial assessment, a detailed risk analysis (which includes an acknowledgement of data gaps) and research approvals should relate to defined areas and defined periods only.[49]

Third, scientific research and marine geo-engineering projects more generally must comply with the environmental safeguards set out in UNCLOS and developed under other global and regional instruments. Article 192 of UNCLOS creates a general obligation to protect and preserve the marine environment and Article 194 requires states to take all measures to prevent the pollution of the marine environment from *any* source. Pollution is defined in Article 1(4) of UNCLOS and it is of course open to interpretation as to whether all geo-engineering projects are likely to cause pollution in this sense. Ocean fertilization projects and, more particularly, the utilization of deep ocean pumps appear – at least at first sight – one step removed from causing harm.

It is of course possible to identify with relative ease numerous additional environmental obligations can be identified from within Part XII of UNCLOS itself, under other marine-focused and environmental agreements and as principles of international law. I can do no more than highlight them here this afternoon. They might include (but are certainly not restricted to) environmental impact assessment; prior notification, consultation and cooperation more generally; the minimization of transboundary harm and the obligation

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[47] Part III of the 1982 UNCLOS.

[48] Articles 245 and 246 of the 1982 UNCLOS.

[49] See the Annex attached to the Report of the Ocean Fertilization Working Group (LC/SG 32 WP.7 (28 May 2009).

to refrain from transferring one type of pollution into another; the requirement to develop contingency plans and to monitor activities and to adapt management where that is appropriate; considering the ecosystem as a whole, taking a precautionary approach where information is uncertain and the activity risks substantial harm to the environment as well as principles relating to state responsibility and civil liability.

Nevertheless, identifying the likely principles and concepts which undoubtedly underpin the regulation of marine geo-engineering is not the same as governance. There is currently no international organization with a clear regulatory mandate over marine geo-engineering. Following its Statement of Concern issued in 2007[50] in connection with ocean fertilization activities the parties to the London Protocol declared in 2008 that the remit of both the Protocol and the Convention includes fertilization activities and, that in order to provide for legitimate scientific research, such research should be regarded as placement for a purpose other than mere disposal thereof under Article 1.4.2.2 of the Protocol rather than dumping. However, ocean fertilization activities for purposes other than research should be currently regarded as contrary to the aims of the Convention and Protocol.[51]

There is no time here to extensively analyze the extent to which the dumping regime constitutes a suitable forum for the management of ocean fertilization activities – scientific or otherwise – given that the object of such activities is not disposal per se.[52] In light of the regime's more general focus on marine environmental protection, the fact that fertilization activities are already taking place and that there is no obvious alternative regulatory forum, the adoption of the 2008 Resolution seems eminently sensible. Nevertheless, the tension in – what in practice amounts to a clear expansion of the Protocol's mandate – is clearly evident in the on-going negotiations as to how to take the regulatory regime forward. An Intersessional Working Group on Legal and Related Issues connected to ocean fertilization has been established and has identified 8 options ranging from a non-binding statement of concern through to amendment of the definition of dumping and a free standing article relating to fertilization. Although some states – notably New Zealand and Australia – favor amending Annex I to permit regulated research activities only, there are difficulties in doing this without any amendment to the definition of dumping, which in its current formulation, would seem to still permit fertilization activities for purposes other than disposal whether they are scientific or not. But an amendment to the definition of dumping under the 1996 Protocol would potentially create challenges for the application of Article 210 of UNCLOS. In any case, whilst the dumping regime might be utilized to manage other geo-engineering techniques which involve the introduction of substances into the marine environment such as certain weathering technologies and crop residue permanent sequestration, it does not

[50] See LC-LP.1/Circ.14 (13 July 2007)

[51] Resolution LC-LP.1 (2008).

[52] See further J. Dean, "Iron Fertilization: A Scientific Review with International Policy Recommendations" 32 (2008 – 2009) *Environs Envtl. L & Pol'y J.* 321; D. Freestone and R. Rayfuse, "Ocean Fertilization and International Law" 364 (2008) *Marine Ecology Progress Series* 227; K. Güssow *et al*, "Ocean Fertilization: Why Further Research is Needed" (2010) *Marine Policy* (in press); J. Peterson, "Can algae save civilization? A look at technology, law and policy regarding iron fertilization of the ocean to counteract the greenhouse effect" 6 (1995) *Colorado Journal of International Environmental Law and Policy* 61; R. Rayfuse, "Ocean Fertilization and Climate Change: The Need to Regulate Emerging High Seas Uses" 23 (2008) *International Journal of Marine and Coastal Law* 297; K. Scott, "The Day After Tomorrow: Ocean CO_2 Sequestration and the Future of Climate Change" 18 (2005 – 2006) *The Georgetown International Environmental Law Review* 57, 93 – 106; R. Warner, "Preserving a balanced ocean : Regulating Climate Change Mitigation Activities in Marine Areas Beyond National Jurisdiction" 14 (2007) *Australian International Law Journal* 99.

have a natural mandate to regulate other forms of geo-engineering such as the ocean pipes proposal.

Moreover, where no clear regulatory forum can be identified this may lead to multiple organizations taking "ownership" so-to-speak of the issue. This may lead to divergent standards or approaches being developed towards particular technologies. In the case of ocean fertilization for example, the parties to the 1992 Convention on Biological Diversity adopted Decision IX/16 in 2008 whereby they requested parties to ensure that ocean fertilization activities do not take place until there is an adequate scientific basis on which to justify 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 activities within coastal waters. This is not necessarily consistent with the approach of the parties to the 1996 London Protocol which, at least at the moment, are still continuing to consider non-regulatory options for the management of research activities. As has been pointed out by the IOC the reference to coastal waters is both unclear and, narrowly, likely to apply in practice to urea as opposed to iron fertilization.

Finally, the lack of a clear regulatory mandate may lead individual states or corporations to develop their own regulations for research and other activities. Climos for example, has developed its own Code of Conduct (in 2007)[53] and, as I noted earlier, a committee of the House of Commons in the UK recommended that the precautionary principle as a discrete principle should be excluded from the five principles they identified as integral to the foundation of a management framework.[54]

Marine Geo-engineering: the Integration Challenge

The most significant challenge in my view is that without the identification of a clear regulatory forum marine geo-engineering will not be managed in a cohesive and integrated manner. Whilst it is understandable and, indeed, appropriate that the parties to the London Protocol have taken the initiative to develop a regulatory approach to try to manage activities which have already begun, they arguably do not possess the mandate to decide whether geo-engineering of the marine environment is an appropriate policy and technological response to climate change. Moreover, it in fact makes little sense to separate out marine geo-engineering from other technologies that make use of the biosphere, the atmosphere or even outer space. These are policy questions that ultimately need to be assessed alongside other climate change mitigation strategies such as emissions reductions, renewable energy promotion and sequestration. In practice, these policy questions need to be dealt with within the climate change regime.

Proposal

I would like to conclude this paper with a very brief sketch of one possible model of an integrated regulatory regime for geo-engineering.

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[53] *Climos Code of Conduct for Ocean Fertilization Projects* (27 September 2007) available online at: http://www.climos.com/standards/codeofconduct.pdf.

[54] House of Commons, Science and Technology Committee, *The Regulation of Geo-engineering* (5th Report of Session 2009 – 10) (UK)) (para. 86).

First, in my opinion we need a global over-arching instrument which will provide both the catalyst and the forum for examining geo-engineering options at the international level. This instrument should set out common principles of application to both research and mitigation activities. In connection with marine geo-engineering in particular, those principles should include respect for other users of the oceans, marine environmental protection, protection of scientific research as well as standard environmental tools such as environmental impact assessment, monitoring, cooperation, liability etc. This instrument should also establish the appropriate institutions to provide advice on science and engineering matters and to take policy decisions on what if any technologies should be developed and how information should be shared. I think that this global instrument should be developed as a protocol to the 1992 UN Framework Convention on Climate Change given that geo-engineering is one of a number of mitigation measures and needs to find its place within the context of other measures including emissions reductions and adaptation. To the extent that the Kyoto principles of joint implementation and the clean development mechanism are applied to geo-engineering projects it is clearly appropriate that these regimes are closely connected.

It is unlikely that such an instrument would provide an appropriate forum to develop detailed regulation of application to very different geo-engineering techniques. I therefore propose that the parties to the Protocol designate subsidiary bodies with the appropriate expertise to this. Arguably the London Protocol is the appropriate body for fertilization and similar techniques. The IMO may be the appropriate body to regulate techniques using pipes and the UN Committee on the Peaceful Uses of Outer Space is the obvious forum for technologies located in space. What is important however, is that appropriate processes and institutions are established for the purpose of coordination and communication between these bodies so that these activities are managed in a consistent and integrated manner. Management would have to be adaptive and be based on science. Ultimately, it will be up to the management or regulatory body established by the over-arching Protocol to decide which technologies if any, should be utilized and under what circumstances. This proposal undeniably creates an opportunity for international law to proactively manage the development of these technologies and to directly influence and guide both state and non-state activities in this field. Without a coordinated response, international regimes and institutions including those with responsibility for activities taking place within the marine environment risk being in a position where they are simply reacting to developments, the consequences of which may extend well beyond the international legal system itself.