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DEPLOYMENT OF GEOENGINEERING BY THE PRIVATE AND PUBLIC SECTOR: CAN THE RISKS OF GEOENGINEERING EVER BE EFFECTIVELY REGULATED?

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Introduction

In light of the slow progress of emissions reductions, geoengineering has become increasingly attractive as a method of avoiding or mitigating the harmful consequences of climate change. Geoengineering has been described as any large-scale environmental manipulation designed with the purpose of mitigating the effects of climate change without decreasing greenhouse gas emissions (GHGs).[2] However, the Intergovernmental Panel on Climate Change (IPCC) has stated that, due to the pervasive uncertainties of nearly all geoengineering techniques, "the potential role of geoengineering as a viable component of climate policy is yet to be determined."[3]

Despite its uncertain effects, geoengineering technologies could be deployed by one or several States or by a private entity without considering the risks of their actions for other countries and ecosystems.[4] At least a dozen nations already possess the technological and economic capacity to implement geoengineering technologies by themselves.[5] There are already some start-up companies active in carbon dioxide removal (CDR) geoengineering techniques including ocean fertilisation.[6] This is particularly concerning because the irresponsible deployment of geoengineering could result in disastrous effects on other countries.

Ironically, the effects of geoengineering could potentially cause exactly what it was deployed to prevent: an environmental disaster. Currently there are no specific rules regulating geoengineering activities[7], particularly if geoengineering is deployed in areas beyond national jurisdiction. This article argues that, in order to mitigate the risks of geoengineering, there needs to be effective regulation of its deployment both in international and domestic law. The risks of geoengineering can only be effectively regulated if there is international cooperation between all levels of governments and private individuals involved in the research and development of geoengineering.

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[2] Vishal Garg, 'Engineering a Solution to Climate Change: Suggestions for an International Treaty Regime for Governing Geoengineering' (2014) *University of Illinois Journal of Law, Technology and Policy* pg 201

[3] IPCC, Fifth Assessment Report, 'Climate Change 2014: Impacts, Adaptation and Vulnerability' (2014) Chapter 6, pg 91

[4] David Humphreys, 'Smoke and Mirrors: Some Reflections on the Science and Politics of Geoengineering' (2011) 20 *The Journal of Environment Development* pg 105

[5] Adam D.K. Abelkop, Jonathan C. Carlson, 'Reining in Phaethon's Chariot: Principles for the Governance of Geoengineering' [2013] 21 *Transnational Law & Contemporary Problems* pg 767

[6] The Royal Society, 'Geoengineering the climate: science, governance and uncertainty' (2009) <https://royalsociety.org/~/media/Royal_Society_Content/policy/publications/2009/8693.pdf> (accessed 27 August 2014), pg 44

[7] Tuomas Kuokkanen and Yulia Yamineva, 'Regulating Geoengineering in International Environmental Law' 3 *Carbon and Climate Law Review* pg 163

Regulation of geoengineering needs to be implemented with regard to disaster risk reduction and establishing relief and compensation mechanisms in the event of a disaster. Geoengineering regulation should consider the perspectives of vulnerable communities, and ensuring that they are being represented in public discussions[8] so that they can implement appropriate adaptation measures to manage the risks of geoengineering.

This article focuses on ocean fertilisation and its transboundary impacts. It is divided into the following parts: Part I will explain the attractiveness of geoengineering as a mitigation mechanism, Part II will discuss geoengineering in the context of climate disaster law, Part III will explore the implications of geoengineering deployment by States and existing international customs and treaties, Part IV will explore the implications of geoengineering deployment by private companies and existing regulations and Part V will consider how international law should be reformed to manage the risks of geoengineering. However, due to the huge international cooperation required and the international community's fragmented approach to managing climate change and disasters, it is concluded that the risks of geoengineering can probably never be effectively regulated.

Part 1: Geoengineering as a mitigation mechanism

Current efforts to reduce greenhouse gas emissions have not been effective. Global emissions continue to rise at a rapid rate and are now 30% higher than in 2000.[9] The Kyoto Protocol has not stopped global emissions from continuing to grow due to increased emissions in the US, China and other countries that do not have Kyoto emissions targets.[10] This is because only nine states in addition to the 27 members of the EU have agreed to extend their commitments to reduce GHGs from 2012[11], excluding the US, China, Russia, India, Canada and Japan. Unless the Kyoto Protocol can be dramatically increased in scope or replaced by another more effective agreement, global emissions will continue to rise as China and other developing countries industrialize.[12]

According to typical estimates, emissions from industrialized countries need to be reduced by 80% or more by 2050 to allow for economic development in poor countries, while global emissions need

[8] Christopher J Preston, 'Ethics and geoengineering: reviewing the moral issues raised by solar radiation management and carbon dioxide removal' (2012) 4(1) *Wiley Interdisciplinary Reviews: Climate Change* pg 28

9 Daniel Bodansky, 'The who, what and wherefore of geoengineering governance' (2013) 121(3) *Climatic Change* pg 539

[10] Ibid

[11] Karen N. Scott, 'International law in the Anthropocene: Responding to the Geoengineering Challenge' [2013] 34(2) *Michigan Journal of International Law* pg 317

[12] Daniel Bodansky, 'The who, what and wherefore of geoengineering governance' (2013) 121(3) *Climatic Change* pg 540

to be reduced by 40-50% during this time.[13] This drastic reduction of emissions is necessary to avoid a global temperature rise of more than 2 degrees Celsius.[14] As Lin points out, there would need to be an unprecedented degree of global cooperation and substantial costs to achieve these emissions targets.[15] Such global cooperation has clearly not been achieved yet.

Due to extreme difficulties with achieving emissions reductions, some foreign governments have considered deploying geoengineering technologies to avoid the more serious risks of climate change.[16] Geoengineering has been seen as a potential 'third way' that may complement adaptation and mitigation strategies.[17] Geoengineering is attractive because it does not require the big lifestyle changes associated with conventional mitigation strategies[18] such as using renewable energy sources and decarbonising fossil fuels. It may also be relatively cheap to deploy.[19] While the IPCC states that the costs of deploying geoengineering techniques are still uncertain, it has acknowledged that direct costs for solar radiation management (SRM) methods might be considerably lower than the costs of conventional mitigation.[20]

Geoengineering technologies are generally divided up into two categories: carbon dioxide removal (CDR) and solar radiation management (SRM). CDR aims to remove carbon dioxide from the atmosphere by employing chemical, biological or physical mechanisms to enhance existing carbon sinks in the land and ocean or to create new carbon sinks altogether.[21] Some CDR methods include the capture and removal of atmospheric carbon dioxide by planting artificial trees, enhanced weathering of silicate or carbonate rocks which naturally removes carbon dioxide from the atmosphere, bio-energy carbon capture and storage and ocean fertilisation.

Ocean fertilisation consists of adding large deposits of nutrients in the ocean to spur the growth of marine algae and phytoplankton.[22] Phytoplankton converts dissolved carbon dioxide into organic

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[13] Albert C. Lin, 'Geoengineering Governance' [2009] 8(3) *Issues in Legal Scholarship* Article 2, pg 9
[14] Ibid
[15] Ibid
16 US Congressional Research Service, 'Geoengineering: Governance and Technology Policy' (Nov 2013) by Kelsi Bracmort, Richard K. Lattanzio, < http://fas.org/sgp/crs/misc/R41371.pdf> (accessed 25th August 2014) pg 2
[17] Thom Brooks (ed), 'Climate Change Justice' (2013) 46(1) *Political Science and Politics*, Cambridge University Press pg 11
[18] Karen N. Scott, 'International law in the Anthropocene: Responding to the Geoengineering Challenge' [2013] 34(2) *Michigan Journal of International Law* pg 320
[19] Ibid, pg 320
[20] IPCC, Fifth Assessment Report, 'Climate Change 2014: Impacts, Adaptation and Vulnerability' (2014) Chapter 6, pg 96
[21] Adam D.K. Abelkop, Jonathan C. Carlson, 'Reining in Phaethon's Chariot: Principles for the Governance of Geoengineering' [2013] 21 *Transnational Law & Contemporary Problems* pg 768
[22] David A. Wirth, 'Engineering the Climate: Geoengineering as a Challenge to International Governance' (2013) 40 *Boston College Environmental Affairs Law Review* pg 415

carbon so that when they die, they will take the carbon along with it to the deeper waters.[23] Once incorporated into the deep ocean, the carbon will be isolated from the atmosphere for hundreds of years. It has been estimated that up to three percent of annual carbon dioxide emissions could be stored in the ocean by fertilising an area the size of the entire Southern Ocean each year.[24] Ocean fertilisation is estimated to cost about US$30 to $300 per ton of carbon sequestered.[25] The IPCC estimates that CDR requires roughly twice as much carbon dioxide removed from the atmosphere for any desired reduction in carbon dioxide concentration.[26]

SRM methods aim to reduce lower potential increases in temperature associated with the build up of GHGs by deflecting incoming solar radiation or increasing the reflectivity of the atmosphere, clouds or Earth's surface.[27] Examples include stratospheric aerosol injections, cloud whitening, land-based enhanced albedo methods such as painting roofs white and spaced-based methods such as mirrors. However, unlike CDR, SRM methods do not addresses the cause of climate change, excessive emissions of GHGs, but only address the symptoms.[28] If SRM methods are terminated, there would be a sudden and sustained rise in temperature, which would devastate ecosystems and test humanity's ability to adapt.[29] Consequently decision-makers should prefer CDR over SRM techniques because they address the root cause of climate change.[30]

Despite the uncertainties of its effects, geoengineering should not be discounted as a potential method of supplementing mitigation and adaptation strategies. If successful, geoengineering could lessen an enormous amount of human suffering and environmental harm from global climate change.[31] The World Bank states that the world's poorest regions, which have the least economic, institutional, scientific and technical capacity to adapt will suffer most from the effects of climate

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[23] Rosemary Rayfuse, 'Drowning our Sorrows to Secure a Carbon Free Future? Some International Legal Considerations Relating to Sequestering Carbon by Fertilising the Oceans'(2008) 31(3) *University of New South Wales Law Journal* pg 920

[24] Ibid, pg 920

[25] US Congressional Research Service, 'Geoengineering: Governance and Technology Policy' (Nov 2013) by Kelsi Bracmort, Richard K. Lattanzio, < http://fas.org/sgp/crs/misc/R41371.pdf> (accessed 25th August 2014) pg 12

[26] Intergovernmental Panel on Climate Change, Fifth Assessment Report (2013), Chapter 6, pg 92

[27] William C. G. Burns, 'Climate Geoengineering: Solar Radiation Management and its Implications for Intergenerational Equity' (2011) 4 *Stanford Journal of Law, Science and Policy* < http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1837833> pg 45

[28] Karen N. Scott, 'International law in the Anthropocene: Responding to the Geoengineering Challenge' [2013] 34(2) *Michigan Journal of International Law* pg 326

[29] William C. G. Burns, 'Climate Geoengineering: Solar Radiation Management and its Implications for Intergenerational Equity' (2011) 4 *Stanford Journal of Law, Science and Policy* < http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1837833> pg 45

[30] D.K. Abelkop, Jonathan C. Carlson, 'Reining in Phaethon's Chariot: Principles for the Governance of Geoengineering' [2013] 21 *Transnational Law & Contemporary Problems* pg 769

[31] Christopher J Preston, 'Ethics and geoengineering: reviewing the moral issues raised by solar radiation management and carbon dioxide removal' (2012) 4(1) *Wiley Interdisciplinary Reviews: Climate Change* pg 24

change.[32] Buck suggests that geoengineering could be seen as a humanitarian effort by developed countries to help poorer countries in adapting to climate change.[33] The implementation of geoengineering by developed countries to help poorer countries could achieve climate justice by being in accordance with the 'polluter pays principle.' This principle denotes that those who have historically emitted the worst GHG emissions should take responsibility.[34] Arguably, if geoengineering could possibly avoid climate disaster-related suffering, the international community should seriously consider implementing geoengineering to alleviate such suffering.

According to the IPCC, a risk management strategy for climate change involves integrating responses in mitigation with different time horizons, adaptation to an array of climate impacts, and even possibly emergency responses such as geoengineering in the face of extreme climate impacts.[35] This recognition of geoengineering as a viable method of combating the effects of climate change highlights the pressing need to regulate its potential deployment. Assuming that it could be effectively regulated, as the Royal Society Report suggests, "why should appropriate geoengineering options not be added to the portfolio of options that society will need and may wish to use to combat the challenges posed by climate change?"[36]

Part II: Geoengineering and climate disaster law

The IPCC states that CDR and SRM methods carry side effects and long-term consequences on a global scale.[37] The risks of geoengineering remain unknown, because geoengineering cannot be tested on a large scale without causing unpredictable consequences.[38] For example, possible effects of ocean fertilisation include increased ocean acidification, disruption of marine ecosystems, creation of toxic harmful algal blooms, increase in emission of other GHGs like nitrous oxide and

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[32] *Turn Down the Heat: Why a 4 degree Warmer World Must be Avoided* (World Bank: November 2012), at xiii < http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2012/12/20/000356161_20121220072749/Rendered/PDF/NonAsciiFileName0.pdf>

[33] Holly Buck, 'Geoengineering: Re-making Climate for Profit or Humanitarian Intervention?' [2012] 43(1) *Development and Change* pg 263

[34] Rosemary Lyster, 'Destroying capabilities, adaptation and climate change justice' in Jonathan Verschuuren (ed), *Climate Adaptation Law* (Edward Elgar Publishing, 2013), pg 22

[35] Intergovernmental Panel on Climate Change, Fifth Assessment Report (2013), Technical Summary pg 9

[36] The Royal Society, 'Geoengineering the climate: science, governance and uncertainty' (2009) <https://royalsociety.org/~/media/Royal_Society_Content/policy/publications/2009/8693.pdf> (accessed 27 August 2014) pg 45

[37] IPCC Scientific-Technical Assessment for its Fifth Assessment Report (AR5) mentioned in US Congressional Research Service, 'Geoengineering: Governance and Technology Policy' (Nov 2013) by Kelsi Bracmort, Richard K. Lattanzio, < http://fas.org/sgp/crs/misc/R41371.pdf> (accessed 25th August 2014) pg 2

[38] Vishal Garg, 'Engineering a Solution to Climate Change: Suggestions for an International Treaty Regime for Governing Geoengineering' (2014) *University of Illinois Journal of Law, Technology and Policy* pg 201

depletion of the ozone layer.[39] Ocean acidification will critically damage the ocean's food chain and make it more difficult for coral reefs to survive.[40] This will have a disastrous effect on the fishing industry and 100 million people who depend on coral reefs or marine wildlife for their livelihoods.[41] Conversely, sulphate aerosol injection could cause a substantial reduction in precipitation in monsoon regions in South-East Asia and Africa which could result in a severe reduction of monsoonal intensity.[42] This could undermine the food security of 2 billion people in the region.[43]

The unpredictable effects of geoengineering could harm the poorest countries and regions which are most vulnerable to climate change.[44] The effects of geoengineering on these regions could cause an environmental disaster. Environmental disasters occur from the failure of a population's legal system to effectively address risks.[45] As the Hyogo Framework for Action states, disaster risk arises when hazards interact with physical, social, economic and environmental vulnerabilities.[46] Communities most vulnerable to climate disasters are the least able to adjust to more frequent and extreme catastrophes because of their economic, political, cultural and environmental conditions. The 2011 floods in Thailand is an example of a climate disaster attributed to a combination of poor urban planning, lack of floodwater management systems and failure of master plans on flood mitigation.[47] Over 12.8 million people were affected by these floods and total economic loss to households was estimated at $2.7 billion.[48] Hence, the risks of geoengineering need to be effectively managed to avoid causing harm to the most vulnerable communities.

Regulating the effects of geoengineering should be considered in reference to climate disaster law. Climate disaster law is described as a portfolio of legal rules for dealing with catastrophic risk including prevention, emergency response, compensation and insurance, and rebuilding.[49] The

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[39] Karen N. Scott, 'International law in the Anthropocene: Responding to the Geoengineering Challenge' [2013] 34(2) *Michigan Journal of International Law* pg 325

[40] D K. Abelkop, Jonathan C. Carlson, 'Reining in Phaethon's Chariot: Principles for the Governance of Geoengineering' [2013] 21 *Transnational Law & Contemporary Problems* pg 770

[41] Ibid

[42] Ibid

[43] Ibid

[44] Christopher J Preston, 'Ethics and geoengineering: reviewing the moral issues raised by solar radiation management and carbon dioxide removal' (2012) 4(1) *Wiley Interdisciplinary Reviews: Climate Change* pg 28

[45] Daniel Farber, 'Environmental Disasters: An Introduction' (2011) UC Berkeley Public Law Research Paper No. 1898401 < http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1898401> pg 9

[46] Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disaster (United Nations International Strategy for Disaster Reduction), WCDR pg 1

[47] Rosemary Lyster, 'Climate Disaster Law and Governance in South East Asia (Forthcoming)' in Philip Hirsch (Eds.), *Routledge Handbook of the Environment in Southeast Asia* (United Kingdom: Routledge, 2015) pg 6

48 Rosemary Lyster, "A fossil fuel-funded Climate Disaster Response Fund under the UNFCCC loss and damage mechanism" (University of Sydney, Law School, Research Paper No. 13/77, 2013)

[49] Rosemary Lyster, 'Climate Disaster Law and Governance in South East Asia (Forthcoming)', in Philip Hirsch (Eds.), *Routledge Handbook of the Environment in Southeast Asia* (United Kingdom: Routledge, 2015) pg 14

risks of geoengineering at each stage of prevention, emergency response and compensation must be managed at the local, national and international level.

a) National and local disaster risk reduction strategies

The disaster risks caused by geoengineering can be prevented or mitigated if governments of vulnerable communities take sufficient adaptation measures.[50] A key method of mitigating disaster risks is to avoid putting people and key facilities in harm's way so that minimal harm is caused when the disaster does occur.[51] Governments could prepare for droughts by strategically planning water resource management and issuing regulations to increase optimal choice of land use. For example, current adaptation measures proposed in Cambodia to prepare for droughts and floods are focused on water management strategies such as changing from rain-fed to irrigated agricultural practices.[52] In preparing to manage the risks of geoengineering, governments should follow the recommendations in the Hyogo Framework for Action by making disaster risk reduction a national and local priority, and using strengthening disaster preparedness for effective response at all levels.[53]

However, it is questionable if the risks of geoengineering could ever be effectively regulated by governments in vulnerable regions. Firstly, they may lack the funding and resources to construct new infrastructure or to introduce disaster warning systems. In developing countries, disaster risk management is normally centralised and have little impact in remote provinces or districts.[54] Local governments of these districts struggle with inadequate staffing, technical skills or financial resources.[55] Secondly, disaster risk reduction requires cooperation from all levels of government which involves coordination across municipalities and with national agencies.[56] Coordination between these institutions can be limited in some communities[57] so relying on policy changes on the local level may not be prudent. Thirdly, vulnerable people most likely to be affected can have

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[50] Daniel Farber, 'Catastrophic Risk, Climate Change, and Disaster Law' (2013) *16 Asia Pacific Journal of Environmental Law* pg 43

[51] Daniel Farber, 'Environmental Disasters: An Introduction' (2011) UC Berkeley Public Law Research Paper No. 1898401 < http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1898401> pg 9

[52] Sushil Vachani and Jawed Usmani (Ed.), *Adaptation to climate change in Asia* (Edward Elgar Publishing, 2014) pg 179

[53] *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disaster* (United Nations International Strategy for Disaster Reduction), Article 14

54 Geoff O'Brien, Phil O'Keefe, Joanne Rose and Ben Wisner, 'Climate change and disaster management' (2006) 30(1) *Disasters*, pg 73

[55] Judy Baker, *Climate Change, disaster risk and the urban poor: building resilience for a changing world* (World Bank Publications, 2012) pg 86

[56] Ibid

[57] Ibid

low adaptive capacity because of environmental, social and economic status.[58] For South-Eastern Asian countries such as Cambodia, the process of adapting to climate change is currently at an early stage because of the low adaptive capacity of farmers, and high sensitivity of agricultural production on changing rainfall.[59]

Lastly, disaster risk management, as defined by the IPCC, involves implementing and evaluating strategies, policies and measures to improve the understanding of disaster risk.[60] A priority of the Hyogo Framework for disaster risk reduction is for governments to use knowledge, innovation and education to build a culture of safety and resilience. This is an especially important priority for geoengineering, given that fresh evidence may be discovered about its likely hazards after it has been deployed. Governments of vulnerable regions would need regular up-to-date information about these hazards so that they know how to prepare for the consequences of such hazards. Yet monitoring of geoengineering hazards would likely be conducted by scientists or governments in developed countries that may not be accessible to governments in these vulnerable regions. Such information may be difficult to access because of language barriers and delayed or lack of communication between countries and different levels of governments.[61] This lack of access about the newly discovered hazards of geoengineering would impede local governments from undertaking adaptation measures specific to these hazards. The need for global information sharing and internal cooperation between regional governments suggests that it is too idealistic to suppose that the risks of geoengineering could be managed for vulnerable communities.

However, even if geoengineering was not deployed, the challenge of climate change adaptation to vulnerable countries remains. Few developing country cities have attempted to incorporate climate change systematically into their decision-making processes.[62] These populations will still be exposed to the risks of climate disasters, regardless of whether they are caused by geoengineering or climate change. They will still face difficulty in obtaining adequate resources and funding for adopting disaster risk reduction strategies. For example, only $161.5 million was dedicated for disaster risk reduction over the last twenty years for Niger, Eritrea, Zimbabwe, Kenya and

[58] Sushil Vachani and Jawed Usmani (Ed.), *Adaptation to climate change in Asia* (Edward Elgar Publishing, 2014) pg 179
[59] Ibid, pg 179
[60] IPCC, Special Report, 'Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation' (SREX) (2012), pg 5
[61] Ibid, pg 319
[62] Rosemary Lyster, 'Climate Disaster Law and Governance in South East Asia (Forthcoming)', in Philip Hirsch (Eds.), *Routledge Handbook of the Environment in Southeast Asia* (United Kingdom: Routledge, 2015) pg 6

Malawi.[63] Consequently, the possibility that the risks of geoengineering may never be effectively regulated is only a continuation of the present situation.

b) International cooperation

Yet if geoengineering is found to be the lesser evil in comparison to climate change, there is still need to reduce the risk of it causing harm to vulnerable communities. As vulnerable communities cannot reduce the risks of geoengineering alone, international cooperation must be involved. This includes ensuring that developing countries are being represented in continuing research discussions about geoengineering and any proposed geoengineering activities.[64] Climate justice can also be better achieved if perspectives from developing and vulnerable countries are considered. As Lyster points out, in our globalized and interconnected world the impacts on developing countries now, and in the future cannot be ignored.[65] It is important that the general public in vulnerable countries are consulted so that they are aware of the risks of geoengineering. This can shed light on how geoengineering could specifically impact their communities. With increased knowledge on the nature of geoengineering technologies, vulnerable countries can implement adaptation measures specific to potential geoengineering hazards.

International cooperation would also be needed in providing post-disaster relief funding for victims should a disaster caused by geoengineering occur. Post-disaster assistance generally consists of providing compensation mechanisms which is important in helping victims begin to rebuild their lives.[66] Yet if a disaster caused by geoengineering did occur to devastate vulnerable communities, governments in developing countries would have difficulty providing compensation to its victims. In the aftermath of disasters, low income developing countries are often exhausted beyond their capacity to recover financially.[67] They face empty tax bases, depleted reserves and declining credit ratings making external borrowing difficult.[68]

63 Rosemary Lyster, "A fossil fuel-funded Climate Disaster Response Fund under the UNFCCC loss and damage mechanism" (University of Sydney, Law School, Research Paper No. 13/77, 2013), pg 33

64 Christopher J Preston, 'Ethics and geoengineering: reviewing the moral issues raised by solar radiation management and carbon dioxide removal' (2012) 4(1) *Wiley Interdisciplinary Reviews: Climate Change* pg 28

65 Rosemary Lyster, 'Destroying capabilities, adaptation and climate change justice' in Jonathan Verschuuren (ed), *Climate Adaptation Law* (Edward Elgar Publishing, 2013), pg 36

66 Daniel Farber, 'Catastrophic Risk, Climate Change, and Disaster Law' (2013) *16 Asia Pacific Journal of Environmental Law* pg 47

67 Rosemary Lyster, 'Climate Disaster Law and Governance in South East Asia (Forthcoming)', in Philip Hirsch (Eds.), *Routledge Handbook of the Environment in Southeast Asia* (United Kingdom: Routledge, 2015) pg 15

68 Ibid

In the event of a geoengineering disaster, affected countries may have to rely on international disaster relief mechanisms such as the International Monetary Fund.[69] Yet arguably current international disaster relief assistance is disorganised and haphazard. Even though many disaster relief agencies are now global, their actions can overlap and may not consider unique local characteristics.[70] International disaster relief involves an ever-increasing uncoordinated body of actors, including non-governmental organisations and intergovernmental organisations.[71] The problems associated with disaster response can be seen in the South-East Asia tsunami where the involvement of so many NGOs and governments led to poor communications, duplicated efforts and failures in assistance.[72] The fragmented system of disaster relief can also be seen in the difficulty that the international community faced in responding to the sheer scale of the 2010 Haitian earthquake and Pakistani floods.[73] Unless the system of international disaster relief is reformed before the deployment of geoengineering, some people in the most vulnerable countries will be left without relief or assistance in the event of a disaster caused by geoengineering.

Part III: Geoengineering by States

Regulating the risks of geoengineering is a challenge, given the possibility that geoengineering technologies could be deployed by a small number of States or unilaterally by one powerful State.[74] These States could deploy geoengineering without considering the risks for other countries and ecosystems.[75] The irresponsible deployment of geoengineering can cause disastrous effects on some populations, due to the transnational nature of some geoengineering techniques, such as ocean fertilisation. Ocean fertilisation may take place in coastal waters subject to a State's exclusive jurisdiction but the nutrients involved would likely drift into international waters.[76] As geoengineering activity carries an inherent risk of transboundary impacts,[77] not only do the risks of geoengineering need to be regulated through domestic law, but also in international law. There

[69] Daniel Farber, 'Catastrophic Risk, Climate Change, and Disaster Law' (2013) *16 Asia Pacific Journal of Environmental Law* pg 47
[70] Teresa Thorp, 'International climate law and the protection of persons in the event of disasters' (online) (2013) 11(2) *New Zealand Journal of Public and International Law* pg 439
[71] Ibid, pg 440
[72] Daniel Farber, 'Catastrophic Risk, Climate Change, and Disaster Law' (2013) *16 Asia Pacific Journal of Environmental Law* pg 52
[73] Teresa Thorp, 'International climate law and the protection of persons in the event of disasters' (online) (2013) 11(2) *New Zealand Journal of Public and International Law* pg 437
[74] Karen N. Scott, 'International law in the Anthropocene: Responding to the Geoengineering Challenge' [2013] 34(2) *Michigan Journal of International Law* pg 354
[75] David Humphreys, 'Smoke and Mirrors: Some Reflections on the Science and Politics of Geoengineering' (2011) 20 *The Journal of Environment Development* pg 105
[76] David A. Wirth, 'Engineering the Climate: Geoengineering as a Challenge to International Governance' (2013) 40 *Boston College Environmental Affairs Law Review* pg 417
[77] Adam D.K. Abelkop, Jonathan C. Carlson, 'Reining in Phaethon's Chariot: Principles for the Governance of Geoengineering' [2013] 21 *Transnational Law & Contemporary Problems* pg 779

must be some international legal framework which ensures that geoengineering technologies are safe, effective and fully disclosed and debated before deployment.[78] The careful implementation of geoengineering will reduce the risks of causing a disaster on unsuspecting populations. Furthermore, should geoengineering activities cause harm to some populations, those States responsible for its deployment must be held accountable so that victims can be compensated.

Currently there is no overarching multilateral treaty regulating geoengineering and few international constraints which prevent States from deploying geoengineering. This section examines the customary international law principles and existing international agreements that may be relevant to geoengineering. It argues that existing international principles and agreements are ambiguous, difficult to apply towards geoengineering and lack enforceability.

a) Precautionary principle

The precautionary principle may apply to constrain States from deploying geoengineering where there is a risk of serious environmental harm. This can require States to consider the risks of harm towards other countries in deciding whether to deploy geoengineering. The precautionary principle was recently confirmed as a part of customary international law in the ICJ decision of *Pulp Mills*[79] so it applies to all countries who have not persistently objected to the principle.[80] However, no single articulation of the precautionary principle has emerged as a norm of customary international law.[81]

There are mainly two different versions of the precautionary principle which can be applied to geoengineering. The strong version of the precautionary principle states that action should be restricted where risks are not fully known as long as there is possible environmental risk.[82] In contrast, the weak version, which is articulated in Article 3(3) of the UNFCCC convention, permits action to be taken even where full scientific certainty is not known so long as the action is done to avoid serious irreversible damage.[83] If States followed the strong version of the precautionary

[78] David A. Wirth, 'Engineering the Climate: Geoengineering as a Challenge to International Governance' (2013) 40 *Boston College Environmental Affairs Law Review* pg 423
[79] *Pulp Mills on the River Uruguay Case (Arg v Uru)* Judgment, 2010, ICJ 71, 164
[80] US Congressional Research Service, 'Geoengineering: Governance and Technology Policy' (Nov 2013) by Kelsi Bracmort, Richard K. Lattanzio, < http://fas.org/sgp/crs/misc/R41371.pdf> (accessed 25 August 2014) pg 19
[81] The Royal Society, 'Geoengineering the climate: science, governance and uncertainty' (2009) <https://royalsociety.org/~/media/Royal_Society_Content/policy/publications/2009/8693.pdf> (accessed 27 August 2014) pg 38
[82] Vishal Garg, 'Engineering a Solution to Climate Change: Suggestions for an International Treaty Regime for Governing Geoengineering' (2014) *University of Illinois Journal of Law, Technology and Policy* pg 204
[83] Ibid, pg 204

principle, they would not implement geoengineering so long as there is risk of environmental harm. Yet if they followed the weak version, they may decide to implement geoengineering, seeing it as the lesser evil to prevent the 'irreversible damage' caused by climate change. This means that States have a huge amount of discretion on deciding which version of the principle they apply.[84] The ambiguity of the principle causes confusion and is not effective in constraining the irresponsible deployment of geoengineering activities.

It has been suggested that neither the weak or strong precautionary principle can be fully relevant to geoengineering.[85] As geoengineering cannot be tested on a large scale before its deployment, scientific uncertainty regarding its potential harms can never be complete enough to satisfy a strong precautionary principle.[86] Yet the weak precautionary principle does not account for the significant possibilities of harm that can be caused by geoengineering.[87] This suggests that risks of geoengineering can only be effectively regulated by the precautionary principle if it is re-defined or re-clarified.

b) Environmental Impact Assessments (EIA) and Requirement to Notify

There seems to be a generally agreed requirement in international customary law for a State to provide prior notification to affected States of its proposed activity, any information on its risks, and give them an opportunity to comment.[88] Articulations of this principle can be implicated to geoengineering. The 1982 United Nations Convention on the Law of the Sea imposes an obligation for states to cooperate on a global or regional basis for the protection of the marine environment and sets out various obligations associated with notification in an environmental emergency,[89] which could apply to ocean fertilisation. Giving potentially affected countries prior notification on the risks of geoengineering will help them implement disaster risk reduction strategies.

The requirement to conduct an EIA has also been recognised as part of customary international law obligations where impacts of an activity may have transboundary implications.[90] Much of the

[84] Daniel Bodansky, 'The who, what and wherefore of geoengineering governance' (2013) 121(3) *Climatic Change* pg 542
[85] Vishal Garg, 'Engineering a Solution to Climate Change: Suggestions for an International Treaty Regime for Governing Geoengineering' (2014) *University of Illinois Journal of Law, Technology and Policy* pg 210
[86] Ibid
[87] Ibid
[88] Gerd Winter, 'Climate Engineering and International Law: Last Resort or the End of Humanity?' [2011] 20(3) *Review of European Community & International Environmental Law* pg 283
[89] Karen N. Scott, 'International law in the Anthropocene: Responding to the Geoengineering Challenge' [2013] 34(2) *Michigan Journal of International Law* pg 344
[90] Ibid, pg 345

scope and content of an EIA can be determined by States, but they must be prepared with due diligence, include an assessment of alternatives, be adequate to the size, type and effects of the project and be carried out prior to the implementation of the project.[91] Continuous monitoring of the activity's effect on the environment is required.[92] If States conduct a comprehensive EIA and notify the countries identified in the EIA as being likely victims of potential harm before the deployment of geoengineering, then those countries will be better informed and able to prepare for its harmful effects.

An EIA would fulfil much of the risk comparison necessary to achieve an equitable balance of interests[93] by considering the risks of geoengineering on other communities. However, due to the uncertainties of geoengineering techniques, and inability to test geoengineering on a large scale, EIA's cannot provide a complete inoculation against the possibility of its unanticipated adverse consequences.[94] While some indication of risk is better than none at all, it is inevitable that some consequences of geoengineering will still be unpredictable. Consequently, governments of affected populations will still need to improve their emergency response mechanisms such as warning systems and evacuation plans to prepare for sudden and unpredictable geoengineering-related catastrophes.

c) United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCC is of nearly universal application with 196 signatories, including the United States. The aim of the Convention is to stabilize "greenhouse gas concentrations in the atmosphere at a level to prevent dangerous anthropogenic interference with the climate system…"[95] However it does not directly address geoengineering[96], does not impose binding obligations on signatory countries, contains no enforcement mechanisms, and articulates vague notions of climate justice. It mentions the climate justice principle of "common but differentiated responsibilities" which denotes that while all states have a responsibility to address the problem of climate change, states

[91] Gerd Winter, 'Climate Engineering and International Law: Last Resort or the End of Humanity?' [2011] 20(3) *Review of European Community & International Environmental Law* pg 284
[92] Ralph Bodle, 'Geoengineering and International Law: The Search for Common Legal Ground' (2011) 46 *Tulsa Law Review* pg 311
[93] Adam D.K. Abelkop, Jonathan C. Carlson, 'Reining in Phaethon's Chariot: Principles for the Governance of Geoengineering' [2013] 21 *Transnational Law & Contemporary Problems* pg 778
[94] David A. Wirth, 'Engineering the Climate: Geoengineering as a Challenge to International Governance' (2013) 40 *Boston College Environmental Affairs Law Review* pg 421
[95] *United Nations Framework Convention on Climate Change*, open for signature 9 May 1992 (entered into force 21 March 1994), Article 2
[96] Albert C. Lin, 'Geoengineering Governance' [2009] 8(3) *Issues in Legal Scholarship* Article 2, pg 15

that have historically emitted the most GHGs bear the most responsibility.[97] Yet it does not clarify how this principle can be applied in international climate-policy development.[98]

As the IPCC recognises, "international cooperation can contribute by defining and allocating rights and responsibilities with respect to the atmosphere."[99] Yet there is little guidance in the UNFCCC on how the rights and responsibilities of States can be allocated according to the 'common but differentiated responsibilities' principle. There are a multitude of ways that geoengineering could be deployed in accordance with this principle. The few States that have emitted the most GHGs could deploy geoengineering techniques purportedly on behalf of the international community. A collective number of States could engage in a multilateral geoengineering effort where States contribute funding proportionately according to their GHG emissions. Developed States could also fund developing countries to implement territorial geoengineering techniques such as afforestation and mineral sequestration. Any of these methods could be used by States to fulfil their 'common but differentiated responsibilities' without carefully considering the risks posed by geoengineering on other populations. The problem is because the UNFCCC does not directly address geoengineering[100] and can provide little guidance on how to approach geoengineering.

d) London Convention and Protocol (LC/LP) Assessment Framework

The 2010 LC/LP Assessment Framework for ocean fertilisation[101] and the CBD COP10 decision specifically address the risks of implementing ocean fertilisation. Under the 1972 London Convention and 1996 Protocol, ocean fertilisation for legitimate scientific research is permitted if it constitutes a purpose other than mere disposal[102], and is carried out in accordance with the Assessment Framework agreed by the parties in 2010.[103] The Assessment Framework is designed to control and facilitate ocean fertilisation research and provides a comprehensive model for assessing risk. It involves conducting environmental assessment examining the environmental

[97] David Humphreys, 'Smoke and Mirrors: Some Reflections on the Science and Politics of Geoengineering' (2011) 20 *The Journal of Environment Development* pg 108
[98] Thom Brooks (ed), 'Climate Change Justice' (2013) 46(1) *Political Science and Politics*, Cambridge University Press pg 11
[99] IPCC, *Fifth Assessment Report* (2013), Technical Summary, pg 5
[100] Albert C. Lin, 'Geoengineering Governance' [2009] 8(3) *Issues in Legal Scholarship* Article 2, pg 15
[101] *London Convention-London Protocol Resolution LC-LP (2010) on the Assessment Framework for Scientific Research Involving Ocean Fertilization* LC 32/15 (Oct 14, 2010)
[102] *The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter* ("The London Convention"), open for signature 29 December 1972 (entered into force 30 August 1975), Article III.1(b)(ii)
[103] Karen N. Scott, 'International law in the Anthropocene: Responding to the Geoengineering Challenge' [2013] 34(2) *Michigan Journal of International Law* pg 351

impact and risks of the proposed activity and ways to manage the risk.[104] Relevant information to consider includes proximity to other uses of the sea, unintended impacts of the delivery method and human health considerations including food chain effects, and potential hazards to navigation and fishing grounds.[105] These findings on ways to manage risk and consideration of impacts would guide affected communities on which disaster risk reduction strategies to adopt.

The Assessment Framework also contains decision-making step requiring parties to determine if the process should move forward and requires the country to notify affected countries and obtain consent from those affected.[106] Furthermore, activity should be monitored to determine the impacts of the ocean fertilisation activity and this information gathered should inform future decision-making.[107] The Framework seems to be an effective starting point for regulating the risks of ocean fertilisation in its requirement to notify affected countries, and consideration of possible environmental impacts. It makes a notable attempt to achieve climate justice by attempting to achieve a global scientific consensus[108] through requiring parties to engage in international dialogue with affected countries on whether the experiment should be deployed. Since the borderline between research experiments and deployment can become artificial once experiments are conducted on a large scale[109], the Assessment Framework could also be used to regulate the deployment of geoengineering.

However, the Assessment Framework only applies to a limited number of countries.[110] Eighty-seven states are parties to the London Convention and forty-four states are parties to the London Protocol.[111] Additionally, the Assessment Framework is not binding in either form or writing.[112] The limitations of the Assessment Framework demonstrate that it cannot regulate the risks of ocean fertilisation effectively. Again, it is within the discretion of States whether to follow this Framework.

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[104] Vishal Garg 'Engineering a Solution to Climate Change: Suggestions for an International Treaty Regime for Governing Geoengineering' (2014) *University of Illinois Journal of Law, Technology and Policy* pg 205
[105] Ralph Bodle, 'Geoengineering and International Law: The Search for Common Legal Ground' (2011) 46 *Tulsa Law Review* pg 320
[106] Vishal Garg 'Engineering a Solution to Climate Change: Suggestions for an International Treaty Regime for Governing Geoengineering' (2014) *University of Illinois Journal of Law, Technology and Policy* pg 205
[107] Ibid
[108] Thom Brooks (ed), 'Climate Change Justice' (2013) 46(1) *Political Science and Politics*, Cambridge University Press pg 11
[109] Ralph Bodle, 'Geoengineering and International Law: The Search for Common Legal Ground' (2011) 46 *Tulsa Law Review* pg 320
[110] Vishal Garg 'Engineering a Solution to Climate Change: Suggestions for an International Treaty Regime for Governing Geoengineering' (2014) *University of Illinois Journal of Law, Technology and Policy* pg 211
[111] Ibid
[112] Ralph Bodle, 'Geoengineering and International Law: The Search for Common Legal Ground' (2011) 46 *Tulsa Law Review* pg 320

The transnational nature of ocean fertilisation further highlights the Framework's weaknesses. Those conducting ocean fertilisation experiments could deliberately undermine the Assessment Framework by incorporating their companies, flagging their vessels and fertilizing the ocean in non-LC/LP party states.[113] Hence, scientists conducting these experiments will not be required to follow the LC/LP Assessment Framework if they work in non-LC/LP Party countries.

e) Convention on Biological Diversity (CBD)

In 2010, CBD Conference of the Parties adopted a decision which bans geoengineering from taking place in the absence of science-based global transparent regulatory mechanisms, until there is adequate scientific basis, with the exception of small scale scientific research studies that can be conducted in a controlled setting and subject to thorough prior assessment of potential environmental impacts.[114] This decision is structured as a blanket ban with limited exceptions to be authorised through a multilateral approval scheme, and is intended to apply to virtually all interventions that can be considered as geoengineering.[115] The COP 2010 X/33 decision is notable because it directly addresses the risks of geoengineering, and foresees a global and transparent mechanism to approve geoengineering activities which presumably involves public notification of proposals and opportunity for public input.[116]

However, the COP 2010 X/33 decision is arguably too vague to be effective in regulating risks of geoengineering. For example, it provides the exception of small-scale scientific research studies to be conducted in a controlled setting, but does not clarify the meaning of a 'controlled setting.' A controlled setting could mean that these small-scale studies be conducted in areas within control of the Parties or could just reiterate that States have a duty to prevent transboundary harm.[117] It also does not clarify the requirement of geoengineering activities having an 'adequate scientific basis.' Scientific basis could mean based on scientific discovery, or be conducted by scientists or that the risk be manageable from a scientific perspective.[118] Furthermore, since geoengineering can never be tested on a large scale, its scientific uncertainty would probably never satisfy the requirement of having an 'adequate scientific basis.' This questions whether the decision is suggesting that

113 David Freestone and Rosemary Rayfuse, 'Iron Ocean Fertilisation and International Law' (Marine Ecology Progress 2008/9, UNSW Law Research Paper 2008-37) < http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1397400> pg 5
114 *Convention on Biological Diversity*, opened for signature 5 June 1992 (entered into force on 29 December 1993), 2010 COP Decision X/33, Article 8(w)
115 David A. Wirth, 'Engineering the Climate: Geoengineering as a Challenge to International Governance' (2013) 40 *Boston College Environmental Affairs Law Review* pg 421
116 Ibid, pg 420
117 Ralph Bodle, 'Geoengineering and International Law: The Search for Common Legal Ground' (2011) 46 *Tulsa Law Review* pg 318
118 Ibid

geoengineering should never be implemented. Hence, the language of the ban provides little guidance for States on how to manage the risks of geoengineering experiments.

The COP 2010 X/33 decision is also not legally binding. It merely invites parties and other governments to consider its guidance.[119] The US, one of the most economically and technologically capable countries to deploy geoengineering technologies, is not a party to the CBD. Since the COP decision is not binding, its interaction with the LC/LP Assessment Framework is unclear. States who are parties to both the CBD and the LC/LP could choose whether to impose a ban on ocean fertilisation in accordance with the COP decision, or may choose to allow ocean fertilisation experiments to proceed in accordance with the LC/LP Assessment Framework. It is possible that ocean fertilisation experiments permitted under the Framework could be banned under the COP decision because they do not qualify as 'small-scale research studies'. This exemplifies the current fragmented and inconsistent approach to geoengineering governance.

f) United Nations Convention on Law of the Sea (UNCLOS) and Regulation on the High Seas

The UNCLOS establishes the principle of freedom of the high seas, and specifically allows scientific research activities on the high seas.[120] This suggests that ocean fertilisation could be conducted in international waters.[121] The regulation of ocean fertilisation in high seas is highly dependent on cooperation by flag States who must ensure compliance by vessels flying their flags with international rules and standards.[122] If ocean fertilisation projects were conducted by vessels flying the flags of countries that are unable or unwilling to adopt or enforce international customary law principles or their treaty obligations, then communities may suffer the effects of geoengineering with no prior warning or consultation.

In 2007, a Workshop on High Seas Governance found that there was a lack of any regulatory regime for climate change mitigation activities in marine areas beyond national jurisdiction, and there was an absence of requirements for EIA's.[123] Given the transboundary effects of ocean fertilisation, the lack of regulation on the high seas is particularly concerning. International

[119] Ralph Bodle, 'Geoengineering and International Law: The Search for Common Legal Ground' (2011) 46 *Tulsa Law Review* pg 314
[120] *United Nations Convention on the Law of the Sea*, opened for signature 10 December 1982 (entered into force 16 November 1994), Article 87
[121] David A. Wirth, 'Engineering the Climate: Geoengineering as a Challenge to International Governance' (2013) 40 *Boston College Environmental Affairs Law Review* pg 418
[122] Robin Warner, 'Preserving a balanced ocean: regulating climate change mitigation activities in marine areas beyond national jurisdiction' (2007) 14 *Australian International Law Journal* pg 107
[123] Ibid, pg 116

governance of the high seas needs to be comprehensively reformed so that the risks of ocean fertilisation can be managed and communicated to affected communities.

g) State responsibility for environmental harm

All States have a duty to ensure that activities within their jurisdiction or under their control do not cause harm to the environment of other States.[124] If States fail to meet their obligation, they can be held responsible under international law, and may have legal obligations to cease the activity or make full reparation for the injury caused.[125]

The principle of state responsibility is important for both risk prevention of geoengineering-related disasters and providing compensation for States affected from a geoengineering-related disaster. The theory that the exposure of the risk taker to liability can have an advantage of providing incentives of prevention[126] can be analogous to a State that may be more cautious in deploying geoengineering technologies given the threat of being held responsible if their actions cause harm to other States. To avoid liability, States may consult potentially affected States and give affected States an opportunity to adopt disaster risk reduction measures before they deploy geoengineering. When a geoengineering-related disaster occurs, victim States may be able to obtain compensation from the responsible State to help them rebuild their communities. This is especially for poorer countries whose resources have been depleted by the disaster and need the extra funding.

However, the difficulty of proving causation impedes claimant States from successfully holding a State responsible for harm caused by geoengineering. For a State to be held responsible, the activity's effects must be proven to cause particular harm to the environment of other States.[127] For example, claimant States would have show that the particular geoengineering activity caused changes in precipitation, and that these changes of precipitation patterns caused environmental harm.[128] As Faure points out, it may be difficult to adequately distinguish between man-made disasters and natural disasters[129], and geoengineering only exacerbates this difficulty. It could be near impossible to prove that changes in precipitation patterns are direct results of geoengineering,

[124] Karen N. Scott, 'International law in the Anthropocene: Responding to the Geoengineering Challenge' [2013] 34(2) *Michigan Journal of International Law* pg 333
[125] Ibid
126 Michael Faure, 'Private liability and critical infrastructure' (Presentation at the International Symposium 'Risk, responsibility and liability in the protection of critical infrastructures', St Gallen, May 23-24 2014) pg 2
[127] Ralph Bodle, 'Geoengineering and International Law: The Search for Common Legal Ground' (2011) 46 *Tulsa Law Review* pg 306
[128] Ibid
[129] Michael Faure, 'Private liability and critical infrastructure' (Presentation at the International Symposium 'Risk, responsibility and liability in the protection of critical infrastructures', St Gallen, May 23-24 2014) pg 3

considering that they could also be natural consequences of climate change. Further causation problems may arise if affected States could have but did not take measures to prevent the damage, such as building dams to prepare for droughts. The difficulty in proving causation indicates that the principle of State responsibility would not be an effective deterrent for States to deploy geoengineering more carefully. The primary method of reducing the risks of a geoengineering-related disaster must still be safety regulations prescribed by governments of affected States.

However, even if States cannot be proven responsible for causing harm to other States, affected States may nevertheless be able to obtain compensation through an out of court settlement. In 2008 Ecuador filed proceedings in the ICJ against Colombia for Colombia's aerial spraying of chemical herbicides over the border that destroyed crops and livestock and damaged the health of Ecuadorian farmers.[130] Ecuador dropped these proceedings when both countries reached a settlement agreement in September 2013.[131] The settlement agreement required Colombia to pay $15 million in compensation to be invested in areas affected by the spraying.[132] The agreement also required Colombia to give Ecuador 10 days notice before spraying, indicating the exact locations and dates.[133] This case illustrates that a State does not need to be held responsible through international law for affected States to obtain compensation for harm caused by geoengineering. Future out-of-court settlements may be an effective alternative compensation mechanism.

Part IV: Geoengineering by private companies

The potential for geoengineering to be deployed by a wealthy individual or private company with no regard for social, economic and environmental risk points to a pressing need for the risks of geoengineering to be effectively regulated. There is active interest in CDR methods, particularly ocean fertilisation by the private sector. There are already a number of start-up companies active in ocean fertilisation,[134] and there is potential for these companies to profit from geoengineering activities through future earnings through carbon trading mechanisms.[135] Research scientists, engineers and companies have already begun filing patents on geoengineering technologies.[136]

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130 Angela Melendez, 'Ecuador-Colombia Settlement Won't End Spraying', *Interpress Service News Agency* (online), 28 October 2013 < http://www.ipsnews.net/2013/10/ecuador-colombia-settlement-wont-end-spraying/>

131 Ibid

132 Ibid

133 Ibid

134 The Royal Society, 'Geoengineering the climate: science, governance and uncertainty' (2009) <https://royalsociety.org/~/media/Royal_Society_Content/policy/publications/2009/8693.pdf> (accessed 27 August 2014) pg 44

135 Ibid

136 Adam D.K. Abelkop, Jonathan C. Carlson, 'Reining in Phaethon's Chariot: Principles for the Governance of Geoengineering' [2013] 21 *Transnational Law & Contemporary Problems* pg 473

Patenting of geoengineering technologies could have serious negative impacts by creating a culture of secrecy that could delay much needed developments.[137] The potential for geoengineering to be deployed with no rigorous assessment of its possible impacts is extremely troubling in the context of disaster prevention.

Companies are not subject to any international obligations that may constrain States regarding the deployment of geoengineering. This is because international law regulates the conduct of States and applies to individuals through nations implementing legislation.[138] As they are not subject to international customary law principles such as the requirement to notify other States or the requirement to conduct an EIA, companies can deploy geoengineering with prior notification to any affected communities. With no prior notification and no time to adopt any specific adaptation measures, the impact of harm on unsuspecting communities could be particularly severe.

It is also difficult to hold companies responsible for causing geoengineering harms under international law. International criminal law does not and has never provided for jurisdiction over companies.[139] There are several international instruments containing criminal and civil liability for companies which will later be discussed, but they do not necessarily address geoengineering. Affected States could claim damages from the State which the company was incorporated in under the principle of State responsibility. However, a State is not automatically held responsible for damage caused by private individuals unless that State authorised or was legally responsible for authorising those activities.[140]

Due to the limitations of international law, the regulation of geoengineering by private companies is heavily dependent on the domestic cooperation of States. If a State wished to comply with its international obligations regarding geoengineering, they would have to enact domestic legislation. For example, countries would have to ban ocean fertilisation under their own laws for the CBD COP 2010 X/33 ban to apply to companies within their jurisdiction or control. Even if a country is willing to comply with the ban on geoengineering activities, they may be unable to comply. It may be difficult to police small-scale geoengineering activities by private actors within their jurisdiction,

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137 Daniel Cressey, 'Cancelled project spurs debate about geoengineering patents' (2012) 485(7399) *Nature* 429

138 Daniel Bodansky, 'The who, what and wherefore of geoengineering governance' (2013) 121(3) *Climatic Change* pg 545

139 Jan Wouters, Anna-Luise Chane, 'Multinational Corporations in International Law' (Working Paper No 129, Leuven Centre for Global Governance Studies, December 2013) < https://ghum.kuleuven.be/ggs/publications/working_papers/new_series/wp121-130/wp129-wouters-chane.pdf> pg 18

140 Karen N. Scott, 'International law in the Anthropocene: Responding to the Geoengineering Challenge' [2013] 34(2) *Michigan Journal of International Law* pg 347

particularly if governments have limited administrative capacity to control and monitor such conduct.[141]

The 2012 Haida Gwaii ocean dump in Canada highlights the difficulty for countries to enforce a geoengineering ban and the potentially harmful impacts of geoengineering on vulnerable communities. In July 2012, the Haida Salmon Restoration Corporation (HSRC) dumped more than 100 metric tons of iron near the coast of Haida Gwaii.[142] HSRC apparently misled the de facto government of the Haida people into believing that the community would earn carbon credits from the dump, and were not told of the risks and international legal status of ocean fertilisation.[143] The experiment was only discovered months later by ETC Group and oceanographers.[144] The fact that the Canadian government did not detect the dump highlights the ability for geoengineering activities to be carried out in secret. Furthermore, the misleading information given to the Haida community suggests a pressing need to inform the international community, particularly vulnerable populations, on the risks of geoengineering.

As a party to the CBD, Canada has implemented the COP10 X/33 decision ban on ocean fertilisation by making it illegal under the *Canadian Environmental Protection Act* unless it was assessed and found to qualify as legitimate scientific research.[145] HSRC is now facing up to 10 charges under Canadian law for environmental violations.[146] However, the Canadian government's inability to prevent the HSRC iron dump from occurring indicates that lack of enforcement is a significant obstacle to managing geoengineering by corporations. Suggested permitting systems and case-by-case control of geoengineering will not prevent geoengineering from being irresponsibly deployed by corporations unless countries have an effective monitoring or policing mechanism.

This section examines existing legal mechanisms which may be relevant to regulating the risks of geoengineering technologies deployed by private companies. It argues that, like the fragmented

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[141] Daniel Bodansky, 'The who, what and wherefore of geoengineering governance' (2013) 121(3) *Climatic Change* pg pg 543

[142] Dene Moore, 'Ocean fertilization experiment loses in B.C. court; charges now likely' (3 February 2014), The Globe and Mail <http://www.theglobeandmail.com/news/british-columbia/ocean-fertilization-experiment-loses-in-bc-court-charges-now-likely/article16672031/>

143 ETC Group, 'Informational Background on the 2012 Haida Gwaii Dump' (27 March 2013) <http://www.etcgroup.org/content/informational-backgrounder-2012-haida-gwaii-iron-dump>

[144] Ibid

145 Judith Lavoie, 'Haida readying for second round of iron dumping in ocean' Times Colonist (online), April 20, 2013 < http://www.timescolonist.com/news/local/haida-readying-for-second-round-of-iron-dumping-in-ocean-1.115880>

[146] Dene Moore, 'Ocean fertilization experiment loses in B.C. court; charges now likely' (3 February 2014), The Globe and Mail <http://www.theglobeandmail.com/news/british-columbia/ocean-fertilization-experiment-loses-in-bc-court-charges-now-likely/article16672031/>

international governance of geoengineering at the State level, the current regime which applies to companies needs to be reformed to directly address geoengineering.

a) OECD Guidelines for Multinational Enterprises

The OECD guidelines for multinational enterprises are voluntary standards negotiated and agreed by national governments in 1976.[147] The guidelines recommend that enterprises should take due account of the need to protect the environment in consideration of relevant international agreements, principles, objectives and standards, and the laws in the countries they operate.[148] It also recommends that enterprises should be governed by the precautionary principle and should not use lack of scientific certainty for postponing cost-effective measures to prevent or minimise environmental damage resulting from their activities.[149]

While the Guidelines do not specifically address geoengineering, they could be used to guide companies to deploy geoengineering with caution in accordance with international obligations such as the CBD COP10 X/33 decision or the LC/LP Assessment Framework. The Guidelines can also be implicated to suggest companies take measures to mitigate the environmental damage caused by geoengineering, which could include consulting affected communities of the potential risks before deployment.

However, the Guidelines are not binding and do not provide a liability scheme.[150] Given that the Guidelines are not binding, and are not directly applicable to geoengineering, companies would have no incentive to follow them. The Guidelines would hardly stop a company from deploying geoengineering if the benefits to the company outweighed the potential environmental harm. Hence, the Guidelines are effective for reducing the disaster risks of geoengineering.

147 Amanda Perry-Kessaris, 'Corporate liability for environmental harm'in Fitzmaurice and Ong (eds) *Research Handbook on International Environmental Law* (Cheltenham Edgar Publishing, 2007) < http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1087548> part 2.2

148 *OECD Declaration on International Investment and Multinational Enterprises*, 'OECD Guidelines for Multinational Enterprises' (1976), Chapter 5

149 Ibid, Chapter 5(6)

150 Amanda Perry-Kessaris, 'Corporate liability for environmental harm'in Fitzmaurice and Ong (eds) *Research Handbook on International Environmental Law* (Cheltenham Edgar Publishing, 2007) < http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1087548> part 2.2

b) Oxford Principles

Self-regulation may be relevant to scientists or scientific corporations who deploy geoengineering. An example of this is the Oxford Principles. These Principles articulate that geoengineering needs to be regulated as a public good, and urges public participation in geoengineering decision-making, disclosure of geoengineering research and open publication of its results.[151] It also recognises the need for an independent assessment of its potential impacts[152] and states that geoengineering should not be deployed unless there are robust governance structures already in place.[153]

If followed, these Principles would be effective in reducing the risk of a disaster caused by geoengineering. It would stop companies from deploying geoengineering until 'robust governance structures' were in place. These governance structures could include waiting until affected communities adopt appropriate disaster risk reduction strategies. It also attempts to achieve climate justice by urging international dialogue and discussion on the nature of geoengineering.

Unfortunately these Principles are not legally binding, but could become the basis for an inter-governmental code of conduct or formal agreement on responsible geoengineering research.[154] Some sort of liability scheme or incentive would need to be established in order to ensure that companies comply with the Principles.

c) Alien Tort Claims Act

The *Alien Torts Claims Act* (US) could be an effective regime for holding companies liable for the harm caused by their deployment of geoengineering. The Act allows foreign claimants to circumvent legislative and adjudicative barriers by any breach of a fundamental principle of international law in a foreign jurisdiction into a tort under US law.[155] This allows a foreign victim to sue in US courts for damages and other civil remedies.[156] Environmental harms were recognised as covered by the Act in *Sarei v Rio Tinto Plc* where the court allowed residents of Papua New Guinea to bring an action against Rio Tinto for allegedly dumping mining waste which

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[151] Gerd Winter, 'Climate Engineering and International Law: Last Resort or the End of Humanity?' [2011] 20(3) *Review of European Community & International Environmental Law* pg 286
[152] Ibid
[153] Ibid
[154] Daniel Bodansky, 'The who, what and wherefore of geoengineering governance' (2013) 121(3) *Climatic Change* pg 547
155 Amanda Perry-Kessaris, 'Corporate liability for environmental harm'in Fitzmaurice and Ong (eds) *Research Handbook on International Environmental Law* (Cheltenham Edgar Publishing, 2007) < http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1087548> 1.2.2
[156] Ibid

contaminated international waters.[157] Similarly, claimants would probably be able to bring an action against a company for harm caused by ocean fertilisation to their community under the *Alien Torts Claims Act*.

However, causation problems, limited liability of corporations, difficulties in accessing justice and inability to identify tortfeasors indicates that liability rules only play a limited role in preventing a disaster.[158] Any lawsuit against a State or company that deployed geoengineering would have difficulty proving that geoengineering caused the particular damage. The ETC Group, for example, recognises that the environmental impact of the Haida Gwaii dump may never be known.[159] There were unprecedented incidences of toxic algae blooms which led to closure of the local shellfish bed on Haida Gwaii in the winter of 2012/2013, but it is difficult to conclude that this was directly connected to the iron dump.[160] The difficulty in proving causation means that any claims against the responsible company will be unsuccessful. Furthermore, victims may be from vulnerable communities and can face hurdles to go to court.[161]

Companies can also avoid liability by claiming bankruptcy or fragmenting its business into a number of subsidiary corporations that operate in different jurisdictions.[162] This would reduce the company's availability of assets to compensate victims. While the *US Comprehensive Environmental Response, Compensation and Liability Act* (CERCLA) imposes strict liability on parent companies and other institutional shareholders for the environmentally harmful acts of their subsidiaries, it has not been effective in practice.[163] The many barriers to holding companies liable for geoengineering indicate that tort liability is not the best avenue for victims of geoengineering to obtain compensation.

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[157] Ibid

[158] Michael Faure, 'Private liability and critical infrastructure' (Presentation at the International Symposium 'Risk, responsibility and liability in the protection of critical infrastructures', St Gallen, May 23-24 2014) pg 6

[159] ETC Group, 'Informational Background on the 2012 Haida Gwaii Dump' (27 March 2013) <http://www.etcgroup.org/content/informational-backgrounder-2012-haida-gwaii-iron-dump>

[160] Ibid

[161] Michael Faure, 'Private liability and critical infrastructure' (Presentation at the International Symposium 'Risk, responsibility and liability in the protection of critical infrastructures', St Gallen, May 23-24 2014) pg 6

[162] Amanda Perry-Kessaris, 'Corporate liability for environmental harm' (2007) in Fitzmaurice and Ong (eds) *Research Handbook on International Environmental Law*, Cheltenham Edgar Publishing < http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1087548> 1.2.3

[163] Ibid

d) Lugano Convention

There are a few international agreements that apply directly to private actors by holding them liable for grave environmental damage such as oil spills or nuclear leakages.[164] The *1993 Lugano Convention on Civil Liability for Damage Resulting from Activities Dangerous to the Environment* is the broadest effort to date to address corporate liability for environmental harm[165] and may apply to geoengineering. The Lugano Convention aims to provide adequate compensation for damages including loss of life, personal injury, damage to property, costs of preventative measures and environmental damage[166] resulting from activities dangerous to the environment.[167] It channels liability to the operator who is defined as the person who exercises control of a dangerous activity.[168] Unlike earlier instruments, the operator cannot limit their liability.[169] Victims can bring actions against the operator responsible in the national courts of the country where the damage was suffered or where the dangerous activity was conducted. For example, a company that conducted ocean fertilisation projects could be liable under the Lugano Convention for depletion of coral reefs and consequent loss of profit for fishing communities. It is interesting to note that under the Convention, that a company could also be required to compensate communities for any preventative measures they adopted to reduce the damage by geoengineering activities.

However, the Lugano Convention only has nine signatories and is unlikely to ever enter into force.[170] As of 2014, it has only received three ratifications.[171] As the effectiveness of international agreements depends on its number of signatories, and domestic cooperation from States[172], the Lugano Convention is not an effective instrument for allowing potential victims of geoengineering to claim compensation from companies. Nevertheless, its far-reaching provisions can be used as a model for the establishment of a civil liability scheme for geoengineering.

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164 Jan Wouters, Anna-Luise Chane, 'Multinational Corporations in International Law' (Working Paper No 129, Leuven Centre for Global Governance Studies, December 2013) < https://ghum.kuleuven.be/ggs/publications/working_papers/new_series/wp121-130/wp129-wouters-chane.pdf> pg 18

165 Amanda Perry-Kessaris, 'Corporate liability for environmental harm' (2007) in Fitzmaurice and Ong (eds) *Research Handbook on International Environmental Law*, Cheltenham Edgar Publishing < http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1087548> 2.4

166 *Council of Europe Convention on Civil Liability for Damage Resulting from Activities Dangerous to the Environment 1993*, opened for signature 21 June 1993, CETS No. 150, Article 2(7)

167 Ibid, Article 1

168 Ibid, Article 2(5)

169 Phillipe Sands and Jacqueline Peel, *Principles of International Environmental Law* (Cambridge University Press, 3rd ed, 2013), pg 767

170 Ibid, pg 766

171 Council of Europe, Treaty Office, 'Convention on Civil Liability for Damage Resulting from Activities Dangerous to the Environment 1993 <http://conventions.coe.int/Treaty/Commun/ChercheSig.asp?NT=150&CM=3&DF=&CL=ENG> (accessed 14 September 2014)

172 Jan Wouters, Anna-Luise Chane, 'Multinational Corporations in International Law' (Working Paper No 129, Leuven Centre for Global Governance Studies, December 2013) < https://ghum.kuleuven.be/ggs/publications/working_papers/new_series/wp121-130/wp129-wouters-chane.pdf> pg 18

e) Corporate criminal liability for environmental harms

The possibility of holding companies criminally liable could deter them from deploying geoengineering irresponsibly and provide remedies for affected communities. Several international instruments contain criminal liability for companies, such as the *European Convention on the Protection of the Environment through Criminal Law*. As with all international agreements, the Convention requires cooperation from State parties to establish the listed criminal offences and remedies in domestic law. It also only applies to European countries.

The Convention covers environmental offences such as the discharge of substances into air, soil or water that causes death or serious injury to any person, or substantial damage to protected monuments, objects, property, animals or plants.[173] Dumping iron into an ocean would classify as the discharge of substances into water. Hence, if an ocean fertilisation project caused damage to marine ecosystems and damaged the health of fishing communities, the company responsible for conducting the project would have committed this offence.

The Convention includes sanctions such as the 'reinstatement of the environment' which require the offender to take necessary steps to repair the damage caused to environmental interests or create a situation which approaches the environmental conditions before the offence.[174] However, while it is questionable whether the effects of geoengineering can ever be reversed, perhaps a sanction such as 'reinstatement of the environment' can enforce companies to provide some disaster relief for affected communities.

The fundamental problem of holding companies civilly or criminally liable for harmful effects of geoengineering is that it does not prevent them from causing harm. There are limited advance provisional measures in international law to stop activities that could be in breach of international obligations.[175] The Lugano Convention attempts to provide advance provisional measures. It grants standing to environmental protection groups to request the prohibition of an activity which is unlawful and poses a grave threat of damage to the environment or to request that the operator take measures to prevent an incident or damage.[176] However, its lack of signatories and hence limited application does not make it an effective mechanism for disaster prevention.

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[173] *European Convention on the Protection of the Environment through Criminal Law,* opened for signature on 4 November 1998, CETS No. 172, Article 2(1)
[174] Ibid, Article 6
[175] Ralph Bodle, 'Geoengineering and International Law: The Search for Common Legal Ground' (2011) 46 *Tulsa Law Review* pg 308
[176] *Council of Europe Convention on Civil Liability for Damage Resulting from Activities Dangerous to the Environment 1993*, opened for signature 21 June 1993, CETS No. 150, Article 18

The threat of being held criminally liable may also not be an adequate deterrent for companies; it clearly did not deter HSRC from dumping iron in Haida Gwaii. This means that currently, communities can only protect themselves from harm caused by commercial geoengineering through adopting disaster risk reduction strategies.

Part V: Reform Considerations

The current international governance framework for geoengineering is clearly not capable of effectively regulating the risks of geoengineering. A governance mechanism must be developed to prevent States or a private company from deploying geoengineering without considering its possible disastrous effects, particularly on vulnerable communities with the least capability of adapting to climate related disasters.

This section recommends options to regulate the risks of geoengineering in the context of climate disaster law and achieving justice for vulnerable communities. It examines the shortcomings of these options and recognises that given the transboundary nature of geoengineering and the massive international and domestic cooperation required, the risks of geoengineering may never be effectively regulated. As the Solar Radiation Management Governance Initiative Report concedes, "it may be impossible to reach agreements that are acceptable to all parties owing to significant differences based on geopolitical, ethical, equity and climate issues."[177]

1. Risk mitigation – Governance of the deployment of geoengineering

To prevent or reduce the risk of geoengineering causing a disaster, there should be an international agreement on geoengineering requiring a full assessment of its risks and authorisation before a geoengineering activity can be deployed. An international agreement will be beneficial for setting out the governance regime of geoengineering in one document, rather than in its existing piecemeal fashion of the LC/LP Assessment Framework, CBD and international customary law. Ideally, a geoengineering protocol to the 1992 UNFCCC would provide the most appropriate forum to regulate geoengineering because of the UNFCCC's near universal support.[178] Inspiration can be

[177] Solar Radiation Management Governance Initiative (SRMGI), Solar radiation management: the governance of research (2011) < http://www.srmgi.org/files/2012/01/DES2391_SRMGI-report_web_11112.pdf> (accessed 3 September 2014) pg 52

[178] Karen N. Scott, 'International law in the Anthropocene: Responding to the Geoengineering Challenge' [2013] 34(2) *Michigan Journal of International Law* pg 356

drawn from the Oxford Principles in ensuring that geoengineering is regulated as a public good, there is public participation in geoengineering decision making, and international dialogue and discussion about its research with affected countries.[179] This agreement should be signed by all States, who would need to ratify their obligations in domestic law so that this agreement would be applicable to companies as well.

The authorisation procedure established by an international geoengineering protocol should assess whether or not to authorise a geoengineering proposal by considering various factors. This would include costs, probabilities of success, impacts on ecosystems, adverse weather impacts, and the ability of the geoengineering project in addressing the threat of climate change.[180] A geoengineering proposal should be assessed by exploring possible alternatives, and its suggested ways of minimising the health, environmental and welfare harm caused by the geoengineering activity.[181] The State and/or company proposing to deploy geoengineering should also be required to submit an EIA and file regular reports about further research discoveries and potential harms or unforeseen consequences of the activity.[182] All information about the proposed geoengineering activity should be publicly disclosed before it is authorised[183] and affected States should be warned and consulted during this authorisation stage.

The requirement to notify and consult affected States would particularly help reduce the risk of disasters for developing countries. It will inform them on the potential impacts of geoengineering and give them time to adopt disaster risk reduction strategies addressing the specific risk of the proposed activity. It will also allow their perspectives to be considered by giving them the opportunity to express their views on whether geoengineering should be deployed. As suggested by Strong, an international geoengineering agreement should include that the specific needs and special circumstances of developing country parties that are particularly vulnerable to the adverse effects of climate change be given full consideration.[184]

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[179] Oxford Geoengineering Programme, 'The Principles' < http://www.geoengineering.ox.ac.uk/oxford-principles/principles/? >

[180] Gerd Winter, 'Climate Engineering and International Law: Last Resort or the End of Humanity?' [2011] 20(3) *Review of European Community & International Environmental Law* pg 287

[181] Ibid

[182] Vishal Garg, 'Engineering a Solution to Climate Change: Suggestions for an International Treaty Regime for Governing Geoengineering' (2014) *University of Illinois Journal of Law, Technology and Policy* pg 215

[183] Adam D.K. Abelkop, Jonathan C. Carlson, 'Reining in Phaethon's Chariot: Principles for the Governance of Geoengineering' [2013] 21 *Transnational Law & Contemporary Problems* pg 779

[184] Aaron Strong, 'Toward an International Geoengineering Agreement: The Promises (and Pitfalls) of Negotiating a Convention on Global Climate Interventions' [2011] 18 *Papers on International Environmental Negotiation: The Next Generation of Environmental Agreements* pg 37

A point of contention for establishing an international agreement would be deciding the threshold of harm for a geoengineering project not to be authorised. Strong urges in his draft geoengineering agreement that "where there are threats of serious or irreversible damage to ecosystems, human health, biodiversity, agriculture or human rights, from a global climate intervention, no such intervention should be implemented."[185] Yet banning geoengineering from deployment due to the threat of serious or irreversible damage does not recognise that the benefits of geoengineering could outweigh its harms.[186] An international agreement should recognise if geoengineering is found as the lesser evil compared to climate change, then some tradeoffs may be necessary.[187] It is also possible that any 'serious or irreversible damage' of geoengineering can be reduced through disaster risk reduction strategies by affected States. Depending on its nature and scientific knowledge, geoengineering may also be carried in ways that minimise damage. This suggests that the authorisation of geoengineering proposals should be approached by a cost-benefit analysis of geoengineering, and exploring the adaptation and mitigation measures that can be adopted.

However, an authorisation procedure may never protect communities from the negative effects of geoengineering. Even if geoengineering was authorised, the IPCC has stated that the efficacy, cost and risks of CDR techniques are presently highly uncertain.[188] This requires an international agreement on geoengineering to require careful environmental monitoring of the risks of a geoengineering project after it has been authorised.[189] As the Royal Society points out, "geoengineering requires flexible frameworks of governance and regulation, which can be adapted in light of fresh evidence and analysis."[190] It is critical that an international agreement require fresh discovery of likely geoengineering hazards to be communicated to affected communities. In the meanwhile, the unpredictable effects of geoengineering would be best managed, not necessarily by an international agreement, but by populations implementing emergency plans such as swift relocations, replacement of housing and emergency portable water[191].

In any case, the risks of geoengineering are currently most effectively regulated through disaster risk reduction strategies due to the near impossibility of establishing an international

185 Ibid, pg 36
186 Vishal Garg, 'Engineering a Solution to Climate Change: Suggestions for an International Treaty Regime for Governing Geoengineering' (2014) *University of Illinois Journal of Law, Technology and Policy* pg 214
187 Adam D.K. Abelkop, Jonathan C. Carlson, 'Reining in Phaethon's Chariot: Principles for the Governance of Geoengineering' [2013] 21 *Transnational Law & Contemporary Problems* pg 779
188 IPCC 5th Assessment Report (2014), Chapter 6, pg 96
189 Adam D.K. Abelkop, Jonathan C. Carlson, 'Reining in Phaethon's Chariot: Principles for the Governance of Geoengineering' [2013] 21 *Transnational Law & Contemporary Problems* pg 770
190 The Royal Society, 'Geoengineering the climate: science, governance and uncertainty' (2009) <https://royalsociety.org/~/media/Royal_Society_Content/policy/publications/2009/8693.pdf> (accessed 27 August 2014), pg 45
191 Christopher J Preston, 'Ethics and geoengineering: reviewing the moral issues raised by solar radiation management and carbon dioxide removal' (2012) 4(1) *Wiley Interdisciplinary Reviews: Climate Change* pg 31

geoengineering agreement. Multilateral treaty making is complex, time-consuming and difficult.[192] Given the international consensus required, a single system of global governance for geoengineering would probably take years to create.[193] Since some States would inevitably be more adversely affected by effects of geoengineering, States would disagree on the strictness of the authorisation procedure and the threshold of harm required. Negotiations would probably be highly polarised and continue for a long time without any meaningful outcome.[194] Even if an agreement was reached, its applicability would be challenged by those States who refuse to become a Party to the agreement. Furthermore, as Lin points out, any agreements achieved often contain watered-down obligations.[195] Hence, it is too idealistic to envisage that disaster risk prevention of geoengineering would be effectively regulated through an international agreement.

Problems in establishing a governance body for authorising geoengineering proposals further suggests that an international geoengineering agreement would be ineffective. There is little incentive for States to turn over decision-making about geoengineering to an international body.[196] Even if such an organisation could be established, it would likely lack the authority to fully regulate or enforce its members' compliance with the terms of the international agreement.[197] The international body would still need to rely on States to ensure that no geoengineering technology is deployed without its prior authorisation. This requires an effective monitoring and/or policing mechanism to detect projects carried out in secrecy like the Haida Gwaii iron dump. The improbability of this level of enforcement being achieved indicates that perhaps the risks of geoengineering can never be effectively regulated by the international community.

2. International disaster relief reform

To address the current haphazard and disorganised system of international disaster relief, an international framework for disaster relief should be adopted to ensure that victims of geoengineering can be given relief and assistance. This framework could create an emergency response management body to provide disaster relief to vulnerable communities. Farber recommends the creation of an international equivalent of Emergency Management Australia which

[192] Albert C. Lin, 'Geoengineering Governance' [2009] 8(3) *Issues in Legal Scholarship* Article 2, pg 16
[193] David Humphreys, 'Smoke and Mirrors: Some Reflections on the Science and Politics of Geoengineering' (2011) 20 *The Journal of Environment Development* pg 114
[194] Tuomas Kuokkanen and Yulia Yamineva, 'Regulating Geoengineering in International Environmental Law' 3 *Carbon and Climate Law Review* pg 165
[195] Albert C. Lin, 'Geoengineering Governance' [2009] 8(3) *Issues in Legal Scholarship* Article 2, pg 16
[196] Daniel Bodansky, 'The who, what and wherefore of geoengineering governance' (2013) 121(3) *Climatic Change* pg 549
[197] US Congressional Research Service, 'Geoengineering: Governance and Technology Policy' (Nov 2013) by Kelsi Bracmort, Richard K. Lattanzio < http://fas.org/sgp/crs/misc/R41371.pdf> (accessed 25 August 2014) pg 38

would determine the willingness of nations and private organisations to supply resources and manage logistics.[198] Inspiration can be drawn from the International Law Commission's Draft Articles on the protection of persons in the event of disasters[199] which creates a framework of terms and conditions for external assistance. For example, States could provide information on the specific needs of the persons affected by disasters and scope and type of assistance needed to the emergency response body.[200] Such information can ensure that local characteristics and needs are considered for providing shelter, food and water to those afflicted.

However, international reform in respect to disaster response is unlikely to happen due to the absence of political will.[201] If the current system of international disaster relief is haphazard despite the increasing frequency, intensity and complexity of climate extremes and disasters[202] then it is unlikely that the threat of a disaster caused by geoengineering could motivate the international community into reforming international disaster response systems. This indicates that the current shortcomings of international disaster relief will inevitably cause some victims of a geoengineering-related disaster to miss out on relief and assistance.

3. Global geoengineering compensation fund

Victims of geoengineering activities should be provided with compensation. Post-disaster compensation usually takes three forms: private insurance, government programs and the tort system.[203] The difficulty in proving that States and/or companies caused the harm and other problems with liability rules indicates that the tort system would not be an effective post-disaster compensation mechanism. Private insurance is also unlikely to be effective. Poorer individuals in developing countries are unlikely to be insured. For example, the loss caused by the extraordinary rainfall in China in 2010 was estimated to be US$53 billion with estimated insured losses of only US$761 million.[204] The remainder of the damage was covered by individuals, government and

[198] Daniel Farber, 'Catastrophic Risk, Climate Change, and Disaster Law' (2013) *16 Asia Pacific Journal of Environmental Law* pg 52
[199] Teresa Thorp, 'International climate law and the protection of persons in the event of disasters' (online) (2013) 11(2) *New Zealand Journal of Public and International Law* pg 468
[200] International Law *Commission Sixty-Fourth Session Report*, Draft Article 13, Conditions on the provision of external assistance (provisionally adopted by the drafting committee on 30 July 2012)
[201] Teresa Thorp, 'International climate law and the protection of persons in the event of disasters' (online) (2013) 11(2) *New Zealand Journal of Public and International Law* pg 441
[202] Ibid, pg 437
[203] Daniel Farber, 'Environmental Disasters: An Introduction' (2011) UC Berkeley Public Law Research Paper No. 1898401 < http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1898401> pg 23
204 Rosemary Lyster, "A fossil fuel-funded Climate Disaster Response Fund under the UNFCCC loss and damage mechanism" (University of Sydney, Law School, Research Paper No. 13/77, 2013) pg 8

NGOs.[205] Government programs and compensation schemes may be of some assistance. The Thai government, for example, established the National Disaster Fund of US$1.6 billion to support households, firms and industries after the 2011 Thai floods.[206] However, governments of developing countries may have difficulty compensating its victims when its resources have been depleted.

This article recommends the creation of a global and accessible geoengineering compensation fund contributed by States and companies responsible for deployment of geoengineering. This would overcome the problems associated with claiming compensation under tortious liability, private insurance and national governments. It would also relieve developed countries from having to budget for loss and damage costs in addition to funding mitigation and adaptation activities.[207] Lyster recommends the creation of a Climate Disaster Relief Fund based on proportionate contributions from the top 200 fossil fuel producers.[208] Similarly, a global compensation fund for geoengineering should require contributions by States and or companies planning to deploy geoengineering. Unlike the fossil-fuelled relief fund, their liability would be prospective rather than retrospective[209] in seeking to compensate future losses from their activities.

The *Convention on Civil Liability for Oil Pollution,* which establishes a collective fund for compensation financed by compulsory insurance, can be used as a model for establishing a global liability and compensation scheme. The geoengineering compensation fund could have a similar structure to the Global Oil Pollution Fund[210] with several tiers of compensation. For example, strict liability could be imposed on the particular company responsible for the deployment of the geoengineering activity which caused harm. If the company is unable to cover the loss because they are uninsured or insolvent, then victims should be compensated by the geoengineering compensation fund. Similarly, if victims are citizens of a State which participated in a multilateral geoengineering project, then their first available mechanism of compensation should be from their own government. Where their own government cannot cover all losses, victims should be entitled to compensation from the global compensation fund.

[205] Ibid
[206] Ibid, pg 16
[207] Ibid, pg 13
[208] Ibid, pg 31
[209] Ibid, pg 28
[210] *International Convention on Civil Liability for Oil Pollution Damage (Civil Liability Convention) 1992, International Oil Pollution Compensation Fund 1992, International Supplementary Fund for Compensation for Oil Pollution Damage 2003*

The establishment of a global compensation fund before the deployment of any geoengineering activities would ensure from the outset that victims of geoengineering activities will be compensated. Victims should be compensated for types of damages such as loss of life or personal injury, loss of profit deriving from an interest in the environment, cost of reinstating the impaired environment and the cost of preventative measures taken to prevent the damages of the geoengineering activity. Compensation for the cost of preventative measures would be especially important for allowing communities to recoup their costs for adopting adaptation measures and use the funds for rebuilding. The reassurance that they will be compensated for their adaptation measures in the event of a geoengineering-related disaster can also provide communities with the incentive to adopt these measures, despite their costs.

However, with all multilateral treaty-making, there would be difficulties in establishing and designing a global geoengineering compensation fund. A governance body to manage the Fund[211] would also need to be established to enforce and impose the levies and contributions. Like an international geoengineering agreement, a global compensation fund would require global cooperation and may take years to develop. Perhaps it is too idealistic to suppose that the damages caused by geoengineering could be covered for all victims.

Conclusion

The risks of geoengineering are unlikely ever to be effectively regulated. Current international governance of geoengineering in regards to disaster risk prevention is fragmented, heavily reliant on cooperation by States and difficult to enforce. Due to the difficulties of establishing a single international geoengineering regime, the governance of geoengineering will likely develop through the extension of existing treaty regimes.[212] This indicates a continuation of the present situation where States are subject to certain international customary obligations such as the requirement to notify affected States and conduct EIA's. There is a pressing need to ensure that companies are also subject to the same constraints. However, the cooperation needed by States to ratify these obligations, and the profit-driven motives of companies suggests that it is unlikely that companies will notify and consult affected communities before they deploy geoengineering. Furthermore, due to the uncertainties of geoengineering techniques, no notification or risk assessment can guard against its possible unpredictable consequences.

211 Rosemary Lyster, "A fossil fuel-funded Climate Disaster Response Fund under the UNFCCC loss and damage mechanism" (University of Sydney, Law School, Research Paper No. 13/77, 2013) pg 30

212 Daniel Bodansky, 'The who, what and wherefore of geoengineering governance' (2013) 121(3) *Climatic Change* pg 550

Inevitably, burden of disaster risk reduction will be borne by those populations affected by the deployment of geoengineering. Yet the most vulnerable regions are unlikely to have the capability to adopt appropriate adaptation measures. The causation difficulties in holding companies and/or States responsible for harm caused by geoengineering indicates that affected populations will have to cover the damage themselves with reliance on the current haphazard system of international disaster relief. Perhaps then, just like climate change will disproportionately affect the poorest regions[213], so too will the effects geoengineering. However, vulnerable populations should be involved in an international dialogue and discussion about the development of geoengineering. This will improve their understanding of geoengineering risks, and perhaps their ability to adapt. While such international cooperation to regulate the risks of geoengineering will never be achieved, a deeper consideration of the perspectives of vulnerable communities can be a first step.

[213] Daniel Farber, 'Catastrophic Risk, Climate Change, and Disaster Law' (2013) *16 Asia Pacific Journal of Environmental Law* pg 550

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