International EIA Law and Geoengineering: Do Emerging Technologies Require Special Rules?

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Abstract

This article explores the adequacy of the international rules on environmental impact assessment (EIA) to contribute to geoengineering governance with a focus on three fundamental challenges. First, the near universal trigger for EIA is the likelihood of significant environmental impact, which may prove to be insufficiently precautionary in light of current risk preferences surrounding geoengineering. Second, the scope of EIA has traditionally focused narrowly on the assessment of direct physical impacts, however many of the concerns that geoengineering research raises relate to environmental and social risks associated with downstream technological implications. A third and related challenge is the consultation requirements under EIA laws, which focus on affected States and affected members of the public. Because many geoengineering activities are anticipated to impact the global commons, there is no clear institutional mechanism for implementing notification and consultation. Additionally, the broader sets of concerns that geoengineering raises are spatially unbounded, again making the identification of consultation partners uncertain. The article concludes with a discussion of the implications of the challenges and limitations of the rules of EIA for geoengineering.

1. Introduction

As geoengineering research moves from modeling and laboratory studies to field experiments, there is a need for legal processes to assess the potential risks associated with field experiments. To this end, environmental impact assessment (EIA) is anticipated to form a key part of the governance framework for geoengineering research.[1] The source of EIA rules is found in both domestic and international law. The focus of this article is on the international legal rules respecting EIA. This is not to suggest that domestic EIA processes are of lesser importance in this context. On the contrary, as described below, it is likely that the assessment of small-scale experiments will be largely governed by domestic EIA law, and any international commitments will be implemented through domestic EIA processes. That said, the international rules on EIA deserve our attention because some of the early field experiments are contemplated to occur in areas of the global commons or may have some potential to have transboundary impacts, and as experimentation scales up, the risk implications are global in scale. As a consequence, the governance expectations surrounding geoengineering field experiments, regardless of their location, tend to transcend national polities.

At its simplest, EIA 'is a process to predict the environmental effects of proposed initiatives before they are carried out.'[2] While the precise form of EIA varies, EIAs typically apply to activities that are likely to have a significant environmental impact, and require a comprehensive consideration of the direct, indirect and cumulative environmental impacts of the activity, and further require that potentially impacted

[1] Steve Rayner, Clare Heyward, Tim Kruger, Nick Pidgeon, Catherine Redgwell, and Julian Savulescu, 'The Oxford Principles' (Climate Geoengineering Governance Working Paper No.1, 2013); Solar Radiation Management Governance Initiative (SRMGI), *Solar Radiation Management: The Governance of Research.* (London: The Royal Society, 2011); Robert Olson, *Geoengineering for decision makers* (Washington, DC: Woodrow Wilson International Center for Scholars, 2011)*;* Royal Society, *Geoengineering the climate: science, governance and uncertainty* (London: Royal Society. 2009); David Victor, 'On the regulation of geoengineering', 24(2) *Oxford Review of Economic Policy* (2008) at 322-336.

[2] Canadian Environmental Assessment Agency, 'Introduction to Federal Environmental Assessment' (2011), online at: <www.ceaa-acee.gc.ca/default.asp?lang=En&n=0DF82AA5-1&offset=2&toc=show> at Part 1.1.

persons be consulted.[3] EIA processes rarely prescribe particular environmental standards or outcomes, but rather rely on open, participatory and reasoned processes to promote environmentally benign and democratically legitimate outcomes.[4] International EIA refers to those processes that seek to identify and evaluate environmental impacts that are transboundary in nature, impact the global commons, or impact issues of global common concern, such as climate change and biological diversity. As a legal and policy tool, EIA is used throughout the world and is entrenched in numerous international environmental law treaties and customary international law.[5]

The attractiveness of using international EIA as part of the governance framework for geoengineering is that EIA provides a pre-existing and structured decision-making process that responds, at least in part, to the governance challenges associated with geoengineering. International law requires states to exercise due diligence in order to avoid creating significant adverse environmental harm to other states or to global resources.[6] EIA, as a process that examines the environmental consequences of planned activities is, on its face, well suited to satisfying this due diligence obligation.[7] EIAs also address issues of legitimacy through the inclusion of well-defined procedural requirements for transparency and consultation.[8] EIAs are not a substitute for state consent, but may provide an alternative to formal state consent by providing a mechanism by which the interests of other states may be accounted for in environmental decision-making processes.

Despite the acknowledged importance of international EIA processes to geoengineering governance frameworks, little attention has been paid in the legal or policy literatures to the adequacy of the international EIA rules to address geoengineering research proposals. The rules were not designed to accommodate geoengineering research proposals and it cannot be assumed that international EIA processes can be easily adapted for this purpose. The rules themselves are often inchoate, leaving critical questions regarding the application, scope and nature of EIA unanswered.[9] The International Court of Justice has indicated that certain aspects of transboundary EIA ought to be left to the discretion of individual States, but a high degree of State discretion

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[3] J. Holder, *Environmental Assessment: The Regulation of Decision Making* (Oxford: Oxford University Press, 2004); C. Wood, *Environmental Impact Assessment: A Comparative Review,* (Harlow, UK: Prentice Hall, 2003).

[4] Holder, ibid; Bartlett, R. and P. Kurian (1999). 'The Theory of Environmental Impact Assessment: Implicit Models of Policy Making', 27(4) *Policy and Politics* (1999), at 415.

[5] Principle 2 of the Rio Declaration, United Nations Conference on Environment and Development, 14 June 1992, UN Doc. a/conf.15/5/Rev.1, reprinted in 1993 31 ILM 874; see also *Pulp Mills on the River Uruguay (Argentina v, Uruguay*) (2010), ICJ 20 April 2010 (hereinafter *Pulp Mills*),.

[6] International Law Commission, *Draft Articles on Prevention of Transboundary Harm from Hazardous Activities* in *Report of the International Law Commission,* Fifty-third session, UN GAOR, 56th Sess., Supp. 10, UN Doc. A/56/10 (2001).

[7] *Pulp Mills*, supra note 5, at para 204; Neil Craik, *The International Law of Environmental Impact Assessment: Process, Substance and Integration* (Cambridge: Cambridge University Press, 2008); but see John Knox, 'The Myth and Reality of Transboundary Environmental Impact Assessment', (96) *American J. Int'l Law* 291 (2002).

[8] Neil Craik, 'Deliberation and Legitimacy in Transnational Environmental Governance', 38(2) *Victoria University of Wellington Law Review* 381 (2007).

[9] Craik 2008, supra note 7, at 126.

may undermine the overall acceptability of EIA outcomes; a critical consideration where engendering legitimacy of outcomes is a key goal of the EIA process.[10]

The international rules may provide a legal framework, but the actual implementation of these rules is likely to require elaboration in light of the broader governance considerations surrounding geoengineering. The principal goal of this article is to examine the nature and extent of the international legal duties to conduct EIAs for geoengineering research proposals and to consider the form and substance of the normative elaboration that would allow for the successful implementation of those duties.

To this end, the first section of this article describes the current trajectory of geoengineering field research. The second section provides a brief overview of the current status of EIA obligations in international law. Section three examines the application of EIA rules to potential geoengineering field experiments. A range of experimental scenarios and regulatory contexts are considered. The approach is principally descriptive, with a view to examining how existing EIA rules constrain and structure decision-making processes surrounding field experiments. There is a normative element to the analysis in that the article also seeks to comment on the adequacy of existing EIA rules to meet the governance demands associated with geoengineering research. The article concludes with a discussion of the nature of EIA processes themselves, and in particular how the structure of EIA obligations is likely to influence the broader governance debates surrounding the development of geoengineering technologies.

2. Geoengineering Field Experiments

This article considers field experiments in relation to both carbon dioxide reduction (CDR) and solar radiation management (SRM) technologies.[11] While these constellations of possible technologies differ considerably in their potential impacts and risk profiles, they raise some common governance considerations pertinent to EIAs. What unites these approaches is that they are directed at countering the impacts of greenhouse gas emissions in the atmosphere through technologies that seek to remove and permanently store greenhouse gas, chiefly carbon dioxide, in the case of CDR, or by reducing the amount of solar radiation absorbed by the earth, in the case of SRM, and by being employed at a sufficient scale to impact climate at global scale.[12]

Within the domain of CDR experiments, ocean fertilization experiments have attracted the most attention.[13] The basic mechanism being exploited is the fixing of carbon dioxide through photosynthesis by phytoplankton, with some of the CO_2 being sequestered in the deep ocean or ocean floor as these organisms work their way through the food chain. As the availability of nutrients is a limitation to phytoplankton growth,

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[10] *Pulp Mills*, supra note 5, at para 205

[11] Ken Caldeira, Govindasamy Bala and Long Cao, 'The Science of Geoengineering' 41 Annu. Rev. Earth Planet. Sci. 231 (2013); David Keith, 'Geoengineering the climate: History and Prospect', 25(1) *Annual Review of Energy and the Environment* 245 (2000); Royal Society, supra note 1.

[12] Royal Society, supra note 1 at 1 (defining geoengineering as "the deliberate large-scale manipulation of the planetary environment to counteract anthropogenic climate change").

[13] Doug Wallace, Cliff Law, Philip Boyd, Yves Collos, Peter Croot, Ken Denman, Phoebe Lam, Ulf Riebesell, Shigenobu Takeda, and Phil Williamson, *Ocean fertilization: A scientific summary for policy makers* (Paris: IOC/UNESCO, 2010).

ocean fertilization proposals seek to add nutrients, such as iron, to the ocean environment to stimulate the growth of algal blooms. Field experiments, involving the deposition of nutrients into the ocean and subsequent monitoring of the effects, have been carried out on a number of occasions over the past twenty years.[14]

The scale of ocean fertilization experiments has been small, for example, the most extensive experiment involved less than twenty tonnes of released material and an area of impact of under 300 square kilometres.[15] Since the experiments involve releases into the marine environment, including the high seas, the experiments have raised questions respecting compliance with the London Convention for the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, as well as concerns under the Convention on Biological Diversity.[16] The risk assessment carried out in relation to a joint German-Indian experiment, referred to as LOHAFEX, which proposed a deposition of iron sulphate in the Southern Atlantic Ocean, indicated that the deposition contemplated was in the range of naturally occurring iron inputs, and that the predicted environmental impacts would 'range from negligible to benign and innocuous.'[17] Further independent reviews of the environmental risks associated with the experiment were also carried out, and concluded that the proposed experiment adhered to environmental and international legal standards.[18]

In 2012, another proto-experiment involving ocean fertilization was carried out by a private company seeking to use ocean fertilization technologies to contribute to salmon stock restoration, as well as to seek carbon credits for sequestered carbon.[19] The experiment, which was undertaken off the west coast of Canada, but in international waters, was not publicly funded, did not involve academic researchers, and was carried out without any prior authorization or assessment. The project was widely condemned, including drawing statements of concern from the parties to the London Convention,[20] and demonstrated the concerns respecting the potential for privately motivated geoengineering experimentation.[21]

Other forms of carbon sequestration, such as direct air capture, afforestation and reforestation, biomass, or biochar, are likely to pose lower risks from an experimental standpoint because they use better understood bio-sequestration methods, although there

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[14] Ibid.

[15] Alfred Wegener Institute, *Risk Assessment for LOHAFEX* (2009), online at: <http://www.awi.de/fileadmin/user_upload/News/Selected_News/2009/LOHAFEX/0%20AWI_NIO_LOHAFEX_Risk_Assessment.pdf>

[16] Convention on Biological Diversity, COP Decision IX/16, online at < http://www.cbd.int/decision/cop/?id=11659>; London Convention and London Protocol, Resolution Lc-LP.1 (2008) (adopted 31 October 2008)

[17] Alfred Wegener Institute, supra note 15

[18] Climos, 'LOHAFEX Given Green Light to Proceed' (2008), online at <http://www.climos.com/note_detail.php?pid=120>.

[19] Neil Craik, J. J. Blackstock, and A. M. Hubert, 'Regulating Geoengineering Research through Domestic Environmental Protection Frameworks: Reflections on the Recent Canadian Ocean Fertilization Case', 7(2) *Carbon and Climate Law Review* 117 (2013).

[20] Statement of Concern by Contracting Parties to the London Convention and London Protocol, 2 November 2012

[21] D. Bodansky, 'Governing Climate Engineering: Scenarios for Analysis', Discussion paper for the Harvard Project on Climate Agreements (2011), online at: www.ssrn.com/abstract=1963397.

are risks, such as bio-diversity concerns, associated with these technologies when implemented at large scales. These methods tend to be distinguishable from identified mitigation approaches by virtue of the scale of implementation that would be necessary to have an appreciable impact on global climate conditions. As a consequence, there appears at present to be less public and international concern being directed towards these CDR experiments.

The principal forms of SRM technologies where field experiments are being contemplated are stratospheric aerosol releases, which would have the objective of reflecting incoming solar radiation away from the Earth's lower atmosphere by placing material with light scattering properties in the stratosphere; cloud albedo techniques, such as marine cloud brightening and cirrus cloud stripping; and land-based albedo enhancement. Marine cloud brightening exploits the reflective quality of clouds and seeks to enhance that effect by increasing the number of cloud-condensation nuclei, such as saltwater. Cirrus cloud stripping targets higher altitude cirrus clouds that trap radiative energy in the earth's atmosphere, and seeks to reduce this effect by seeding the clouds to reduce their duration. Other hypothesized SRM techniques, such as the use of space-based reflectors, are not the subject of contemplated field experimentation. Stratospheric aerosol, marine cloud brightening experiments and cirrus cloud stripping, like ocean fertilization, are perturbative, in the sense that the experiments involve the release of a substance into the environment with the intention of creating a particular response that can be measured and assessed. In some cases, there may be natural or man-made analogues, such as releases from volcanoes or ship exhausts, which could be the subject of experimental observations.[22] Limited direct SRM field experimentation has been carried out to date.[23]

Keith, Duran, and MacMartin, in a 2014 paper, describe a portfolio of possible SRM field experiments with the aim of generating a better understanding of how a research programme on SRM technologies might unfold.[24] They distinguish between a number of experiment types, differentiated by experimental purpose.[25] Beyond modeling and laboratory experiments, the types of experiments include technology development studies, which would test the hardware necessary to undertake field experiments and deployment activities; process studies, which are directed towards understanding chemical and physical interactions and dynamics at small-scales, and would include both controlled release experiments and observations of natural and man-made analogues; scaling tests, which recognize that interactions studied in process studies may not scale up in linear and predictable ways, demanding further mid-scale studies that are intended to assess interventions across larger geographic scales and involving larger perturbations, but not intended to induce measurable climate responses; and finally, climate response

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[22] Alan Robock, '20 reasons why geoengineering may be a bad idea', 64(2) *Bull. Atomic Scientists*, (2008)14, doi:10.2968/064002006.

[23] Committee on Geoengineering Climate: Technical Evaluation and Discussion of Impacts et al. *Climate Intervention: Reflecting Sunlight to Cool Earth*. (Washington, D.C.: National Academy of Sciences, 2015), at 113.

[24] David Keith, Riley Duran, and Douglas MacMartin, 'Field Experiments on solar geoengineering: report of a workshop exploring a representative research portfolio' 372/2031 Philosophical Transactions of the Royal Society A, DOI: 10.1098/rsta.2014.0175, (2014).

[25] Ibid, summarized in Table 1 at 3.

tests, where the intention is to conduct experiments at large enough scales to produce measurable climate responses to interventions that can be monitored and evaluated. At present, despite some calls for the development of increased research activities,[26] no State has adopted a long-term research strategy in relation to SRM research, but researchers are actively proposing process studies.

In some respects, the factors that relate to environmental impacts of geoengineering field experiments will be similar to other types of planned activities, such as the magnitude of planned disturbance, i.e. its duration, geographic scope and intensity, and the sensitivity of the receiving environment. The fate of introduced substances and the reversibility of induced impacts is very clearly of concern. Papers describing proposed perturbative process studies indicate confidence that effects are transitory and present low physical risks.[27]

Whether SRM field experiments directly impact natural systems subject to international jurisdiction, by virtue of their transboundary impact or impact upon global commons resources, will depend on the parameters of the individual experiment. It is quite likely that small-scale experiments would be carried out entirely within a State's territory and would in any event be projected as having insignificant environmental impacts given the small amount and duration of the anticipated releases. Stratospheric aerosol injection experiments could be carried, for example, over land, while cloud albedo experiments are likely to be conducted over marine environments, but within areas under State control, such as territorial seas or exclusive economic zones. As noted ocean fertilization experiments are more likely to be conducted in areas beyond national jurisdiction. Risks, however, increase as experiments scale up due to the more complicated feedback mechanisms and interactions that would arise. By definition, it is only at large scales, i.e. climate response tests, where experiments would be anticipated to have appreciable impact on global climate.

Keith et al. anticipate that any research program would be sequential and iterative, which is to say, that research would not proceed to a further, likely larger-scale, stage, until the risks and scientific merit of proceeding were justified at smaller scales.[28] Environmental assessment and the policy decisions that flow from these assessments necessarily rely on the scientific findings at earlier stages of the research program. However, in order to ensure that the full range of public concerns respecting geoengineering are considered, decision-making processes must provide opportunities for assessing the social and ethical risks, as well as the environmental risks, associated with an experiment.

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[26] Committee on Geoengineering Climate, *supra* n. 23Jane Long, Stephen Rademaker, James G. Anderson, Richard E. Benedick, Ken Caldeira, and Joe Chiasson, *Geoengineering: A national strategic plan for research on the potential effectiveness, feasibility, and consequences of climate remediation technologies* (Washington, DC: Bipartisan Policy Center, 2011); Royal Society, supra note 1

[27] John Dykema, David Keith, James Anderson and Debra Weisenstein, 'Stratospheric controlled perturbation experiment: a small scale experiment to improve understanding of the risks of solar geoengineering' 372/2031 Phil. Trans. R. Soc. A. 20140059 (2014); Latham *et al.* 'Marine Cloud Brightening' 370 Phil. Trans. R. Soc. A 4217-4262 (2012).

[28] Ibid at 5; see also Long et al, supra note 26; Olson, supra note 1.

The social and ethical concerns connected to geoengineering research are the subject of an extensive and growing literature.[29] These impacts are indirect in the sense that the concerns that are raised principally relate to the implications of the development and deployment of the technology, as opposed to the experimental activity itself. It has been posited that research activities raise the potential for technological lock-in, such that the research activities themselves may generate a set of vested interests that favour particular technological solutions, notwithstanding public concerns and the presence of alternative solutions.[30] A second concern relates to the impact that geoengineering research would have on mitigation and adaptation efforts. Here the potential for a type of moral hazard has been put forward, where the prospect of geoengineering solutions creates incentives for governments and emitters to reduce their commitment to other climate change solutions.[31] There are further concerns respecting the future political and distributional consequences of geoengineering, where access to the control of the technology may be restricted to particular States, and the benefits and burdens of deployment may be unevenly distributed.[32] For example, changes in radiative forcing could potentially alter global precipitation patterns, inducing floods or droughts. Given the complexity of the climate system attributing specific climate events to experimentation would be challenging, creating further difficulties surrounding responsibility for harmful outcomes. Unlike the direct physical impacts of an experiment, these social and ethical concerns are more abstracted from the experiment itself and transcend the spatial boundaries of the experiment, raising significant questions surrounding whether EIA approaches that tend to focus on physical impacts are a suitable mechanism for addressing experimentation.

The possibility of benign environmental impacts in small-scale process studies or in technology development activities does not necessarily suggest that the assessment of social and ethical concerns ought to be postponed until the environmental risks reach a certain scale or risk threshold. For example, in connection with a proposed stratospheric aerosol experiment, referred to as the Stratospheric Particle Injection for Climate Engineering (SPICE) experiment, which in its first stage was intended to test equipment for a subsequent small-scale controlled release experiment, the decision-making process included a highly deliberative, staged process that sought public input on a range of issues related to the potential development of SRM technologies. The process employed

[29] For example, see Christopher Preston, (ed.) *Engineering the Climate: The Ethics of Solar Radiation Management* (Plymouth, U.K.: Lexington Books, 2012); Wil Burns and Andrew Strauss (eds.), *Climate Change Engineering: Philosophical Perspectives, Legal Issues, and Governance Frameworks* (Cambridge, U.K.: Cambridge University Press, 2013)

[30] Christopher Preston, 'Ethics and geoengineering: reviewing the moral issues raised by solar radiation management and carbon dioxide removal', 4(1) *Wiley Interdisciplinary Reviews: Climate Change* 23 (2013), 26; SRMGI, supra note 1 at 2; Jane Long and Dale Scott, 'Vested interests and geoengineering research', Spring *Issues in Science and Technology* 45 (2013); Lisa Dilling and Rachel Hauser, 'Governing geoengineering research: why, when and how?', 121(3) *Climatic Change* 553 (2013), doi: 10.1007/s10584-013-0835-z.

[31] Preston, ibid; Albert Lin, 'Does Geoengineering Present a Moral Hazard? 40 *Ecol. L. Q.* 673 (2013); Dilling and Hauser, supra note 30; Royal Society, supra note 1 at 39.

[32] Jack Stilgoe, Richard Owen, and Phil Macnaghten, 'Developing a framework for responsible innovation', 42(9) *Research Policy* 1568 (2013); Bronislaw Szernyski, Matthew Kearnes, Phil Macnaghten, Richard Owen, and Jack Stilgoe, 'Why solar radiation management geoengineering and democracy won't mix', 45(12) *Environment and Planning A* 2809 (2013).

recognized that it might be difficult to separate the science that informs geoengineering from the broader implications of the development of the technology itself. Technology development understood as an ongoing, generative process suggests that in order for scientific findings to gain purchase within policy discussions respecting the development of controversial technologies, attention must be paid to the legitimacy of the research, as well as its scientific credibility.[33]

It follows that additional information respecting the purpose of the proposed experiment, how it is funded, who is undertaking it, and the objectives of the experiment will be salient to the assessment of that experiment. Disentangling intent in the early stages of development, where experiments may inform multiple activities, will be a particular challenge for geoengineering. For example, process studies may provide knowledge that informs other aspects of climate interactions, such as cloud physics, and carbon cycle dynamics.[34] The experimenters in the LOHAFEX case quite explicitly maintained that their research was oriented towards understanding the role of iron in the global climate system, as opposed to testing ocean fertilization approaches for geoengineering purposes.[35] In another experiment, the geoengineering implications of the experiment were not recognized until after the experiment had been conducted.[36]

The characteristics of geoengineering field experimentation raise several important implications for the design of EIA processes. First, EIA processes depend on the ability of assessors to make accurate predictions respecting environmental impacts, or to be able to identify areas where risk from uncertainty arises in relation to a proposal.[37] Experimental technologies may be more likely to entail risk. This is particularly likely in relation to impacts on large, complex systems, such as ocean environments, the atmosphere and the climate system. The direct environmental risks are likely to be scale-dependent, with lower risks associated with smaller scale experiments, but will also be contingent upon the particular characteristics of the experiment itself. Risk determination in relation to geoengineering will be more dependent upon theoretical considerations, than observed phenomena, raising thorny issues around determining the degree of scientific consensus that ought to be present and the method of ascertaining the degree of consensus on controverted issues.[38]

Second, many of the indirect risks, which relates to the social and ethical concerns of the development of geoengineering technology, are less scale-dependent and are less likely to be resolved by improved scientific understandings alone. Nevertheless, the presence of these concerns may impact the public's assessment of the acceptability of specific experimental activities and broader research programs. These concerns, which implicate global interests, give rise to questions respecting the extent to which EIA processes are well suited to include consideration of indirect social and ethical concerns.

[33] Neil Craik and Nigel Moore, 'Disclosure-based Governance for Climate Engineering Research', CIGI Paper Series, Paper no. 50, (2014).
[34] Keith, supra note 11, Lynn Russell, Armin Sorooshian, John H. Seinfeld, Bruce A. Albrecht, Athanasios Nenes, Lars Ahlm, and Yi-Chun Chen, 'Eastern Pacific Emitted Aerosol Cloud Experiment', 94(5) *Bulletin of the American Meteorological Society* 709 (2013).
[35] Climos, supra note 18.
[36] Russell et al, supra note 34.
[37] Holder, supra note 3.
[38] Royal Society, supra note 1

The spatially-unbounded nature of these concerns potentially implicate a much wider set of interests than the physical impacts. For example, one can certainly conceive of a small-scale experiment that has only minor and very localized physical impacts, but which generates much wider concerns. Identifying the community of concern, for the purposes of notice and consultation becomes a particular challenge.

3. Sources of International EIA Obligations

International rules in this context are salient because they structure the requirements for activities that are of international concern by virtue of where the activity is carried out or where the impacts of the activity manifest themselves, such as in other States or in areas beyond national jurisdiction, or because the experiment may impact environmental resources, the atmosphere or biodiversity, that are of global concern. Beyond the physical impacts of the experiments, the implications of geoengineering clearly implicate global interests pointing to governance demands that extend beyond the State. In this context international law may harmonize domestic EIA processes by imposing minimum requirements. It also structures the interactions between States which have jurisdiction over the activity and affected States, as well as the broader international community.

EIA obligations arise from both customary international law and treaty law. The customary obligation was confirmed in the *Pulp Mills* case (Argentina v. Uruguay), which involved a dispute over the adequacy of an EIA conducted by Uruguay in connection with a pulp mill located on the River Uruguay, a shared watercourse. The International Court of Justice (ICJ) set out the basic requirements of the obligations as follows:

> In this sense, the obligation to protect and preserve [the environment]…, has to be interpreted in accordance with a practice, which in recent years has gained so much acceptance that it may now be considered a requirement under general international law to undertake an environmental impact assessment where there is a risk that the proposed industrial activity may have a significant adverse impact in a transboundary context, in particular, on a shared resource. Moreover, due diligence, and the duty of vigilance and prevention which it implies, would not be considered to have been exercised, if a party planning works liable to affect the régime of the river or the quality of its waters did not undertake an environmental impact assessment on the potential effects of such works.
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> …Consequently, it is the view of the Court that it is for each State to determine in its domestic legislation or in the authorization process for the project, the specific content of the environmental impact assessment required in each case, having regard to the nature and magnitude of the proposed development and its likely adverse impact on the environment as well as to the need to exercise due diligence in conducting such an assessment. The Court also considers that an environmental impact assessment must be conducted prior to the implementation of a project. Moreover, once operations have started and, where necessary, throughout the life

of the project, continuous monitoring of its effects on the environment shall be undertaken.[39]

The basic structure of the customary obligation as described by the ICJ contains several key elements. First, the obligation arises as a 'practice' by which the broader obligation of due diligence to prevent significant transboundary harm is implemented. Second, the obligation applies to harm that may have 'a significant adverse impact in a transboundary context.' And third, international law leaves it to States to determine the specific content of the EIA required in each case.

In speaking to the content of an EIA, the ICJ means to allow States the discretion to determine for themselves the particular requirements of the assessment study itself, such as the methodologies employed; and the details respecting the procedural requirements, that is, who actually prepares the assessment, and how the information is released to the public. The content of an EIA may be further elaborated in domestic EIA legislation, or as between States, in treaties. In a decision issued subsequent to the *Pulp Mills* case, the International Tribunal of the Law of the Sea, affirmed that rule's customary status and extended the obligation to areas beyond national jurisdiction. In effect, the obligation mirrors the requirements of due diligence, which apply to both transboundary harm and to harm to the global commons.[40]

Treaty provisions imposing obligations to perform EIAs maintain this basic structure. For example, article 206 of the United Nations Convention on the Law of the Sea contains a qualified ('as far as practicable') obligation to assess planned activities that 'may cause substantial pollution of or significant and harmful changes to the marine environment.'[41] This provision also requires States to communicate the results of the assessment to other States through a 'competent international organization,' although the Convention does not specifically identify those organizations.[42] Regional seas conventions also contain broadly worded commitments to perform EIAs for activities that fall within the convention's jurisdiction.[43]

The Convention on Biological Diversity (CBD) also contains a qualified ('as far as possible and as appropriate') EIA obligation that requires States to 'introduce appropriate procedures requiring environmental impact assessment of its proposed projects that are likely to have significant adverse effects on biological diversity.'[44] The CBD is arguably more expansive than the customary obligation in several ways. First, the obligation is not restricted to transboundary harm or harm to the global commons, but rather applies to any activity that may have significant adverse effects on biological diversity. This extension is in keeping with the characterization of biological diversity as

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[39] *Pulp Mills*, supra note 5 at para 204-5.
[40] ITLOS, *Advisory Opinion on the Responsibilities and Obligations of States Sponsoring Persons and Entities with Respect to Activities in the Area*, February 2011, para. 145, 148.
[41] United Nations Convention on the Law of the Sea (Montego Bay, December 10, 1982), 21 ILM 1261 (1982), entered into force November 16, 1984, at Article 206
[42] Ibid, at Article 205
[43] See: Craik 2008, supra note 5.
[44] Convention on Biological Diversity, 1760 UNTS 79; 31 ILM 818 (1992), entered into force 1993, at Article 14(1)(a).

an issue of 'common concern.'[45] Second, the obligation extends beyond project-based activities to include 'programmes and policies.' In both instances, though, the qualified nature of the EIA obligation under the CBD suggests an intention to avoid hard legal requirements.[46] Nevertheless, the provision does indicate the international community's legal interest in activities that impact biodiversity regardless of its location, and that a State owes an obligation to cooperate, through assessment, notification and consultation, with other States.

Article 4(1)(f) of the United Nations Framework Convention on Climate Change (UNFCCC) also references environmental assessment, indicating that EIAs ought to be employed as an 'appropriate method' to minimize the adverse impacts of 'projects or measures undertaken…to mitigate or adapt to climate change.' While geoengineering is understood as an activity that is distinct from mitigation and adaptation, this provision identifies EIA as an important mechanism to address activities that are undertaken in response to climate concerns. This provision is again qualified and effectively leaves it to individual States to determine how best to address environmental impacts associated with climate-related activities. Like biodiversity, the international community's interest is defined as one of 'common concern.'[47]

The Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention), signed in 1991, and negotiated under the auspices of the UN Economic Commission for Europe, provides a much more elaborated set of requirements in relation to transboundary impacts, which are limited in the treaty to significant environmental impacts in one State that arise from activities undertaken under the jurisdiction of another state, but which excludes impacts to areas beyond national jurisdiction. The requirements include procedures for notification and consultation with affected states and members of the public in affected states, greater detail on the required content of an EIA, and provisions providing for the resolution of disputes regarding whether an EIA ought to have been carried out.[48] The Espoo Convention has a non-binding provision respecting the assessment of programmes and policies. The assessment of policies and programmes is also the subject of the more detailed Protocol on Strategic Environment Assessment, which entered into force in 2010, but the signatories are limited to European states.[49]

The Protocol on Environmental Protection to the Antarctic Treaty (Antarctic Protocol) also contains detailed EIA requirements for all activities within the Antarctic

[45] Ibid, at Preamble

[46] Neil Craik, 'Principle 17: Environmental Impact Assessment' in Jorge Vinuales (ed,) *The Rio Declaration on Environment and Development: A Commentary,* Oxford Commentaries on International Law (Oxford, U.K.: Oxford University Press, 2015) 451

[47] United Nations Framework Convention on Climate Change (UNFCCC), New York, May 9, 1992, 31 ILM 851 (1992), entered into force March 21, 1994, at Preamble.

[48] Convention on Environmental Impact Assessment in a Transboundary Context (Espoo, Finland, February 25, 1991), 30 ILM 802, entered into force January 14, 1998. (While a UNECE treaty, the Espoo Convention is open to accession by other UN members, who are not members of the UNECE, see Decision II/14, "Amendment to the Espoo Convention", adopted February 27, 2001, in force August 26, 2014.)

[49] Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context, adopted May 21, 2003, not in force (SEA Protocol).

Treaty area that have at least a 'minor or transitory impact.'[50] There are several innovative features of the Antarctic Protocol that are salient to this discussion. The threshold requirement for triggering an EIA is lower than the usual 'significance' threshold. The justification for a lower threshold is that the fragile Antarctic environment presents greater risks for environmental harm and therefore justifies a more precautionary approach. The Antarctic Protocol also provides a clear institutional mechanism for notification and consultation of other Contracting States (to the Antarctic Protocol) through the use of the Committee on Environmental Protection.[51]

A final source of international EIA obligations is geoengineering-specific instruments that include EIA requirements. At present, the only such instrument is the 'Oceans Assessment Framework'[52] adopted under the Protocol to the (London) Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. The Oceans Assessment Framework was adopted as an Annex, in connection with a 2013 amendment to the London Protocol (not yet in force) regulating 'marine geoengineering activities' and ocean fertilization in particular. Compliance with the framework is a precondition to the issuance of a required permit and because the only ocean fertilization experiments allowable are those 'constituting legitimate scientific research,' the framework provides the basic regulatory mechanism for ocean fertilization field experiments. There is no minimum threshold for the application of the framework, and as a result the framework will apply to all ocean fertilization activities, even where the activity is not anticipated to have a likelihood of significance impact. The framework includes very detailed requirements for the content of the assessment, including information respecting the scientific merit and researcher's intentions; elements that go to the assessment of the legitimacy of the scientific research, as opposed to its environmental affects.[53]

4. Applying EIA to Geoengineering Experiments

Because international EIA obligations are not a set of unified rules of general application, it is necessary to look carefully at the specific characteristics of the geoengineering experiments themselves, which also differ substantially, such as the geographic location of the experiment, the environmental elements that are potentially impacted and the degree of risk, in order to determine how EIA obligations may apply. As the rules themselves structure a variety of questions throughout the EIA process, this section disaggregates the application of field experiments across several elements of the EIA: the types of activities to which EIA commitments will apply; the scope of the issues addressed through the EIA; the requirements for notice and consultation; and the relationship of the EIA to any final decision to allow an activity to proceed.

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[50] Protocol on Environmental Protection to the Antarctic Treaty, 4 October 1991, 30 ILM 1455 (1991) (Antarctic Protocol), at Article 8(1)
[51] Ibid.
[52] Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention), December 29, 1972, entered into force August 30, 1975, 26 UST 2403, 11 ILM 1294 (1972), Annex 4: Assessment Framework for Scientific Researching involving Ocean Fertilization (Oceans Assessment Framework).
[53] Ibid, at Article 8.

4.1. Types of Activities subject to EIA

EIA processes will typically apply to field experiments, so long as they meet the triggering threshold. Field experiments will be considered a form of 'project' or 'activity,' which tend to be restricted to physical undertakings. Laboratory experiments and modeling activities would generally not fall into the scope of covered activities due to their encapsulated or non-physical nature. While international rules do provide for special rules in order to ensure a measure of non-interference for scientific experiments, these measures do not exempt experiments from the scope of activities subject to assessment. This is evident in the Antarctic regime, where the permissible activities within the Antarctic are focused on research, but nonetheless maintains a robust system of EIA. Similarly, under United Nations Convention on the Law of the Sea (UNCLOS), the provision preserving the freedom of scientific research in the high seas does not operate to exempt experimentation from the assessment obligations under Article 206. EIA processes are also commonly applied to scientific experiments in domestic EIA systems.[54] Research programmes or broader policies on geoengineering research are excluded from international EIA obligations, which apply in very restricted circumstances to 'policies, plans and programs.[55]

A central determinant of whether an international obligation will be triggered is the location of the activity and any projected impact. As discussed above, the obligations in international law have focused on transboundary harm and harm to global commons, leaving purely domestic impacts to national laws. Consequently, activities carried out in the marine environment, such as ocean fertilization experiments or ocean surface albedo modification, will attract international scrutiny. Even in cases where the activity occurs within a State's exclusive economic zone or territorial sea, the requirements of the London Protocol and Article 206 of the UNCLOS would be applicable. Marine-based cloud albedo experiments are less likely to be caught under the EIA requirements of the law of the sea because they are not contemplated to involve the release of material directly into the marine environment, but rather would deposit material into the atmosphere, albeit from a location in the ocean, although it should be noted that UNCLOS does address, through Article 212, pollution deposited from or through the atmosphere.[56] Depositions from precipitate that exceeded the "substantial pollution" requirement of Article 206 would trigger EIA obligations.

Atmospheric tests, whether carried out over land or over oceans, present a more complicated case. The air space above a State's physical territory is considered to be part of that State's territory. However, in recognition of the shared reliance on the atmospheric resources, issues such as climate change and ozone depletion have been identified as issues of 'common concern.'[57] Very clearly, an atmospheric field test that would have direct or indirect physical impacts on another State's territory would engage

[54] National Environmental Policy Act (NEPA), 42 USC 4321-4370

[55] Protocol on Strategic Environmental Assessment (Kiev), 21 May 2003, in force 11 July 2010, UN Doc. ECE/MP.EIA/2003/2.

[56] UNCLOS, *supra* n.41, Art. 212.

[57] Jutta Brunnée, 'Common Areas, Common Heritage and Common Concern' in Daniel Bodansky, Jutta Brunnée and Ellen Hey (eds), *The Oxford Handbook of International Environmental Law* (New York: Oxford University Press, 2007) 550; ILC 2001, supra note 6.

international obligations. Direct impacts may occur if the released materials are deposited through precipitate, which has some harmful impact. Indirect impacts may arise where the experiment triggers a physical change in atmospheric properties that can be shown to impact another State's environment, for example more or less rainfall or changes to the amount of sunlight. These types of impacts are not contemplated in the case of small-scale geoengineering experiments, but presumably any State potentially impacted by increased (or decreased) cloud cover or the presence of stratospheric aerosols over their territory would demand evidence of the potential impacts in order to assess their acceptability.

In cases where the risks are to atmospheric properties themselves, the rights of other States are ambiguous.[58] Issues of common concern do not trigger specific rights in individual States, but do signal the broader interest of the international community in those issues. This does not equate, at least at the current time, to an *erga omnes* right of any State to prevent risks to the environment; a point clearly illustrated by the inability of States to intervene individually in another State's ozone depleting or greenhouse gas emitting activities. But risks to the atmosphere would trigger a collective right, exercisable through a competent international organization, to safeguard the atmosphere against environmental risks.

The non-binding resolutions issued by the Conference of the Parties to the CBD limiting the rights of States and private actors to engage in ocean fertilization activities premised on the risks of those activities to marine biodiversity should be understood as an exercise of collective rights in furtherance of addressing an issue of common concern; in this case marine biodiversity.

Even where it can be shown that the activity is impacting an area or issue that is subject to international legal competence, there remains a further threshold requirement for the impact in question to present a 'significant', (or "substantial" in the case of UNCLOS), risk of harm. The rationale for having a minimum level of harm potentially present before imposing assessment obligations is that a vast number of activities will have measurable, but not serious impacts, and the imposition on the affected State or international community must be balanced against the right of the State carrying out the activity to be able to do so without unreasonable interference. The structure of international obligations respecting transboundary harm are closely aligned with the maxim *sic utere tuo ut alienum non laedas*, which prevents unreasonable interferences. In other words, State sovereignty, which operates reciprocally, requires that states accept that other States may impose small impacts on them (and they, in turn may impose small impacts on other States).[59]

The term 'significant' in this context has been defined as 'something more than "detectable", but need not be at the level of "serious" or "substantial"'.[60] International law does recognize that this determination may require a risk assessment approach in

[58] ILC 2001, ibid; Michael Bowman, 'Environmental Protection and the concept of the common concern of mankind' in Malgosia Fitzmaurice, David Ong and Panos Merkouris (eds.) *Research Handbook on International Environmental Law* (Cheltenhan, U.K.: Edward Elgar, 2010) 493.

[59] *Trail Smelter Arbitration (United States v Canada)*, 3 RIAA 1905, reprinted in (1939) 33 AJIL 182 (decision dated April 16, 1938) and in (1941) 35 AJIL 684 (final decision dated March 11, 1941).

[60] ILC 2001, supra note 6, at Article 2, Commentary 4.

which account is taken of both the degree of potential harm and the probability of its occurrence. Thus, activities that may result in a low probability of harm with more serious consequences may meet the threshold requirement.[61] The precautionary principle has not operated to impose a lower threshold for conducting an EIA, but it does suggest that evidence of potential harm need not be demonstrated with certainty. As a consequence, the determination of significance will be a function of the magnitude of the harm, the probability of its occurrence and the degree of uncertainty in determining both, with higher degrees of uncertainty increasing the level of risk and thus militating in favour of conducting an EIA. The risk assessment approach to determining the threshold will be relevant in the experimental context where the nature of the activity involves gaining scientific knowledge to resolve uncertainties.

As activities tend to be assessed individually, a determination of whether a field experiment poses a risk of significant harm will be made on a case-by-case basis. However, the requirement that harm be both transboundary and significant creates a high threshold and it is reasonably likely that small-scale field experiments would not trigger international assessment requirements, in the absence of specialized rules. Technology related tests seem especially unlikely to engage international legal interests, particularly where they are carried out within a state's territory. SRM process studies are also unlikely to trigger international EIA requirements given their small scale and short duration. Even in cases where the experiment is proposed to be carried out in areas beyond national jurisdiction, there will be a need to show that the significance threshold has been exceeded. As experiments scale-up, one would expect stronger international supervision, but even as the potential for transboundary impacts due to the larger size of the experiment increases, the threshold for some potential significant transboundary harm is still required to be met.

In assessing harm, the focus has been on physical risks, but includes both direct and indirect impacts. For example, the definition of impact under the Espoo Convention includes effects on cultural heritage and socio-economic conditions, but only insofar as they result from impacts to the physical environment.[62] Other likely sources of EIA rules, such as the CBD and UNCLOS, also focus on physical aspects of harm. EIA obligations cannot be triggered solely on the basis of the social and ethical concerns that geoengineering raises. (The question of the scope of international EIA obligations is considered in greater detail below.)

One of the challenges inherent to EIA is its circularity: a determination of 'significant harm' requires an assessment of sorts, but an obligation to assess is only triggered where the threshold is exceeded. Domestic and international approaches to EIA have addressed this difficulty by identifying classes of activities that are automatically subject to EIA or by requiring an initial screening assessment of a very wide scope of activities with the intention of subjecting those activities that meet the threshold to a full EIA process. The approach taken under the U.S. federal National Environmental Policy Act (NEPA) is illustrative. The regulations to NEPA that govern the application of EIA to federally funded research exempt most scientific research from EIA requirements, but

[61] Ibid.
[62] Espoo Convention, supra note 49, Article 1.

the regulations specifically include 'any project that provides for the testing and release of biological-control agents for purposes of ecosystem manipulation and assessment of short- and long-term effects of major ecosystem perturbation.'[63] In effect, the approach recognizes the potential risk of any perturbative deposition and requires an initial environmental assessment. The amendments to the London Protocol, whereby any activity that meets the definition of marine geoengineering is subject to assessment, can similarly be understood as a predetermination by the Parties that marine geoengineering experiments at any scale raise sufficient concern to warrant assessment.

Following the rules under the London Protocol, one possible approach would be the development of a broad obligation to ensure that geoengineering field experiments, or some subset, are subject to at least an initial environmental assessment; in effect, a requirement that the proponent, at a minimum, inform themselves sufficiently in order to determine whether there is some likelihood of significant harm arising from the activity. This approach would require new rules, but is bolstered by the presence of an overarching duty to cooperate in international law that requires States to exchange information and consult one another in respect of the activity in question. For example, the International Law Commission's (ILC) approach is to require a source State to provide reasons for a decision of no significant transboundary impact at the request of another State, so long as the potentially affected State has a 'serious and substantiated' belief that significant transboundary harm may arise.[64] An initial environmental assessment provides the basis by which a State can satisfy its duty to cooperate. Given the level of controversy around geoengineering experimentation, it is likely that States would be under pressure to justify any finding of no significant impact.

While such an approach may be possible, it is important not to underestimate the difficulties in defining what counts as a geoengineering experiment, especially in light of the multiple intentions that may be associated with certain field experiments. In addition, unlike ocean fertilization, where the London Protocol provided a clear candidate to regulate an activity that involved releases into the marine environment, the atmospheric context for SRM experimentation has no obvious candidate. Given that there is some potential for stratospheric aerosol injections to effect ozone levels, the ozone regime is a possibility, but neither the Vienna Convention nor the Montréal Protocol contain an EIA obligation.[65] As noted, the UNFCCC has a weak EIA commitment, but has a regulatory focus on GHG emissions, rather than atmospheric impacts more generally.

A final issue that arises in connection with the threshold requirement is whether international law provides any support for the imposition of a lower threshold requirement than 'significance' for geoengineering field experiments. The approach under the London Protocol suggests that a more precautionary threshold might be welcomed, in light of the concerns surrounding geoengineering field experiments. The

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[63] *Code of Federal Regulations*, Title 45, Volume 3, 45CFR640 (1996) 'Chapter 5 – National Science Foundation, Part 640 – Compliance with the National Environmental Policy Act', s 640.3(b)(5) (NSF Regulations).

[64] ILC Draft Articles, *supra* note 6, Art. 11, Commentary 3.

[65] Vienna Convention for the Protection of the Ozone Layer, 22 March 1985, in force 22 September 1988, (1990) UKTS 1, reprinted 26 ILM 1529 (1987); Montreal Protocol on Substances that Deplete the Ozone Layer, in force 1 January 1989, UKTS 19 (1990), reprinted 26 ILM (1987) 1550.

other salient precedent here is the Antarctic Protocol, which uses the lower threshold of 'minor or transitory impact.'[66] The lower threshold is justified in the Antarctic context by the fragile nature of the Antarctic environment, and the collective goal of maintaining the Antarctic environment as a special conservation area.

The justification for a more stringent threshold for geoengineering field experiments would relate to their controversial nature. A lower threshold to trigger EIAs would ensure that field experiments are subject to greater public scrutiny, which would contribute to the broader goals of research transparency and participatory decision-making that have been identified as key geoengineering research governance objectives.[67]

Here too, specialized rules would necessitate some tricky line drawing. Technology development activities raise similar social and ethical concerns respecting the facilitation of the development of geoengineering technologies, but do not involve physical interventions that pose risks to any element of the international environment, including issues of common concern, as currently accepted. One approach might be to limit the application of lower threshold to any perturbative experiment, but this may raise questions respecting why depositions in an experimental context are subject to greater scrutiny than other planned releases, such as ship and plane exhausts.

4.2. The Scope of Assessment

A second set of questions that arise in relation to field experiments is the contents of the assessment itself. International EIA rules do not tightly prescribe the contents of an EIA, preferring instead to leave the scope of assessment to state discretion. The baseline requirements to satisfy the requirements of due diligence would include the identification of environmental impacts, a determination of the risk that the impacts pose, publication of the results, and usually some opportunity for public consultation. Cumulative impacts, which may be relevant in the case of multiple or staged experiments, should be identified. Monitoring, which was identified by the ICJ in the *Pulp Mills* case as being an integral part of EIA, and more broadly, as necessary to fulfill a state's due diligence obligations, would be an expected part of any field experiment assessment process, which given the research goals in the geoengineering context, one would expect as part of any field experiment proposal.[68]

A more uncertain element would be the requirement for the proponent to identify and assess alternatives to the proposal. Assessing alternatives is considered by many as central to the EIA process,[69] since alternatives analysis gives decision-makers and the public a range of options to compare, including the option of not proceeding with the activity. Despite this, alternatives assessment is not a requirement under most international EIA obligations, and whether alternatives are included will be driven by the requirements of the domestic system.[70]

[66] Antarctic Protocol, supra note 51, Article 8(1)(a).
[67] Rayner et al, supra note 1.
[68] Oceans Assessment Framework, supra note 52.
[69] For example, the *NEPA Regulations*, 40 CFR § 1502.14 (describing alternatives as the heart of the environmental impact statement).
[70] E.g.: Espoo Convention, supra note 48, Appendix II (indicating alternatives should be described, "where appropriate").

There are good reasons for requiring those conducting geoengineering experiments to consider a range of alternatives, including the alternative of not proceeding. Alternatives are particularly important in areas where the standards of safe behavior are unclear. By identifying other courses of potential action, the relative value of different approaches can be considered. The 'no action' alternative requires the proponent to justify the activity itself. While there may be a strong presumption in favour of scientific research, the contested nature of geoengineering research may require researchers to consider and justify the need for the proposed research. Other alternatives that could usefully be explored would include whether the experiment might be undertaken in a less risky manner, such as by taking advantage of natural or man-made analogues or through enhanced modeling.[71] The requirement to examine alternatives is implemented in the Oceans Assessment Framework through a requirement to include a 'clear justification for why the expected outcomes cannot reasonably be achieved by other methods,' which in effect requires the proponent to demonstrate that there are not alternative means of acquiring the same knowledge.[72]

The more vexing issue in relation to the contents of the EIA is the extent to which social and ethical issues can and ought to be considered as part of the EIA. As noted above, social impacts as a basis to trigger an assessment have traditionally fallen outside the bounds of the international EIA obligation, which flows out of a State's due diligence obligations, and as such is concerned with the physical consequences of planned activities. Social impacts are considered, but only insofar as they flow from the physical impacts of the activity. The concerns most commonly identified in relation to geoengineering field experiments are not tied to the direct impacts of the experiment, but to the implications of future technological development. The remoteness of these concerns from the research activity is not necessarily (or at all) dependent on the stage of experimentation. The concerns respecting moral hazard, technological lock-in and governability, including the concern with SRM deployment that once started it may be necessary to continue activities for very long periods of time to avoid a sudden shift in average global temperatures,[73]arise from the prospects of technological development even in its early stages.

However, limiting assessment to physical impacts would avoid addressing some of the central concerns that decision-makers and the public have in relation to geoengineering field research. This in turn has the potential to undermine the legitimation function of EIA, as the decision to undertake experimentation may be understood as being based on a narrow, technocratic basis, and fails to account for the broader set of concerns being voiced about geoengineering technology development. It is possible to separate the question of what triggers an EIA from the scope of the EIA itself, which is often determined with public input. The closing down of certain aspects of the public discourse around geoengineering may further weaken claims that the research is being

[71] See: Oceans Assessment Framework, supra note 52, at Article 8.
[72] Ibid.
[73] This concern is sometimes referred to as the "termination effect", see Committee on Geoengineering Climate, *supra* n.23, at 48-54.

undertaken in the public good.[74] On the other hand, these concerns transcend a particular experiment and their impacts are not likely to be dependent upon the particulars of the experiment. Consider, for example, the approach indicated in under the National Science Foundation (NSF) (U.S.) EIA (NEPA) regulations:

> Most NSF awards support individual scientific research projects and are not "major Federal actions significantly affecting the quality of the human environment" except in the sense that the long term effect of the accumulation of human knowledge is likely to affect the quality of the human environment. However, such long term effects are basically speculative and unknowable in advance; thus they normally do not provide a sufficient basis for classifying research as subject to NEPA (See 40 CFR 1508.8) and are categorically excluded from an environmental assessment.[75]

The suggestion here is that consideration of the long-term implications of technology development or knowledge accumulation is ill-suited to EIA methodologies that concern themselves with predicting and assessing calculable risks.

The role of addressing the larger social and ethical issues related to emerging technologies has fallen to technology assessments, which instead of looking at particular activities consider the broader implications of the development of a particular technology.[76] Technology assessment processes may include other forms of public deliberation, such as citizen juries or polling. Technology assessment is often ad hoc, in the sense that it does not necessarily occur within a defined regulatory framework and is not at all present in international requirements. A further potential concern is whether requiring some assessment of issues that transcends the facts of a particular proposal places an unfair burden individual proponents.

There is some potential for strategic environmental assessment processes to address issues that transcend individual experiments. The use of Strategic Environmental Assessment (SEA) presupposes that a State undertakes to develop a policy or program on geoengineering experimentation, such as a defined research program or policy. For example, the identification of a specific amount of research funded dedicated to SRM or CDR research activities, or the identification of geoengineering as a research priority in government science policy. As noted the international commitments respecting SEA are currently restricted to Europe, and SEA practices remain under-developed in national systems outside Europe.[77] The advantage of SEA is that it seeks to address questions at

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[74] Andy Stirling, '"Opening up" and "closing down" power, participation, and pluralism in the social appraisal of technology', 33(2) *Science, Technology & Human Values* 262 (2008).; Rob Bellamy, 'Beyond Climate Control: 'Opening up' Propositions for Geoengineering Governance', Climate Geoengineering Governance Working Paper Series, No.011, published 27 May 2014, online http://www.geoengineering-governance-research.org/perch/resources/workingpaper11bellamybeyondclimatecontrol.pdf.
[75] NEPA, supra note 54, NSF Regulations, supra note 63, at s. 640.3(b)
[76] Albert Lin, 'Technology Assessment 2.0: Revamping Our Approach to Emerging Technologies', 76 *Brooklyn. Law Review* 1309 (2010).
[77] Wood, supra note 3.

an earlier stage in the policy process, where there may be greater scope for considering alternatives to planned activities. Like EIA, the focus remains on physical environmental risks and SEA processes would need to be expanded to address the social and ethical concerns that are often the focus in geoengineering debates.

The Ocean Assessment Framework provides a helpful illustration of an approach that might find broader traction in international EIA instruments. The controlling test for permitting marine geoengineering experiments is that the activity must constitute 'legitimate scientific research.' The Oceans Assessment Framework operationalizes this requirement through a consideration of environmental impacts, but also by requiring that the research itself have certain attributes, such as having an appropriate methodology, being free from economic interests, being subject to peer review and public disclosure of the results and properly financed. The approach requires the proponent to disclose a wider scope of information related to the proponent's intentions and capabilities, but also widens the scope of the assessment itself as it invites a critical consideration of the legitimacy of the proponent's research, particularly in relation to whether the experiment is being carried out to further public, not private goals, and the extent to which it will contribute to public knowledge acquisition. These considerations are tied to the individual experiment and not to the broader justification of whether ocean fertilization experimentation as a class of experiments is socially justified, a determination that transcends the particulars of the experiment at hand. However, one could fairly question whether the requirement to consider whether the activity constitutes 'legitimate scientific research' might also include consideration of whether the research is in the public interest more broadly conceived.

Another salient example is the stage gate process used in relation to the Stratospheric Particle Injection for Climate Engineering (SPICE) proposal, which combined an assessment of the physical risks of the experiment with a program of public engagement that included a more open-ended dialogue intended to have stakeholders and the researchers consider the social and ethical implications of research being undertaken.[78] This approach moves considerably further away from traditional EIA, but does demonstrate how these broad concerns can be considered in light of quite specific proposals.

4.3. Notice and Consultation

The requirements in respect to notification and consultation of field experiments follow the same structure of the broader duty to conduct an EIA, and are, as a consequence, only engaged where the threshold requirement of significant transboundary harm is met. In the case of transboundary harm, the right to notice and consultation extends to the affected State, and potentially to the public within the affected State. The right to notice and consultation does not involve a right to consent, but rather to receive relevant information, usually the EIA report itself, and to be able to provide comments. Any information received, and concerns raised, in the consultation process should be accounted for by the proponent in a final decision on the experiment.

[78] Stilgoe et al, supra note 32.

Notice and consultation in relation to commons areas or in relation to issues of common concern will need to be mediated by an international organization. For example, under the UNCLOS, Article 205, impact assessments are to be provided to 'competent international organizations.' The Oceans Assessment framework refers to notifying 'relevant regional intergovernmental agreements and arrangements,' which would most likely be regional seas commissions, or possibly the Secretariat of the London Protocol.[79] There are no clear candidates for notification of atmospheric experiments. None of the existing multi-lateral treaties addressing aspects of atmospheric degradation provide a mechanism or forum that clearly contemplates a notification function.[80] It has been argued that the designation of the protection of atmosphere as an issue of common concern creates rights in other States of an *erga omnes* nature, a proposition that could give raise to rights of notice and consultation to individual States. The current status of the atmosphere is uncertain, and the presence of such rights is not supported strongly by state practice. A more modest approach is to acknowledge the interest of the international community as a collective, acting through international or regional bodies to address risks in relation to issues of common concern.

The issue of notification and consultation is not restricted to States, and there is an emerging human right to notice of environmental risks that is held by individuals. The principle of public participation, as distinct from State to State notification, is found in Principle 10 of the Rio Declaration,[81] and is included as an obligation in relation to EIA under the Espoo Convention, and the Convention on Biological Diversity.[82] The right to participate in environmental decision-making, including EIA processes, is also included in the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (the Aarhus Convention), negotiated under the auspices of the United Nations Economic Commission for Europe (UNECE), but with only European states as parties at the present time.[83] The obligation of notification and consultation of the public is owed to those members of the public who are potentially affected by the activity, typically at the threshold of 'significance.' The Aarhus Convention, however, indicates that the 'public concerned' would include both those individuals who are affected by an activity, but also those who have an 'interest' in the decision.[84]

Restricting public participation to those 'affected' by geoengineering experiments, may limit participation to those individuals who are at risk from the physical effects of an experiment. At small-scales, where the projected physical impacts are negligible, the right to notice may be very limited. At the other end of the scale, a

[79] See Craik (2008) *supra* note 7 at 145.
[80] Convention on Long Range Transboundary Air Pollution, Geneva, November 13, 1979, 18 ILM 1442, entered into force March 16, 1983; Vienna Convention for the Protection of the Ozone Layer, 22 March 1985, in force 22 September 1988, (1990) UKTS 1, reprinted 26 ILM 1529 (1987); UNFCCC, supra note 47.
[81] 1992 Rio Declaration on Environment and Development (Rio Declaration), 14 June 1992, Rio de Janeiro, Brazil, UN Doc A/CONF. 151/26 (vol. 1)/31 ILM 874 (1992), Principle 10.
[82] Espoo Convention, supra note 48.
[83] Convention on Access to Information, Public Participation in Decision Making and Access to Justice in Environmental Matters, Aarhus, Denmark, June 25, 1998, 38 ILM 517, entered into force October 30, 2001.
[84] Ibid, at Article 2(5)

climate response test may implicate regional or any global human rights, requiring some collective mechanism. In the event that the scope of assessment includes social and ethical questions surrounding the development of geoengineering technology, the range of persons with an interest is spatially (and temporally) unbounded.

As a practical matter, given the range of potential State and non-State interests that geoengineering engages, the approach to notification may be to ensure that any experiment subject to EIA is subject to broad publicity requirements without differentiating the treatment of domestic and non-domestic interests. Such an approach would be consistent with the principle of non-discrimination, and could be implemented through domestic EIA practices, such as publication of notice and details of any assessment on publicly accessible electronic registries, including identification of the experiment as having implication for geoengineering.

4.4. Final Decision

The relationship between the EIA and any final decision respecting whether a field experiment is approved will vary depending on the regulatory requirements of the decision-making process. EIAs inform final decisions, but do not often dictate outcomes. At a minimum, international requirements indicate that the decision should provide reasons and that those reasons should account for the findings in the EIA and be responsive to the concerns raised in any processes of public participation.[85] EIAs, while procedural in their orientation, are evaluative processes, and as such require decision-makers to justify decisions in light of accepted norms. The harm principle provides one clear substantive criterion, such that where the EIA discloses a risk of significant environmental harm to another State's territory or to the global commons, the source State must refrain from the activity in the absence of clear consent. The difficulty in practice is that the term "significant harm" has such an open textured meaning, its controlling effect is minimized except in the clearest of cases.[86]

In the event that the scope of assessment is widened to include the broader issues, one might expect to see proponents of geoengineering experiments justifying their actions in light of a wider normative framing. As discussed above, the requirement under the London Protocol to allow only activities that constitute 'legitimate scientific research' is one attempt to project normative considerations that extend beyond the confines of the harm principle.

5. Conclusion

In considering whether geoengineering field experiments require the development of special international EIA rules much turns on what we expect from EIA as a governance mechanism. To take the most immediate scenario, small-scale technology development and process studies, where there is considerable likelihood that the physical impacts on the environment will be neither significant nor will they extend beyond national boundaries. Under these circumstances, international law has little to say. Or perhaps

[85] UNEP Goals and Principles of Environmental Impact Assessment, UNEP Res. GC14/25, 14th Sess (1987), endorsed by GA Res 42/184, UN GAOR 42nd Sess, UN Doc A/Res/42/184 (1987), at Article 9; Espoo Convention, supra note 48, at Article 6.

[86] On the relationship between EIA and the harm principle, see Craik, *supra* n.46.

more accurately, international law tells us that such matters are the province of individual States. Yet, there may be good reasons for not abandoning the oversight of even these small-scale activities at the international level.

At a minimum, there are high expectations that such activities be subject to assessment and that the assessment is undertaken in full view. These concerns are not confined to the State where the activity occurs because the implications of the experiment are necessarily international in scope. For example, a series of unassessed and unpublicized research activities could have broadly detrimental effect on the trust that the public, both within and outside the State where the experiment occurs, has in this research area. If one modest goal of EIA is to ensure that when experiments are undertaken that they are seen as being legitimate, then requiring minimum standards for EIA is a sound policy objective.

The current approach of international law, which focuses almost exclusively on physical risks, does not recognize the international dimensions of geoengineering research. The concept of common concern comes close to capturing the nature of the international interest that is rooted in a collective sense of responsibility, but as a matter of positive international law does not extend international EIA commitments into domestic activities. This is less of a problem for ocean fertilization experiments because international law more clearly recognizes the international dimensions of protecting the marine environment. For SRM research, the ambiguous legal status of the atmosphere creates a gap between the international communities concerns over responsible SRM experimentation and international regulatory authority.

It is beyond the scope of this paper to assess the degree to which the international community might be willing to accept a extension of international law to impose EIA requirements for activities that, while of broad global concern, do not have physical impacts beyond the source state. It should, however, be recognized that this would be a significant alteration in the structure of international environmental law, and, in particular, would impinge on the sovereignty of States to undertake activities within their territory without interference.[87]

One potential approach would be the development of soft law commitments that create normative expectations that States will assess SRM field experiments, (the London Protocol requirements adequately address ocean fertilization experiments, while other CDR technologies do not at this time pose the same levels of concern), and ensure that the results of the assessment are publicized. It has been suggested that scientists themselves could develop such rules through codes of conduct, but there are also examples of EIA guidance documents that have been developed under the auspices of treaty bodies and adopted in non-binding resolutions through the Conference of the Parties.[88]

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[87] Principle 2, Rio Declaration, *supra* note 5.

[88] Guidelines for Incorporating Biodiversity-Related Issues into Environmental Impact Assessment Legislation and/or Processes and in Strategic Environmental Assessment, Report of the Sixth Meeting of the Conference of the Parties to the Convention on Biological Diversity, UN Doc UNEP /CBD/COP/6/7; 1997 Guidelines for Environmental Impact Assessment in the Arctic, adopted by the Arctic Council in the 1997 Alta Declaration on the Protection of the Arctic Environmental Protection Strategy.

The contents of an EIA for geoengineering field experiments also requires further consideration. EIAs mediate the relationship between science, politics and law by ensuring that decision-makers consider the approval of planned activities in light of both scientific understanding of their impacts and substantive norms respecting environmental well-being and sustainability. Extending the scope of review to encompass a wider set of concerns around the implications of geoengineering may recognize the uncertain boundary between science and policy - a form of post-normal assessment.

EIA presents an opportunity for the proponents and other stakeholders to examine their relationship with emerging technologies in the context of a specific experiment. This may have some benefits in relation to those issues that can be profitably examined in relation to the specifics of a concrete proposal. As discussed, the Oceans Assessment Framework's emphasis on 'legitimate scientific research' provides one model of an expanded assessment. The stage gate assessment approach undertaken in relation to the SPICE experiment provides another example, albeit one that moves the process away from something that is recognizably an EIA. The tension here is that a failure to include the issues that actually matter to the public in relation to an experiment may erode the trust-building function of EIA. On the other hand, allowing EIAs to be too open-ended shifts EIA processes into terrain that requires specialized expertise in methods of technology assessment, including the design of public deliberation mechanisms,and may place significant burdens on individual researchers. A final avenue worthy of consideration in this regard is structuring more formal relationships between technology assessment and EIA, perhaps through SEA or tiered assessment processes.[89]

One of the unfolding debates surrounding geoengineering research is whether research in this field should only be undertaken once clear governance mechanisms are in place.[90] Parker has argued that waiting for comprehensive governance before experimentation is both unfeasible and undesirable, but recognizes that governance is not a binary proposition. EIA will play an important governance role by better ensuring that decisions taken around geoengineering field experiments are subject to processes of scientific, normative and public justification.

[89] Dilling and Hauser, supra note 30.
[90] Andy Parker, 'Governing solar geoengineering research as it leaves the laboratory' 372 *Phil. Trans. R. Soc. A* 20140173 (2014); Clive Hamilton, 'Geoengineering: governance before research please', 22 September 2013, online at http://clivehamilton.com/geoengineering-governance-before-research-please/