ENGINEERING A SOLUTION TO CLIMATE CHANGE: SUGGESTIONS FOR AN INTERNATIONAL TREATY REGIME GOVERNING GEOENGINEERING

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TABLE OF CONTENTS

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I. INTRODUCTION

Global climate change threatens to seriously and irreversibly impact Earth's climate in ways that scientists are just beginning to understand.[1] The effects of climate change are likely to have devastating consequences for humans and the ecosystems upon which they depend.[2] As a global problem, climate change requires an international response.[3] However, economic disincentives, combined with the temporal and spatial complexities inherent to climate change, have interfered with the international community's ability to adequately respond to the problem.[4] Exacerbating the difficulty in combating climate change is the presence of positive feedback loops—mechanisms by which greenhouse gas emissions lead to environmental changes that drive further climate change.[5] The international community's proposed solution to climate change, abating greenhouse gas emissions, has largely been ineffective, leading many to consider alternatives in the form of geoengineering.[6]

In recent years, geoengineering has become attractive as an option to mitigate the effects of climate change, gaining broad public support.[7] Geoengineering, the practice of international large-scale environmental manipulation, would combat climate change by modifying the climate rather than by reducing greenhouse gas emissions.[8] Geoengineering proposals generally involve reflecting solar radiation to offset the effect of greenhouse gases or removing greenhouse gases from the climate.[9]

Advocates of geoengineering argue that conventional climate policy options are too slow to effectively combat climate change, necessitating a new approach to solving the problem.[10] The costs of geoengineering are likely to be significantly lower than the costs of reducing greenhouse gas emissions;[11] in

1. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: SYNTHESIS REPORT 45–54 (2007).

2. *Id.* at 48–53.

3. Eric Biber, *Climate Change and Backlash*, 17 N.Y.U. ENVTL. L.J. 1295, 1297 (2009).

4. *See* Cinnamon P. Carlarne, *Arctic Dreams and Geoengineering Wishes: The Collateral Damage of Climate Change*, 49 COLUM. J. TRANSNAT'L L. 602, 606–07 (2011) ("[T]he problem of climate change is further complicated by temporal and special complexities that have prompted it to be labeled as a 'super wicked problem.'").

5. *Id.* at 638 ("[G]eoengineering and Artic governance questions converge around questions of positive feedback . . . .").

6. Jay Michaelson, *Geoengineering and Climate Management: From Marginality to Inevitability*, 46 TULSA L. REV. 221, 230–33 (2010).

7. Institute of Physics, *Public Support for Geoengineering Research, Survey Finds*, SCIENCEDAILY (Oct. 25, 2011), http://www.sciencedaily.com/releases/2011/10/111024084714.htm.

8. Alan Carlin, *Why a Different Approach Is Required if Global Climate Change Is to Be Controlled Efficiently or Even At All*, 32 WM. & MARY ENVTL. L. & POL'Y REV. 685, 734–36 (2008).

9. Catherine Redgwell, *Geoengineering the Climate: Technological Solutions to Mitigation–Failure or Continuing Carbon Addiction?*, 2 CARBON & CLIMATE L. REV. 178, 179 (2011).

10. Thomas Homer-Dixon, Paper delivered at the American Political Science Association Annual Meeting: Nonlinearity, Uncertainty, and Time Lags: Why We Must Start Planning Now to Geoengineer Earth Soon (Aug. 30, 2009), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1450781.

11. *See id.* at 8 ("[T]he effort would cost only a tiny fraction of the expense of meaningful efforts to

fact, geoengineering may be among the least expensive policy options to reduce climate change.[12] Additionally, geoengineering projects do not require the same level of globally coordinated action as efforts to reduce emissions.[13] Rather, a single country or a small group of countries with sufficient technical and financial resources could carry out an entire geoengineering project.[14] A geoengineering project to resolve the harms associated with global warming may therefore become an appealing option if international agreements to reduce greenhouse gas emissions continue to fail to meet their goals.

This Note examines the international law that could govern geoengineering programs. It concludes that, because geoengineering has the potential to cause widespread climatological problems affecting several nations, international law must require that geoengineering be done on a multilateral scale and that geoengineering programs adhere to sound principles of international environmental law.

Part II of this Note examines geoengineering in detail and discusses current widely accepted international environmental law that might apply to geoengineering. Part III surveys the ways in which current international law might regulate geoengineering and argues that current international law is insufficient to avoid the potential hazards geoengineering poses. Part IV suggests a framework that adopts concepts and principles from international law that would be necessary for any geoengineering treaty regime. The framework proposed in Part IV is designed to ensure that the risks of geoengineering are fully evaluated and mitigated prior to the start of any major geoengineering project, provide a mechanism to encourage information sharing which enhances compliance and avoids disputes, establish procedures by which disputes can be resolved, and create substantive norms governing the potential harms caused by geoengineering.

II. BACKGROUND

This Part provides background information regarding geoengineering and applicable international law. Subpart A discusses the definition of geoengineering, the kinds of activities that fall under the umbrella term "geoengineering," and the potential harms associated with geoengineering. Subpart B discusses current international law that might be applicable to the geoengineering activities of states that are parties to the relevant conventions.

A. What Is Geoengineering?

Geoengineering includes "any technologies that deliberately reduce solar

reduce man's carbon emissions.").

12. *See generally* Michaelson, *supra* note 6, at 243 (discussing how climate management may be the least expensive strategy against climate change).

13. *See* Alan Carlin, *Implementation & Utilization of Geoengineering for Global Climate Change Control*, 7 SUSTAINABLE DEV. L. & POL'Y 56, 57 (2007) (discussing the various geoengineering implementation phases).

14. *Id.*

inslation [sic] or increase carbon sequestration from the atmosphere on a large scale. . . ."[15] The distinction between geoengineering and more conventional methods of combating climate change is that geoengineering focuses on mitigating the harms of climate change, whereas standard approaches to climate change concentrate on decreasing greenhouse gas emissions.[16]

Geoengineering includes various types of projects.[17] Current proposed geoengineering projects generally fall into two types.[18] The first kind of geoengineering project involves albedo modification, the process of increasing the reflection of light entering the atmosphere, thus decreasing energy absorption.[19] Albedo modification can include a variety of different processes.[20] The most widely discussed method of albedo modification involves using stratospheric sulfate aerosols, which reflect sunlight away, thereby substantially reducing the solar radiation that reaches the earth's surface.[21] A second albedo modification method involves using aerosols in a process called cloud-seeding, creating clouds to reflect sunlight.[22] A third approach to albedo modification would use space-based technology to reflect solar radiation before it enters the atmosphere.[23]

A second type of geoengineering involves sequestration of greenhouse gases such as carbon dioxide (CO_2).[24] Such removal can take place through modification of terrestrial ecosystems,[25] modification of oceanic ecosystems,[26] or through the use of technology to remove greenhouse gases from the atmosphere.[27] Terrestrial ecosystem modification approaches generally involve intensive forest management to increase the rate of CO_2 removal from the atmosphere.[28] Oceanic ecosystem modification proposals involve fertilizing the ocean with phosphate or iron, both of which stimulate algae

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15. Conference of the Parties to the Convention on Biological Diversity, Nagoya, Japan, Oct. 18–29, 2010, *Decision Adopted by the Conference of the Parties to the Convention on Biological Diversity at Its Tenth Meeting*, 5 n.2, U.N. DOC. UNEP/CBD/COP/DEC/X/33 (Oct. 29, 2010) [hereinafter Convention on Biological Diversity Dec. X/33].

16. *See* Alan Carlin, *Global Climate Change Control: Is There a Better Strategy than Reducing Greenhouse Gas Emissions?*, 155 U. PA. L. REV. 1401, 1450–64 (comparing conventional approaches for controlling climate change, which involve reducing emissions, with geoengineering techniques, which involve carbon sequestration or deflection of solar radiation).

17. *See* Finbarr Sheehy, *Geoengineering Projects Around the World – Map*, GUARDIAN (July 17, 2012, 9:44 PM), http://www.theguardian.com/environment/graphic/2012/jul/17/geoengineering-world-map (introducing various geoengineering projects around the world).

18. *See About Geoengineering*, INTEGRATED ASSESSMENT OF GEOENGINEERING PROPOSALS, http://www.iagp.ac.uk/about-geoengineering (last visited Mar. 5, 2014) (discussing the two types of geoengineering approaches).

19. David W. Keith, *Geoengineering the Climate: History and Prospect*, 25 ANN. REV. ENERGY & ENV'T 245, 261 (2000).

20. William C.G. Burns, *Geoengineering the Climate: An Overview of Solar Radiation Management Options*, 46 TULSA L. REV. 283, 289–96 (2010).

21. *Id.* at 289.

22. Keith, *supra* note 19, at 261–63.

23. Burns, *supra* note 20, at 294.

24. Keith, *supra* note 19, at 264.

25. *Id.* at 265.

26. *Id.* at 265–67.

27. Carlin, *supra* note 16, at 1456–57.

28. *Id.* at 1447.

growth.[29] Because algae absorbs CO_2 from the atmosphere and eventually falls to the ocean floor, increased algae growth would increase the amount of CO_2 sequestered at the bottom of the ocean floor.[30] Technological approaches to greenhouse gas sequestration involve removing CO_2 from the atmosphere using artificial means and storing it in geological formations.[31]

The key feature of both these types of proposals is that they would mitigate the impact of CO_2 and other greenhouse gases on the environment without decreasing overall greenhouse gas emissions.[32] Thus, for the purposes of this Note, we can understand geoengineering as any large-scale environmental manipulation designed with the purpose of mitigating the effects of climate change without decreasing greenhouse gas emissions.

Though geoengineering projects are diverse and each project is unique in its own way, this Note focuses on similarities that all such projects share. First, geoengineering projects can be done by a single country or a small group of countries.[33] Second, geoengineering can be utilized relatively inexpensively.[34] Third, as other climate change strategies continue to fail to reach emissions benchmarks, the appeal of geoengineering will continue to increase.

However, while geoengineering offers significant promise, it also has the potential to create numerous significant environmental risks.[35] In a worst-case scenario, a geoengineering project could fail to mitigate any of the harms from climate change while simultaneously creating side effects with worldwide implications.[36] Because geoengineering projects cannot be tested physically on a large scale,[37] the risks of geoengineering remain unknown. However, those risks could include severe and irreversible impacts on biodiversity.[38] While the risks of different projects are diverse, it is worthwhile to consider the risks posed by the two most popularly suggested geoengineering projects: ocean iron fertilization (with the goal of removing CO_2 from the atmosphere) and the placement of reflective particles in the stratosphere (with the goal of reflecting sunlight).

Risks of ocean fertilization include the possibility of severe changes in marine food webs and reduced productivity in areas that are down-current from

29. *Id.*

30. *Id.*

31. *Id.* at 1446.

32. Keith, *supra* note 19, at 279.

33. Hadi Dowlatabadi, *Scale and Scope in Integrated Assessment: Lessons from Ten Years with ICAM*, *in* SCALING IN INTEGRATED ASSESSMENT 51, 70 (Jan Rotmans & Dale S. Rothman eds., 2003).

34. *See* Michaelson, *supra* note 6, at 243 (discussing how costs related to geoengineering are decreasing and not of great concern anymore).

35. *See* Alan Robock, *20 Reasons Why Geoengineering May Be a Bad Idea*, 64 BULL. ATOMIC SCIENTISTS, MAY/JUNE 2008, at 14, 14–18, *available at* http://climate.envsci.rutgers.edu/pdf/20Reasons.pdf (listing and expounding on possible risks associated with geoengineering).

36. *See* Keith, *supra* note 19, at 274 (noting that some side effects of CO_2 control include "loss of biodiversity or loss of aesthetic value that may arise from manipulating ecosystems to capture carbon . . . .").

37. *See* Robock, *supra* note 35, at 17 (discussing difficulty in testing projects on a large scale).

38. Pat Mooney et al., *Darken the Sky and Whiten the Earth – The Danger of Geoengineering*, WHAT NEXT VOL. III, Sept. 2012, at 210, 227.

the fertilized area.[39] Because fertilization must take place in the ocean, these risks pose problems of transboundary harm; that is, the nation undertaking the project to fertilize the ocean with iron may cause harm to the environment and economy of other nations.[40] Additionally, the production of various chemicals resulting from ocean fertilization could have significant impacts on atmospheric chemistry and global climate, and thus affect nations whose economics do not rely on the ocean.[41]

The placement of reflective particles in the atmosphere also carries severe risks. Such placement is likely to have differential effects; it is not likely to reduce sunlight equally around the globe, resulting in equatorial regions experiencing increased drought.[42] Additionally, the reflective particles (most likely sulfate) will eventually come back to earth, and will have the potential to cause global pollution.[43] The risks of geoengineering make it imperative that some international framework govern implementation of projects to engineer the climate.

B. International Environmental Law

There is a great deal of international law that could potentially govern geoengineering. Such law includes multilateral treaties and other international agreements as well as general principles of international environmental law. This subpart discusses the ways in which extant international environmental law applies to geoengineering. It focuses on five aspects of international law that may be relevant to geoengineering: the transboundary harm principle, the precautionary principle, the Environmental Modification Convention, a decision from the Convention on Biological Diversity regarding geoengineering, and the London Convention / London Protocol's Assessment Framework on ocean fertilization. These five pieces of international law provide a fairly comprehensive framework of the international law potentially applicable to geoengineering.

1. The Transboundary Harm Principle

The Transboundary Harm principle is one of the most significant customary principles of international environmental law.[44] Its origins in international environmental law can be found in the Trail Smelter case, where an arbitral tribunal found Canada liable for pollution that entered the United States.[45] It can be found in a variety of international treaties, including Principle 2 of the Rio Declaration[46] and Principle 21 of the Stockholm

39. *Id.* at 232.
40. *Id.* at 227–28.
41. *Id.*
42. *Id.* at 235.
43. *Id.*
44. P.M. DUPUY, INTERNATIONAL LAW AND POLLUTION 61, 64 (1991).
45. *Id.*; Trail Smelter (U.S. v. Canada), 3 R.I.A.A. 1905, 1921–25 (Int'l Joint Comm'n) (1938).
46. United Nations Conference on Environment and Development, Rio de Janeiro, Braz., June 13, 1992, *Rio Declaration on Environment and Development*, U.N. Doc. A/CONF. 151/5/Rev.1, 876 (June 14,

Declaration.[47] Both treaties impose a norm on nations to avoid causing damage to areas outside of a state's jurisdiction.[48] However, neither the Rio Declaration nor the Stockholm declaration imposes liability on states; instead, both call for additional development of international law to give fuller content to the principle.[49] Such development has come from the International Law Commission, which has imposed obligations of prevention and cooperation among states while requiring states to engage in extensive information sharing and consultation to avoid transboundary harm.[50]

The transboundary harm principle can be thought of as having two elements. First, an activity must be attributable to a state; second, the effects from the activity must be shown to cause harm outside of the state.[51] Therefore, establishing that a geoengineering project violates the transboundary harm principle would require proving that the geoengineering activity would need to be attributable to the state (or states) in question and that the activity's effects are the cause of the harm that occurred outside the state's boundaries.[52] Where both elements are proven, remedies might include legal obligations upon the violating state to cease the geoengineering activity and make restitution for the injury caused.[53]

2. The Precautionary Principle

The Precautionary Principle (sometimes called the Precautionary Approach) can be loosely stated as the notion that precaution should be taken when embarking on potentially risky activities.[54] While the principle has been understood in multiple different ways,[55] the general approaches governing application of the precautionary principle can be understood in two ways: the weak precautionary principle and the strong precautionary principle.[56] The weak precautionary principle permits action to be taken even where risks are not fully known, so long as the action is done to avoid serious irreversible damage.[57] The strong precautionary principle suggests that action should be

1992) [hereinafter *Rio Declaration*].

47. United Nations Conference on the Human Environment, Stockholm, Swed., *Declaration of the United Nations Conference on the Human Environment*, A/CONF.48/14 (June 5–16, 1972) [hereinafter *Stockholm Declaration*].

48. *Id.*; *Rio Declaration*, *supra* note 46.

49. *Rio Declaration*, *supra* note 46 (citing to Principle 2); *Stockholm Declaration*, *supra* note 47 (citing to Principle 22).

50. INTERNATIONAL LAW COMMISSION, DRAFT ARTICLES ON PREVENTION OF TRANSBOUNDARY HARM FROM HAZARDOUS ACTIVITIES, ILC REP. 370, 371–74 (2001).

51. *Id.*

52. *Id.*

53. *Id.*

54. Frank B. Cross, *Paradoxical Perils of the Precautionary Principle*, 53 WASH. & LEE L. REV. 851, 851 (1996).

55. *See* R.B. Stewart, *Environmental Regulatory Decision-Making Under Uncertainty*, 20 RES. L. & ECON. 76, 76 (2002) (identifying multiple versions of the precautionary principle and arguing that those different versions can be reduced to four basic versions of the precautionary principle).

56. Stephen M. Gardiner, *A Core Precautionary Principle*, 14 J. POL. PHIL. 33, 43 (2006).

57. Gregory N. Mandel & James Thuo Gathii, *Cost Benefit Analysis Versus the Precautionary Principle: Beyond Cass Sunstein's Laws of Fear*, 2006 U. ILL. L. REV. 1037, 1039.

restricted where risks are not fully known as long as there is a possible environmental risk.[58] The weak version of the principle has been adopted as part of the Rio Declaration with respect to climate change, and some have suggested that the Rio Declaration thereby permits the use of geoengineering as a tool to mitigate climate change, despite the uncertainty of its success.[59]

3. *The Environmental Modification Convention (ENMOD)*

The Environmental Modification Convention (ENMOD) restricts the use of environmental modification technologies.[60] ENMOD is part of the law governing armed conflict.[61] Parties to ENMOD agree to refrain from using hostile environmental modification techniques as a means of injuring other signatories to the treaty.[62] Because ENMOD defines environmental modification techniques broadly to include nearly any intentional modification of any part of the environment, it imposes a significant restriction on countries' ability to engage in projects that have environmental impacts.[63] Although there has been some debate as to the applicability of ENMOD to geoengineering projects, the more prevalent view is that ENMOD does not apply to geoengineering carried out in the absence of armed conflict.[64] The text of ENMOD seems to agree with the majority view, since it specifically excludes from its scope environmental modification techniques when used with peaceful intentions.[65] However, ENMOD's approach of broadly restricting environmental modification techniques may serve as a useful framework for international geoengineering agreements. Scholars who have recommended using ENMOD as a model for geoengineering agreements have suggested that such an approach must account for ENMOD's limited participation and the fact that its rules have not been applied in practice.[66]

4. *Convention on Biological Diversity X/33 Decision*

The only international law that specifically addresses geoengineering is the Convention on Biological Diversity (CBD), which published a 2010 decision addressing geoengineering.[67] The decision, while not binding on parties to CBD due to its language "inviting" parties to follow it rather than requiring them to do so, provides guidance on geoengineering as a general

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58. Noah M. Sachs, *Rescuing the Strong Precautionary Principle from its Critics*, 2011 U. ILL. L. REV. 1285, 1295–96.

59. *Rio Declaration*, *supra* note 46; Ralph Bodle, *Geoengineering and International Law: The Search for Common Legal Ground*, 46 TULSA L. REV. 305, 309 (2010).

60. Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques, art.1, Dec. 10, 1976, 31 U.S.T. 333, 1108 U.N.T.S. 151 [hereinafter ENMOD].

61. Bodle, *supra* note 59, at 312.

62. ENMOD, *supra* note 60, at Art. I.

63. *Id.* at Art. II.

64. Bodle, *supra* note 59, at 312.

65. ENMOD, *supra* note 60, at Art. III.

66. Bodle, *supra* note 59, at 312.

67. Convention on Biological Diversity Dec. X/33, *supra* note 15, ¶ 8(w).

concept.[68] The CBD decision adopted a version of the strong precautionary principle with respect to geoengineering, finding that no climate-related geoengineering activities should take place without an adequate scientific basis to justify those activities.[69] However, the drafters excluded forms of carbon capture from the definition of geoengineering.[70]

Some have claimed that, despite its non-binding language, this decision imposes a de facto moratorium on geoengineering activities.[71] The decision, however, contains exceptions that would allow for geoengineering. First, the decision allows for geoengineering where regulatory mechanisms exist, are based on science, and are global and transparent.[72] Second, geoengineering activities are allowed when there is an adequate scientific basis for those activities and environmental risks and their associated impacts are appropriately considered.[73] Third, small-scale scientific studies designed to study the effects of geoengineering are also exempted.[74]

5. The London Convention / London Protocol Assessment Framework

The London Convention / London Protocol Assessment Framework for Scientific Research Involving Ocean Fertilisation (Assessment Framework) applies specifically to ocean fertilization, one form of geoengineering.[75] The London Convention provides a mechanism by which countries can assess whether ocean fertilization activities conform to the aims of the London Convention and London Protocol.[76] The Assessment Framework counsels nations to engage in a four-step process.[77] First, an Initial Assessment determines whether the activity falls within the definition of "ocean fertilization" and is thus eligible to be evaluated under the Assessment Framework.[78] Second, an environmental assessment examines the environmental impact and risks of the proposed activity as well as ways to manage the risk.[79] Third, a decision-making step requires countries to determine whether the process should move forward, notify potentially affected countries, and obtain consent from those affected.[80] Fourth, the activity should be monitored to determine the impacts of the ocean fertilization activity and use the information gathered to inform future decision-making

68. Bodle, *supra* note 59, at 314.
69. Convention on Biological Diversity Dec. X/33, *supra* note 15, ¶ 8(w).
70. *Id.* ¶ 8(w) n.2.
71. *CBD COP 10 Concludes in Nagoya,* MEA BULL. (Int'l Inst. for Sustainable Dev.), Nov. 1, 2010, at 1.
72. Bodle, *supra* note 59, at 317.
73. *Id.*
74. *Id.* at 318.
75. Int'l Maritime Org. [IMO], *The Assessment Framework for Scientific Research Involving Ocean Fertilisation*, IMO Assemb. Res. LC-LP.2 (Oct. 14, 2010) [hereinafter *Assessment Framework*], *available at* http://www.imo.org/blast/blastDataHelper.asp?data_id=31100&filename=2010resolutiononAFOF.pdf.
76. *Id.* at 2.
77. *Id.* at 2–3.
78. *Id.* at 5.
79. *Id.* at 5–19.
80. *Id.* at 20.

regarding the activity.[81] The Assessment Framework is designed to examine the scientific basis for the project and determine the extent to which such a project has scientific merit.[82]

The preceding discussion of the transboundary harm principle, precautionary principle, ENMOD, CBD X/33 decision, and Assessment Framework provides a basis of the major norms and principles of international environmental law applicable to geoengineering. Part III examines the applicability of each of these in additional detail, and assesses the degree to which they could contribute to creating a treaty framework for geoengineering.

III. ANALYSIS

This Part focuses on analyzing the current international law governing geoengineering, and its successes and failures in avoiding the transboundary harms that are likely to arise from geoengineering.[83] Subpart A argues that current international law fails to adequately protect against these harms; it also provides a brief analysis of the ways in which current international law fails. Subpart B examines the specifics of this failure by considering specific international legal principles, treaties, and decisions and analyzes those pieces of international environmental law with a view toward making suggestions for a robust international framework that could govern geoengineering.

A. The Shortcomings of Current International Law in Regulating Geoengineering

Current international law, while protecting against some of the harms of geoengineering, fails to fully protect against the kinds of harms that must be addressed. First, since geoengineering can take place on a small scale and projects can be carried out by a few nations to the detriment of others, there must be some method of allowing for harms to be avoided or, if unavoidable, then those bearing the harms should be compensated.[84] Second, because the complexity of climatological and ecological sciences do not often permit the kinds of proof of causation that would be available in other cases,[85] the international law governing geoengineering must allow for some liberalization in the requirements of proving causation. Third, because harms from geoengineering may be irreversible,[86] international law governing geoengineering must take a forward-looking approach to geoengineering, rather than allowing for after-the-fact injunctive relief and damages as the only available remedies.[87] Fourth, because the purpose of geoengineering is to avoid the harms of climate change, geoengineering projects should be subject

81. *Id.*
82. Bodle, *supra* note 59, at 319.
83. *See supra* Part II.A (discussing the aspects of geoengineering, including its benefits and harms).
84. Carlin, *supra* note 13, at 57.
85. NICOLAS DE SADELEER, ENVIRONMENTAL PRINCIPLES: FROM POLITICAL SLOGANS TO LEGAL RULES 219 (2002).
86. Mooney et al., *supra* note 38, at 227.
87. *Id.* at 226–27.

to a cost-benefit analysis that considers distributive justice, as the costs of geoengineering may be borne by countries that are least able to handle them.[88] In the remainder of Part III, this Note analyzes the specific current laws governing geoengineering and shows that, while they do not accomplish the specifics outlined above, there are ways in which they could be modified to serve as a starting point for developing a framework for legal norms governing geoengineering projects.

B. Specific International Laws and Principles

1. The Transboundary Harm Principle

The most significant problem facing application of the Transboundary Harm Principle to geoengineering involves the difficulty in proving causation. Application of the Transboundary Harm Principle, which is borrowed from nuisance law, is generally focused on the sorts of harm where the causal link between the harm and the cause can be established with sufficient certainty to impose liability.[89]

However, in the context of geoengineering, causation will be difficult to prove. For example, where a geoengineering project involves emitting sulfur dioxide into the upper atmosphere to reflect sunlight, that sulfur dioxide has the possibility of increasing the likelihood of acid rain.[90] However, while acid rain is a foreseeable consequence of sulfur dioxide emissions, it will be very difficult in practice to determine whether any specific instance of acid rain is the result of sulfur dioxide emissions from a geoengineering project or the result of atmospheric sulfate from some other cause, thus making it difficult for countries that are harmed to successfully seek compensation.[91] Because of this difficulty, international law governing geoengineering must adopt an approach that allows for the difficulties in causation to be surmountable by nations seeking damages from those countries that enact a major geoengineering project. The absence of such a requirement would allow countries to externalize the harms of geoengineering and would violate basic principles of distributive justice.[92]

The requirement of proving causation cannot, however, be completely eliminated from the transboundary harm principle. Rather, the requirements can be relaxed in ways that are analogous to those used in some domestic tort

88. *Id.* at 228.

89. *See, e.g.*, Trail Smelter (U.S. v. Can.), 3 R.I.A.A. 1905, 1921 (1941) (undertaking an extensive causation analysis before finding Canada liable for damage to property in the United States).

90. *AIRTrends 1995 Summary*, ENVTL. PROTECTION AGENCY, http://www.epa.gov/airtrends/aqtrnd95/acidrain.html (last updated Jan. 5, 2012).

91. *See* Patrick J. Scully, *Proof of Causation in a Private Action for Acid Rain Damage*, 36 ME. L. REV. 117, 131 (1984) ("A multitude of variables affects the process through which utility emissions are transformed into sulfate and nitrate particulates and transported hundreds of miles before finally falling to earth as acid rain. As a result, it is virtually impossible to trace particular acid rain incidents to individual upwind sources.").

92. *See id.* at 117–18 (arguing that difficulties in proving causation in domestic tort actions operate as an effective bar to such actions).

cases. For example, where a country engages in an ocean fertilization geoengineering project that creates harmful algal blooms downstream, affected countries harmed by those blooms may be able to avail themselves of an "alternative" liability theory in which the burden is shifted to polluting countries to prove that they were not the cause.[93] Alternatively, where sulfate emissions into the atmosphere or the amount of iron deposited into the ocean in an iron fertilization project are known, a market-share theory of liability (in which a country engaging in a geoengineering project is responsible for its share of the harm on the basis of the amount of sulfate/iron it puts into the environment) may be an effective tool to ensure that countries are only held liable to the extent justified by their emissions.[94]

Also worth noting is that a relaxed causation requirement as suggested here would promote the creation of ex-ante estimates of harm from those countries interested in enacting a geoengineering project.[95] Countries and private actors that could be held liable for the harms they commit would likely factor that into their accounting of the costs of geoengineering.[96] Because minimizing harm would reduce costs, this will encourage countries to adopt projects in a way that minimizes transboundary harm.[97]

An additional problem with the transboundary harm principle as applied to geoengineering is that any geoengineering treaty regime must account for harm to the commons. While codifications of the transboundary harm principle in international law suggest that harm to the commons is forbidden, the traditional remedy for such harm involves granting standing to third states (states not directly affected by the harm).[98] However, there is no settled approach to third state remedies, and it is unclear whether any international bodies have the authority to engage in the sort of collective decisions necessary to enact third state remedies in the case of widespread harm to the commons affecting multiple countries, as would be likely with geoengineering.[99] A complete geoengineering treaty regime thus needs to adopt a version of the transboundary harm principle that accounts for harms to the commons while simultaneously creating a body with the jurisdiction and competence to address those harms.

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93. *See id.* at 132–34 (discussing the possibility of an alternative liability theory for domestic acid rain torts).

94. *See, e.g.*, Sindell v. Abbot Laboratories, 607 P.2d 924, 937 (Cal. 1980) (providing a test for market-share liability under which those companies that contribute to the total amount of a fungible product in the market are held liable to the extent of their contribution).

95. *See* Lucian Arye Bebchuk, *Property Rights and Liability Rules: The Ex Ante View of the Cathedral*, 100 MICH. L. REV. 601, 629–631 (2001) (discussing alternative causation rules affecting potential defendants' investment strategies).

96. *Id.* at 630.

97. *Id.*

98. Jonathan I. Charney, *Third State Remedies for Environmental Damage to the World's Common Spaces*, *in* INTERNATIONAL RESPONSIBILITY FOR ENVIRONMENTAL HARM 149, 175–77 (Francesco Francioni & Tullio Scovazzi eds., 1991).

99. Jonathan I. Charney, *Third State Remedies in International Law*, 10 MICH. J. INT'L L. 57, 92 (1989).

2. The Precautionary Principle

Application of the precautionary principle to geoengineering under current international law is chiefly problematic for two reasons. First, while the principle itself has been accepted as a governing international norm, its precise content is unclear.[100] Second, different international legal regimes mandate different applications of the principle.[101]

The precautionary principle has been used to resolve international disputes governing the legality of state actions.[102] However, the principle itself is disputed as a rule of law, and its content and the consequences of violating it have not been clarified.[103] Questions regarding the application of the precautionary principle include questions about its specific content, its functions, and whether application of it requires specific regulatory approaches.[104] Further complicating the application of the precautionary principle is that different versions of it have been enacted and used in different places in environmental law.[105]

The weak precautionary principle, which allows actions to go forth when their purpose is to avoid an irreversible harm, permits geoengineering activities.[106] The Rio Convention, which allows for the weak precautionary principle to govern efforts to mitigate climate change, would therefore allow geoengineering projects to move forward without restrictions because such projects promise the possibility of mitigating the harms of climate change.[107]

The strong precautionary principle, on the other hand, suggests that projects should not move forward when their potential environmental costs are unknown.[108] Thus, because the potential environmental costs of geoengineering projects cannot be known with certainty, the strong principle would likely serve as a bar to geoengineering activities. The CBD X/33 decision, which adopts a strong version of the precautionary principle, would prohibit geoengineering because any geoengineering project significant enough

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100. Simon Marr, *The Southern Bluefin Tuna Cases: The Precautionary Approach and Conservation and Management of Fish Resources*, 11 EUR. J. INT'L L. 815, 816, 821 (2000).

101. *See id.* at 823–28 (discussing various approaches different legal entities have taken in interpreting the precautionary principal).

102. Southern Bluefin Tuna Case (Austl. & N.Z. v. Japan), Award on Jurisdiction and Admissibility, at 33–34 (Arbitral Tribunal constituted under Annex VII of the United Nations Convention for the Law of the Sea 2000), *available at* https://icsid.worldbank.org/ICSID/FrontServlet?requestType=ICSIDPublicationsRH&actionVal=ViewAnnouncePDF&AnnouncementType=archive&AnnounceNo=7_10.pdf (applying the precautionary principle, at the request of the parties, to a dispute regarding overfishing of Bluefin Tuna).

103. Marr, *supra* note 100, at 816.

104. Lothar Gundling, *The Status in International Law of the Principle of Precautionary Action*, 5 INT'L. J. ESTUARINE & COASTAL L. 23, 25–30 (1990).

105. *See* EDITH BROWN WEISS ET AL., INTERNATIONAL ENVIRONMENTAL LAW AND POLICY 314 (2007) ("Various versions of the principle have been included in resolutions of the UN Environment Programme, the Paris and Oslo Commissions, the London Dumping Convention, the Caribbean and Mediterranean Regional Seas Programmes, and the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), among others.").

106. *See supra* Part II.B (describing the areas of international law that could potentially govern geoengineering).

107. *Rio Declaration*, *supra* note 46.

108. *Geoengineering the Climate: Science, Governance and Uncertainty*, ROYAL SOCIETY (Sept. 1, 2009), http://royalsociety.org/policy/publications/2009/geoengineering-climate/.

to have a meaningful impact on climate change would also carry significant risks of environmental harm.[109]

Neither version of the principle offers a complete approach to geoengineering; the magnitude of the harms associated with climate change counsel against using too strong a version of the precautionary principle. Because geoengineering cannot be tested on a large scale prior to deployment, scientific certainty regarding potential harms can never be complete enough to satisfy the requirements of a strong version of the precautionary principle. However, a weak version of the principle fails to account for the significant possibilities of harm from geoengineering projects. Thus, some sort of middle ground is needed that would permit geoengineering to move forward while also recognizing the potentially significant harms that could occur. Additionally, because the principle lacks content to be fully applied under current international law, any treaty regime governing geoengineering must adopt a robust version of the principle that takes this middle-ground approach.

Because the strong precautionary principle puts too much weight on the potential costs of geoengineering, and the weak precautionary principle overemphasizes the benefits, a potential middle ground could be found through cost-benefit analysis. By requiring a scientifically viable cost-benefit analysis weighing the potential benefits of a geoengineering project (in terms of mitigation against climate change) against its potential risks (in terms of transboundary harm), international law would help to ensure that the only geoengineering projects that move forward would be able to resolve harms from climate change without simultaneously creating new, more severe harms.[110] This Note goes into more detail about the specifics of such a cost-benefit approach in Part IV.

3. ENMOD

While ENMOD's status as a wartime legal norm would prevent it from being used to govern geoengineering projects designed to mitigate the effects of climate change,[111] it could serve as a valuable check on ensuring that technologies created through geoengineering would not become weaponized. Because geoengineering technologies carry a significant possibility of harm to other nations, those nations engaging in geoengineering research might wish to weaponize their technology.[112] Furthermore, because even small countries or non-state actors could weaponize geoengineering technology,[113] it is possible that the actors using weaponized geoengineering would not be parties to ENMOD, and thus not fall within the reach of its jurisdiction.

Additionally, because it may be unclear whether a particular geoengineering technology will be used to combat climate change or as a

109. Convention on Biological Diversity Dec. X/33, *supra* note 15, at ¶ 8(w).

110. *See infra* Part IV (laying out a comprehensive framework for a geoengineering treaty).

111. Bodle, *supra* note 59, at 310.

112. Jamais Cascio, *Battlefield Earth*, FOREIGN POLICY (Jan. 28, 2008), http://www.foreignpolicy.com/articles/2008/01/27/battlefield_earth.

113. *Id.*

weapon, countries may not realize until after the harmful technology has been deployed that ENMOD applies.[114] Thus, international law needs a mechanism to monitor the development of geoengineering technologies to ensure peaceful intentions on the part of the country enacting a geoengineering project. Such mechanisms may include transparency, international cooperation on geoengineering technology, and extensive monitoring of countries engaging in geoengineering research.[115] These solutions are discussed in more detail in Part IV.

4. CBD X/33 Decision

The CBD X/33 decision is not binding on countries. However, some of the principles outlined in the decision may serve as valuable tools to understand how geoengineering could be governed by the law. First, the decision allows for geoengineering projects to move forward in three circumstances: (1) where regulatory mechanisms exist, are scientifically-based, and are transparent;[116] (2) where an adequate scientific basis for the activity exists and environmental risks and impacts are appropriately considered;[117] and (3) where small-scale scientific studies are designed to study the potential effects of larger-scale geoengineering projects.[118] These three exceptions could be adopted by a geoengineering treaty regime.

First, a regime could require that small-scale scientific studies occur before large-scale projects are enacted. Such a requirement would help to ensure that countries engaging in large-scale geoengineering activities are adequately aware of the potential consequences. Second, those small-scale scientific studies could provide the basis for scientifically sound intrastate regulatory mechanisms governing geoengineering. Third, the studies would also ensure that environmental risks and impacts to other states and the global commons would be appropriately considered for any major geoengineering activity. By adopting these requirements, a geoengineering treaty would transform these concepts from aspirational goals into binding international norms.

5. The LP/LC Assessment Framework

One major problem with attempting to apply the Assessment Framework to geoengineering is the limited number of countries to which the Assessment Framework applies. Only eighty-seven states are parties to the London Convention and only forty-four states are parties to the London Protocol.[119] Because countries that are not parties to a treaty are not bound by its norms,

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114. *Id.*
115. *Id.*
116. Bodle, *supra* note 59, at 317.
117. *Id.*
118. *Id.* at 318.
119. *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter*, INT'L MARITIME ORG., http://www.imo.org/OurWork/Environment/LCLP/Pages/default.aspx (last visited Mar. 7, 2014) [hereinafter *Convention on Prevention*].

fewer treaty participants decreases the force and effect of a treaty's laws.[120] Because over half the nations of the world are not parties to the Assessment Framework,[121] its norms governing geoengineering have insufficient force on the international stage to prevent potential harms associated with geoengineering. A second problem with the Assessment Framework is its use of precatory language, which fails to bind parties to the Assessment Framework.[122] For example, the treaty frequently uses the term "should," suggesting an aspirational norm, rather than the word "shall," which would suggest a mandatory norm.[123]

Despite these problems, the Assessment Framework provides a useful tool for determining the content of an international treaty governing geoengineering. First, the Assessment Framework requires consideration of social and cultural effects in addition to economic effects.[124] Furthermore, step three of the Assessment Framework requires a detailed environmental assessment that requires consideration of biodiversity and other ecosystem considerations.[125] The detailed step-by-step requirements of the Assessment Framework would serve as an excellent basis for a treaty governing all geoengineering.

IV. RECOMMENDATIONS

The preceding Part shows the ways in which current international law fails to adequately protect against the harms of geoengineering. However, it also serves as a starting point for developing a comprehensive framework for an international agreement that would govern geoengineering projects. The remainder of this Note lays out a comprehensive framework for a geoengineering treaty regime in light of the previous analysis of international law and the necessary requirements for an effective geoengineering treaty regime. Included in the discussion are Environmental Impact Assessments to be undertaken during the planning stages of a geoengineering activity, information-sharing mechanisms that occur both before and during the geoengineering project, procedural mechanisms for resolving disputes regarding transboundary harm, and substantive norms governing transboundary harm caused by geoengineering activities.

A. *Environmental Impact Assessments*

Any nation considering a geoengineering project should evaluate the

120. *See* Catherine Logan Piper, *Reservations to Multilateral Treaties: The Goal of Universality*, 71 IOWA L. REV. 295, 296 (1985) ("The greater the number of nations joining the treaty, the greater the force and effect of the laws rising out of the treaty.").

121. *Convention on Prevention, supra* note 119.

122. *See, e.g.*, *Assessment Framework*, *supra* note 75, at 20 (using the term "should" rather than "shall" when referring to states' obligations to ensure that activity is not contrary to the aims of the London Convention and Protocol).

123. *Id.*

124. Bodle, *supra* note 59, at 319.

125. *Assessment Framework*, *supra* note 75, at 11–12.

potential harms resulting from that geoengineering project before undertaking it. Environmental Impact Assessments (EIAs) have become a common tool in international law to ensure that decision makers have assessed the environmental impacts of a project.[126] EIAs can play a vital role in ensuring that countries undertaking geoengineering projects are complying with the international law governing such projects.[127] This subpart addresses the requirements that should go into an EIA for a geoengineering project; these requirements are largely adopted from Part III.

Because EIAs are one of the primary mechanisms through which states assess the environmental harms associated with a proposed action,[128] EIAs for geoengineering projects must take full account of the potential harms of a proposed geoengineering project. Accounting for the potential harms includes several aspects. First, an EIA must examine the likely transboundary harms from a project and identify the states that are likely to be harmed by such a project.[129] Second, where harm may occur to the commons, an EIA should identify such harm as well.[130] Such harm to the commons should include not only common spaces, but the sorts of harms that raise issues of common global concern, such as biological diversity.[131]

In order to satisfy the requirements of the middle-ground version of the precautionary principle, countries undertaking a geoengineering project should include a cost-benefit analysis as part of an EIA.[132] The middle-ground principle would not let all projects move forward, as would be the case under a weak precautionary principle.[133] However, such a principle would also not prohibit projects from moving forward in the face of the inevitable scientific uncertainty that arises from the fact that such projects cannot be tested on a large scale before being implemented.[134] Rather, a version of the precautionary principle that urges caution until the reasonably expected benefits of a geoengineering project can be shown to outweigh the reasonably expected harms of the project would serve as a check on risky projects while simultaneously allowing sound ones to move forward.

While such a cost-benefit analysis could not be undertaken with the same sort of certainty that often governs regulations in the United States and other countries, it should nonetheless be based on the best scientific estimates available.[135] Furthermore, such analysis should be supported by peer-reviewed research in order to ensure objectivity of the results. A treaty framework requiring nations engaging in geoengineering to include a cost-benefit analysis as part of an environmental assessment undertaken in conjunction with other

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126. NEIL CRAIK, THE INTERNATIONAL LAW OF ENVIRONMENTAL IMPACT ASSESSMENT 5 (2008).
127. *Id.*; *see* Bodle, *supra* 59, at 311.
128. Craik**,** *supra* note 126, at 64.
129. *Id.*
130. *Id.* at 50.
131. *Id.*
132. *See supra* Part III.B.1 (discussing the requirements of the precautionary principle).
133. *Id.*
134. *Id.*
135. *Id.*

nations, including those likely to be affected by the environmental impacts, can ensure objectivity of the results while simultaneously encouraging discussions between the countries engaging in geoengineering and those who are potentially affected.

Included in the cost-benefit analysis should be a discussion of both monetized costs and benefits and "soft" costs and benefits such as impacts on ecosystem services, which cannot be easily monetized.[136] Furthermore, because the harms of both geoengineering and global warming will have diverse impacts on different countries, nations undertaking a cost-benefit analysis should factor problems of distributive justice as part of a cost-benefit analysis.[137]

However, a simple cost-benefit analysis cannot be the only aspect of an EIA. Because the harms of geoengineering are not well-known, an EIA must be based on the best available science.[138] Thus, treaty provisions could require that, in preparing an EIA, nations considering a geoengineering project engage in small-scale scientific studies in order to better understand the potential risks and benefits of such a project, as well as be able to adequately predict the transboundary consequences and harm to other nations.[139] Additionally, provisions within the treaty framework could include requirements that a state considering engaging in geoengineering activity specify in its EIA whether it has adopted scientifically sound, intrastate regulatory mechanisms that would govern geoengineering and explain how those mechanisms are supported by scientific studies.[140]

Additionally, because geoengineering will probably cause transboundary harm,[141] a treaty regime should require that a country prove its continued economic viability (at least to the extent that the country can afford to pay out damages for the expected harms) to the international community as part of undertaking an EIA. This will help to ensure that countries harmed by geoengineering projects will be able to receive compensation for those harms. Additionally, such a requirement will also incentivize risk minimization because harms will likely be ongoing and it will almost certainly be cheaper to incur start-up costs to minimize harms than to pay out significant damages for long periods of time after the fact.[142]

B. Transparency, Notification, and Consultation

Several international agreements include requirements to make information available, notify parties potentially affected by transboundary

136. WEISS ET AL., *supra* note 105, at 125.

137. *See* Robert W. Hahn & Cass R. Sunstein, *A New Executive Order for Improving Federal Regulation?: A Deeper and Wider Cost-Benefit Analysis* 33–34 (John M. Olin Law & Econ., Working Paper No. 150, 2002) (arguing that accounting for distributional effects improves cost-benefit analysis).

138. *See* CRAIK, *supra* note 126, at 8 (discussing how potential environmental impacts require scientific understanding).

139. *See supra* Part III.B.3 (discussing the requirement of small-scale scientific studies).

140. *See id.* (discussing the adoption of regulatory mechanisms).

141. *See supra* Part III.B.1 (discussing the Transboundary Harm Principle).

142. *Id.*

pollution, and engage in consultation with affected countries.[143] Transparency requirements in other international law agreements include making information available to other countries and to the public.[144] Such transparency helps to ensure that geoengineering activities comply with international norms and to assure other countries that the country engaging in geoengineering activity is not violating any international agreements.[145]

Additionally, countries should be required to notify those countries that an EIA identifies as being likely to be victims of transboundary harm. Such notification procedures are common procedural mechanisms used in international environmental treaties.[146] Adding notification requirements to a geoengineering convention may help to ensure that affected countries are aware of the potential effects of geoengineering activities and allow those countries to make informed decisions about whether to engage in consultation.

In addition to serving a valuable function before an activity starts, information-sharing activities can also play a role during a geoengineering project.[147] Transparency enhances compliance because it provides greater access to information for other states, thus putting those states in a better position to encourage and enforce accountability during a geoengineering project.[148] One of the best ways in which a treaty regime can induce compliance through transparency is by requiring the filing of regular reports.[149] Furthermore, while making such reports to other states plays a role in compliance, evidence strongly suggests that reports that go outside of formal governmental channels can encourage greater compliance by educating the public and putting public pressure on governments to comply with their treaty obligations.[150] For a geoengineering project, reports could contain information concerning the progress of the project, potential harms or other foreseen consequences, and other discussions of compliance with procedural mechanisms of an international geoengineering treaty.

A treaty that requires that reports be made available to the public creates a mild form of coercion that can potentially embarrass a nation into complying with its international obligations.[151] Although public pressure does not have

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143. *See* WEISS ET AL., *supra* note 105, at 347–59 (discussing international agreements that include requirements of transparency, notification, and cooperation).

144. *See, e.g.*, Rep. of the Int'l Law Comm'n, 53d Sess., Apr. 23–Jun. 1, Jul. 2–Aug. 10, 2001, U.N. Doc. A/56/10, 374–5; GAOR, 56th Sess., Supp. No. 10 (2001) (outlining United Nations notification and information exchange rules).

145. Cascio, *supra* note 112.

146. *See Rio Declaration*, *supra* note 46, Principle 19 (imposing a requirement on states to notify and provide information to states whose environments may be adversely affected); Dietrich Rauschning, *Legal Aspects of the Conservation of the Environment*, 60 INT'L L. ASSOC. REP. CONF. 157, 171–75 (1982) (outlining rules of international law requiring prior notice and consultation where "transfrontier" pollution is possible).

147. Harold K. Jacobson & Edith Brown Weiss, *Strengthening Compliance with International Environmental Accords: Preliminary Observations from a Collaborative Report*, 1 GLOBAL GOVERNANCE 119, 130 (1995).

148. *Id.*

149. *Id.* at 140.

150. *Id.*

151. Mark R. Goldschmidt, *The Role of Transparency and Public Participation in Environmental Agreements: The North American Agreement on Environmental Cooperation*, 29 B.C. ENVTL. AFF. L. REV. 343, 353 (2002).

the same force as a binding norm of international law, it plays an important role in restraining governmental actions.[152] In order for such pressure to be effective, there must be some external body willing to publicize noncompliance and a constituency that can encourage compliance with international obligations.[153] Non-governmental organizations, expert communities, and populations that may be harmed by a geoengineering project can all serve a vital role in ensuring that noncompliance is publicized.[154] Additionally, because geoengineering projects in one nation are likely to harm neighboring nations, countries will have an incentive to bring their actions into compliance with treaty obligations in order to maintain good relations with their neighbors.

In addition to information-sharing from the country engaging in the project, information-sharing processes that allow for consultation between the country engaged in geoengineering and potential victims of transboundary harm may provide significant additional benefits.[155] The benefits of consultation stem from its use in preventing disputes through allowing countries to reach understandings before dispute arises.[156] However, for consultation to be effective, a treaty regime that allows for it must include a requirement that parties to the consultation consult in good faith.[157] In addition to avoiding disputes, consultation can also improve compliance with treaty norms.[158] A treaty provision requiring consultation at the request of one or both parties and encouraging ongoing consultation can thus serve to avoid disputes with treaties while also enhancing compliance. Because transparency, notice, and consultation can help to avoid disputes while simultaneously encouraging compliance on the part of the acting country, a treaty regime governing geoengineering ought to include provisions for each.

C. Dispute-Resolution Mechanisms

While information-sharing mechanisms can encourage compliance during geoengineering activities, history has shown that no country complies perfectly with the norms imposed by international environmental treaties.[159] Because of this, and because transboundary harm is extremely likely to result from geoengineering projects, a geoengineering treaty regime must ensure the existence of adequate dispute resolutions mechanisms. Since no international environmental court exists, the best dispute resolution mechanisms for transboundary harm resulting from geoengineering are likely to be mediation and arbitration.[160]

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152. Jacobson & Weiss, *supra* note 147, at 140.
153. Goldschmidt, *supra* note 151, at 352.
154. *Id.*
155. WEISS ET AL., *supra* note 105, at 161.
156. *Id.*
157. *Id.*
158. Jacobson & Weiss, *supra* note 147, at 130.
159. *Id.* at 138.
160. *See* Louise Gray, *Lawyers Call for International Court for the Environment*, TELEGRAPH (Nov. 27, 2008, 2:27 PM), http://www.telegraph.co.uk/earth/environment/climatechange/3530607/Lawyers-call-for-

Like domestic mediation, international mediation occurs when parties to a dispute bring in a third party to assist with negotiation of a resolution.[161] The best choice for a third party is one that is on good terms with all of the parties to the dispute but not particularly close to any of them.[162] A geoengineering treaty regime could create a body to monitor compliance with its norms; it is likely that at least some members of such a body would be on good terms with the parties to a dispute without being particularly close to any of them, and thus could serve as mediators. Additionally, a compliance-monitoring body would develop experience with compliance matters in geoengineering which would serve it well in assisting in dispute resolution.

Arbitration would ideally be used as a last resort when attempts at mediation fail. Arbitration requires the creation of an arbitral tribunal, which resolves a transboundary harm dispute in a quasi-judicial proceeding, similar to a judge or a panel of judges in a court case.[163] A geoengineering regime must include an agreement to arbitrate, a mechanism for establishing an arbitral tribunal, and provisions discussing its jurisdiction and procedures.[164] Including such procedures would ensure that an arbitral tribunal could be rapidly assembled to resolve transboundary harm disputes arising out of geoengineering activity.

D. Substantive Law

In addition to procedural mechanisms to resolve disputes, a geoengineering regime must include substantive legal norms to be used as standards to resolve disputes. Such norms should include provisions allowing for compensation when transboundary harm occurs, provisions allowing for resolutions of harm to the global commons, and provisions to compensate countries and possibly enact sanctions when geoengineering technology is weaponized.

Countries seeking compensation for harms caused by other countries that enacted geoengineering projects should be able to avail themselves of a slightly relaxed causation requirement vis-à-vis the transboundary harm principle.[165] This will encourage countries to enact treaties or other agreements to settle disputes prior to the launch of a large-scale geoengineering project. Furthermore, it will ensure that countries cannot externalize the economic harm of such projects to other nations. This is crucial for distributive justice because countries enacting geoengineering projects will likely be among the wealthiest nations, and externalizing the harms would protect their economies at the expense of poorer nations. Such a result would

international-court-for-the-environment.html (discussing a proposal to create the first international environmental court).

161. WEISS ET AL., *supra* note 105, at 164.

162. *Id.*

163. *Id.* at 166.

164. *Id.* at 167.

165. *See supra* Part III.B.1 (explaining the difficulty of applying the trans-boundary harm principle to geoengineering).

allow some nations to maintain their economic status at the expense of weaker nations, a result that violates basic principles of justice.

Additionally, a complete geoengineering framework must address harms to the global commons. Because geoengineering may involve ocean fertilization or space-based activity, geoengineering activities may harm areas that fall within the scope of the global commons rather than individual countries.[166] By providing third-state standing to any countries that make use of a particular commons or have a state interest in that commons and are affected by harm, a geoengineering treaty could ensure that the transboundary harm principle applies to the commons as well as to individual countries.

In addition, to address transboundary harms and harms to the global commons, a geoengineering treaty should address weaponization of geoengineering technologies. Because geoengineering technology can easily be weaponized, there is good reason to include substantive treaty provisions prohibiting such weaponization.[167] While disputes regarding weaponized geoengineering technology may be resolvable through international courts under the laws of war or other substantive international law, the experience of the specialized geoengineering arbitral tribunal discussed in the previous section may render it a better option for resolving problems that arise through the weaponization of geoengineering technology. Additionally, because weaponization of technology is to be especially discouraged (unlike transboundary harm, which should be seen as a probable consequence of geoengineering), a geoengineering treaty regime should have the power to impose sanctions on nations that fail to comply with prohibitions on weaponization of geoengineering technology.

V. CONCLUSION

This Note has shown that unilateral geoengineering creates risks for the international community, and that current international law is insufficient to avoid these risks. While particular provisions of current international law fail to provide an adequate mechanism to regulate geoengineering, an analysis of international environmental law and its associated legal principles serves to provide a valuable source of information from which a geoengineering treaty regime can be created.

In order for a geoengineering treaty regime to adequately address the potential risks of geoengineering, it must contain requirements for an Environmental Impact Assessment to identify potential harms and weigh risks and benefits, provide mechanisms for information-sharing to encourage early dispute resolution and compliance with treaty obligations, establish procedural mechanisms to resolve transboundary harm disputes, and have substantive legal norms to ensure that transboundary harms are fully compensated.

166. Keith, *supra* note 19, at 263–64.
167. Cascio, *supra* note 112.