

Geoengineering and International Law

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Abstract: Due to the largely transboundary nature of technologies concerned, the legality of geoengineering ought to be examined in accordance with the rules of public international law. This legal system does not contain norms that were specifically developed and comprehensively made applicable to the research and use of geoengineering. This is why the legality of geoengineering testing or deployment must be judged separately for each individual technology on the basis of international treaty and customary law. Despite persisting legal uncertainties, there is a good case to argue that a general prohibition of geoengineering does not exist in international law. Furthermore, a closer examination of individual geoengineering technologies supports the conclusion that carbon dioxide removal tends to meet with fewer legal objections than solar radiation management. Testing or deployment of geoengineering generally requires that due regard be paid to the existing rights and territorial integrity of other states or the areas beyond the limits of national jurisdiction. As this cannot normally be assumed in the case of purely unilateral action, a disputable presumption of illegality exists for such measures. Finally, the legal assessment of geoengineering to a large degree depends on how the phenomenon of conflicting environmental objectives is managed in the future.

Keywords: Climate change, principle of prevention, precautionary principle, risk assessment
Klimawandel, Prinzip der Prävention, Prinzip der Vorbeugung, Risikoeinschätzung

1. Introduction

According to a preliminary definition provided by the parties to the Convention on Biological Diversity (CBD), the term ‘geoengineering’ refers to “technologies that deliberately reduce solar insolation or increase carbon sequestration from the atmosphere on a large scale that may affect biodiversity (excluding carbon capture and storage from fossil fuels when it captures carbon dioxide before it is released into the atmosphere)”.¹ The debate on these technologies is spreading increasingly across multiple disciplines. Taking into account the potential negative side effects, nobody would dispute today that geoengineering involves serious legal challenges. Evidence for this can be found in two recent decisions adopted by the Conference of Parties (COP) to the CBD which specifically address under what conditions geoengineering should be considered as being lawful.² While these decisions, which have attracted widespread attention, are not legally binding, their political importance has triggered assessments of the legal challenges related to geoengineering, as well as projections of potential future developments on the field.³ Building upon these documents, this article aims at providing a survey of the relevance and effectiveness of public international law with regard to geoengineering. It focuses

on the requirements of both customary international law and international treaty law, and delivers a brief outline on potential future developments.

2. Geoengineering and International Law: Current Situation

Due to the largely transboundary and potentially global character of geoengineering, the legality of respective technologies must be examined in accordance with the rules and principles of public international law. However, with the partial exception of ocean iron fertilization on which an informal regime for the regulation of respective experiments has meanwhile been established (see section 3.2), this legal system does currently not contain norms that were specifically developed and comprehensively made applicable to the research and deployment of geoengineering. That individual geoengineering activities are nonetheless addressed by existing international agreements can be attributed to the framework approach commonly found in international law – particularly in the context of global environmental issues. It is characteristic of this approach that a specific issue is comprehensively regulated in a multi-stage process: whereas a framework convention contains general principles and rules for, e.g., the peaceful resolution of disputes, specific rights and obligations are substantiated in annexes to the convention or in subsequently adopted protocols. This often allows the rules contained in the framework convention to be applied to new phenomena. The broad scope of the agreements also implies that a specific geoengineering technology is frequently covered by several treaties. For example, marine geoengineering will have to be assessed against the requirements of the United Nations Convention for the Law of the Sea (UNCLOS), the United Nations Framework Convention on Climate Change (UNFCCC), the CBD and the London Convention and Protocol. In addition, treaty provisions that address specific issues are often „openly“ formulated so that factual developments that

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1 The definition is contained in a footnote to Decision X/33 on Biological Diversity and Climate Change adopted by the 10th Conference of the Parties (COP) to the CBD, available at: <<http://www.cbd.int/decision/cop/?id=12299>>.

2 Decision IX/16 on Biodiversity and Climate Change of May 2008, para. 5, available at: <<http://www.cbd.int/decision/cop/?id=11659>>; Decision X/33 on Biological Diversity and Climate Change, *supra* note 1.

3 See UNEP/CBD/SBSTTA/16/INF/29 of 2 April 2012, Regulatory Framework for Climate-related Geoengineering relevant to the Convention on Biological Diversity, available at: <<http://www.cbd.int/doc/meetings/sbssta/sbssta-16/information/sbssta-16-inf-29-en.pdf>>; Wilfried Rickels et al., *Large-Scale Intentional Interventions into the Climate System? Assessing the Climate Engineering Debate*, 2011, pp. 85-105, at: <http://www.kiel-earth-institute.de/activities/research/scoping_reportCE.pdf>.

were not part of the treaty's original intentions can nonetheless be subsumed under treaty norms. Finally, apart from the law of treaties, geoengineering activities must also be judged against the requirements of international custom, as evidence of a general practice accepted as law (cf. Article 38 (1) lit. b Statute of the International Court of Justice (ICJ)).

2.1 Geoengineering and Customary International Law

Within the realm of international environmental law, customary international law has been particularly relevant with regard to the resolution of conflicts arising from activities which take place within the territorial jurisdiction of a State ("State of origin") that damage the environment of one or more other State(s) ("victim State"), or the environment of areas beyond the limits of national jurisdiction respectively.⁴ In such situations, a balance must be struck between the sovereign interests of the States involved. The prohibition of significant transboundary harm, frequently referred to as the "Trail Smelter" or "no harm" principle,⁵ offers some clarification as to how that balance can be achieved. According to a recommendation submitted by the OECD, transboundary environmental damage can be described as „the introduction by man [...] of substances or energy into the environment resulting in deleterious effects of such nature as to endanger human health, harm living resources and ecosystems, and impair or interfere with amenities and other legitimate uses of the environment.”⁶ This definition does not refer to geographic proximity or a common boundary, but it is instead solely based on a causal connection between the damaging activity and the environmental damage. The "Trail Smelter" principle is thus applicable when environmental damage that has already been occurred can clearly be attributed to the consequences of a specific action. In this respect, it is incumbent upon the victim State to provide the necessary evidence.

In the course of the second half of the last century, it became a desideratum that international law should not only prohibit the causation of significant transboundary harm but should rather oblige States involved in activities that may result in adverse environmental impacts to take measures to prevent such impacts. The ICJ recently held that this need is reflected in the principle of prevention, and that this principle is binding under customary international law.⁷ Concerning its content, the International Law Commission (ILC), established by the United Nations (UN) General Assembly with the task to promote the progressive development of international law and its codification, clarified that

[t]he obligation of the State of origin to take preventive or minimization measures is one of due diligence. [...] The duty of due diligence involved, however, is not intended to guarantee that significant harm be totally prevented, if it is not possible to do so. In that eventuality, the State of origin is required, as noted above, to exert its best possible efforts to minimize the risk.⁸

Therefore, the principle of prevention contains an "obligation of conduct" rather than an "obligation of result".⁹ It obliges the State of origin to select the most environmentally sound available technology, and to respect the interests of other States and those of the global commons. In terms of procedural law, the ICJ emphasized the existence of a duty to inform, notify and negotiate deriving from the due diligence requirement that forms the core of the principle of prevention.¹⁰ It thereby implicitly made recourse to Principle 19 of the 1992 Rio Declaration,¹¹ according to which

States shall provide prior and timely notification and relevant information to potentially affected States on activities that may have a significant adverse transboundary environmental effect and shall consult with those States at an early stage and in good faith.

Finally, the ICJ held that it is necessary to conduct an environmental impact assessment (EIA) prior to commencing the activity, when there is sufficient likelihood of damage occurring.¹² As currently adverse environmental impacts cannot be excluded in the case of geoengineering, its experimental use or deployment will usually give rise to an obligation of the authorizing State to undertake an EIA. While the exact content and structure of that procedure are, according to the ICJ, not set out in international law,¹³ it can nonetheless be assumed that the stringency of the EIA increases in proportion to the potential danger.

It has been argued that activities involving significant environmental risks should automatically be considered a violation of the prohibition of transboundary environmental damage on account of its preventative function.¹⁴ The structure of the prohibition of transboundary environmental damage, which is built on the causal connection between the damaging activity and the damage to the environment, militates against this approach, however. The ICJ insisted in the *Pulp Mills* case on the necessity that the victim State provides conclusive evidence that the obligation of due diligence has been breached by the State of origin,¹⁵ thereby rejecting to accept that the duty to act with due diligence implies a shifting of the burden of

8 Commentary to Article 3 of the ILC Draft Articles on Prevention of Transboundary Harm from Hazardous Activities, para. 7, reprinted in: *Yearbook of the ILC*, 2001/II-2, 154. See also ICJ, *Case Concerning Pulp Mills on the River Uruguay* (Argentina v. Uruguay), ICJ Reports 2010, 14, para. 228.

9 Patricia Birnie/Alan E. Boyle/Catherine Redgwell, *International Law and the Environment*, 3rd ed. 2009, p. 147, 150 et seq.

10 ICJ, *Case Concerning Pulp Mills on the River Uruguay* (Argentina v. Uruguay), ICJ Reports 2010, 14, paras. 80 et seq.

11 Declaration on Environment and Development of 13 June 1992, *International Legal Materials (ILM)*, 31 (1992), 876.

12 *Case Concerning Pulp Mills on the River Uruguay* (Argentina v. Uruguay), ICJ Reports 2010, 14, para. 204.

13 *Ibid.*, para. 205.

14 C. Wilfred Jenks, *Liability for Ultra-Hazardous Activities in International Law*, *Recueil des Cours*, 117 (1966-I), 105 et seq.

15 *Case Concerning Pulp Mills on the River Uruguay* (Argentina v. Uruguay), ICJ Reports 2010, 14, paras. 101, 265.

4 Cf. ICJ, *Legality of the Threat or Use of Nuclear Weapons*, Advisory Opinion, ICJ Reports 1996, 226, para. 29; ICJ, *Case Concerning Pulp Mills on the River Uruguay* (Argentina v. Uruguay), ICJ Reports 2010, 14, para. 101.

5 This principle has its origins in the Trail Smelter arbitration of 1938, in which the arbitral tribunal came to the result that no State has the right "to use or permit the use of its territory in such a manner as to cause injury by fumes in or to the territory of another [...], when the case is of serious consequence [...]" (*Trail Smelter Arbitration*, RIAA III, 1938, 1965).

6 OECD, Recommendation C(74)224 of 14 November 1974, *Principles Concerning Transfrontier Pollution*, Part A (Introduction).

7 ICJ, *Case Concerning Pulp Mills on the River Uruguay* (Argentina v. Uruguay), ICJ Reports 2010, 14, para. 101.

proof.¹⁶ Moreover, State practice does not support a general prohibition of such activities. The Draft Articles on Prevention of Transboundary Harm from Hazardous Activities submitted by the ILC in 2001¹⁷ do not assume such a prohibition, but instead call for the application of the principle of prevention in its traditional (due diligence) shape.¹⁸

In light of the aforementioned points, the relevance of the principle of prevention vis-à-vis geoengineering is limited. If environmental damage has occurred, the burden of proof imposed on the victim State requires the submission of evidence that at least a sufficient likelihood exists that the damage has been caused by the geoengineering activity concerned. This will not be an easy task for the victim State, because scientific certainty is typically lacking on the causal connection between the implementation of such measures and potential adverse environmental impacts. The situation is even more problematic for geoengineering testing or deployment in areas beyond the limits of national jurisdiction. While it is meanwhile recognized that the principle of prevention is also applicable vis-à-vis activities undertaken on the high seas, on the deep seabed, or in outer space,¹⁹ it will generally be challenging to attribute environmental damage that has occurred within these common spaces to the specific conduct of a State or a group of States.

Further difficulties arise from the fact that even if a causal relationship between an environmental harm on the one hand and geoengineering experiments or deployment on the other can be established in a given case, it is far from clear how and by whom the potential violation of the preventive principle can be challenged. Concerning claims for compensation of the environmental damage that has occurred, e.g., on the high seas, the absence of an individually injured State raises the question whether every State can bring a claim on behalf of the international community before an international court or tribunal. As the concept of *actio popularis* has arguably not (yet) found general recognition on the international plane,²⁰ it seems unlikely that possible violations of the principle of prevention related to activities in common spaces will become subjects of compulsory dispute settlement procedures. With a view to the procedural duties contained in the principle of prevention, the ICJ furthermore contended that their violation would be sufficiently remedied by way of the ICJ's finding of wrongful conduct of the State of origin,²¹ thereby considerably weakening the claim for normative validity of these duties.²² Leaving here aside the relevance of the precautionary principle (see section 3.1), the limited scope and specificity of customary international law thus call for an observation of the more specific requirements arising out of international agreements.

16 Ibid, para. 164.

17 Supra note 8.

18 Articles 3 and 4 of the Draft Articles on Prevention of Transboundary Harm from Hazardous Activities.

19 Supra note 4.

20 Cf. *South West Africa* (Ethiopia v. South Africa; Liberia v. South Africa), ICJ Reports 1966, 6, para. 88.

21 *Case Concerning Pulp Mills on the River Uruguay* (Argentina v. Uruguay), ICJ Reports 2010, 14, paras. 269, 275.

22 Critically *Case Concerning Pulp Mills on the River Uruguay* (Argentina v. Uruguay), Joint Dissenting Opinion Al-Khasawneh/Simma, ICJ Reports 2010, 108, para. 26 et seq.

2.2 Geoengineering and Treaty Law

As stated above, geoengineering activities ought to be measured against the requirements of the treaties that are, depending on the factual situation, particularly affected (provided, of course, that the State of origin is a party to them).²³ Multinational environmental agreements are frequently dedicated to the protection of a specific environmental good such as the marine environment. Consequently, marine geoengineering, e.g. ocean iron fertilization, is to be assessed against the requirements of the UNCLOS and the London Convention and Protocol. Some international agreements, such as the UNFCCC and the CBD, are based on considerably broader approaches, which renders them equally or even particularly relevant in the present context. However, as will be shown by reference to the example of the Convention on Long-Range Transboundary Air Pollution (CLRTAP) and others, neither of these types of treaties provides clear answers as to the legality of individual geoengineering technologies. Rather, in most instances only those activities ought to be declared unlawful by the State parties according to the terms of the agreements concerned that are likely to have a negative impact on a certain part of the environment.

The lawfulness of introducing reflective aerosols or particles into the stratosphere for solar radiation management (SRM) purposes is to be assessed on the basis of, inter alia, the CLRTAP. This treaty, which has only 51 State parties, was negotiated in the 1970s in light of increasing air pollution and acid rain. While this background prompts the assumption that the CLRTAP does not have direct legal implications for geoengineering, the "open" character of its norms provides latitude for its potential application in the legal assessment of SRM. Article 2 CLRTAP states that "Parties [...] shall endeavor to limit and, as far as possible, gradually reduce and prevent air pollution". Accompanying this, air pollution is defined in Article 1 (a) as the "introduction by man [...] of substances or energy into the air", which not only includes sulphur particles but also all other particles and aerosols which are being discussed for introduction into the stratosphere.²⁴ The materials being introduced must additionally "result [...] in deleterious effects of such a nature as to endanger human health, harm living resources and ecosystems and material property and impair or interfere with amenities and other legitimate uses of the environment" (Article 1 (a) CLRTAP). The Convention thus demands a negative impact of the introduced substances in order to be qualified as air pollution. Even though SRM intends to counteract global warming by introducing aerosols in the stratosphere, negative consequences cannot be excluded at the present time. However, the CLRTAP contains no indication that the mere possibility of damage would be sufficient. Due to the lack of reference to features of precaution, it is, again, necessary

23 Note that according to the principle "pacta tertiis nec nocent nec prosunt" codified in Article 34 of the Vienna Convention on the Law of Treaties (VCLT), which is also recognized as customary international law, third States are not bound by a treaty to which they have not consented.

24 See Rex J. Zedalis, Climate Change and the National Academy of Sciences' Idea of Geoengineering: One American Academy's Perspective on First Considering the Text of Existing International Agreements, *European Energy and Environmental Law Review*, 2010, 18 at 21.

that adverse effects on the environment must be definitively proven in order for the CLRTAP to be applicable.

The United Nations Convention on the Prohibition of Military or Any Hostile Use of Environmental Modification Techniques (ENMOD Convention) has at present 76 State parties, including the USA, China, Russia and most other major powers. Article I of the Convention provides that “[e]ach State Party to this Convention undertakes not to engage in military or any other hostile use of environmental modification techniques [...].” Keeping in mind that geoengineering also interferes with natural processes, it seems that ENMOD could be applicable. ENMOD contains a legal definition of the term “environmental modification techniques” in Article II, according to which technologies concerned encompass “changing – through the deliberate manipulation of natural processes – the dynamics, composition or structure of the Earth, including its biota, lithosphere, hydrosphere and atmosphere, or of outer space.” This definition is further substantiated in an Understanding appended to the Convention.²⁵ It is an interpretive agreement, not part of ENMOD, but incorporated into the negotiation report and the Report of the Conference of the Committee on Disarmament. Irrespective of their non-binding character, such agreements provide important information to be taken into account when interpreting the corresponding provisions of ENMOD in accordance with Article 31 (3) and (4) VCLT. In regard to Art. II ENMOD, the Understanding underlines that the norm’s description of environmental modification techniques is not exhaustive, so that measures not specifically named in the Convention can also fall within its scope.²⁶ By expressly referring to changes in climate patterns, changes in the state of the ozone layer and changes in the state of the ionosphere, it clarifies that measures to modify the climate can also be subsumed under the term “environmental modification techniques”.²⁷

On the other hand, the specified objective contained in the title of the ENMOD Convention – the regulation of the use of the environment as a *weapon* or as part of a military operation – militates against its applicability to geoengineering activities as long as these are not deployed in a hostile manner.²⁸ Further evidence for a restrictive interpretation of the Convention’s scope can be found in the seventh recital of the preamble, where the contracting parties express their intention of effectively prohibiting the military or otherwise hostile use of environmental modification technologies. Again, this objective, which is central to the interpretation of the treaty provision in accordance with Article 31 VCLT, does not *per se* rule out that non-military and non-hostile environmental modification could also be touched on by the treaty. The fifth recital of the preamble according to which “the use of environmental modification techniques for peaceful purposes could improve the interrelationship of man and nature and contribute to the preservation and improvement of the environment for the benefit of present and future generations”,

suggests that ENMOD not only refers to adverse effects but also to the potential benefits of the peaceful use of environmental modification techniques.²⁹ This suggestion seems to be backed by Article III (1) ENMOD Convention.

However, the contracting parties stated in an Understanding concerning Article III that ENMOD does *not* address the question “whether or not a given use of environmental modification techniques for peaceful purposes is in accordance with generally recognized principles and applicable rules of international law.”³⁰ Consequently, Article III does not as such establish the legality of geoengineering, but only stresses in a declaratory manner that geoengineering research ought to be measured against the requirements of the applicable general principles and rules of international law. Given the fact that ENMOD is systematically and historically linked to the law of armed conflict, it is arguably doubtful whether it constitutes a suitable starting point for future geoengineering governance.

The UNFCCC is the central regulatory instrument for protecting the world’s climate. With 194 State parties it is universally applicable. Although the UNFCCC does not directly address geoengineering, its objective of addressing adverse changes in the climate system resulting from anthropogenic greenhouse gas emissions (GHG) is nonetheless meaningful in this context as geoengineering ultimately shares the same target. Because the UNFCCC is a framework convention, it contains only comparatively broad obligations which primarily address procedural requirements such as the obligation to collect and communicate information on GHG, national policies and best practices. Additionally, the UNFCCC contains various principles such as the precautionary principle (cf. Article 3 (3)) and the principle of common but differentiated responsibilities and respective capabilities (cf. Article 3(1)) which could potentially be employed to issues arising in regard to geoengineering. These principles assume particular importance where no detailed guidelines exist with which individual geoengineering technologies can be regulated (see below).

Stabilizing the atmospheric concentrations of GHG at a level to prevent dangerous disruptions of the climate system laid down in Article 2 UNFCCC is operationalized in the Kyoto Protocol of 1997. The Protocol requires the industrialized countries listed in Annex I to the UNFCCC to ensure that their GHG emissions do not exceed the individual reduction commitments set in Annex B to the Kyoto Protocol. Article 3 (3) Kyoto Protocol provides two different strategies: the removal of GHG through sinks and the reduction of GHG emissions at the source. Both concepts are already defined in the UNFCCC. Whereas “source” refers to “any process or activity which releases a greenhouse gas, an aerosol or a precursor of a greenhouse gas into the atmosphere” (Article 1 No. 9 UNFCCC), a “sink” is a “process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere” (Article 1 No. 8 UNFCCC). It is submitted that carbon dioxide

25 GAOR, 31st Session (1976), Supplement No. 27 (A/31/27), Report of the Conference of the Committee on Disarmament, Vol. I, p. 91 et seq.

26 Ibid, p. 92 (Understanding Relating to Article II).

27 See also Zedalis, *supra* note 24, at 20.

28 Ibid, at 19.

29 Ibid, p. 20.

30 Report of the Conference of the Committee on Disarmament, *supra* note 25, p. 92 (Understanding Relating to Article III).

removal (CDR) technologies, different to SRM,³¹ fall under the definition of sinks as their intention is to remove GHG from the atmosphere. As such, they not only support the overarching objective of the UNFCCC but also represent an implementation mechanism for achieving its objective. Different to the CBD which has been interpreted by the COP as setting comparatively strict legal limits to geoengineering research and deployment, climate protection law cannot, as far as CDR technologies are concerned, be interpreted as establishing a categorical or even partial prohibition of geoengineering. It further clarifies that mitigation and geoengineering cannot always be clearly distinguished.

2.3 Preliminary Conclusions

In light of the aforementioned, the following preliminary conclusions can be drawn: First, despite legal uncertainties attributable above all to scientific uncertainty concerning the risk of environmental damage posed by geoengineering, it can be confirmed that a general prohibition of geoengineering does not exist in international law. Secondly, analysis of the UNFCCC indicates that CDR meets with significantly fewer legal objections than SRM. Thirdly, customary international law requires that due regard is paid to the existing rights and territorial integrity of other States, and to the integrity of the global common spaces. As this cannot normally be assumed in the case of purely unilateral action that is likely to produce transboundary environmental effects, it is submitted that a general presumption of illegality exists for such measures.

3. The Way Forward

The preceding survey has revealed that the legal framework applicable to geoengineering is incomplete and comparatively vague. Particular challenges derive from the large degree of scientific uncertainty which exists in respect of the feasibility as well as the potential adverse effects on the environment of geoengineering technologies. As shown above (see section 2.1), customary international law demands that every decision for or against geoengineering research and/or deployment requires a risk assessment to be carried out prior to the commencement of the respective activity. At the same time, geoengineering is in essence aimed at contributing to the objectives of the UNFCCC, namely to combat global warming. This raises the question whether the targets pursued with geoengineering can lawfully be included in the risk assessment process.³² If this question is answered in the affirmative, defining trigger points above which pertinent activities ought to be considered unlawful constitutes a central challenge to be addressed in upcoming years.

³¹ Gerd Winter, Climate Engineering and International Law, *Review of European Community and International Environmental Law*, 2011, 277 et seq.

³² Cf. also UNEP/CBD/SBSTTA/16/INF/29, supra note 3, paras. 59 et seq.

3.1 Risk Balancing under the Precautionary Principle

In terms of international law, the issue of scientific uncertainty is addressed by the precautionary principle. The core elements of this principle are contained in Principle 15 of the Rio Declaration:

In order to protect the environment, the precautionary approach shall be widely applied by all States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradations.

Application of the precautionary principle is therefore characterized by the fact that different to the “no harm” principle discussed above, a causal connection between an action and environmental damage is not required.³³ While there is still a considerable degree of controversy on its legal status, with the USA recently reaffirming their position that the precautionary principle could not be considered as reflecting customary international law,³⁴ it should be noted that it can be found in at least rudimentary form in virtually all international agreements (except CLRTAP) relevant in the geoengineering context. In light of this, the precautionary principle can be considered as the “smallest common denominator”,³⁵ i.e., a regulatory tool establishing the relevant minimum standards in the international environmental law applicable to geoengineering.

Recourse to the precautionary principle in the context of geoengineering is particularly challenging due to the dual nature of scientific uncertainty. If the precautionary principle as included in the relevant international treaties would be interpreted as exclusively covering the potentially detrimental effects of geoengineering, this would not only ignore the existing interactions between climate protection, protection of biological diversity and marine environmental protection. Rather, such a one-dimensional reference to the precautionary principle would imply the danger that scientific uncertainty be perpetuated: A specific human activity (geoengineering) would be considered as prohibited because of a lack of scientific certainty regarding its potentially negative effects on the environment, while at the same time scientific testing carried out with the aim of obtaining the necessary evidence to make a determination as to the suitability of that activity in light of its potentially beneficial effect in respect of addressing global warming falters on the existence of the mere possibility of an environmentally detrimental consequence. Cass Sunstein has described the dilemma involved in the traditional reading of the precautionary principle in the following words:

³³ Cf. only James Cameron and Juli Abouchar, The Status of the Precautionary Principle in International Law, in: David Freestone and Ellen Hey (eds.), *The Precautionary Principle and International Law*, 1996, 29 at 45.

³⁴ UNEP/CBD/COP/11/3 of 21 June 2012, Report of the Sixteenth Meeting of the Subsidiary Body on Scientific, Technical and Technological Advice, para. 130 (available at: <<http://www.cbd.int/doc/meetings/cop/cop-11/official/cop-11-03-en.pdf>>).

³⁵ Alexander Proelss and Monika Krivickaite, Marine Biodiversity and Climate Change, *Carbon Capture Law Review*, 4 (2009), 437 at 444.

The real problem is that the principle offers no guidance – not that it is wrong, but that it forbids all courses of action, including regulation. [...] It is only to say that the simultaneous possibility of benefits at low levels and of harms at low levels makes the Precautionary Principle paralyzing. The principle requires use of a linear, non-threshold model; but simultaneously condemns use of that very model. [...] [T]he Precautionary Principle, taken for all that it is worth, is paralyzing: It stands as an obstacle to regulation and non-regulation, and to everything in between.³⁶

This is why it has been suggested that increased attention should be paid to a comprehensive, multi-faceted operationalization of the precautionary principle under which decisions on geoengineering testing and deployment are taken on a basis of a balancing of risks involved.³⁷ This submission is based on the particular structural nature of the precautionary principle, which may be detected by recourse to the normative theoretical distinction between rules and principles. It has rightly been stated that the principles of international environmental law, bearing their structural character in mind, “can provide an indication as to how conflicts between other rules and principles are to be resolved.”³⁸ If one accepts that it is in the legal nature of the precautionary principle to operationalize as a procedural balancing mechanism in order to resolve norm conflicts between different environmental regimes, it adds, in addition to the mechanisms of the law of treaties (collision clauses and treaty interpretation) and those of institutional cooperation, a third approach to the coordination of international environmental agreements.³⁹

In light of the rule of *pacta sunt servanda*, the following parameters determine the international minimum standards, i.e., standards that may well be tightened within a particular international agreement, or on the domestic plane respectively, that ought to be respected in the process of risk balancing in a given situation: (1) the manner in which the precautionary principle was drafted in the treaties simultaneously applicable in a given situation, (2) the degree of scientific uncertainty in regard to the potential negative environmental consequences of the activity concerned, (3) the magnitude of potential environmental damage caused by geoengineering research and/or deployment, and (4) the general primacy of mitigation (in terms of emissions reductions) as incorporated in the UNFCCC, i.e., the process of risk balancing must take account of the emissions reductions targets in force at the moment when the decision on geoengineering testing or deployment is taken. The outcome of the balancing process is particularly influenced by the precautionary principle’s “degree of hardness,” as determined by the relevant treaty. Thus, if scientific uncertainty exists in regard to the probability of e.g. climate-induced catastrophic environmental consequences, it must imply a fundamental precedence for the objects of protection of the treaty addressing these consequences, provided that the precautionary principle is not formulated

in a “harder” manner in the colliding treaty. In other words: The higher the risk of dramatic environmental damage, the less weight is to be ascribed to the objects of protection of the conflicting regime.⁴⁰

These parameters are further accompanied by the customary law duties resulting from the principle of prevention (see section 2.1 above) and an obligation to continuously monitor the impacts of ongoing geoengineering research in relation to the degree of existing scientific uncertainty.⁴¹ Even if a decision is taken in favour of geoengineering, it is mandatory that the environmental protection objectives of the “edged out” treaty need to be respected as far as possible due to the *pacta sunt servanda* maxim.⁴² With regard to geoengineering deployment or SRM experiments, applying the aforementioned parameter will, in particular in light of the extensive degree of scientific uncertainty vis-à-vis the potential disastrous environmental damage caused by these activities, at present inevitably lead to a decision *against* the acceptability of such a conduct.

3.2 Institutional Setting

With a view to the institutional setting of the balancing process, it is essential that that process is incorporated into some kind of international legal framework in the future. While one might think of the institutions that have arisen from the only global framework governing international relations, the UN Charter, it should be noted that the UN Security Council is not a world legislature with the competence to enact uniform standards for geoengineering treatment. It bears the primary responsibility for the maintenance of international peace and security, but has so far interpreted this mandate as only encompassing the prevention of the use of force, or massive violations of human rights respectively. Furthermore, the specific regime governing global warming as codified in the UNFCCC and the Kyoto Protocol is not equipped with an independent decision making body. Thus, the Conferences of the Parties (COPs) of the relevant international agreements will remain the competent fora for negotiating international minimum standards for the regulation of geoengineering. In the case of more specific treaties such as the London Convention and Protocol, it should be noted, though, that these fora only have the mandate to set the framework for individual geoengineering technologies. Moreover, allocating the final decision on whether geoengineering testing and/or deployment can be authorized to an international agency, or a board of internationally renowned scientists respectively, would involve serious problems of democratic legitimacy, taking into account the potential degree of affection of people and individuals by geoengineering activities.

The recently adopted Assessment Framework for Scientific Research Involving Ocean Fertilization⁴³ confirms that the legality of a specific geoengineering method is unlikely to be

36 Cass Sunstein, *Laws of Fear – Beyond the Precautionary Principle*, 2005, p. 26, 30–31, 33.

37 See Alexander Proelss, International Environmental Law and the Challenge of Climate Change, *German Yearbook of International Law*, 53 (2010), 61 at 81.

38 Alan E. Boyle, Some Reflections on the Relationship of Treaties and Custom, *International and Comparative Law Quarterly* 48 (1999), 901 at 907.

39 Proelss, *supra* note 37, 82.

40 For a foundation see Proelss, *supra* note 37, 83.

41 See COP CBD, Decision X/33 on Biological Diversity and Climate Change, para. 8 (w).

42 Proelss, *supra* note 37, at 82 *et seq.*

43 Resolution LC-LP.2 (2010) on the Assessment Framework for Scientific Research Involving Ocean Fertilization.

conclusively addressed at the international level. Instead, the final decision to authorize a geoengineering experiment will remain to be taken by the responsible national authorities, even though on the basis of the specifically applicable international. The situation would be different only if one or more geoengineering technologies were specifically prohibited or allowed at the international level. There are no indications that this will occur in the near future, however. Amendments to the London Protocol to regulate ocean fertilization that are presently discussed⁴⁴ would, in case of their adoption by the State parties, adhere to the fact that decisions on the admissibility of geoengineering experiments will have to be taken on the national level by the competent authorities of the State in accordance with general international law and the individual framework set by the London Protocol. As such, they would constitute a specifically applicable occurrence of the risk-balancing scheme discussed above and, indeed, a mechanism for adapting the general content and nature of the precautionary principle to a particular geoengineering technology.

44 Cf. LP CO₂ 5/1 of 31 March 2012.

4. Conclusion

Because scientific uncertainty in regard to both the potential negative impacts of geoengineering on the environment and the adverse consequences of climate change is unlikely to be resolved in the near future, regulatory strategies are called for which enable a flexible approach to new scientific findings and developments. This cannot be achieved by establishing norms of obligation or prohibition – a proposition which is already unrealistic due to the divergence of interests in the international community. If one accepts that it will be necessary in the future to answer the question on a case-by-case basis as to which potential environmental impacts are acceptable from geoengineering methods that are potentially suitable for mitigating the adverse effects of global warming, particular attention should be paid to the procedural safeguarding of decisions made on the basis of risk assessments. In addition, the general customary duties to conduct consultations and perform EIAs in the context of the pertinent treaties ought to be adapted to the specifics of the geoengineering methods in question and effectively implemented at the international level.

What are the Costs and Benefits of Climate Engineering? And Can We Assess Them?

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Abstract: Climate engineering is discussed as an alternative to the control of greenhouse gas emissions because it is perceived that there will be no sufficiently strong international agreement on effective climate policy measures and that many climate engineering technologies can be implemented at very low cost compared to emission control. We argue that the costs and benefits of climate engineering are so far essentially unknown and in many cases no adequate concept of the costs is used. Economic cost concepts are likely to show that the cost of climate engineering will be larger than currently perceived. However, many costs will be very difficult to quantify, thus making a full cost-benefit analysis essentially impossible and requiring a debate that goes beyond purely economic arguments.

Keywords: Climate engineering, economic cost, unintended side-effects
Klima-Engineering, wirtschaftliche Kosten, nichtintendierte Nebeneffekte

1. Introduction

Climate Engineering (CE) is the large-scale manipulation of the earth's radiation balance in order to counteract the fundamental changes of the earth system brought about by the continued emissions of greenhouse gas (GHG). Although the desire of the international community to limit the average temperature increase to 2°C within this century has been repeatedly confirmed – once again at the recent meeting of the parties to the United Nations Framework Convention (UNFCCC) in Durban, this desire has not been supported by agreements to control the increase in GHG and eventually reduce them to very low levels. It is therefore not surprising

that an increasing interest in CE can be observed. First small-scale field test of CE technologies are currently planned in the United States with privately funded money (e.g., in New Mexico).¹ At the same time strong opposition starts to form in several areas of civil society (e.g., ETC or Hand off Mother Earth Campaign).

Manipulating the weather is a century-old idea, although it was never clear whether the attempts have been successful. Nevertheless, the idea has also been transferred from weather

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