German Environment Agency

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Policy Brief: Governance of Geoengineering

What is Geoengineering?

Geoengineering comprises the conscious and deliberate intervention in the climate system – mostly on a large scale – for the purpose of limiting anthropogenic global warming.

All geoengineering measures have one thing in common: they are based on the assumption that global warming can be reduced by means of large-scale technical measures which directly intervene in the climate system. Geoengineering does not reduce anthropogenic greenhouse gas emissions, and therefore fails to address the cause of the anthropogenic global warming. It is merely intended to influence and alleviate the consequences.

Most geoengineering measures are still in their infancy and at the stage of theoretical consideration. All measures deployed at large-scale can have significant adverse side effects. Often, two categories of geoengineering measures are distinguished: Solar Radiation Management and Carbon Dioxide Removal (CDR).

Governance Principles

All Geoengineering Techniques

All geoengineering techniques are a deliberate intervention in the global climate system. Natural systems to which the climate system belongs are extremely complex and characterized by the nonlinear dynamics of their processes. The consequences of large-scale technical intervention are extremely difficult to assess.

In view of such a momentous decision it has to be considered that none of the proposed geoengineering techniques constitutes a lasting and sustainable solution for anthropogenic climate change. They **do not reduce the emission of greenhouse gases**. Instead they constitute further interventions in the natural global systems bound with various risks and even unknown effects.

These large-scale interventions might have the effect of gaining some time to reduce emissions at a more comfortable pace. However, this could amount to just postponing problem-solving. If geoengineering proves ineffective, then ironically it will have delayed mitigation possibly to the point that dangerous climate change is no longer avoidable. **Combating the causes of climate change could be delayed** while geoengineering would be pursued as an alternative to the necessary reductions of greenhouse gas emissions ("Moral Hazard"). As a result, future generations would be burdened with still-unknown additional consequences on top of the ongoing global warming.

Restrictive Regulation out of precaution

Though there is a desire for technical solutions for climate change we have to bear in mind that there is and will continue to be **incomplete knowledge** of the type, extent and probability of occurrence of adverse effects on the environment.

International and national governance approaches have to ensure that **for reasons of precaution** large-scale technical interventions that can have considerable adverse effects on humans and the environment do not take place. But if strictly defined exceptions for some CDR-techniques (e.g. CCS-based approaches) or small scale research activities should be carried out, governance mechanisms need to ensure that transparent, inclusive and thorough **impact assessments** take place. Permission has to be granted by competent authorities. A control mechanism based on self-commitment is not appropriate due to the potentially far reaching effects. Moreover, the potential for **climate effectiveness** has to be **proven**. This includes a comprehensive energy balance, which covers the energy-related cost of preparation and realization of the measure.

Two approaches for international governance of geoengineering are at hand. First, there should be a standardized, **broad regulation** on geoengineering that provides for the governance principles. Second, the **respective international conventions** and **specialized regimes** should be supplemented. Both approaches complement each other. The amendment of specialized regimes can take into account the fact that geoengineering measures differ significantly and require individual, differentiated assessments whereas a broad regulation can formulate overarching principles and minimum requirements for impact assessments.

It should be pointed out that geoengineering measures are based, at least in part, on **evolving technologies**. The result is that international regulations were often not drawn up with these technologies in view. Thus, where necessary, there is a **need for adaptation** or amendment.

Some technologies and possible side effects

In this paper, it is not possible to discuss all proposed geoengineering techniques. Instead, we highlight some techniques and their side effects. Often, two categories of geoengineering measures are distinguished: Solar Radiation Management and Carbon Dioxide Removal.

Solar Radiation Management

Solar radiation management (SRM) is intended to reduce the incidence and absorption of incoming short-wave solar radiation and to cool the atmosphere at ground level. Proposed SRM-measures are for example the release of aerosols such as sulphur compounds into the atmosphere, desert reflectors, or the brightening of human settlements. These measures do not counteract the causes of global warming since they do not reduce increased concentrations of greenhouse gases. Thus, they offer no solution to additional environmental impacts caused by greenhouse gas concentrations. Such environmental impacts include, for example, the acidification of the oceans.

Stratospheric aerosols might have the effect of rapidly cooling down the earth´s surface temperatures. But the overall intervention in the natural environment would be unparalleled. These aerosols only reside for a certain time in the stratosphere, so that sulphur compounds would have to be released at regular intervals in order to guarantee a long-term effect. Generally speaking, the effect of this measure is difficult to control. For instance, cloud formation in the troposphere would probably be affected as a result of the reduced incidence of solar radiation on

the ground. Reductions in rainfall would be a consequence. Dependent on the chemical compounds used, the aerosols could result in acid rain or the destruction of the ozone layer. Unforeseen effects could occur. Moreover, if SRM is terminated there would be a rapid and damaging rise in temperatures (termination shock). Currently, it is not possible to determine these effects to a satisfactory extent or to carry out reliable risk assessments. For precautionary reasons, this method must under no circumstances be employed before an adequate clarification of possible risks.

Moreover, there is a risk that SRM-measures could be carried out unilaterally by individual states. Such measures, however, bear considerable global conflict potential since geoengineering can entail highly varied risks in different regions, both for humans and the environment.

Carbon Dioxide Removal

Carbon dioxide removal (CDR) methods remove and store CO_2 that is already in the atmosphere, with the intent of reducing atmospheric CO_2 concentration. When deployed at a large scale these measures are also considered geoengineering. CDR-technologies currently discussed in the literature include BECCS (Bioenergy-combined with Carbon Capture and Storage) as well as Ocean Fertilization and Carbon capture from ambient air (DACCS). Depending on scale and design of implementation, afforestation can also be defined as geoengineering (e.g. hundreds of kilometers of monoculture plantations, possibly where forest would not naturally occur, requiring large chemical and water input).

In theory, CDR can reduce atmospheric CO_2 concentration and help limit global temperature increase. But it has to be stressed that the quantity of anthropogenic greenhouse gas emissions is not affected, which are the cause of the increasing CO_2 concentration. Deployed at large scale CDR measures are very resource intensive and tend to conflict with the Sustainable Development Goals and the conservation of natural resources. Most notable are the potential land use conflicts associated with BECCS and risks posed for food security, water resources and forests as well as other ecosystems.

The effectiveness of certain CDR measures requires that captured CO_2 be verifiably stored for long periods. The integrity of the storage medium must ensure that the stored CO_2 remains permanently removed from the atmosphere. The environmental effects that CO_2 storage might have at local levels – for instance, salinization through the permeation of saline water into aquifers and acidification of drinking water – must be investigated in each individual case. With a number of these measures it must be expected that the cost of consumed energy and logistics is often too high to justify the relative effect. On a societal scale, it would be more efficient to simply implement measures to reduce emissions.

Ocean fertilization: The use of ocean fertilization was initially encouraged on the basis of theoretical calculations. The goal of this method is to remove CO_2 from the atmosphere by converting carbon into phytoplankton biomass that sinks to the ocean floor and is thereby sequestered. The enthusiasm derived from theoretical studies dissipated because it became clear that the amount of phytoplankton that sank to the ocean floor was limited. Evidence of the effectiveness of ocean fertilization is therefore still lacking. The quantity of CO_2 emissions that arise during fertilizer production, transport and dumping would also have to be deducted from the potential sequestered quantity of CO_2. Besides the questionable effectiveness of the measure, **adverse effects** on the marine environment are also very probable. Ocean fertilization intervenes in the highly complex structure of **ocean food chains**. The costs of the ecological consequences of ocean fertilization such as eutrophication (excessive nutrient enrichment) and modified food chains, are **incalculable**. In the end, the eutrophication produced by ocean fertilization

undermines global, European and regional marine protection policy, which pursues the objective of reducing eutrophication and achieving a „good status“ of marine waters.

For further Information see: Umweltbundesamt, Geoengineering - effective climate protection or megalomania?, Dessau 2011, available under www.uba.de.

Need for responsible research

Even if global efforts for decarbonisation are successful, there will be **residual emissions** since it is not possible to reduce all anthropogenic greenhouse gas emissions to zero. Thus, there is a need for further research with regard to CDR. As mentioned above, due to the enormous risk, research on SRM techniques should not be supported.

A major focus of government funded research regarding CDR should therefore be on identifying successful policies and measures for reversing land degradation and deforestation in a sustainable manner throughout the world and determining the resulting carbon sequestration potential. In addition, research is required to better understand potential risks and tradeoffs of all CDR measures, particularly those that would require a large-scale implementation in order to be effective and therefore be considered as Geoengineering.

Being aware of the risks of large-scale technical interventions on the one hand and the need for further research on the other hand, risks have to be balanced. For a constructive debate the restrictive governance of research activities has to be separated from research support and funding.

The regulation of geoengineering must include the **regulation of research** in the case of a field experiment taking place which could have adverse effects on humans or the environment. Only **legitimate research** may be conducted (see below London Protocol). The risks of research activities must be determined and assessed at a preliminary stage. Before authorization of research or testing, considerable risks for humans and the environment must be ruled out. As a rule, accompanying research on potential risks should be obligatory.

Existing International Governance

De-Facto Moratorium on Geoengineering under CBD

As of October 2010, the politically significant resolution in CBD COP-Decision X/33, provides for a **broad moratorium** on geoengineering, summarized here:

A global, transparent, scientifically sound, and effective **control and regulation mechanism** for geoengineering is lacking. For this reason and in accordance with the **principle of precaution**, no geoengineering measures should be implemented until certain preconditions have been established. These include the existence of an appropriate scientific basis for justification of geoengineering and the proper consideration and examination of the risks for the environment and biodiversity as well as the social, economic and cultural consequences. Excluded from this moratorium are small-scale research studies that are conducted under controlled circumstances. Furthermore, such research projects must serve the purpose of acquisition of specific scientific data, and possible environmental effects have to be thoroughly examined. Some forms of CCS are excluded from the scope of application in footnote 2 of the decision.

With this decision, general requirements for geoengineering activities and, above all, research projects were formulated for the first time under the aegis of a globally valid convention. A possible legally binding regime in the future will reflect the provisions of the resolution.

Marine Geoengineering under London Protocol

The Contracting Parties to the London Protocol on Prevention of Marine Pollution adopted an amendment on 18 October 2013, concerning the framework regulation of marine geoengineering. So far, this framework regulation only prohibits ocean fertilization – as listed in the new Annex 4. Commercial projects of ocean fertilization are prohibited, while only legitimate scientific research in the field of ocean fertilization may be permitted. Based on the criteria of the "Assessment Framework" in Annex 5 it has to be assessed whether projects comprise of legitimate scientific research and whether adverse environmental effects are excluded. Economic interests may not influence the direction of the research project. Before a permission is granted, other states and interested parties have to be consulted. This amendment establishes an international agreement for assessment standards to distinguish between legitimate scientific research and deployment – both in general and within the field of geoengineering.

The framework regulation allows for the inclusion of other types of marine geoengineering techniques. The Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) will provide a research study on existing concepts of marine geoengineering early 2019. Based on this report the Contracting Parties of the London Protocol will consider whether additional marine geoengineering techniques should be listed and how they should be regulated.

Germany has ratified this amendment. In Germany it will come into force in June 2019.

Summary and Outlook

The governance of geoengineering in accordance with the precautionary principle has to ensure that considerable adverse effects on humans and the environment are ruled out. The De-Facto-Moratorium on geoengineering under the CBD-Convention acknowledges this basic principle by formulating a general prohibition on deployment and large-scale field experiments and restrictive exemptions for small-scale research projects on a preliminary basis. The amendment under the London Protocol takes the same approach going a step further with regard to marine geoengineering by establishing a legally binding regime. Both instruments are **mile stones** in the international governance of geoengineering. Future governance initiatives should aim at strengthening and supplementing the existing international governance. By no means should they result in a weakening of existing governance.

An UNEA-Resolution on geoengineering should contain a commitment on the De-Facto-CBD Moratorium on Geoengineering (COP-Decision X/33) and the Amendment of the London Protocol on Marine Geoengineering (Resolution LP.4(8) 2013).

More Information

Umweltbundesamt (2011), Geoengineering - effective climate protection or megalomania?, Dessau 2011, available here under uba.de.

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