A civil society briefing on Geoengineering

Climate change, smoke and mirrors

For the past decade, a small but growing group of governments and scientists, the majority from the most powerful and most climate-polluting countries in the world, has been pushing for political consideration of geoengineering, the deliberate large-scale technological manipulation of the climate.

Geoengineering is inherently high-risk and its negative effects will likely be unequally distributed. Because of this, geoengineering has often been presented as a "Plan B" to confront the climate crisis. But after the Paris Agreement, which set the ambitious goal of keeping the temperature to well below 2°C and possibly even 1.5°C, the discourse has changed. Now, geoengineering is increasingly being advanced as an "essential" means to reach this goal, through a mix of risky technologies that would take carbon out of the atmosphere to create so-called "negative emissions" or take control of the global thermostat to directly lower the climate's temperature.

It should be no surprise that geoengineering is gaining political currency as temperatures rise. The fossil fuel industry is desperate to protect its estimated $55 trillion of installed infrastructure and its $20-28 trillion in booked assets that can only be extracted if the corporations are allowed to overshoot GHG emissions.

The theoretical assumption is that geoengineering technologies might eventually let them recapture CO_2 from the atmosphere and bury it in the earth or ocean, or that injecting sulfates in the stratosphere could lower the temperature, "buying us more time" to finally agree to radically reduce our fossil fuel emissions. Either way provides the fossil fuel industry with means to avoid popping the "carbon bubble" beyond outright climate denial.
In other words, geoengineering proposals are becoming the fossil fuel industry's main tool to undermine the political will to lower actual emissions now. Geoengineering proposals are also becoming the weapon of last resort for some desperate climate scientists unable to produce pathways that realign our growth-driven economic model with a climate-safe future.

But what exactly is geoengineering and what technologies are being proposed? And what are the risks and implications associated with the respective technologies when it comes to ecological integrity, environmental and climate justice and democracy?

What is geoengineering?

The notion of geoengineering the climate has been around for well over a century. Until recently, it was mostly discussed as a proposed military tool to control the weather for hostile purposes. With the onset of the growing climate crisis, the spectrum of geoengineering proposals has increased, and today, public debate about geoengineering explores whether it is a means to combat climate change rather than other nations.

Geoengineering, or climate geoengineering, refers to a set of proposed techniques and technologies to deliberately intervene in and alter Earth systems on a large scale – particularly to climate system manipulations as a "technofix" for climate change. It is increasingly suggested as a way to "buy more time" for real, transformative change in the future, or as an insurance policy for our great grandchildren, thus passing on the difficult burden to the next generation.

Geoengineering may comprise interventions on land, oceans, or in the atmosphere. It may include so-called solar radiation management (SRM), as well as other Earth system interventions under the umbrella of carbon dioxide removal (CDR) or greenhouse gas removal (GGR). These are all theoretical proposals, and although a few CDR techniques may be closer to the market according to their promoters, the claim that these technologies would be effective for addressing climate change is speculation, based at best on limited computer modeling.

Significantly, none of the geoengineering techniques on the table aim to address the root causes of climate change. Instead, they are intended to partially counteract some of its symptoms. Underlying drivers of climate change (e.g. growing consumption, deforestation, unsustainable agriculture and land use changes) will continue unaffected. Because geoengineering by definition aims to intentionally alter Earth systems such as the carbon cycle and hydrological cycle, it is transboundary in nature. And because we know very little about the functioning of the planetary ecosystem as a whole, and all its subsystems, there is a significant likelihood that rather than improving the climate, it could make things worse.

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Feedback and comments are welcome. Contact: grupoetc@etcgroup.org / schneider@boell.de

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Why is geoengineering so dangerous?

Every geoengineering technology has particular risks, but all share some key problems:

Scale: For any geoengineering technique to have an impact on the global climate, it will have to be deployed on a massive scale. Unintended consequences arising from deployment could therefore also be at massive scale and will likely be transboundary.

Unreliable and high-risk: Geoengineering intends to intervene in poorly-understood, dynamic and complex systems, such as climate and ocean ecology. Interventions could go awry because of mechanical failure, human error, incomplete knowledge and climate data, unpredictable synergic effects, natural phenomena (like volcanic eruptions, earthquakes, tsunamis), trans-boundary impacts, change in political regime or funding failures, among others. In some cases, such as solar radiation management, sudden termination could lead to jumps in temperature and feedback effects that could be even worse than the climate effect meant to be addressed.

Irreversibility: Many tipping points in the global climate system will be irreversible. No amount of "negative emissions" are likely to help to refreeze the Arctic or restore the Monsoon. The application of geoengineering technologies itself can also be irreversible: ecological or social damage done through geoengineering deployment or experiments may not be undone. Once we begin with artificially cooling the planet while continuing to emit fossil fuel emissions, it will be impossible to stop half way.

Promote climate inaction: Geoengineering is a "perfect excuse" for climate deniers and governments seeking to avoid the political costs of carbon reductions. For those looking to stall meaningful climate action, the active development of geoengineering tools and experiments appears as the preferred pathway to "address" climate change, as well as an argument to ease restrictions on high-carbon-emitting industries. And even climate change deniers might see this as a convenient (military) solution to a problem that they think does not exist. Already some of the strongest forces pushing for geoengineering research are neo-conservative thinktanks close to industry who previously peddled climate denialism as a tactic (e.g. Bjorn Lomborg's Copenhagen Consensus Center or the American Enterprise Institute).

Deviate resources, funding and research efforts from urgently-needed, real, precautionary, ecological, just pathways for mitigation and adaptation to climate change.

Unilateral and unequal: It appears that the same powerful countries' corporations, which are the principal historical emitters of GHG, control the budgets and the technologies best able to develop and execute these proposals. By keeping the polluters in charge of the solution to climate change, the interests of marginalized and oppressed peoples will continue to be excluded. The negative impacts of many proposals will be particularly harsh among developing countries in the Global South.

Environmental hazards: All proposed geoengineering techniques have potentially serious environmental impacts. For example, ocean fertilization is able to disrupt the marine food chain, create harmful algae blooms and anoxia in some of the sea layers. Deploying bio-energy with carbon capture and storage (BECCS) would imply a devastating grab for land, water and nutrients, involving even "massive displacements of land and people, with global implications for food supply, land rights, and environmental justice."[1] With SRM techniques, it is not possible to know with any certainty how altering the amount of incoming heat to the planet could affect ecosystems, since it will create an entirely new ecological balance (or disturbance) that could diminish biodiversity and disrupt ecosystems. The energy from incoming sunlight is an essential resource for life on the planet and is closely linked, for example to supporting the oceanic algae who produce most of the world's oxygen. Basic ecological common sense tells us that changing this one key variable could have ripple effects throughout global ecosystems. There are other potentially very grave effects of SRM depending on the technique and geography, including increased depletion of the ozone layer, changed weather patterns around the tropics and subtropics, and severe droughts in Africa and Asia, that could be catastrophic. These would severely affect the source of food and water for billions of people.

1 Silke Beck and Martin Mahony, "The IPCC and the politics of anticipation," *Nature Climate Change,* vol. 7 no. 5, April 2017.

Intergenerational injustice: The idea that geoengineering will just "buy time" to allow for a change towards low carbon sustainable policies in the coming decades, is profoundly unrealistic and unjust for future generations. The efficacy and viability of "negative emissions" based on theoretical CDR techniques is not proven anywhere, yet just the idea of negative emissions is already functioning to delay the urgently-needed reductions that must happen now. These phantom technologies put the burden on future generations. Anderson & Peters (2016) call it an "unjust and high-stakes gamble." [2] In the case of SRM, because it would mask the actual warming in the atmosphere, if it was terminated, a sudden jump in warming would occur, which would be much more difficult for ecosystems to adapt to and for society to tackle than gradual warming. We cannot condemn our children and grandchildren to be either captives of geoengineering that we began and cannot stop, or victims of an even harder climate future because we left them to come up with fantasy technologies that we ourselves did not have available.

Weaponization: The military origin and implications of geoengineering for warfare are often forgotten or intentionally not mentioned. Yet the concept of controlling the weather and climate comes from military strategies, and even precipitated the signing of the international Environmental Modification Convention (ENMOD).[3] Military leaders in the United States and other countries have pondered the possibilities of weaponized weather manipulation for decades. That the publicly-stated aim of a technology is to "combat climate change" does not guarantee its applications will be limited to peaceful uses, and provides a handy cover for dual-use experimentation. If anybody can claim to control the Earth's thermostat, this can and will be used for military and geopolitical purposes, as Historian James Fleming has described.[4] Even before hostile use, any state or actor claiming to be able to alter global weather patterns will hold a powerful geopolitical bargaining chip with which to threaten and bully.

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Exacerbating global power imbalances: The prospect of controlling global temperatures raises serious questions of power and justice: Who gets to control the Earth's thermostat and adjust the climate for their own interests? Who will make the decision to deploy if such drastic measures are considered technically feasible, and whose interests will be left out? Governments of the world found it impossible to collaborate democratically to agree on a global legally binding climate change treaty with fair effort sharing and support for all. It is hard to imagine that governments would be able to do this when it comes to geoengineering, where countries have clear geopolitical interests to determine regional to global climate realities. In fact, were we able to achieve such international collaboration and trust over decisions about our common climate, we would not need to talk about geoengineering now. We would already see real climate action across the globe.

Commercialization of climate: Competition is already stiff in the patent offices among those who think they have a planetary fix for the climate crisis. The prospect of a private monopoly holding the "rights" to modify the climate is terrifying.

Carbon profiteering: Several geoengineers have their own commercial interests in promoting geoengineering techniques for profit. They own patents, and some of them have actively sought to establish geoengineering technologies as eligible for carbon trade schemes.

Treaty violation: Deployment of geoengineering would constitute a violation of different UN treaties and decisions, including the ENMOD treaty, the Convention on Biological Diversity and the London Convention / London Protocol.

2 Kevin Anderson and Glen Peters, "The trouble with negative emissions." *Science,* vol. 354, no. 6309, October 2016

3 ENMOD is an international treaty signed in 1977 that prohibits the military or other hostile use of environmental modification techniques that could have widespread, long-lasting or severe effects. It was formed after the USA used weather modification as a means of war in the Vietnam war.

4 James Fleming, *Fixing the Sky: The Checkered History of Weather and Climate Control, Columbia Studies in International and Global History,* Columbia University Press, 2012.

Proposed geoengineering techniques

Greenhouse Gas Removal

Greenhouse Gas Removal (GGR) refers to a set of proposed technologies that remove greenhouse gases from the atmosphere. A more common umbrella term is **Carbon Dioxide Removal (CDR)**, but that excludes other gases such as methane. Below are some of the proposals:

Ocean Fertilization (OF)

Ocean fertilization refers to dumping iron or other nutrients (e.g. urea) into the ocean in areas with low biological productivity in order to stimulate phytoplankton growth. In theory, the resulting phytoplankton draw down atmospheric CO_2 and then die, falling to the ocean bed and sequestering carbon. The efficacy of OF is strongly questioned, as much of the “sequestered” carbon would likely be released again through the food chain. It can also provoke marine food chain disruption and anoxia (lack of oxygen) in some of ocean layers and may cause toxic algae blooms.

Artificial upwelling

A technique to mix ocean waters by artificially bringing nutrient-rich waters from depths up to the surface ocean to stimulate phytoplankton activity. In theory, this would draw down CO_2 by ocean fertilization. As with OF, its efficacy is questioned. It will also disrupt marine food chain and environment, and bring already-sequestered CO2 to the surface.

Carbon Capture and Storage (CCS)

CCS usually refers to the mechanical capture of CO_2 emissions from power plants or other industrial sources. The CO_2 is typically captured before the emissions leave the smokestack, generally with a sorbent chemical. The liquified CO_2 is then pumped into underground aquifers for long-term storage. CCS was originally called “enhanced oil recovery/EOR” since it is a technology from the oil industry to recover residual reserves of petroleum by pumping pressurized gas into empty wells. CCS is not economically viable unless heavily subsidized, and when used as an oil recovery technique it promotes further oil exploitation. Its ability to permanently sequester carbon is broadly questioned. The captured carbon could leak out due to many reasons: faulty construction, earthquakes or other underground movements. At these concentrations, CO_2 is highly toxic for animal and vegetable life. CCS associated with fossil fuels was exempted from the UN Convention on Biodiversity definition on geoengineering, but it is still included in other definitions.

Carbon Capture Use and Storage (CCUS)

The idea behind CCUS is that captured CO_2 from either industry or the atmosphere can be used as a feedstock for manufacturing, theoretically resulting in the CO_2 being stored in manufactured products. One hypothetical example involves feeding captured CO_2 to algae which produce biofuels; another is reacting CO2 with calcifying minerals to produce concrete for building purposes. CCUS has many of the potential impacts of CCS, but with increased risk for CO_2 releases in processing and from the end-products. CCUS may also have questionable energy balance once the total energy required for transport and processing is factored in, as well as end of life considerations – there may be net increase in GHG emissions.

Direct Air Capture (DAC)

DAC refers to extracting CO_2 or other greenhouse gases from the atmosphere by chemical and mechanical means, generally using a chemical sorbent and large fans to move ambient air through a filter. The CO_2 is then available as a stream of gas for CCS or enhanced oil recovery or other uses. DAC is a commercial proposal that appears to have very heavy energy requirements, and like CCS is being proposed for enhanced oil recovery in locations where industrial sources of CO_2 may be limited. Current DAC prototypes recover ambient CO_2 at low levels. To have any significant effect they may have an environmental impact on land, and to supply the necessary levels of sorbent there may be significant toxicity impacts. The storage question is unresolved, and theoretically linking in it to CCS or CCUS will not resolve it, as described above.

Bioenergy with Carbon Capture & Storage (BECCS)

BECCS describes capturing CO_2 from bioenergy applications (e.g., producing ethanol or burning biomass for electricity) and subsequently sequestering that CO_2 through either CCS or CCUS. The theory is that BECCS is “carbon negative” because bioenergy is theoretically “carbon neutral,” based on the idea that plants will regrow to fix the carbon that has been emitted. Bioenergy critics point out that this overlooks emissions from land use change and life cycle emissions. According to IPCC AR5, to keep the temperature under 2 degrees with a theoretically effective BECCS system would require between 500 million and 6 billion hectares of land. Current global crop production covers 1.5 billion hectares – the impact on land, water, biodiversity and livelihoods, as well as competition for land to grow food would be devastating.

Enhanced Weathering (EW)

EW techniques propose to dissolve crushed minerals (particularly silicate minerals) on land or in the sea in order to chemically react with and fix atmospheric CO_2 into oceans and soils. The huge demand for minerals would have serious impacts on land and biodiversity, extending the harmful impacts of mining operations. Deliberately changing the overall chemistry of oceans is fraught with many unknowns and unpredictable factors.

Biochar

Biochar techniques propose to burn biomass and municipal waste without oxygen to create charcoal. This charcoal is then mixed into soils as a soil additive, directly burying carbon into the soil. Biochar soils are claimed to be more fertile since they have higher carbon content. The approach is inspired by (but very different from) Amazonian Terra Preta black soils where indigenous communities have used charcoal to improve fertility. Industrial biochar would demand large land areas for plantations to be burned afterwards; it could disrupt soil life, potentially increasing greenhouse emissions from soil; and depending on the source of the biomass, may create concentrations of toxic contaminants. The claimed productivity boost from biochar as a soil amendment is inconsistent across different chars.

Solar Radiation Management

Solar Radiation Management (SRM) describes a suite of proposed technologies that aim to reflect sunlight back into space before it warms the Earth's climate. The main SRM proposals include:

Stratospheric Aerosol Injection (SAI)

This is an SRM proposal to spray large quantities of inorganic particles (e.g. sulphur dioxide) into the stratosphere (the upper layer of the atmosphere) to act as a reflective barrier against incoming sunlight. Proposals range from shooting particles from artillery guns, using large hoses to reach the sky, or emptying particles from the back of aircrafts. The design of self-levitating particles, as well as the use of particles of other reflective materials (e.g. titanium, aluminum, calcite, even diamond dust) have also been considered. SAI using sulphates, the most-studied option, would likely cause ozone layer depletion and may disrupt rain and wind patterns across the tropics and subtropics. This could cause droughts in Africa and Asia and affect monsoons, with serious environmental impacts, and endanger the source of food and water for two billion people.

Marine Cloud Brightening (MCB) or Cloud Reflectivity Enhancement

MCB proposals aim to increase the whiteness of clouds in order to reflect more sunlight back into space. As with other SRM proposals, changing solar radiation can impact weather patterns and there may be impacts on marine and coastal ecosystems as well as agriculture.

Cirrus Cloud Thinning

By thinning cirrus clouds (wispy, elongated clouds at high altitudes), some researchers have proposed that more heat could be allowed to escape into space, creating an overall cooling of the climate. This idea could have even opposite effect, as there are many unknowns about cloud formation and chemistry with potentially unpredictable effects.

High-Albedo Crops and Snow Forest Clearance

Various proposals suggest that growing crops that reflect more light (either new genetically-engineered crops, or high-albedo varieties of existing crops) could cool the atmosphere by reflecting more solar radiation back into space. Others suggest clearing forests that exist in areas that are snow-covered for a large part of the year, which would increase the amount of light reflected back into space by the flatter, brighter snow. Using genetically modified crops or trees carries all the biosafety and land use impacts of these plantations, including soil erosion and heavy use of contaminating agrochemicals. Clearing forests to create white desserts would negatively impact biodiversity and climate.

Microbubbles and Sea Foams

Proposals are being advanced to increase the reflectivity of the ocean surface (or other water bodies) by creating tiny bubbles or dispersing foaming agents on the surface of the water. Besides disrupting the flux of light for ocean life, foams may also reduce oxygen to the upper layers of the ocean, negatively affecting biodiversity.

Weather Modification

Weather modification (WM) refers to various techniques – including cloud seeding and related techniques – for changing weather and precipitation patterns without intending to change overall climate patterns. WM have caused communities to suffer droughts and/or flooding of crops, but because it is believed to have local or regional impacts only, it is often not considered geoengineering.

To learn more about the impacts of each technology, see Geoengineering Monitor **www.geoengineeringmonitor.org**

About governance of geoengineering

The UN **Convention on Biological Diversity (CBD)** has been discussing geoengineering since 2007. In 2009, after producing a thorough, peer-reviewed technical report on ocean fertilization and taking into account a call for "utmost caution" from the London Convention,[5] the CBD took a consensus decision calling for a moratorium on ocean fertilization, urging governments to ensure that no fertilization activities would take place until a series of stringent requirements are met, including that a "global, transparent and effective control and regulatory mechanism is in place."[6]

In 2010, the CBD took another landmark decision on a de facto moratorium on geoengineering, a consensus call from 193 governments (the USA is not a party to the CBD), to ensure that "in line and consistent with its previous decision" on ocean fertilization, "no climate-related geo-engineering activities that may affect biodiversity take place, until there is an adequate scientific basis on which to justify such activities and appropriate consideration of the associated risks for the environment and biodiversity and associated social, economic and cultural impacts."[7] However, in the definition of geoengineering, "CCS from fossil fuels" (not from bioenergy) were not considered geoengineering by the CBD. The CBD has since produced two peer-reviewed technical reports on geoengineering and has reaffirmed the moratorium in 2012 and 2016.[8]

Both moratoria leave a space for "small scale" experiments, but only "if justified to gather scientific data" and with a list of prior requirements to be fulfilled before they proceed, such as a thorough prior environmental impact assessment, a "controlled setting," and ensuring that no transboundary impacts would occur.

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In the case of ocean fertilization, it is also stated that it can "not be used for generating and selling carbon offsets or any other commercial purposes."

Governments at the CBD consider these decisions to be highly relevant, to the point that discussion on three geoengineering experiments have addressed the CBD decisions. (Ocean fertilization experiment LOHAFEX by India and Germany,[9] the private HRSC ocean fertilization rogue experiment near Haida Gwaii, Canada,[10] and one experiment devised to try SRM equipment, SPICE, in the UK.[11])

The **London Convention**, and its **London Protocol** (Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter), have moved forward the discussions and decisions on ocean fertilization since 2007, and issued several calls on "utmost precaution." In 2013, the London Protocol took a decision that all ocean fertilization activities shall not be permitted, excepting those that constitute "legitimate scientific research" – a term that has also been closely defined.[12]

Notwithstanding, a very small group of governments from Northern high-emitting countries, as well as geoengineering promoters, insist today that the moratoria are just "a call," trying to downplay their relevance. Instead, they promote non-binding "ethical guidelines," "codes of conduct," and similar voluntary measures developed by groups of academics as a way forward when it comes to building global governance for geoengineering research and potential deployment. Comparing the consensus decision of 193 governments in a universal treaty like the CBD to guidelines developed by academics endorsed by pro-geoengineering institutions is a mockery of democratic governance, but useful to pave the way for more experiments and for collecting more funding for research.

5 International Maritime Organization, "Ocean Fertilization under the LC/LP," (History of the negotiations on geoengineering under LC and its London Protocol). Available at: http://www.imo.org/en/OurWork/Environment/LCLP/EmergingIssues/geoengineering/OceanFertilizationDocumentRepository/OceanFertilization/Pages/default.aspx

6 CBD, COP 9 Decision IX/16 section C, paragraph 4, 2008. Available at https://www.cbd.int/decision/cop/?id=11659

7 CBD, COP 10 Decision X/33 paragraph 8(w), 2010. Available at https://www.cbd.int/decision/cop/?id=12299

8 The decade-long history of the CBD negotiations and produced reports are gathered at: https://www.cbd.int/climate/geoengineering/

9 Quirin Schiermeier, "Ocean fertilization experiment suspended," *Nature News,* 14 January 2009. Available at http://www.nature.com/news/2009/090114/full/news.2009.26.html

10 ETC Group, "Case Study: Ocean Fertilization near Haida Gwaii," 28 March 2013. Available at http://www.etcgroup.org/content/case-study-ocean-fertilization-near-haida-gwaii

11 ETC Group, "Say no to the Trojan Hose," News Release, 27 September 2011. Available at http://www.etcgroup.org/content/say-no-trojan-hose

12 London Convention/ London Protocol, Resolution LP.4 (8) in LC 35/15

The **UN Framework Convention on Climate Change (UNFCCC)** has not considered geoengineering as such in its official agenda. It has debated the issue of Carbon Capture and Storage (CCS) since 2005, with many governments opposing it. In 2011, CCS was approved to be included in the Clean Development Mechanism. In 2014, a Technical Expert Meeting on CCS was held. The approval of the Paris Agreement and the gap between the stated goals and the presented NDCs created a situation in which geoengineers are now attempting to introduce the issue of geoengineering into the UNFCCC, for example in the context of the facilitative dialogue that will take stock of governments' nationally determined contributions in 2018.

The **Intergovernmental Panel on Climate Change (IPCC)** has made very minor mentions of geoengineering since its 2nd Assessment Report (AR2) through to its AR4 report, basically indicating that "geoengineering options are largely speculative and unproven and with the risk of unknown side-effects." In 2011, the IPCC held a Meeting of Experts on Geoengineering, an initiative that was widely criticized by 160 international and national civil society organizations.[13]

In AR5, the IPCC included a small section analyzing some of the CDR techniques and in its Synthesis Report expressed that:

> "SRM technologies raise questions about costs, risks, governance and ethical implications of development and deployment. There are special challenges emerging for international institutions and mechanisms that could coordinate research and possibly restrain testing and deployment. Even if SRM would reduce human-made global temperature increase, it would imply spatial and temporal redistributions of risks. SRM thus introduces important questions of intragenerational and intergenerational justice. Research on SRM, as well as its eventual deployment, has been subject to ethical objections. In spite of the estimated low potential costs of some SRM deployment technologies, they will not necessarily pass a benefit–cost test that takes account of the range of risks and side effects. The governance implications of SRM are particularly challenging, especially as unilateral action might lead to significant effects and costs for others."[14]

However, the surprising element in AR5 was that the IPCC considered the extensive use of one geoengineering approach, BECCS, in the majority of the scenarios for possible futures in its Working Group 3. In the four main Representative Concentration Pathways (RCPs) offered to climate policy makers, the use of BECCS and "negative emissions technologies" are heavily represented, without any consideration of their viability and the extremely serious social, food security and environmental impacts of such a large deployment of BECCS. This bias has motivated the publication of an increasing number of highly critical papers from both scientific media and civil society organizations.[15]

__Comparing the consensus decision of 193 governments in a universal treaty like the CBD to guidelines developed by academics endorsed by pro-geoengineering institutions is a mockery of democratic governance, but is useful to justify further geoengineering experiments and to attract more funding for research.__

In the light of this mistake, and the critical position of AR5 towards SRM, it is again surprising to see that in the background documents for several special reports and other documents for AR6, geoengineering has been put forward as an option to analyze. The IPCC Chairman's Vision for the Sixth Assessment Report included a proposal for geoengineering to be considered as a cross-cutting issue throughout all working groups. This has already motivated criticism from both governments and civil society. The final decision on the contents of the AR6 is still to be discussed at the IPCC 46th session, in September 2017.

Both CBD and London Convention/London Protocol decisions, as well as provisions in other multilateral fora, constitute important pieces of an evolving geoengineering governance framework. Geoengineering's foreseen unequal negative impacts among countries and regions, and its potential to further imbalance the global climate system, means that any decisions on geoengineering open-air experiments or deployment must be taken by a multilateral, democratic, transparent and accountable global governance mechanism, including the consideration of the possibility to establish a permanent ban on geoengineering. The speed with which the pro-geoengineering discourse and related science are currently developing tools for large experiments and potential unilateral deployment means that we have to act fast. A lively and critical civil society discussion on geoengineering is crucial to inform policy makers and the wider public about the implications and alternatives.

13 Open Letter to IPCC, 2011. Available at http://www.etcgroup.org/content/open-letter-ipcc-geoengineering ETC Group, "The IPCC´s AR5 and geoengineering," Briefing, 28 March 2014. Available at http://www.etcgroup.org/content/ipcc-ar5-geoengineering-march2014

14 IPCC, *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* IPCC, 2015, p. 69.

15 Biofuelwatch & Heinrich Boell Foundation, *BECCS: Last-ditch climate option or wishful thinking?* Report, April 2016. Available at: https://www.boell.de/en/2016/04/29/last-ditch-climate-option-or-wishful-thinking

But should we not at least do experiments to learn more…?

Small scale geoengineering experiments are often presented as a harmless and necessary step toward a more-informed debate on the risks and benefits of geoengineering. It is argued that these experiments would have less-immediate environmental impact and would first and foremost be experiments to better understand atmospheric chemistry and physics related to geoengineering. But that perspective overlooks key issues.

First, geoengineering must be considered as a political rather than a technical issue. We need much wider discussion on other aspects to decide as society if we choose to embark on these high-risk, undemocratic technologies.

Second, geoengineering advocates are keen to move to open-air experimentation not for the purpose of disinterested science, but for political reasons: once a technical field moves into 'proof of principle' experiments, it crosses a significant line towards realization and can be more credibly advanced as a policy option.

…it is essential to strengthen the precautionary approach: experiments in the real world (open air, ocean, land) should not be allowed in the absence of strong governance.

This is one of the reasons that 'field tests' have often become so controversial (e.g. field testing of nuclear technologies, GMO crops, space weapons, "scientific whaling").

Third, there is no such thing as a "geoengineering experiment." None of the geoengineering proposals are ready to be deployed on a scale that would have any impact on the global climate. "Small-scale" experiments to develop scientific knowledge and hardware will tell us nothing about the influence on the global climate system. To have that effect, they would need to be deployed on a geographical and temporal scale (to be able to differentiate the impacts of normal climate variations and climatic "noise") that could no longer be called an experiment: it would be deployment, with all its risk and likely irreversible impacts.

Therefore, it is essential to strengthen the precautionary approach: experiments in the real world (open air, ocean, land) should not be allowed in the absence of strong governance.

Politics and precaution first

Because of the geopolitical high-stakes, risk of weaponization, and intergenerational implications of geoengineering, the global community should first and foremost debate these aspects, before allowing the development of tools that a climate-denying government or "a coalition of the willing" could use, even if all other governments would conclude it is too risky and unfair to use. Geoengineering can never be confined to a technical discussion, a matter of "developing tools, just in case" or confined just to a climate perspective.

Geoengineering research should – in line with the CBD decision – be focused on socio-political, ecological, ethical questions and potential impacts and contribute to a debate about whether democratic governance of geoengineering is ever possible, and how. And even more important: funding and research on climate change needs to urgently be scaled up to support implementation of proven and locally adapted ecologically and socially sound solutions to the climate crisis – not speculative and distracting technofixes.

More information:

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