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Geoengineering

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(ETC Group)

GEOENGINEERING is the intentional, large-scale, technological manipulation of the Earth's systems including systems related to climate. These manipulations may include so-called solar radiation management (SRM) and carbon dioxide removal (CDR), as well as other earth system interventions. Geoengineering can be a land-based intervention or interventions in the oceans or in the atmosphere.

ISSUE: Geoengineering is moving rapidly from academic discussion to political action. The IPCC's latest assessment report (AR5), for the first time, includes a discussion of geoengineering as a theoretical "Plan B" to address climate change if governments fail to adequately reduce greenhouse gas (GHG) emissions. Since 2008, however, governments and scientific academies in such countries as USA, UK, Germany and Russia have conducted debates, requested studies, and/or conducted research and experiments on ocean fertilization intended to sequester carbon and SRM techniques to reflect or block sunlight.

UN ACTIVITIES: Discussions of geoengineering in the United Nations have been focused in the Convention on Biological Diversity (CBD) through a de facto moratorium on ocean fertilization (2008), which broadened to a moratorium on all forms of geoengineering in 2010. Rio+20's outcome ("The Future We Want") reiterated global opposition to ocean fertilization and, this October, the London Protocol on Ocean Dumping made its existing ocean fertilization prohibition legally binding. The summary for policy makers of the IPCC Working Group I report, also adopted in October, tackled the potential of CDR techniques to achieve negative emissions and weighed in on the pros and cons of geoengineering technologies.

CONTINUING RISK: Some governments see geoengineering as a quick, cheap and potentially unilateral 'techno- fix' that allows them to sidestep their historic mitigation and adaptation obligations to the international community.

Computer modeling and peer-reviewed studies of geoengineering techniques to-date show, overwhelmingly, that while the interventions may, in some cases, temporarily, lower temperatures or appear to sequester carbon dioxide, the negative impacts on some or several parts of the tropics and subtropics could be catastrophic. Galvanized by growing alarm over climate change and the domestic political costs of reducing emissions and changing lifestyles in Annex I countries, some governments are increasingly sanguine about developing these technologies.

In the absence of a fully-informed international debate in the UN General Assembly, the political trend line is clear: one or a handful of major governments will, within the next few years, unilaterally experiment with large-scale earth system manipulations, purportedly to forestall climate change.

What technologies are involved in Geoengineering?

There are three broad categories of geoengineering technologies in research and development in Northern academic, public and private settings: (1) Solar Radiation Management (SRM); (2) Carbon Dioxide [CO_2] Removal; and (3) Weather Modification. Within each category, the most prominent of these technologies are:

1. **Solar Radiation Management**

- Aerosol sulphates in the stratosphere: Pumping aerosol sulphates or aluminum (nano)particles into the stratosphere to block sunlight, thereby lowering the Earth's surface temperature, though without reducing the level of greenhouse gases (GHGs) in the atmosphere.

- Cloud whitening: Spraying seawater into the atmosphere to increase the reflectivity and condensation of clouds, thereby reflecting more of the sun's rays back into space.

- Space sunshades: Launching trillions of small free-flying spacecrafts, or space mirrors, a million miles above the Earth to prevent a portion of the sun's rays from hitting the planet, thereby reducing global warming.

- Albedo enhancement: Increasing the reflectivity of the Earth's surface by planting whiter or shinier crops, or covering desert regions or mountains with reflective white material.

Implications: The artificial manipulation of radiative forcing could wreak havoc on the fragile balance of complex ecosystems that has taken millennia to evolve. SRM is a blunt instrument – an emergency measure theoretically used to cool the climate in catastrophic situations. Increasingly, however, it is being considered as part of a permanent planetary management, where different variables could be optimized to deliver a made-to-order climate.[1] It is well established that geoengineering's impact on regional climates would be diverse and not sufficiently understood with current modeling techniques. The countries capable of deploying such technologies would effectively have one hand on the thermostat and the other on the water cycle.

2. **Carbon Dioxide Removal**

- Ocean fertilization: Promoting carbon sequestration deep at sea by using iron or nitrogen to artificially stimulate the growth of phytoplankton.
- Ocean upwelling or downwelling enhancement: Using giant pipes to bring nitrogen or phosphorous-enriched waters up from the deep ocean in order to cool surface waters and enhance ocean sequestration of CO_2.
- Genetic engineering of algae: Using genetically engineered algae, often created through synthetic biology techniques, to cover urban buildings, open ponds, or the surface of the ocean in order to capture CO_2.
- Carbon-sucking machines or synthetic trees (air capture): Extracting CO_2 from the air by using liquid sodium hydroxide (or other materials), which is converted to sodium carbonate; the "excess" solid carbon dioxide is then buried in the soil or dumped in the oceans.

[1] See, for example, "Optimizing Climate Change Reduction," Carnegie Institution, Department of Global Ecology, 2010, which reports on a study by Ken Caldeira and George Ban-Weiss that asked, "how, if people decided what kind of climate they want, they would go about determining the aerosol distribution pattern that would come closest to achieving their climate goals;" available at http://carnegiescience.edu/news/optimizing_climate_change_reduction

- Biochar: Planting huge quantities of biomass and burning it by pyrolysis (low oxygen environment) and burying the concentrated carbon in the soil, a proposal backed by the corporate-driven International Biochar Initiative. The industrial production of biochar claims traditional Amazonian *terra preta* as its ancestor, but the practices differ both qualitatively and in scale.
- Carbon capture and storage: This umbrella heading most often refers to capturing CO_2 at source (before it enters the atmosphere) and storing it in the oceans or in terrestrial geologic formations. It is generally not considered a geoengineering technique as it aims to capture CO_2 before it is released to the atmosphere. Nonetheless, it is problematic from an environmental perspective as an accidental and/or sudden release of stored CO_2 could provoke climate disruptions.

Implications: When used on a large scale, Carbon Dioxide Removal technologies that aim to capture carbon dioxide from the atmosphere after it has been emitted can destroy, unintentionally modify or trigger unpredictable side effects on complex ecosystems, such as our oceans. The duration, reliability and safety of carbon sequestration (by biological or mechanical means) on land or in the sea are mostly unknown. Moreover, a massive investment and scale-up would be required before there would be a noticeable impact on the climate. Many of these techniques require unsustainable inputs or land/ocean-use changes that will negatively affect the marine food webs and the livelihood of thousands of peoples subsisting on artisanal fisheries.

3. **Earth System Interventions Targeting Weather**

Technological interventions intended to alter local weather have a long and checkered past, including hostile use in the Vietnam War, and are today employed in dozens of countries in some form or other – despite lack of scientific proof of effectiveness. The impact of weather-altering technologies is presumably localized and short-term, but the technologies are, nonetheless, historically and scientifically related to the geoengineering enterprise:

- Cloud seeding (for precipitation) has been around since the 19th century, promising rain to farmers whose crops are suffering from drought, and later as a military technique to hinder troop movements. While based on dubious science, alleged impacts on nearby fields can be serious, provoking conflicts between neighbouring communities that think the cloud seeders have stolen their rain.
- Hurricane suppression or redirection: Patent claims are already pending on unproven technologies to suppress or change the direction of hurricanes.

Implications: Some Earth system interventions targeting weather seem to have local impacts but we do not know what, if any, other changes in regional weather patterns have occurred due to their use. Diverting hurricanes and modifying storms could have potentially devastating global and regional impacts. For example, it is conceivable that the path of a hurricane could be artificially deviated, either intentionally or accidently, toward an unsuspecting population.

LEADING GEOENGINEERING TECHNOLOGIES: A SUMMARY OF POTENTIAL IMPACTS

Stratospheric aerosols (SRM)	• interruption of African and Asian monsoons, potentially affecting food supplies of up to 2 billion people[2] • ozone depletion • irreversibility (sudden temperature-rise if stopped) • worsening ocean acidification • reduced efficacy of solar energy generation • profiteering • militarization[3]
Cloud whitening (SRM)	• altered precipitation patterns and storm tracks[4] • unknown effects on marine life if executed on a vast scale • extremely energy intensive • is inherently trans-boundary • would take place over the oceans, a global commons
Ocean Fertilization (CDR)	• disturbance of marine food web[5] • worsening ocean acidification[6] • commercial exploitation already underway[7] • production of toxic algal blooms[8] • production of harmful gases such as dimethylsulphide (DMS)
Biochar (CDR)	• unsustainable land-use requirements (hundreds of millions of hectares)[9] • unproven claims regarding soil amendment properties[10] • puts at risk those populations depending on forests and marginal lands • attempts underway to accredit biochar on carbon markets with oil and airline industry backing[11]

[2] Many of these impacts are discussed in Alan Robock, "20 reasons why geoengineering may be a bad idea," *Bull. Atomic Scientists* 64, No. 2, 14-18, 59, doi:10.2968/064002006.
[3] *Ibid.* and Jeff Goodell, *How to Cool the Planet: Geoengineering and the Audacious Quest to Fix Earth's Climate*, Boston and New York: Houghton Mifflin Harcourt, pp. 207-208, and James Fleming, op.cit. p. 168.
[4] See policy statement on geoengineering adopted by American Meteorological Society, available at http://www.ametsoc.org/policy/2009geoengineeringclimate_amsstatement.html
[5] "Scientific Synthesis of the Impacts of Ocean Fertilization on Marine Biodiversity," Convention on Biological Diversity, Technical Series 45, 2009, available at http://www.cbd.int/doc/publications/cbd-ts-45-en.pdf
[6] K. Denman, "Climate change, ocean processes, and ocean iron fertilization," *Marine Ecology Progress Series 234*, 2008, pp. 219–225.
[7] Private companies have already sold carbon offsets on the voluntary market for sponsoring ocean fertilization activities. See, for example, ETC Group and ICTA news release, "Dumping on Gaia," 19 June 2007; available at http://www.etcgroup.org/en/node/637
[8] C. G. Trick *et al.*, "Iron enrichment stimulates toxic diatom production in high nitrate low chlorophyll areas," *Proceedings of the National Academy of Sciences*, 1 February 2010 (10.1073/pnas.0910579107), available at http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2851856
[9] Dominic Woolf *et al*., "Sustainable Biochar to Mitigate Global Climate Change," *Nature Communications*, 10th August 2010, available at http://www.nature.com/ncomms/journal/v1/n5/full/ncomms1053.html See also NGO press release challenging these findings: "*Nature Communications* article shows 'true colours' of biochar advocates: Groups condemn implied land-grab for biochar," 30 August 2010, available at http://www.etcgroup.org/en/node/5198
[10] See A. Ernsting and R. Smolker, *Biochar for Climate Change Mitigation: Fact or Fiction?* February 2009 available at http://www.biofuelwatch.org.uk/docs/biocharbriefing.pdf
[11] K. Driver and J. Gaunt, "Bringing Biochar Projects into the Carbon Market Place," Carbon Consulting, Blue Source, Carbon War Room, Conoco Phillips Canada, May 2010.

Why else is Geoengineering unacceptable?

- **It cannot be tested:** No experimental phase is possible: in order to have a noticeable impact on the climate, geoengineering must be deployed on a massive scale. "Experiments" or "field trials" are actually equivalent to deployment in the real world because small-scale tests would not deliver useful data on climate effects. For people and biodiversity, impacts would likely be massive as well, and immediate and possibly irreversible.
- **It is unequal:** OECD governments and powerful corporations (who have denied or ignored climate change and its impact on biodiversity for decades, but are responsible for most of historic GHG emissions) are the ones with the budgets and the technology to execute this gamble with Gaia. There is no reason to trust that they will have the interests of more vulnerable states or peoples in mind.
- **It is unilateral:** Although all geoengineering proposals would likely run into the tens of billions of dollars, for rich nations and billionaires, they could be considered relatively cheap (and simple) to deploy. The capacity to act will be within the hands of those who possess the technology (individuals, corporations, states) in the next few years. It is urgent that multilateral measures are taken to ban any unilateral attempts to manipulate Earth ecosystems.
- **It is risky and unpredictable:** The side effects of geoengineered interventions are unknown. Geoengineering could have unintended consequences due to any number of factors: mechanical failure, human error, inadequate understanding of ecosystems and biodiversity and the Earth's climate, unforeseen natural phenomena, irreversibility, or funding interruptions.
- **It violates treaties:** Many geoengineering techniques have latent military purposes and their deployment would violate the UN Environmental Modification Treaty (ENMOD), which prohibits the hostile use of environmental modification.
- **It is the perfect excuse:** Geoengineering offers governments an option other than reducing emissions and protecting biodiversity. Geoengineering research is often seen as a way to "buy time," but it also gives governments justification to delay compensation for damage caused by climate change and to avoid taking action on emissions reduction.
- **It commodifies our climate and raises the spectre of climate profiteering:** Those who think they have a planetary fix for the climate crisis are already flooding patent offices with patent applications. Should a "Plan B" ever be agreed upon, the prospect of it being privately held is terrifying. Serious planet-altering technologies should never be undertaken for commercial profit. If geoengineering is actually a climate emergency back-up plan, then it should not be eligible for carbon credits under the Clean Development Mechanism or any other offset system.

We call on governments at the UNFCCC to:

- Reject any proposal to deploy geoengineering technologies to reduce greenhouse gas emissions in the atmosphere or attain negative emissions in view of the serious environmental, social, economic and political implications.

- Adopt strong measures to explicitly forbid attempts to carry out experiments outside of a laboratory setting. Such real-world experiments are in no way "in a controlled setting" and in the case of hardware tests are not "justified by the need to gather specific scientific data" for knowledge purposes but are rather engineering attempts to develop working hardware for future deployment.

- Elevate the debate on geoengineering to the UN General Assembly in view of the transboundary and planetary implications and potential consequences that go beyond the purview of climate change.