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Living With Environmental Change

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Geoengineering and its governance

If geoengineering technologies could help to address climate change how should they be governed?

Image of a machine for capturing carbon direct from the air, courtesy of Carbon Engineering Ltd

Living With Environmental Change Policy and Practice Notes

Note No. 18
July 2015

The Living With Environmental Change Partnership brings together 22 public sector organisations that fund, carry out and use environmental research and observations. They include the UK research councils, government departments with environmental responsibilities, devolved administrations and government agencies. The private sector is represented by a Business Advisory Board.

As a response to climate change, some scientists and engineers advocate development of technologies for "the deliberate manipulation of planetary systems to counteract anthropogenic climate change" (Royal Society, 2009). Computer modellers have investigated the proposals' potential effects and some laboratory work has been done, but there is, as yet, nothing approaching a socio-technical system capable of delivering any controlled geoengineering effect. Additionally these ideas remain highly controversial.

What is geoengineering?

There are essentially two geoengineering strategies:

- To reflect more of the sun's energy away from Earth (known as Solar Radiation Management or Albedo Enhancement).
- To suck carbon out of the atmosphere (usually called Carbon Dioxide Removal).

What's controversial about geoengineering?

Different technologies attract different levels of controversy:

- Carbon Dioxide Removal technologies are generally less controversial than Solar Radiation Management and some argue these are just an extension of existing land management practices.
- Strong objections have been voiced to experiments with iron fertilization of the ocean.
- There is animated debate around Solar Radiation Management and in particular about the proposal to inject sulphate aerosols into the stratosphere.

What specific opportunities and risks are associated with injecting sulphate aerosols into the stratosphere?

- This technology promises to be fast acting and cost effective: the cooling effect would be nearly instantaneous. It is also claimed to be inexpensive relative to the wholesale changes in energy, transportation and agricultural technologies that make up conventional mitigation.
- Potential drawbacks, if the technology fails to perform as expected, include disruption of agriculture, due to changes in precipitation patterns, and tension between countries pursuing the technology and those believing themselves to be potentially harmed by it.

What barriers exist?

Barriers to developing geoengineering include:

- Lack of detail about proposed technologies, which are still immature in their development.
- A need to consider these technologies in the context of other mitigation and adaptation efforts: there is conflicting evidence about a so called "moral hazard" under which geoengineering saps the motivation to pursue these alternatives.
- The complexity of Earth systems, which makes it challenging to predict the effectiveness and side-effects of interventions or precisely how they will distribute goods and harms, or to attribute cause and effect after the event.
- Lack of global consensus as to what constitute goods and harms: some countries see themselves as potential beneficiaries of climate change.
- Concern about side-effects of Solar Radiation Management meaning that it would be unlikely without some kind of international treaty, which may take years to negotiate and, as there seem few opportunities to extract value, any development would depend on government financing.
- Fewer legal barriers facing Carbon Dioxide Removal technologies, but these would need deployment at massive scale, requiring huge investment, and even then they would be slow to have a climate impact.

What might geoengineering cost?

Some experts argue that geoengineering approaches (especially injecting sulphate aerosols into the stratosphere) represent good value for money, however:

— There are many examples of optimism bias leading to gross underestimates of the direct costs of new technologies, as in nuclear power or defence procurement.
— Underestimates are particularly likely to apply when, as in this case, the technologies are immature and untested. Further development and massive scaling up might lead to global controversy leading to costly regulatory demands.
— Most estimates of new technologies do not take into account the indirect costs, for example possible major disturbance of the Asian monsoon.
— For injecting sulphate aerosols into the stratosphere there are the potential costs arising when deployment ceases - the "termination effect". The resulting rapid rise in global temperature would potentially mean bigger costs that outweigh the initial benefits of applying the technology.

What are the security implications of geoengineering?

Some proposed geoengineering interventions have raised security concerns, in particular solar geoengineering approaches. Direct security impacts are likely to be minimal. Climate technologies might conceivably be used to reduce access to particular terrain, or to undermine morale, but are unlikely to be cost effective for this, let alone as direct "climate weapons".

However, important indirect security concerns include:

— The likelihood that solar geoengineering would be undertaken by the military or military contractors and would need to be protected by global security infrastructure.
— Possible international tensions arising from different perspectives on the value of geoengineering (with the associated risks of unilateral action).
— That attribution of responsibility for extreme climatic events occurring after a geoengineering experiment or deployment would be difficult and there would be risks of "scapegoating".

How might geoengineering be regulated?

A one-size-fits-all approach to regulating geoengineering may be technically unfeasible, and politically unrealistic, but some existing law may be relevant:

— International law could be adapted to provide forms of control for individual technologies, including ocean iron fertilization and Solar Radiation Management.
— The legal and regulatory control of these methods will need to be fragmented and multifaceted, combining soft-law initiatives (principles, codes of conduct, etc) with the adaptation of existing treaty frameworks, against the backdrop of customary international law and general principles.
— Top-down decision-making processes within either treaty-based bodies or international institutions will need to coordinate with bottom-up governance initiatives originated from networks of non-state organisations, such as scientific bodies, NGOs and businesses.
— In Germany, the UK and the US, for example, there is no dedicated or single law or regulation able to control all geoengineering technologies or even all aspects of one single technology, but they all seem well-equipped to adapt and adjust by employing climate/environmental law, planning law and regulation of scientific research.
— Regulation would need to be supported by some cross-fertilization of international, regional, and other national systems: learning from other national best practice or from developing international norms.

Why is public engagement important at this time?

Engaging in wider dialogue involving publics and stakeholders as well as experts on complex and uncertain technologies such as geoengineering is critical at this moment before there is further financial and emotional investment in specific developments in order to:

— Support democratic ideals.
— Make better informed choices.
— Enhance the legitimacy of decision making.
— Enable reflection on assumptions and uncertainties.
— Ensure societal values influence the future course of innovation.

Research suggests that people:

— Draw heavily upon familiar analogies to contextualise their views on governing geoengineering research. Lessons can be learned from experience in the biosciences and pharmaceuticals, nuclear energy and weapons regulation, and contemporary debates on fracking.
— Believe it important that governance regimes should differentiate between different scales of research or experimentation, often drawing the boundary where research would leave the laboratory and enter the outside world.
— Consider a key challenge to be how to balance scientific autonomy and creativity with oversight and responsibility: how much regulation is too much or too little?

How can research contribute to the governance of geoengineering and how can policymakers and funding agencies support this?

Geoengineering technologies are diverse and at a very early stage. The general aim must be to ensure that regulation keeps one step ahead of the technologies as they develop. This means that for some time the main governance focus will be on ensuring that research is conducted in such a way as to allow society to assess whether any geoengineering approach has any contribution to make.

In parallel with assessments of specific technologies it would be helpful if research funding agencies and policymakers could support more generally applicable research on:

- Values and attitudes towards new technologies and the dynamics of rapid reframings in public responses.
- The variety of cultural and ethical perspectives around the world that influence social definitions of responsibilities for climate change.
- The developing applicability of national and international law and the associated institutions and processes to the regulation of the main geoengineering options.
- The validity and robustness of assumptions behind emerging international and national policy on climate change.

Research funding agencies, initially at national level, should aim to ensure that:

- For each study assessing a particular technology:
  - Experimental design is rigorous, and all results will be published and independently assessed.
  - Learning is in balance with safety and uncertainties are acknowledged.
  - Technical development, economic appraisal and social consent develop in parallel.
  - The experiment doesn't contribute to a "slippery slope" by which a particular technology becomes normalised and scrutiny of it reduced.
- They proceed through a "principles and protocols approach", a combination of:
  - General governance principles such as the often cited Oxford Principles.
  - Technology-specific protocols related to the opportunity and risk profiles of particular technologies.
  - Specific geopolitical considerations related to the environmental characteristics of the country where the technology is to be applied and its political and cultural values and priorities.
- General governance principles and technology specific protocols are brought together in a stage-gate process of research control, when the adherence to research norms can be determined step-by-step as a project proceeds.
- Over time they develop common approaches to research governance as well as sharing details of studies and results internationally.

Further information

This Policy and Practice Note was written by Peter Healey and Steve Rayner drawing on research carried out by the Climate Geoengineering Governance project (CGG) July 2012 to December 2014, funded by the Economic and Social Research Council and the Arts and Humanities Research Council.

Useful resources:

Project website: www.geoengineering-governance-research.org

CGG ran in parallel with two other UK Research Council funded projects on geoengineering:
Integrated Assessment of Geoengineering Proposals www.iagp.ac.uk
Stratospheric Particle Injection for Climate Engineering www.spice.ac.uk

Royal Society (2009) Geoengineering the Climate: Science, Governance and Uncertainty. London: Royal Society - Policy document 10/09 https://royalsociety.org/~/media/Royal_Society_Content/policy/publications/2009/8693.pdf

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Peter Healey & Steve Rayner (2015) *Key Findings from the Climate Geoengineering Governance Project.* CGG Working Paper 25 http://geoengineering-governance-research.org/perch/resources/workingpaper25healeyraynerkeyfindings-1.pdf

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