Global Challenges Foundation

Solar geoengineering

Reviewed by

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What is at stake?

Two sets of emerging technologies known together as geoengineering may make it possible to manipulate the atmosphere, with the potential to reduce climate risk. The first set, known as carbon removal, directly removes carbon dioxide from the atmosphere, and if emissions are eventually reduced to zero, may provide a lasting solution to climate change. Most scientists now concur that some form of carbon removal will be needed to stay within the 1.5-2°C temperature rise goal set in Paris. However, of the many potential carbon removal technologies, none is currently available on the massive scale needed.

The second, known as solar geoengineering, promises to reduce the temperature of the Earth by reflecting light and heat from the sun back into space, particularly through the injection of aerosols or other particles into the stratosphere. Today, solar geoengineering only exists in computer models. The first in situ experiment in the stratosphere is currently being planned by a team of scientists at Harvard university. Eventual deployment of solar geoengineering would be the most global enterprise humanity has ever undertaken, as it would affect the entire atmosphere and therefore all people – though its local impact may vary. The technology therefore poses potentially profound risks that transcend borders and raise significant ethical, socio-economic, political and governance challenges. Good governance will be a crucial part of making these technologies work as part of a comprehensive strategy to address climate change.

How much do we know?

According to scientists, solar geoengineering is the only known technique for quickly stopping or even reversing the rise in global temperatures. Although it does not solve the root cause of climate change, it could be used to reduce the length or the magnitude of a temperature overshoot (beyond the Paris goal) during the transition period needed for massive decarbonization at the global level, or provide insurance against a potential 'climate emergency'. However, we don't know enough about the risks and potential benefits of the technology, and it carries considerable risks – in particular, it may destabilize local and global climate, as well as various elements of the global ecosystem. In addition, a

sudden termination of solar geoengineering would lead to rapid and severe global warming, with no time for natural and social systems to adapt.

A complete geoengineering intervention would require considerable investment and involve drastic reduction of greenhouse gas emissions as well as removal of carbon dioxide from the atmosphere. However, according to some estimates, the direct costs of solar geoengineering only could be as low as $10 billion per year. The cost is low enough that an individual country, a small group of countries, or even a wealthy individual could deploy this technology unilaterally and in an ungoverned manner, without properly taking into account the interests of others. This not only could lead to serious geopolitical tensions, but if side effects prove to be negative, it also opens the relatively close prospect of climatic chaos triggered by reckless human intervention.

"Solar radiation management is the only known technique for quickly stopping or even reversing the rise in global temperatures."

What are key factors driving impact and probability?

- The window for staying within the Paris temperature goals through emissions reduction alone has most likely closed already so that some level of carbon removal and/or solar geoengineering deployment will likely be necessary, which comes with its own risks.
- Unless massive efforts on greenhouse gas reduction are urgently made, carbon removal and solar geoengineering technologies would need to be deployed on a larger scale.
- Carbon removal and solar geoengineering could present a serious moral hazard, and lead countries to avoid emission abatement or encourage inaction.
- Better understanding of the climate system will improve our understanding of risks associated to carbon removal and solar geoengineering and may lead to considerably safer interventions.
- One important risk factor is the potential for hasty, ungoverned, unilateral deployment of solar geoengineering, which better frameworks for global coordination could reduce.

Carbon removal

In order to reduce atmospheric greenhouse gas concentrations to acceptable levels, in addition to drastic emission reductions, a portion of the accumulated carbon dioxide in the atmosphere would also need to be removed and stored in a different form. Some of those solutions are already technologically feasible and adopted today – for instance, reforestation could capture some CO2 in the form of wood, which could in turn be used for construction, turning parts of the built environment into a carbon pit. However, the amount of carbon dioxide to be removed is so large that other technologies would need to be considered – none of which exist at the necessary scale. Leading contenders include "direct air capture (DAC)", using chemical means to fix carbon dioxide and "bioenergy with carbon capture and storage (BECCS)" relying on burning biomass for electricity and immediately capturing the carbon dioxide. Other technologies are also being considered, such as enhanced weathering of rocks, increasing ocean alkalinity, ocean fertilization and various means of land management increasing the carbon content of soils. All of these technologies come with substantial environment, social and economic risks which would need to be managed in relation to the risks of other interventions, or the risks of not intervening at all.

Unlike solar geoengineering, institutional framework for addressing carbon removal exists in a number of fora, such as the UN Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (CBD) and the London Protocol of the London Convention (LC/LP), although there remains a great deal of work to address key governance issues. Governance challenges include establishing clear agreements between countries on responsibilities for removing the accumulated carbon from the atmosphere, developing transparent frameworks for measuring, reporting and verifying carbon removals, enhancing international cooperation for innovation, research, development and deployment of these technologies as well as agreements for their financing.

Key messages for governments and civil society

1. The time for leadership is now. The governance of geoengineering must be addressed before large scale research and deployment begins. Early entrants to this discussion will play a defining role on a critical issue of global governance.
2. We need to learn more. The world does not know enough about the risks, unintended consequences and potential benefits of solar geoengineering. Well-governed research may help answer these questions and can help set the agenda on issues that matter to the community.
3. It takes a village. No one global institution can address all the dimensions of geoengineering governance. Governance must be bottom-up as well as top-down, and span processes and institutions in interconnected ways. Civil society, faith communities, the private sector, young people and others must all make their voices heard.