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Geoengineering Is Inevitable in the Face of Climate Change. But at What Cost?

Stewart M. Patrick | Monday, April 8, 2019

Production stack emissions from the Johns Manville fiberglass insulation plant in Alberta, Canada, Feb. 13, 2019 (Photo by Larry MacDougal via AP Images).

The world is losing its battle against climate change. Greenhouse gas emissions rose to record levels (https://www.nytimes.com/2018/12/05/climate/greenhouse-gas-emissions-2018.html) last year, as countries lagged in meeting their already inadequate pledges under the Paris Agreement. Based on the current trajectory, the warming Earth will blow well past the 2-degrees Celsius ceiling widely agreed to be the maximum acceptable increase in average global temperatures before catastrophic impacts set in. In the face of this looming threat, climate change mitigation and adaptation efforts are necessary but insufficient. Humanity must also consider a third option it has long resisted: geoengineering, or the deliberate, large-scale manipulation of the planetary environment.

Geoengineering takes various forms, but most fall into one of two categories: carbon-dioxide removal (https://www.c2g2.net/wp-content/uploads/C2G2_CDR-Brief-hyperlink.pdf) and solar radiation modification (https://www.c2g2.net/wp-content/uploads/C2G2_Solar-Brief-hyperlink.pdf). The first one, also known as negative emissions, entails the permanent removal of CO2 from the atmosphere and its subsequent storage, either in plants, underground or beneath the ocean floor. Solar radiation modification denotes the deployment of technologies to alter the amount of radiation entering or leaving Earth's atmosphere. Unlike carbon removal, solar radiation modification does not remove greenhouse gases. Rather, it reduces the heat that they trap.

Both types of geoengineering encompass diverse approaches, of varying complexity and maturity. Carbon-dioxide removal strategies, for example, include planting forests at massive scale, capturing carbon from the atmosphere—or from the burning of biomass—and permanently storing it, fertilizing ocean ecosystems to accelerate phytoplankton growth, and dispersing carbon-binding minerals on land or in the oceans. Solar radiation modification technologies, meanwhile, range from injecting aerosols into the stratosphere, to seeding or thinning clouds and brightening Earth's surfaces in order to alter the amount of incoming and outgoing radiation. Many approaches remain experimental, and none—with the

partial exception of afforestation, or planting trees on non-forested land—have been attempted at scale.

Environmentalists hesitate to endorse geoengineering techniques for fear of creating a moral hazard. They worry that governments, corporations and citizens will use the likely false promise of a technological quick fix down the road to avoid taking dramatic but costly steps today to reduce emissions.

In addition, the idea of interfering with Earth's climate system raises a host of practical, distributional and ethical conundrums. To begin with, geoengineering risks unintended consequences. Dare we experiment with the only planet we have? Large-scale geoengineering projects also seem bound to create winners and losers around the world. Who gets to determine where the chips fall? Finally, the very notion of manipulating the climate can induce a cosmological queasiness, especially among the faithful. In taking this path, do we make ourselves gods?

These are all profound and troubling questions. Nevertheless, geoengineering is a Rubicon that humanity seems destined to cross. By spewing massive quantities of CO2, methane and other greenhouse gases into the atmosphere—in fact, an unintentional form of geoengineering—humanity is running the largest uncontrolled scientific experiment (https://www.cfr.org/blog/re-engineering-earths-climate-no-longer-science-fiction) in Earth's 4.5 billion-year history.

Unless dramatic action is taken soon, the end of the century will likely bring (https://www.ucsusa.org/our-work/global-warming/science-and-impacts/global-warming-impacts) a wide range of environmental calamities: the rapid melting of polar ice caps, inundation of coastal regions and low-lying islands, more frequent and extreme natural disasters, widespread desertification and deforestation, the creation of hundreds of millions of climate refugees, accelerated extinction of plant and animal species, and the death of entire marine ecosystems, including coral reefs and fisheries, through warming and acidification.

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Facing such a future, nations are unlikely to stand idly by. They could decide to take matters into their own hands. What is to stop the government in Dhaka, for example, faced with the prospect of losing much of Bangladesh's low-lying territory to the Indian Ocean, from purchasing jumbo-jets and spraying reflective aerosols into the stratosphere in hopes of reducing the absorption of sunlight? Nor will individuals remain on the sidelines. In 2012, an American scientist dumped (https://www.theguardian.com/environment/2012/oct/15/pacific-iron-fertilisation-geoengineering) 100 tons of iron sulfate off the coast of British Columbia. The result was a massive phytoplankton bloom that absorbed atmospheric

carbon and led to record salmon runs. How long before a progressive-minded billionaire seeks to do something similar on a far grander scale?

Geoengineering is quickly moving from the radical fringe to the center of global public policy. In its October 2018 report (https://www.ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments/), the United Nations' Intergovernmental Panel on Climate Change found no feasible pathway to keep average global temperature rise below 1.5 degrees Celsius—a target endorsed in 2015 at the Paris climate conference—without large-scale carbon dioxide removal.

At last month's U.N. Environment Assembly in Nairobi, Switzerland submitted a resolution (https://www.climatechangenews.com/2019/02/26/swiss-push-talk-geoengineering-goes-sci-fi-reality/), co-sponsored by a dozen other countries, asking the U.N. Environment Program to "prepare an assessment of the status of geoengineering technologies." Its purpose would be to establish criteria to define geoengineering; assess the scientific state of play; identify leading actors; summarize the potential risks, benefits, and uncertainties; and propose "global governance frameworks" for all of these things.

The resolution failed within the consensus-based assembly. Such resistance is likely to crumble as the climate crisis worsens, however, and as more actors begin to freelance. Already, hundreds of scientists are conducting small-scale geoengineering experiments outside of public view and official supervision. Geoengineering could become a free-for-all, as uncoordinated governments and individuals take decisions with momentous implications for global security, prosperity and equity.

Carbon dioxide removal, for instance, could place enormous demands on land, energy, water and oceans at the expense of biodiversity, food production, groundwater availability, soil quality and nutrient balance. Likewise, sweeping efforts to increase reflectivity of the atmosphere, clouds, land and oceans could alter regional and global weather patterns, temperatures, hydrological cycles, crop yields and development prospects. Solar radiation modification poses an additional dilemma: Because it does not actually reduce greenhouse gases, it must be continued in perpetuity—or at least until carbon removal has lowered CO2 levels.

Given these risks, the world urgently needs a multilateral governance framework for geoengineering. Such an institution, or set of institutions, would permit sovereign nations to negotiate common standards and shared rules for forays into this uncharted territory. An immediate priority should be to improve transparency—a precondition for good governance. To this end, researchers from the Carnegie Endowment and Atlantic Council advocate (https://carnegieendowment.org/2018/05/29/advancing-public-climate-engineering-disclosure-pub-76448) creating a central clearinghouse to collect and share data on geoengineering research and experiments, as well as to encourage protocols for public disclosure.

Over the longer term, the U.N. system should move from simply sharing information about climate change

to making rules, and enforcing them. A logical setting in which to launch negotiations is the U.N. Framework Convention for Climate Change. Member states can use its annual conference of parties to designate geoengineering a third pillar of climate risk management, alongside mitigation and adaptation. In parallel, the Intergovernmental Panel on Climate Change should expand its expertise on geoengineering.

Stewart Brand of the Long Now Foundation has argued that (https://www.academia.edu/8566675/The_Promises_and_Perils_of_Geoengineering?auto=download) in the 21st century, "humanity is stuck with a planet stewardship role." But as it fails in that mission, humanity may be drawn, ineluctably, to become Earth's engineers.

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