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Research on Solar Climate Intervention Is the Best Defense Against Moral Hazard

As concerns about global warming mount and international efforts to address it lag, should public policy be encouraging or inhibiting research on technologies to reflect sunlight away from the earth? If efforts to limit emissions prove inadequate, solar climate intervention could be the only means of averting catastrophic harms. We need to understand its feasibility, safety, and costs, and that requires more research.

But recent controversy over an innocuous experiment in Sweden has revealed that some influential commentators oppose even small-scale experiments that pose no physical risks to the environment. We believe that, in opposing research, critics are increasing the potential risks not only from climate change generally, but also from solar climate intervention itself.

The proposed Stratospheric Controlled Perturbation Experiment (SCoPEx) in Sweden was postponed in April 2021 after pressure from Indigenous and activist groups such as Greenpeace and Friends of the Earth, along with some high-profile commentators, including Oxford University climate scientist Raymond Pierrehumbert. SCoPEx would involve releasing tiny quantities of reflective particles into the stratosphere. The research would give scientists a better understanding of how stratospheric aerosol injection—one form of solar climate intervention—might affect atmospheric chemistry. Would it reflect sunlight in a useful way? Would it damage the ozone layer? The experiment is not novel: it's the sixth outdoor experiment on solar climate intervention to date. Nor is it reckless: the project was planned by scientists at Harvard University in partnership with the Swedish Space Corporation and is overseen by an independent advisory committee. No one thinks that it poses environmental risks. So far, so mundane.

But opponents of solar climate intervention are vociferous and determined to stop the research. They warn that even limited, unquestionably safe field research represents the first step onto a slippery slope towards deployment and risks creating a "moral hazard" that will distract publics and politicians from crucial emissions cuts. If people think solar climate intervention is a feasible solution to climate change, the concern is that they will be less motivated to undertake mitigation actions.

How persuasive are these arguments? And which poses the greater hazard: too little research on solar climate intervention or too much?

In answering these questions, we review the evidence from empirical research and from two real-world case studies: the history of ocean iron fertilization experimentation, and climate policy in the United Kingdom in the 2010s. Although 10 years ago it might have been reasonable to hypothesize that climate intervention research would pose a moral hazard, this fear has not been borne out by the decade's developments.

The lesson of ocean iron fertilization

Our first case study focuses on ocean iron fertilization (OIF) research, a form of climate intervention meant to remove carbon dioxide from the atmosphere and sequester it in the ocean. We think it offers an important but overlooked lesson: climate intervention research can reduce rather than increase the risk of moral hazard.

The theory behind OIF is quite simple: a deficiency of iron limits algae growth in the open ocean; fertilizing the ocean with iron will encourage the growth of algae and other organisms, thereby taking carbon dioxide out of the atmosphere; and as this bloom of biomass dies, a fraction of the sequestered carbon will be transported to the ocean depths, locking it away for centuries. When astrophysicist and science writer John Gribbin and oceanographer John Martin originally proposed the idea in 1988, it seemed to offer a complete, albeit potentially risky, answer to global warming. As Martin reportedly joked, "Give me half a tanker of iron and I'll give you another ice age."

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Although ocean iron fertilization attracted widespread attention, proposals to test it were controversial—raising concerns similar to proposals to conduct field experiments on stratospheric aerosol injection today. Then as now, people claimed that field research, even if physically safe, was the first step on a slippery slope and would pose a moral hazard.

But this research did not have the effect that critics feared. More than a dozen field experiments cast doubt on the efficacy of ocean iron fertilization as a means of sequestering carbon and raised concerns about potential side effects.

As a result, ocean iron fertilization dropped down the policy agenda. Informed by the field research, major policy reports cooled on it, and attention from policymakers and research funders was redirected to other, more promising forms of carbon dioxide removal. A recent study found that even among experts who support a portfolio approach to carbon removal technologies, fewer than 10% think ocean iron fertilization should be part of the portfolio, citing effectiveness and side effects as major constraints.

There is still, quite reasonably, interest in researching ocean fertilization. But experiments did not result in enthusiasm for the technology, as the moral hazard hypothesis predicted. Instead, they had the opposite effect. Ironically, moral hazard might have been generated if opponents had gotten their way. Had the study of ocean iron fertilization been limited to the lab, claims about its safety and efficacy would have gone untested. Then, in a time of crisis, states might have been willing to engage in large-scale deployment, believing that desperate times call for desperate measures.

We believe the story of ocean iron fertilization research has broader implications. Other types of climate intervention, such as stratospheric aerosol injection, might provide an effective means of reducing climate risks—or they might prove to be infeasible or unacceptably dangerous. The problem is we do not know. That is why a vigorous research program is needed.

What slippery slope?

The recent history of climate policy in the United Kingdom provides further evidence against the slippery slope and moral hazard arguments. Few governments have been better informed about solar climate intervention than the United Kingdom over the last decade. In 2009 leaders received an extensive briefing on the subject when the Royal Society published a seminal report that set out the characteristics, risks, and benefits of climate intervention and recommended spending £100 million on research in the United Kingdom alone. In the aftermath of that report, a parliamentary committee held an inquiry on climate intervention, a government response recognized the need for further information, and the United Kingdom funded three solar climate intervention research projects.

If ever there was cover for a rich country to embrace solar climate intervention, it was the United Kingdom in the 2010s—a decade under a right-of-center Conservative government that might have been expected to prefer engineering climate solutions over government-mandated mitigation. But research on solar climate intervention did not create a slippery slope; the projects ended in 2014 and have not been renewed since. Nor did it undermine the United Kingdom's mitigation efforts. Instead, UK carbon emissions have gone down by over 30% since the Royal Society published its 2009 report. In 2019 the United Kingdom became the first major economy to set a legally binding "net zero" emissions target and, earlier

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this year, it passed legislation committing to reduce emissions by 78% from 1990 levels by 2035.

Of course, we do not know the counterfactual—that is, what mitigation activities might have occurred if the government had been unaware of solar climate intervention. One could argue that the United Kingdom would have made even deeper emissions cuts had solar climate intervention never been discussed. But this is completely speculative. One could equally well argue that knowledge about climate intervention spurred the UK government to do more, by driving home the immediacy and gravity of the climate change problem—a conclusion that would be more in line with the findings of a growing body of social science research on moral hazard and climate action.

For example, a team at Yale University sought to directly test the moral hazard argument by assigning study participants in the United Kingdom and United States to two groups: one group was given information about climate intervention as a response to global warming; the other was given information about regulating pollution. The study's results were remarkable. The researchers found that the group exposed to information about climate intervention was slightly more concerned about climate change risks. That is, they found evidence of a *reverse* moral hazard response.

This research might be dismissed as an academic curiosity, but the same reverse moral hazard effect has been observed using different study methods in Germany, Sweden, the United States, and the United Kingdom.

Moral hazard, of course, is not a monolithic phenomenon, and we do not dismiss the idea. We recognize that solar climate intervention could conceivably elicit a moral hazard response for certain groups at certain times. Familiarity might breed indifference, and concerns about climate intervention might quickly evaporate after a period of initial antipathy. The responses of experts and policymakers might differ significantly from the reverse moral hazard observed in the layperson participants of the studies cited above. It could be dangerous if, for instance, the government of a high-emitting country chose to relax its decarbonization efforts in favor of sunlight reflection. Policy proposals for linking action on solar climate intervention to action on emissions cuts could help prevent such outcomes and should be further developed.

But the experience of the last decade provides little support for the argument that solar climate intervention research would provoke a moral hazard response or represent a step onto a slippery slope. In fact it suggests the opposite. By showing that a proposed technique is less feasible or safe than originally believed, as was the case with ocean iron fertilization, research can inhibit a moral hazard reaction.

To be sure, research on stratospheric aerosol injection may turn out differently from ocean fertilization. Instead of revealing risks and problems, it might suggest that this type of climate intervention would be feasible and safe. Such a result would leave stratospheric aerosol injection on the table as a possible means of addressing climate change.

And there's another very real possibility: that more research on solar climate intervention will not resolve whether the approach is feasible and safe, but will instead reveal more complexities and uncertainties about possible risks and benefits, as can occur with research on complex environmental phenomena. But even a deeper appreciation of the uncertainties would be an improvement over the current state of ignorance, because it would provide a check on the risk that policymakers mistakenly believe that climate intervention could provide an easy fix or, in a panic about climate damages, decide to deploy an untested technology that proves ineffective or dangerous.

As the adage goes, a little bit of knowledge can be a dangerous thing; responsible decisionmaking requires much more. If safe experimentation does not proceed, the overblown chance of a slippery slope would be replaced by the prospect of a cliff edge, from which panicked states might take a leap of faith. That is the true moral hazard that we could face if leaders refuse to seek greater knowledge about climate intervention options.

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