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## Playing God

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***The climate problem, twice over: Seven billion "free riders," meet the "free drivers" of geoengineering.***



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How serious is the threat of global warming? One way to figure out is to take your cues from some leading climate scientists: They have moved on. That doesn't mean they've abandoned the issue, but they are looking beyond what all agree is the most obvious solution — decreasing the amount of carbon we spew into the atmosphere in the first place.

These scientists are beginning to look for a Plan B. There are **two distinct approaches** under consideration — sucking carbon out of the atmosphere, or creating an artificial sun shield for the planet. The former, which involves reversing some of the very processes that are leading to the climate problem, is expensive. The latter just sounds scary. **David Keith**, a leading thinker on geoengineering, calls it “chemotherapy” for the planet. “You are repulsed?” he says. “Good. No one should like it. It’s a terrible option.”

Repugnant or not, with the globe failing to develop other ways to halt climate change, geoengineering is increasingly becoming an option. The science and engineering are relentlessly marching on: Most research so far has focused on computer modeling, but some has started to move beyond — trying to test, for example, how to deliver particles into the upper reaches of the atmosphere. This summer, an entrepreneur conducted a rogue experiment, **dumping** 100 tons of iron into the Pacific in an attempt to “seed” the ocean and spur the removal of carbon dioxide from the atmosphere. This episode represents a particularly apt example of science — in this case, self-experimentation — speeding far ahead of public opinion and oversight.

### **The high costs of doing nothing**

If the world can’t get its act together to limit carbon emissions, geoengineering may be the only option we have. Distill the climate problem down to the essentials, and it becomes obvious that global warming is fundamentally a market failure: All seven billion of us human beings are “free riders” on a planet that is heating up. We put billions of tons of carbon dioxide into the atmosphere every year, and largely aren’t required to pay for the privilege. There’s too little incentive to stop polluting.

Americans are some of the world’s worst offenders. Every U.S. citizen, on average, emits around 20 tons of carbon dioxide a year — twice that of the average European. All kinds of things contribute to that number. Driving the average U.S. vehicle in an average year accounts for more than 5 tons. The full carbon footprint of the average thrice-weekly cheeseburger: half a ton a year. One roundtrip cross-country flight: one ton.

Each of these tons of carbon dioxide **causes** at least \$20 worth of damage in adverse health effects, flooded coastlines, and other effects of climate change. By mid-century, that figure will rise to at least \$50. And a truly catastrophic event caused by a warmer climate, like Antarctic ice sheets collapsing long ahead of schedule or Arctic methane bubbling up at precipitous rates, resulting in runaway global warming, could increase those costs by a factor of 10 or more. How do you put a price tag on even a 1

percent risk of altering the climate so much that it could destroy civilization as we know it?

Few of us are paying our fair share for the damage that we're doing to the planet. For example, airlines don't add \$20 to ticket prices in order to pay for the damage caused per passenger by flying back and forth across the country. That decreases costs up front, but it also comes at enormous cost to society down the road. The world's population — led by the **one billion or so global high emitters** — are doing many hundreds of billions of dollars of damage to the planet, and in the near future the costs will skyrocket into the trillions.

“Free riding” also plagues relations between countries. Some, like the European Union have a cap or tax on carbon pollution. Most are still waiting on the sidelines. Why should any single country cut its carbon emissions when it knows that its reductions will only be a drop in the bucket toward solving climate change — and other nations aren't asking their citizens to pay their fair share? Blame it on short election cycles, partisanship, or fossil energy interests, the political will often doesn't exist — whether in Washington or the latest global environment gathering in Rio de Janeiro.

### **Sitting in the driver's seat**

“Free riders” are only half the problem. “Free drivers” may be as important. The allure of geoengineering derives from the simple fact that — given what little we know about it at the moment — it appears to be a comparatively cheap way to combat climate change. And it doesn't take a global agreement to act. It takes one actor — one country — in the driver's seat.

If, for example, the very existence of an island, nation, city, or agricultural region is threatened by global warming, the question among its leaders will no longer be *whether* geoengineering is an option, but *what* the effects, positive and negative, might be and *how* it could be carried out. That's also where the science stands today, and the economics points in the same direction.

One option that will inevitably come under consideration is the possibility of shooting reflecting particles into the upper atmosphere to create an artificial sun shield for the planet. Blocking some of the sun's rays from hitting the planet may sound like science fiction or hubris, or both. But geoengineers are already looking at which particles would work best, and how to deliver them: Planes, balloons or multiple mile-long hoses are all contenders.

All these options have one thing in common: They are cheap — at least from the narrow perspective of those doing the geoengineering. Hence the “free” in “free driver.”

In fact, the price tag of these geoengineering strategies is likely to be negligible relative to the purported benefits: Columbia University's [Scott Barrett](#), among others, has calculated that it would **cost pennies** to offset a ton of carbon dioxide from the atmosphere. By comparison, it costs dollars per ton to reduce carbon dioxide emissions in the first place.

The higher cost of attacking the problem head-on, by reducing carbon emissions, would still be a bargain compared to the financial, ecological and human costs of unchecked global warming. But “free riding” is so much easier, politically and financially.

That's what makes the “free driver” effect so powerful. Geoengineering is seductively cheap, and it doesn't take the collective will of billions of people – or policies guiding those billions – to have a major effect. Anyone capable of flying a fleet of planes at high altitudes could conceivably have a go at altering the planet's atmosphere, and do so at a fraction of the cost of decreasing carbon dioxide pollution. But here's the catch: Nobody knows the costs of potential unknown and sometimes unknowable side effects, and there could be grave political and legal repercussions when someone starts playing God with the climate.

### **Proof by volcano**

What makes scientists believe geoengineering could work? It's been tried before – by nature, not by humanity.

When Mount Pinatubo erupted in June 1991, it forced the evacuation of 200,000 Filipinos and shot 20 million tons of sulfur dioxide into the stratosphere. The added sulfur counteracted the effect of 1,100 billion tons of carbon dioxide that had been accumulating in the atmosphere since the dawn of the industrial revolution. In 1992 and 1993, it decreased global temperatures by a bit less than 1 degree Fahrenheit by reducing the amount of sunlight that hit the earth's surface. That was about the same amount temperatures had risen at that point from carbon added to the atmosphere by human activity. In other words, Mount Pinatubo alone offset all temperature increases from the beginning of the Industrial Revolution.

The aftermath of Mount Pinatubo's eruption suggests the limitations of this kind of geoengineering. The excess carbon dioxide in the air isn't being removed – geoengineering would simply add millions of tons of sulfur dioxide (or some custom designed material) to the atmosphere. That might lower

temperatures — but it would not address other problems caused by global warming. For example, it wouldn't stop the ongoing acidification of the oceans, which may kill much of the life they hold.

And there will probably be a host of unknown, unexpected consequences. For example, some climatologists blame the Mount Pinatubo eruption for flooding along the Mississippi River in 1993 and for droughts in sub-Saharan Africa. That still pales in comparison to the 1815 eruption of Mount Tambora in present-day Indonesia, which caused the “year without a summer” linked to some 200,000 deaths across Europe in 1816. Incidentally, the eruption also had some unexpected cultural repercussions: All those overcast days also forced Mary Shelley and John William Polidori to spend much of their Swiss summer holidays indoors, jumpstarting the creation of both *Frankenstein* and *The Vampyre* (an inspiration for *Dracula*).

It doesn't take much imagination to see that pumping one pollutant into the atmosphere in an attempt to offset the effects of another could backfire. It may also be impossible to demonstrate which adverse climate events were caused by which single geoengineering intervention. That throws a wrench into the traditional research model: It's one thing to study the effects of a past volcanic eruption or to fiddle in a lab with self-contained experiments. It's quite another to devise an experiment that could be conducted in the real world. It would be all too easy to blur the line between experiment and deployment. That and many other questions need to be answered, lest we enter wholly uncharted territory when it comes to playing with the atmosphere of our shared home.

### **Seat belts are good, but there's no avoiding speed limits**

Talk of geoengineering inevitably leads to the question of “moral hazard.” Will the exploration of these technologies lull humanity into thinking that it need not act responsibly and cut carbon emissions? Perhaps. Seat belt laws may make some drivers feel so safe that they drive more recklessly. Still, that is hardly an argument against those laws.

While the international community should not abandon efforts to limit carbon emissions, scientists must also be prepared to take geoengineering seriously. Humanity may already have passed so many global warming tipping points that — even with radical action to cut emissions — it may be important to have some form of geoengineering in our toolkit.

The worst we can do is fall into the trap of thinking geoengineering is a panacea to our climate change problem. While its initial costs may be seductively low, no one knows the unintended consequences of

trying to alter the planet's atmosphere. Just as it seems to cost almost nothing to emit carbon – leading all of us to emit more than we ought to – geoengineering may appear cheap at first, only to leave humanity and nature to foot a much larger bill later on. “Free riding” turns out not to be cheap after all. “Free driving” may face the same conclusion.

Nor is it likely that everyone will face the same costs. Climate change does not affect all areas of the globe evenly. Neither will geoengineering. What if it leads to a further drying out of the southwestern United States or of sub-Saharan Africa, or to flooding elsewhere?

While the risks cannot be ignored, not even considering geoengineering research is clearly not an option. Desertification and flooding are also among the many consequences of unchecked global warming. The benefit-cost calculation of geoengineering must take these effects into account.

The fact that climate change's effects are distributed unevenly around the globe may also lead some nations to experiment with geoengineering on their own. India's national security advisor wouldn't be doing his job if he didn't at least consider countering the monsoon effects of carbon with relatively small amounts of extra sulfur. And Bangladesh's finance minister would be remiss if he didn't weigh the all-too-real costs of moving tens of millions of people against the benefits of cloud-brightening (another possible way to deflect more sunlight back into space).

In short, it will not just be up to U.S. scientists or a handful of technologically advanced countries to weigh the pros and cons of geoengineering. These technologies will be available to many countries – and as we see today, world leaders don't always succeed in working together to combat the threat of climate change.

All it takes is a single actor willing to focus on the purported benefits to his country or her region to pull the geoengineering trigger. The task with geoengineering is to coordinate international *inaction* while the international community considers what steps should be taken. The fate of the planet cannot be left in the hands of one leader, one nation, one billionaire.

Fortunately, we are still many years off from the full “free driver” effect taking hold. There's some time to engage in a serious global governance debate and careful research: building coalitions, guiding countries and perhaps even individuals lest they take global matters into their own hands. In fact, that is where the discussion stands at the moment, with a [governance initiative](#) convened by the British Royal Society, the Academy of Sciences for the Developing World, and the Environmental Defense

Fund, among other deliberations guiding how geoengineering research should be pursued.

### **With time come the “free drivers”**

The clock, however, is ticking. A single dramatic climate-related event anywhere in the world – think Hurricane Katrina on steroids – could trigger the “free driver” effect. That event need not be global and it need not even be conclusively linked to global warming. A nervous leader of a frightened nation might well race past the point of debate to deployment. The “free driver” effect will all but guarantee that we will face this choice at some point.

“Free riding” and “free driving” occupy opposite poles of the spectrum of climate action: One ensures that individuals won’t supply enough of a public *good*. The other creates an incentive to engage in potentially reckless geoengineering and supply a global *bad*. It’s tough to say which one is more dangerous. Together, these powerful forces could push the globe to the brink.

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