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Will the Future Be Geo-Engineered?

Catalyst by Maywa Montenegro & Veronique Greenwood / April 29, 2009

Five experts debate engineering the climate, **how it would be governed**, and **the ways we're doing it already.**

The Catalyst: Driving Reactions to Issues in the News

Will the Future Be Geo-Engineered? Our Panel Responds:

- **Alex Steffen**, environmental journalist and entrepreneur [Go]
- **Robin Bell**, marine geophysicist [Go]
- **Ken Caldeira**, geochemist [Go]
- **Roger Pielke Jr.**, political scientist [Go]
- **Maria Ivanova**, environmental justice advocate [Go]

Sprinkling sulfur particles into the atmosphere, launching mirrors into space, and seeding the oceans with iron may have once been regarded as fringe science, but no longer. Such ideas are now entering mainstream dialogue, as experts wonder if less extreme efforts to abate global change are too little, too late. It's a touchy subject. And while presidential science adviser John Holdren views geo-engineering as a last resort, others are much more bullish. Earlier this month, for instance, esteemed Princeton physicist Robert Socolow told the National Academy of Sciences, "The way in which people who think about geo-engineering have been framing it has been like an emergency strategy, like epinephrine. But we really don't know the worst that can happen with climate change."

Still, for many environmentalists and scientists, including new NOAA administrator Jane Lubchenco, geo-engineering raises serious concerns. Too much confidence in technological fixes, they fear, could blunt political and scientific efforts to address the underlying energy problem.

But will those efforts be enough? At the recent climate summit in Bonn, the US delegation, led by chief climate negotiator Todd Stern, brought enthusiasm to the table — in itself a noticeable departure from the previous administration — but concrete commitments proved elusive. Developing countries, led by China, pushed the US and Europe to accept bolder short-term carbon emissions targets — at least 40 percent below 1990 levels by 2020 — but in the end were unsuccessful. And further debate erupted over the fact that US goals are significantly less ambitious than those of the EU: The draft climate change bill released in late March by Democratic Congressmen Henry Waxman and Edward Markey aims to restore greenhouse gas emissions to 1990 levels by 2020, while Europe pledges to bring emissions to at least 20 percent below 1990 levels by that date, or 30 percent if other developing economies follow suit.

In June the National Academies' climate panel will convene to examine whether geo-engineering fixes are technically and economically feasible—and whether they can be carried out without unwanted environmental side effects. As pre-Copenhagen process limps along, struggling to meet scientifically defined targets, how would you advise President Obama on geo-engineering? Is it too risky to consider? Or too risky to ignore?

The Little Lifeboat that Couldn't

Alex Steffen is the cofounder and executive editor of Worldchanging.

Imagine finding yourself aboard a burning ocean liner. An increasing number of people are trying to put it out—and they stand a good chance, if they can get access to the fire axes and hoses. Unfortunately, some rich old fat guys are sitting in deck chairs blocking the equipment, enjoying drinks and appetizers, and every time the other passengers try to get them to move, the rich old fat guys say they don't really believe in the fire, and even if it does exist, it probably can't be put out, so we should just trust in the new lifeboat being built—a great technical fix that will get everything back to normal. And, sure enough, there on the deck is a brilliant but somewhat unworldly professor, busily sketching a design for a new lifeboat as the smoke billows in larger and larger clouds.

That's a pretty fair analogy for the situation in which we find ourselves, and for the role that geo-engineering, the hapless lifeboat, is playing in the climate debate.

There is no reasonable basis for doubt that climate change is an extremely pressing problem. We can observe its effects everywhere on the planet. In our ship analogy, the fire is quite real.

Luckily, this is a fire we know how to fight. We know now that we here in the developed world need to cut emissions dramatically and immediately: probably something on the order of 90 percent over the next 20 to 30 years. We know we can do this, mostly at a profit, and definitely in ways that not only avert disaster but also improve the quality of our lives. We know how to build bright green compact cities. We know how to redesign our buildings, transportation systems, infrastructure, and factories to slash energy demand (again, usually at

a profit). We have a good idea what climate-friendly farming and forestry would look like. We even have pretty clear paths ahead of us to running our economy entirely on clean energy. We can do all this, and not only cut the major sources of current emissions, but also provide a model of prosperity that the developing world can use to rise out of poverty without following in our climate-disruptive footprints, thus avoiding future emissions. All of this is within our power now. To return to the analogy, we know where the fire axes and hoses are.

The only reason we aren't already on track toward climate neutrality is that the burning of fossil fuels is extremely profitable, and the coal, oil, and gas industries have used their power to completely distort the political debate. Their lackeys — climate "skeptics," lobbyists, conservative talk radio hosts — have used every possible strategy to slow progress away from fossil fuels by convincing Americans that climate change isn't a scientific certainty, that it won't be that bad, and that, anyway, cutting greenhouse gas emissions will destroy our economy. The fat guys in the deck chairs are full of bunkum, of course.

The professor on the deck is not. He is earnestly trying to figure out a lifeboat design, just as some scientists are eagerly trying to imagine what megascale geo-engineering projects might save our planet from runaway climate change. There's nothing wrong with that.

What's wrong is that we have no real reason to believe that he can, in fact, build a working lifeboat from scratch in time — or that we can, in fact, intervene in the planet's climate on a vast scale without disastrous consequences. But right now, those benefiting from inaction are already using the idea of possible lifeboats as an argument against fighting the fire, so to speak. The idea is that since cutting emissions is "unrealistic," it's good we have a backup strategy.

At very least, serious proponents of geo-engineering need to acknowledge the severe limitations on our actual knowledge of geo-engineering, and point out that emissions reductions are a far more certain and safe approach: The professors should continue sketching lifeboats, by all means, but they should also tell the fat guys to get out of the way and stop misrepresenting their work.

The Backup System

Ken Caldeira is a climate scientist at the Carnegie Institution's Department of Global Ecology at Stanford.

Despite our reluctance to intentionally interfere in planetary processes, at some point in the future such interference could cause less damage than would the further heating of our planet. We need the research now, so that we can make informed decisions should the effects of excessive global heating become intolerable.

The term "geo-engineering" has referred to a mixed bag of proposals, ranging from whitening roofs to whitening skies, from engineered crops to fertilized oceans, so little can be said of "geo-engineering proposals" in general. But there is one category of proposal that deserves special attention, and that is proposals that can cool the Earth quickly in the face of a climate emergency.

In every single greenhouse gas emissions scenario considered by the IPCC, the Earth keeps heating throughout this century — even in the most optimistic scenarios in which we make a rapid transition toward renewable energy sources. And, of course, actual emissions exceed even the most pessimistic of the IPCC scenarios.

If the heating of our planet becomes intolerable in this century, direct intervention in the climate system would be the only way to start the Earth cooling soon.

The fastest and most effective way to cool the Earth rapidly may be to emplace dust in the stratosphere, mimicking the cooling effect of large volcanoes. There may also be opportunities to rapidly whiten clouds over the oceans. It is critical that we actively research these options, with emphasis on a full exploration of the ways in which deployment of such systems might increase or decrease all sorts of risk (environmental, political, etc.).

Most other proposals that fall under the geo-engineering rubric cannot be deployed rapidly enough at large enough scale to cause the Earth to begin cooling within years or decades. These proposals do not merit the same level of urgency as schemes that can be deployed as part an emergency rapid response system. And, of course, the possibility of these options is no reason to relax efforts to diminish greenhouse gas emissions.

It is critical that we research our climate emergency backup system before we need to deploy it. Therefore, it is critical that we investigate options with the potential to initiate global cooling within years or decades. We need to know, before a climate crisis occurs, whether such a system could reduce risk or would merely make things worse.

Does Geo-engineering Meet Criteria for a Successful Technological Fix?

Roger Pielke Jr. is a professor of environmental studies at the University of Colorado and fellow of the Cooperative Institute for Research in Environmental Sciences (CIRES).

Writing in *Nature* last December, Dan Sarewitz and Dick Nelson offer three criteria by which to distinguish "problems amenable to technological fixes from those that are not." Here I apply these criteria to the technology of geo-engineering the climate system, defined by the American Meteorological Society as an effort to "deliberately manipulate large-scale physical, chemical, or biological aspects of the climate system to counteract the climate effects of increasing greenhouse gas emissions." Examples of geo-engineering thus include injecting aerosols into the stratosphere or seeding the ocean with iron, but would not include capturing carbon dioxide from coal plants or the ambient air.

Geo-engineering falls well short of all three of the criteria that Sarewitz/Nelson present as guidelines for when to employ a technological fix.

Sarewitz/Nelson Criterion #1: The technology must largely embody the cause-effect relationship connecting problem to solution.

Geo-engineering does not directly address the cause-effect relationship between emissions and increasing atmospheric concentrations of carbon dioxide (and other greenhouse gases). Geo-engineering addresses the effects, and only in indirect fashion.

Sarewitz/Nelson Criterion #2: The effects of the technological fix must be assessable using relatively unambiguous or uncontroversial criteria.

The effects of geo-engineering on climate impacts of concern — including phenomena such as extreme events, global precipitation patterns, sea ice extent, biodiversity loss, food supply, and so on — would be difficult if not impossible to assess on timescales of relevance to decision makers. Research on weather modification provides a cautionary set of lessons in this regard.

Sarewitz/Nelson Criterion #3: Research and development is most likely to contribute

decisively to solving a social problem when it focuses on improving a standardized technical core that already exists.

Geo-engineering on a planetary scale has never been attempted. Thus, its effects cannot be known, only speculated upon. Geo-engineering could easily have unpredicted or undesirable effects. There is no standardized technical core for geo-engineering.

In short, geo-engineering fails comprehensively with respect to the three criteria for technological fixes offers by Sarewitz and Nelson, suggesting that it offers little prospect to serve as a successful contribution to efforts to deal with increasing concentrations of carbon dioxide. As they write, “one of the key elements of a successful technological fix is that it helps to solve the problem while allowing people to maintain the diversity of values and interests that impede other paths to effective action.” Because it fails with respect to the three criteria, geo-engineering is likely to make the politics of climate change even more complex and contested, resulting in little prospect for success. But even if geo-engineering offered few prospects for successfully addressing the climate issue, continued research on geo-engineering would make sense both to keep options open and also to contribute to a further understanding of the human role in the climate system.

Governing Geo-Engineering: A Daunting Task

Maria Ivanova is an assistant professor of government and environmental policy at the College of William and Mary and the director of the Global Environmental Governance (GEG) Project at the Yale Center for Environmental Law and Policy.

Will the future be geo-engineered? The best place to look for answers will be the negotiations over the successor to the Kyoto Protocol. If the Copenhagen meeting this December yields a stringent, comprehensible, and enforceable agreement to reduce emissions, then the pressure to develop and deploy geo-engineering technology will wane. If instead the new agreement perpetuates the Kyoto Protocol, capping a tiny fraction of global emissions and scheduling reductions that are insufficient to limit warming to 2 degrees, then the reasons to geo-engineer will only grow. A world in which greenhouse gas emissions follow a business-as-usual

trajectory will be one in which collective action to solve climate change has failed. To many governments, unilateral action in the form of a geo-engineering program may seem like the only remaining option to protect their citizens and territory from climate change's effects. In such a world, our current difficulties in coming to a collective solution for a collective problem will seem trivial in comparison with the challenge of stopping such an action from a nation, a company, or a group of individuals.

The governance issues raised by geo-engineering are thus akin to those of nuclear weapons technology. A treaty like the Non-Proliferation Treaty might be an effective means of governing geo-engineering (where the technology would be limited to a few "responsible" powers that work together to prevent dissemination). There is one key difference, however, between nuclear and geo-engineering technologies. Developing nuclear weapons requires a highly advanced scientific program, expensive and time-consuming uranium enrichment, and large dedicated facilities. In other words, there are very high technological and economic barriers to developing nuclear weapons. In contrast, geo-engineering in its simplest form might be done with a rocket and source of sulfate or even a ship and a large source of iron. Even with the high barriers to nuclear technology, the NPT has had only limited success in restricting the proliferation of nuclear weapons. How much more difficult will it be to limit the spread of relatively simple geo-engineering technology? The apparent cheapness and simplicity of geo-engineering, the very qualities that make it an appealing response to climate change, are also the qualities that will make governing the technology extremely difficult.

The Future Is Here

Robin Bell is a senior research scientist at Columbia University's Lamont-Doherty Earth Observatory.

Each morning when I slip the key in the ignition of my car, I participate in a geo-engineering project. Even with its hybrid engine, my Prius spews carbon dioxide into the atmosphere. These molecules join the carbon dioxide contributed by my mother when she used gas to cook Thanksgiving dinners, by my grandfather when he burned the oil in his furnace to warm his office, and by my great-grandfather when he burned coal to warm his waiting room. Our

global carbon project is not new.

Our ingenious use of carbon-based energy systems has enabled us to eat and live on all seven continents, even on the high, cold, polar plateau in Antarctica where I conduct my research. As we recognize the emerging consequences of our changes to the global atmosphere, we must investigate all possible solutions to mitigate the impacts of the increased carbon dioxide in the atmosphere. To remove geo-engineering from the list of potential contributors is irresponsible. Along with our ancestors, we have inadvertently geo-engineered an altered atmosphere. Together with our descendants we must creatively and willfully develop solutions, including responsible geo-engineering.