What if we could engineer the planet to help fight climate change?

Efforts to curb carbon emissions are falling short. As climate change impacts become all too clear, geoengineering is again in the spotlight. Some see it as a last-resort option to fight climate change. Detractors highlight the risks and uncertainties. Will governments end up 'tinkering with Earth's thermostat'?

In the summer of 2018, a succession of heatwaves struck the EU. Record-breaking temperatures were reported, and wildfires ravaged the continent. Sweden suffered the worst forest fires in modern history. In Greece, blazes swept through Attica and left 102 dead. For many citizens, wildfires threw the reality of climate change into sharp relief.

Under the Paris Agreement, nearly 200 countries pledged to keep global warming well below 2°C. But progress in curbing carbon emissions is not on track. If the current trend is not reversed, extreme weather events like the 2018 heatwave will become more and more frequent.

Large-scale tree planting and direct air capture and storage (DACCS) are being considered to boost these efforts. While these are steps in the right direction – and could end up playing a significant role in tackling climate change – DAC is currently very costly and energy intensive, and planting trees can only help so much.

Geoengineering refers to large-scale interventions in the global climate system, intended to counteract climate change. In 2008, the UN Convention on Biological Diversity called for a moratorium on geoengineering 'until there is an adequate scientific basis on which to justify such activities'. Only a decade later, scientists and policy-makers are again looking for last-ditch solutions to buy some extra time. Geoengineering is again in the spotlight.

Potential impacts and developments

Geoengineering includes a number of techniques of varying complexity, risk, and cost. In policy-making, the debate revolves almost entirely around 'solar geoengineering'. This describes a set of methods aimed at cooling the planet by reflecting a portion of solar energy back into space, or increasing the amount of solar radiation that escapes the Earth.

Cirrus clouds are known to have a warming effect on Earth. Seeding the atmosphere with Sahara dust would prevent the formation of cirrus clouds, and reduce global temperatures. Stratospheric aerosol injection entails creating an artificial sunshade by injecting reflective particles in the stratosphere. Its working principle is based in nature. The eruption of Mount Pinatubo in 1991 pumped around 15 million tons of sulphur dioxide into the stratosphere; in the two years that followed, global temperatures decreased by about 1°C.

Solar geoengineering would be inexpensive, and scientists agree on its potential. Without actions to reduce emissions, the concentration of CO_2 is likely to be double pre-industrial levels by 2060. In theory, getting rid of all cirrus clouds would balance the doubling of CO_2; so would using stratospheric particle injection to reflect 2 % of the incoming solar radiation.

But there is no simple solution. For a start, solar geoengineering does not target the root of the problem; it only mitigates its effects. Solar geoengineering has never been tried before. If done incorrectly, it could cause even more global warming; and there could be other unintended consequences. The real challenge, however, may not be technological but rather one of governance. Climate politics is slow and complex; agreeing on using untested

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technology on a planetary scale could prove impossible. Who decides to use solar geoengineering? Who benefits from it? Who is affected?

Solar geoengineering is a geopolitical issue. The atmosphere has no borders, and the actions of some countries could affect the climate of others. To make matters worse, the science is not always conclusive. Some climate models suggest that almost every region in the world would benefit from solar geoengineering. Other scientists claim that since heat-trapping gases would still operate, temperatures would be more evenly distributed. This would reduce precipitation. Such a geoengineered world would be cooler, but also drier.

Many stakeholders see a moral hazard in solar geoengineering. All efforts are now focused on reducing emissions. With new tools in their climatic toolbox, governments could become complacent. Scientists insist that geoengineering is a supplement and not a substitute for mitigation. For example, solar geoengineering will not solve ocean acidification, and its impact on the water cycle is uncertain. Eventually, part or all the carbon released into the atmosphere will need to be recaptured, regardless of whether geoengineering is used or not.

To some citizens, meddling with the climate may sound like playing god. But across the world, about 40 % of the population live within 100 kilometres of the coast. Rising sea levels will threaten these coastal communities. Many regions will see more intense and frequent summer droughts, extreme weather events, and heavy rainfall. This could strain the fragile agricultural systems in the global South, sparking an exodus of climate refugees. As the consequences of climate change accumulate, the public's opinion on solar geoengineering could shift rapidly.

Perceptions could be as important as the science. In 1962, the US started a programme to weaken hurricanes through seeding. In 1963, Hurricane Flora caused thousands of deaths in Cuba. The Cuban government accused the US of waging weather warfare. Similarly, any country suffering from extreme weather could blame geoengineers. In addition, geoengineering would be deployed progressively. Its effects would be initially difficult to decouple from natural fluctuations and climate change. Detractors would be quick to discard it as a failed idea.

There is a bigger problem, however. Once started, solar geoengineering cannot be stopped. Assuming that carbon emissions continued, the artificial sunshade would mask increasing amounts of extra warming. If geoengineering ceased abruptly – due to sabotage, technical, or political reasons – temperatures would shoot up rapidly. This termination shock would be catastrophic for humans and ecosystems.

Anticipatory policy-making

Solar geoengineering should only be considered as a last-resort solution. There is ample consensus that cutting emissions is the safest, most economical route to tackling climate change. The world needs a climate champion to accelerate these efforts, and the EU could lead the way.

Ultimately, the debate surrounding solar geoengineering could come down to balancing the risks and benefits. Solar geoengineering is not without risks. However, failing to mitigate climate change will also bring major new risks, disrupt ecosystems across the world, and hit the most vulnerable regions particularly hard.

Ironically, one reason that solar geoengineering may become necessary is the slow pace of international climate negotiations. Yet discussions on geoengineering are following the same path. Should solar geoengineering become necessary, governments need to be ready. The EU could help advance preparedness in this area; for example, by throwing its diplomatic weight behind multilateral initiatives moving in this direction.

The EU and its partners could promote an international governance framework for solar geoengineering. However, all parties must be on board. There are real risks that some of the countries worst affected by climate change could act unilaterally. Even if well-intentioned, this could create geopolitical tension. An international regulation system would ensure that no country 'goes rogue', and that geoengineering is not done for some at the expense of others.

The EU could also support research on solar geoengineering. Studies and trials may have been hampered by fears of promoting a quick 'technofix'. But if geoengineering became necessary to avert disaster, its full effects must be known. Current techniques are criticised for posing a risk to biodiversity, precipitation patterns, and the ozone layer. A better understanding of these problems is the first step towards tackling them. Research could also help governance. For example, counter-geoengineering tools could serve as a deterrent against unilateral action.

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