Geo-engineering: A new intervention in climate and earth systems?

Briefing by Biofuelwatch and Econexus

Geo-engineering is being proposed as a means to address climate change. It is politically expedient to propose but extremely dangerous to implement as it involves large-scale interventions in complex, dynamic interacting systems that are far from adequately understood. This means that we have no way of accurately predicting the impact of geoengineering applications, which could easily compound the problems we already face from increased climate instability.

What is geo-engineering?

The term geo-engineering refers to the deliberate technological manipulation of the atmosphere or biosphere, increasingly promoted as a means of countering climate change, often using the excuse that there is no political will to reduce emissions. Two main groups of geoengineering approaches are being promoted:

The first – ***Solar Radiation Management*** *(SRM)* – covers different proposals which involve reflecting a proportion of solar radiation back into space so that less heat reaches the planet. SRM proposals include spraying sulphates or other particles into the stratosphere, injecting clouds with seawater to make them more reflective ('cloud whitening') or putting sun shields into space. Biotech companies are also working on genetically engineering crops to reflect more solar radiation.

The second approach is called ***Carbon Dioxide Removal*** (CDR). It involves methods designed either to capture CO_2 directly from the air or to manipulate ocean chemistry or the biosphere so as to make it absorb more CO_2. Proposals which involve manipulating the ocean include dumping iron filings so as to create artificial plankton blooms ('iron fertilisation'), mining, grinding up and dumping carbonate or silicate rock (to make oceans more alkaline (i.e. to counter ocean acidification which is caused by increasing CO_2 levels) and to increase ocean CO_2 absorption) and modifying the upwelling and downwelling of oceans (so as to bring up nutrient rich deep water and to fertilise plankton at the surface). Proposals which involve the biosphere on land include covering large areas of land in industrial, possibly genetically engineered tree plantations (called 'afforestation' although such plantations have little to do with real forests), burning large quantities of biomass in power stations and capturing and sequestering the CO_2 from those, producing vast amounts of charcoal and burying it in soil (biochar), spreading silicate materials such as olivine on soils across large regions (to speed up the weathering of olivine, which would normally help remove CO2 from the atmosphere over geological timescales), or logging trees and removing crop residues and dumping them supposedly out of reach of the atmosphere.

Geoengineering is sometimes represented as a 'Plan B,' which we need to develop now in case efforts to reduce carbon emissions and mitigate climate change fail. One problem with this is that if we/politicians believe that there is an easy technofix for the problem there will be even less political willingness to undertake the difficult measures that are needed.

Why is geo-engineeering dangerous?

To be effective, geo-engineering would by definition have to be very large-scale and many of its effects cannot be known without actually implementing proposals on a large scale – which would be a very dangerous experiment given that impacts may not be reversible on a human timescale and may include completely unforeseen factors to complicate matters.

If real-world experiments were allowed, it would be impossible to predict all of the risks, or to distinguish any subsequent extreme weather from what might

have happened in the absence of the trial. When CFC use for refrigerators was developed, nobody knew that they should be looking at what CFCs might do to the ozone layer until ozone depletion in the Antarctic was far advanced. And while ocean acidification due to increased CO_2 levels is basic chemistry, nobody even looked into it until it was first measured in 2003. Those two examples refer to straightforward physical and chemical changes. Predicting the impacts of new large-scale interventions in complex planetary systems, with the dynamic interactions between the atmosphere, oceans and biosphere only partly understood, is even more difficult. We do not adequately comprehend how planetary systems work, still less how they interact. Computer models are simplistic and flawed. According to geophysicist and climate scientist Raymond Pierrehumbert, "*What we're really talking about is hacking the planet in a case where we don't really know what it is going to do… We already know enough about sulfate albedo engineering to know it would put the world in a really precarious state…[our climate models] are nowhere near advanced enough for us to begin thinking of actually engineering the planet… Our ability to actually say what the regional climate patterns will be in a geoengineered world is very limited*." [tinyurl.com/auwfnm7]

NASA atmospheric scientist Gavin Smith wrote: "*If the planet was a single column with completely homogeneous properties from the surface to the top of the atmosphere and the only free variable was the surface temperature, [geoengineering] would be fine. Unfortunately, the real world (still) has an ozone layer, winds that depend on temperature gradients that cause European winters to warm after volcanic eruptions, rainfall that depends on the solar heating at the surface of the ocean and decreases dramatically after eruptions, clouds that depend on the presence of condensation nuclei, plants that have specific preferences for direct or diffuse light, and marine life that relies on the fact that the ocean doesn't dissolve calcium carbonate near the surface.*" [tinyurl.com/ykfdeh8]

Some specific dangers can be and have been predicted. Scientists have modelled climate responses to sulphate injections in the stratosphere which show that global rainfall would decline by more than global temperature, that it would decline most significantly across large parts of the tropics and that the Asian and African monsoons could be disrupted [tinyurl.com/asft4bz]. Would tropical forests, grasslands and agriculture survive such a disruption? What would sudden vegetation die-back do to CO_2 levels and thus long-term global warming? Let alone to the billion people dependent on the Asian Monsoon alone? Sulphate particles in the stratosphere could also destroy the ozone layer, with potentially disastrous impacts on biodiversity. Although geo-engineering researchers are trying to identify particles small enough not to have that effect, others warn that those could clump together into large particles (tinyurl.com/clm5st6).

Proposals for removing CO_2 from the atmosphere are being promoted as 'safer' than SRM, but this is not true. All but one - direct air capture – involve the deliberate manipulation of the biosphere in the hope of increasing its CO_2 uptake. Study after study has shown that ***healthy and biodiverse ecosystems absorb more CO_2 than degraded ones with less biodiversity – and that they are far more resilient to climate change and other pressures.*** This also applies to soils. Yet all geo-engineering proposals for manipulating the oceans or soils and vegetation on land would further destroy or threaten biodiversity - and thus its ability to help regulate the climate in future. Large-scale proposals such as Bioenergy with Carbon Capture and Storage, 'afforestation' with monocultures, perhaps including GE tree plantations, or biochar would require hundreds of millions of hectares to be turned into new plantations for this purpose. Far more ecosystems and lands on which communities rely for growing food, pasture and other needs would be destroyed compared to those lost due to biofuels to date. Yet ***even at a small scale level, claims do not add up***. For example, studies show that adding biochar to soils can reduce rather than increase soil carbon, while the possibility of sequestering CO_2 in geological formations safely over the long-term is far from proven. Dumping iron filings or carbonate or silicate rock into oceans can harm marine life and whether CO_2 would be sequestered that way is entirely unproven.

The main problem with direct CO_2 air capture is the amount of energy this would require. Capturing CO_2 from power station smokestacks already requires the burning of about one third more fuel. Capturing it from the air, where it is measured in parts per million, will require vastly more energy. In practice, it would mean building many more power stations, and releasing more CO_2 to power CO_2 scrubbers. If scrubbers were powered with wind or solar energy, such energy would then not be available to replace power stations so the effect would be the same.

The politics of geoengineering and climate injustice:
Geo-engineering research and development is being promoted most strongly by governments and corporations with a vested interest in preventing meaningful action to reduce fossil fuel burning. Exxon Mobil, which has long financed climate change deniers, now calls for geoengineering as an alternative to reducing fossil fuel use [tinyurl.com/boe4yfe]. Various tar sands investors are geoengineering proponents. Other supporters of geoengineering R&D include Richard Branson and Shell. The UK and US governments, both of them with close links to the fossil fuel industry and little interest in drastic emissions cuts, are particularly supportive of such research and growing amounts of funding are being made available for it through state-funded UK research councils.

The UN Convention on Biological Diversity voted for a *de facto* moratorium on virtually all geoengineering trials (except for certain small-scale ones under closely prescribed conditions). However this *de facto* moratorium remains vulnerable to being overturned and, furthermore, there is a danger of it being breached unilaterally or by a few nations deciding to forge ahead regardless. Last October, it was revealed that a US company had conducted the biggest ocean fertilisation trial off the Canadian coast, in clear defiance of the moratorium.

Thus, not only is geoengineering being promoted almost exclusively by groups in the global North, many of them with interests linked to the fossil fuel industry, but there is a high risk that geoengineeing could be attempted by such groups and countries, undemocratically and in complete disregard of the interests of the majority of the world's population. ***The impacts could be irreversible and are likely to be felt particularly severely by communities in the global South.*** As stated above, models show that SRM will likely disrupt rainfall in the tropics and sub-tropics more than in other regions (which, nonetheless, could also be in for unpleasant 'surprises'). Geo-engineering methods such as (GE) plantation-based afforestation, biochar and biomass with carbon capture and storage will likely affect Southern countries the most because biomass grows fastest in the tropics and because land in the global South is already the focus of extensive land-grabs for biomass.

Finally, ***geo-engineering is being proposed as an alternative to the urgent emissions cuts that are required***. Even the Royal Society cites as one potential advantage of SRM that it "could be deployed to obviate the need for only the most expensive and politically difficult emissions cuts." [tinyurl.com/aln9lvw].

One of the most persuasive arguments is that we might need geoengineering even if we stopped emissions tomorrow, the warming process would continue for some years because the CO_2 already in the atmosphere has not yet had its full effect.
This justification is being put forward by many who promote geo-engineering R&D. There is indeed plenty of evidence that CO_2 levels in the atmosphere are already extremely dangerous. Yet, in the face of the escalating climate crisis –and its convergence with other equally serious crises such as those of biodiversity destruction,

freshwater and soil depletion – ***it is imperative that we reject options which run a high risk of making those crises even worse even faster.*** There is growing evidence that all geo-engineering options risk doing just that.

There are safe alternatives to geo-engineering, which would give the planet a far better chance of stabilising the climate. Drastic emissions cuts are essential and must involve significant reductions in energy and other resource use in the global North. Countries in the global South need help to avoid going down the same energy development path as the North. And as stated above, biodiverse and healthy ecosystems are best able to help regulate the climate, to sequester carbon and to remain resilient to extreme weather and other stresses. Allowing forests, grasslands and other ecosystems to regenerate naturally and helping to restore them where necessary and appropriate (e.g. by reversing drainage of peatlands) will help draw down carbon and give the biosphere a better chance of surviving unavoidable levels of climate change. This will require reducing our demands for wood, animal feed, biofuels and our overall 'land footprint' – the very opposite of what many geo-engineering proposals would do. Soils hold even more carbon than plants and restoring healthy soils would play a crucial role in countering climate change. La Via Campesina states "Small-scale sustainable farmers cool down the earth" [tinyurl.com/bbvg743] and this is backed by the science. Support for, and a global shift to agro-ecological farming and away from industrial farming would help restore soils and build up soil carbon, increase regional biodiversity, including diversity of crops, offer the greatest resilience to climate change and, at the same time, greatly reduce global greenhouse emissions.