How can we manage

Noel Castree and Rob Bellamy

Limiting climate change is the biggest challenge of cooperation that humans have ever faced. This article looks at the options available for managing this 'global commons' — from mitigation now to geoengineering in the future — and considers the risks involved

Anthropogenic climate change will lead to significant alterations to the world's physical and human geography in the decades and centuries to come. The Intergovernmental Panel on Climate Change (IPCC) — the world's most authoritative climate-science organisation — reports that without very serious and swift actions, humans will have warmed the atmosphere by 2°C (or more) above pre-industrial levels by 2100. That may sound like a small rise in temperature. However, among other effects, it would:

- start notable sea-level rise (as the ice caps melt)
- intensify already destructive hurricanes
- amplify naturally occurring heatwaves
- acidify the oceans (damaging their complex ecology, as shown by recent bleaching of the Great Barrier Reef in Australia)

To set the number in context: if we go beyond 2° then the world's atmosphere will not have been that warm for hundreds of thousands of years, a time when the Earth's physical geography was very different from today. This is why the majority of the world's governments committed themselves in 2015 to the Paris Agreement. The agreement aims to keep average atmospheric temperature below the 2° threshold, and to limit the warming level to no more than 1.5°C above the pre-1800 average.

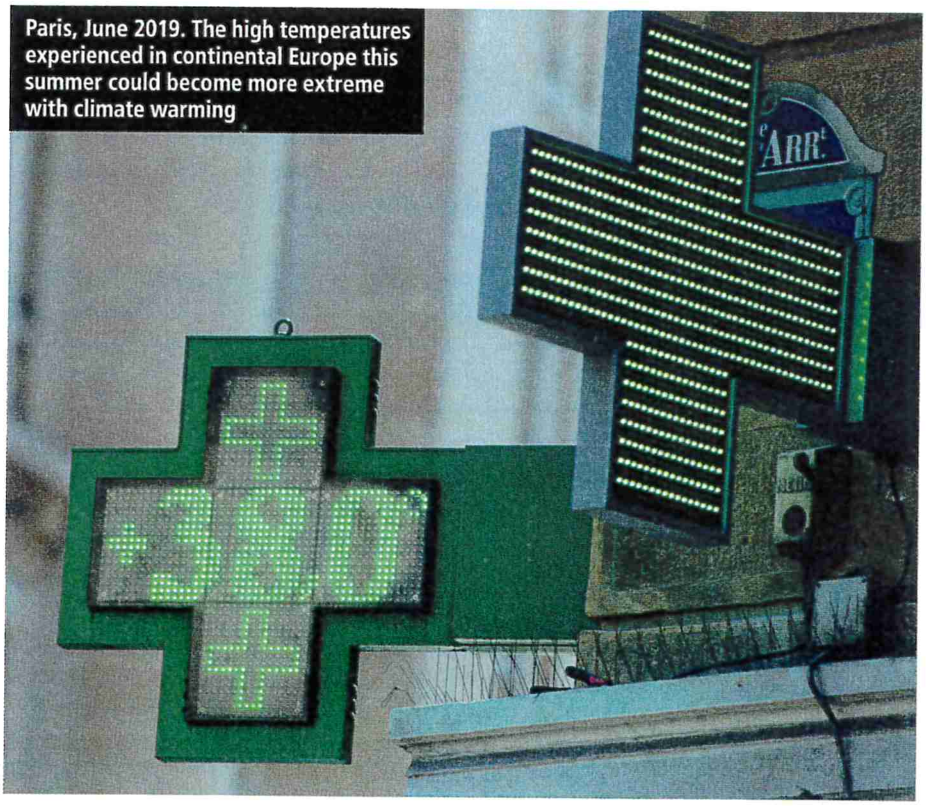
This article explores some of the key ways we could achieve the Paris targets, highlighting the challenges involved in implementing them. Together, these measures would amount to a profound attempt to 'geoengineer' the terrestrial environment and the atmosphere. As we will see, there are significant risks with implementing them at the necessary scale, as well as with delaying implementation.

A challenge of governance

The atmosphere is an **open-access resource**, or a 'commons'. In other words, it provides free services that benefit all people worldwide. Equally, however, all countries are free to do things that impair those services — such as emit greenhouse gases (GHGs) over many decades from coal-fired power stations.

In his famous 1968 essay 'The tragedy of the commons', the American author Garrett Hardin proposed privatisation as one solution to the widespread problem of open-access resources becoming degraded over time (see Box 1). He reasoned that if you divide the commons into parcels of private property, the new owners will have an incentive to look after their own newly acquired resources.

However, the problem with the atmosphere is that, like the high seas, it is too large in size and depth to privatise. More than this,



Paris, June 2019. The high temperatures experienced in continental Europe this summer could become more extreme with climate warming

Box 1 The tragedy of the commons

In 1968, US biologist Garrett Hardin published 'The tragedy of the commons' in the magazine *Science*. In this article, he used a parable about cattle grazing on common land to illustrate the root causes of emerging global problems, like over-fishing in the oceans.

Hardin reasoned that it was rational for each cattle owner to add an extra cow to the commons. Why? Because they enjoyed the full benefit of the cow (e.g. milk or meat), while the other owners had to bear the burden of the extra grazing pressure. If all owners acted rationally in this way, Hardin argued, the eventual result — the tragedy — would be ruination of the pasture and all owners losing out as their cattle starved or were malnourished. This was the 'rational irrationality' of the herders' behaviour over time.

Hardin's essay has had a large impact on people's thinking about open-access resources.

global warming?

like ocean water, the atmosphere is fluid, meaning that a 'responsible' country whose citizens have a low environmental impact will still be affected by a less responsible one whose impact is much higher. The only solution, therefore, is effective intergovernmental cooperation, or what is called 'transnational governance' of the global commons.

Governance is rather different from traditional **government**, where state bodies use laws, rules, money and other mechanisms to influence affairs within their national borders. Governance is the process whereby a number of actors — including but often going beyond governments — cooperate to achieve a strategic objective perceived to be in their shared interest. No one actor may have ultimate power or authority over the others.

Will the Paris Agreement hold?

Since the 1950s, the United Nations (UN) has been the world's main governance body, allowing governments to work together to achieve common objectives, such as avoiding wars. It brokered the Paris Agreement in 2015 after the perceived failure of its predecessor, the Kyoto Protocol on GHG emissions (effective from 2005).

Will the Paris Agreement work?

Many countries signed up to the agreement, because the GHG emissions pledges made by each country are voluntary. Countries are free to vary their commitment to reduce emissions. In other words, the agreement provides plenty of opportunity for Hardin's tragedy of the commons to continue, even though it was designed to tackle the tragedy. A country that wants to make deep emissions cuts might decide against this because it knows that other high-emitting countries are less committed. Because it lacks the traditional powers of a government, the UN's main tools are persuasion and diplomacy (sometimes called 'soft power').

Despite these problems, the agreement does show that, after 30 years of effort, the IPCC seems to have persuaded most of the world's governments that the Earth's natural climatic belts are a **public good** to be protected. In other words, the atmospheric conditions prevailing over the last 12,000 years or so, when the current **interglacial period** began, have been broadly beneficial for humans. A warmer world could bring a large number of 'public bads' that would impact hundreds of millions of our successors in the decades and centuries to come.

Even so, there will be some huge practical challenges once more governments take responsibility for their atmospheric impacts. To understand these impacts we need first to consider the techniques available for keeping the world's temperature below the 2° threshold.

How to regulate the world's temperature

The Kyoto Protocol of 2005 focused on mitigation: that is, on reducing GHG emissions from power stations, cement factories and the like. However, emissions have remained high. At present rates, scientists in the IPCC estimate that we have only 15–25 years before the world's 'carbon budget' is used up (IPCC 2018). This is the amount of carbon dioxide and other GHGs that we can still emit before the subsequent warming takes us to 1.5°C or more.

A big problem is that about 80% of the world's energy supply still comes from burning fossil fuels (coal, oil and natural gas, IEA 2018). 'Decarbonising' the world economy quickly would mean a massive roll-out of renewable-power technologies and reduction in fossil-fuel use — something large oil, coal and gas corporations and fuel-exporting countries fiercely resist. Current GHG emissions would need to be reduced by nearly 100% within two or three decades. The Kyoto Protocol has barely made a dent in emissions levels over the last 14 years.

On the plus side, many renewables like hydro power are proven technologies, with new ones — such as tidal power — set to join them. There is a lot of investment in solving problems like the intermittent nature of wind power. On the down side, many developing countries may still want to follow China and Brazil and base future economic growth on GHG-emitting fuel sources. After all, these countries might argue, the already 'developed' countries like the USA did this historically and are responsible for most global warming. They should therefore do the most to reduce GHG emissions.

This brings us to two sorts of measures that may be necessary in the near future. At present, most are at any early stage of technical development.

NETs

'Negative emissions technologies' (NETs) are designed to take GHGs out of the atmosphere over time, to get us back within the carbon budget. It is likely that by 2050 these will be vital. They would 'lock up' not only present-day emissions but accumulated emissions from the past. They would operate over decades-to-centuries in order to get GHG concentrations back to something like pre-1800 levels.

The main NETs currently being developed are summarised in Figure 1. These still require a lot of research and development.

SRM

Where NETs are focused on sequestering GHGs, 'solar radiation management' (SRM) involves techniques that reflect sunlight away from the Earth. The most widely discussed technique is stratospheric aerosol injection (SAI). This would involve injecting tonnes of fine particulates into the upper atmosphere to alter the reflective properties of the highest clouds. As the after effects of large volcanoes show, such particulates act as a sun-screen, affecting global climate for months or years.

SRM is often called **geoengineering** because it involves deliberate, large-scale change to a part of the world's physical geography (the atmosphere). However, NETs are also geoengineering technologies.

Practical challenges

The world's political leaders may appear to have many options to help them realise the ambitious Paris goals. However, the measures described above will require tough decisions to be taken by countries, alone and together. We can illustrate the difficulties with reference to two NETs and to SAI.

- For **reforestation** and **bioenergy with carbon capture and storage (BECCS)** to store enough carbon dioxide, scientists estimate an area the size of Australia would be needed to grow trees or other biomass. The world population may grow to well over 9 billion by 2100, and these measures could reduce the area devoted to growing food crops, possibly raising prices and creating scarcity.
- Some climate scientists have modelled the atmospheric effects of large-scale **SAI**. It can reduce the average temperature, but it might have serious side-effects. In some computer models it weakens the monsoon rains in India, which would affect insect behaviour and could increase malaria levels. If a group of countries that did not include India had undertaken SAI, it is clear that geopolitical conflicts could arise.

These sorts of practical challenges arise because of the sheer scale of climate geoengineering ideas. Deploying these schemes would have equally large-scale, but uneven, impacts on people and the environment. Precisely who the winners and losers would be would depend on intergovernmental negotiation over climate policy.

Weighing the risks

There are four basic ways to tackle anthropogenic climate change. This article has focused on two (NETs and SRM) and discussed a third (mitigation). The other way is societies adapting to the unfolding impacts of a changing climate (e.g. resettling people

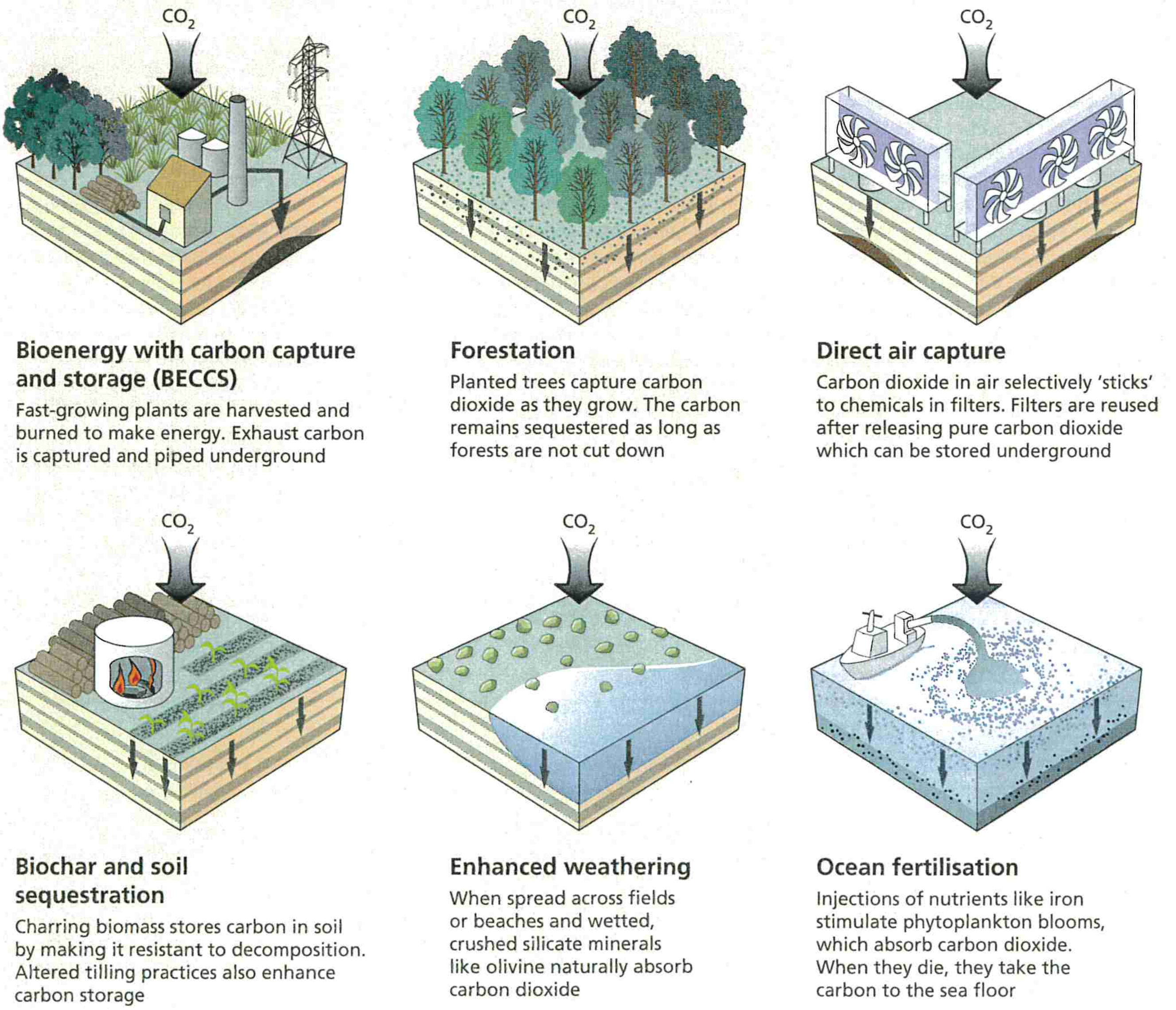


Figure 1 Six ways to pull carbon dioxide out of the atmosphere: the main NETs under development

from small, low-lying Pacific islands as sea levels rise). The four ways are interdependent.

In conclusion, let's consider how the 'tragedy' of climate change may be prolonged by talk of NETs and SRMs among scientists and governments. In other words, how the measures designed to tackle climate change may themselves become an excuse for delay.

Mitigation is sometimes called Plan A for tackling climate change: it is the best approach because it addresses the problem at source, for instance by using renewable energy supplies instead of fossil fuels. However, because fossil fuels have become so integral to our lives — from the plastics we use to the vehicles we drive — Plan A is politically unpopular. As noted earlier, it would be a brave or especially virtuous government that tried to halve its GHGs in, say, 20 years while other governments 'selfishly' increased their emissions to facilitate their economic development.

Therefore, Plan B — NETs and SRMs — looks attractive. It kicks the solution into the future, when large-scale geoengineering can compensate for political failure to reduce GHGs today. However, there are two problems with Plan B:

- **Borrowing from the future** The idea of future NETs and SRMs could be used by politicians to justify weak mitigation today.
- **Temporal burden shifting** This imposes costs on future generations, who inherit today's challenges without a say.

Testing of a tidal-power turbine in Orkney

Political leaders, with the help of scientists, need to weigh the risks.

- If implemented now, Plan A will be economically disruptive and very unpopular, especially in developed countries with high fossil-fuel dependence.
- A mix of the two plans together over the next 30–50 years will be no better.
- A delayed Plan B will be most disruptive environmentally for future generations. In addition, adaptation costs will soar as the atmosphere warms unchecked.

In all cases, **free-rider** problems will exist and geopolitical tensions will emerge as countries bargain over who is — and is not — doing their 'fair share' of managing the Earth's atmosphere responsibly. Never have humans faced such a formidable task of acting together for the benefit of all. Rarely has the risk been so high that weak intergovernmental cooperation will produce negative consequences for people and environment worldwide.

Questions for discussion

1 What barriers do you think might prevent an individual government 'decarbonising' their economy and investing in adaptation measures in the near future? Research this question using a good-quality newspaper, such as the *Guardian*. Find a recent article in the online version about climate policy in a country like Australia that is resistant to change. Use the links to related articles about climate policy and energy policy. Three to four articles will provide helpful insights into the barriers to change.

2 Imagine a world where the United Nations had the authority to make countries implement 'Plan A' and thus tackle the 'tragedy of the commons'. What specific resources or powers would the UN need to ensure countries complied with a 'world climate-change law' to avert 'dangerous climate change'? How likely is it that countries would relinquish some of their independence in order that the UN govern in the general interest?

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Glossary

Free rider A person or organisation who benefits from the actions of others yet knowingly refrains from acting in a similar way.

Geoengineering Any large-scale deliberate attempt to affect the operation of the atmosphere, biosphere, cryosphere, pedosphere or hydrosphere. SRM is one such attempt.

Governance A process of governing involving a range of actors, some of whom are not part of the local or national state.

Government The process of governing a society involving governmental agencies and staff.

Interglacial period Warmer period between times of glacial climate.

Open-access resource Any natural resource that is free to use by groups of people. Such resources range from local in scale to global, like the atmosphere. Often called 'common pool resources' or simply 'commons'.

Public good A natural resource or organisation that provides goods or services that benefit most or all members of a society.

References

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Intergovernmental Panel on Climate Change (2018) 'Mitigation pathways compatible with 1.5°C in the context of sustainable development', *IPCC Special Report on Global Warming of 1.5°C*: **www.ipcc.ch/sr15/**

Key points

- The Earth's atmosphere is an open-access resource or 'commons'.
- To reduce global warming national governments must work together to cut their GHG emissions.
- There are strong incentives for countries to 'free ride' while others try to reduce their GHG emissions.
- NETs and SRM offer a largely untested Plan B to allow countries to cope with further global warming.
- Both technologies have costs and come with risks that might outweigh those involved in mitigating GHG emissions and adapting to global environmental change.