Ethical Anxieties About Geoengineering: Moral hazard, slippery slope and playing God

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In his landmark 2006 intervention, Nobel Prize winning atmospheric scientist Paul Crutzen wrote:

> By far the preferred way to resolve the policy makers' dilemma is to lower the emissions of the greenhouse gases. However, so far, attempts in that direction have been grossly unsuccessful.[2]

The essential starting point for any consideration of the ethics of geoengineering is the failure of the world community to respond to the scientific warnings about the dangers of global warming by cutting greenhouse gas emissions.[3]

Not all those promoting geoengineering research view it as a response to moral failure. To see this it helps to set out the usual arguments in favour of research into and possible deployment of geoengineering. In this paper I will use sulphate aerosol injections, a form of solar radiation management (SRM), as the primary case as it is the geoengineering method that is attracting most interest and seems most likely to be deployed.[4] It also illustrates the ethical issues most starkly.

1. Rationales for climate engineering

Three main justifications are used to defend research into geoengineering and possible deployment—it will allow us to buy time, it will allow us to respond to a climate emergency and it may be the best option economically. These are set out in Table 1 along with some implications.

The buying-time argument—the main one used in favour of more research in the 2009 Royal Society report[5]—is based on an understanding that the failure to cut global emissions arises

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[2] Paul Crutzen, Albedo Enhancement by Stratospheric Sulfur Injections: A Contribution to Resolve a Policy Dilemma? *Climatic Change*, 77: 211-220, 2006
[3] When we say it is a failure of the "world community" this should not obscure the fact that it has been certain powerful nations, and certain powerful groups within those nations, that have been responsible for this failure. Even so, all citizens within the nations with high per capita greenhouse gas emissions must bear some responsibility for their nation's failure, even if they have taken all reasonable measures to reduce their personal emissions. On individual *versus* collective responsibility, see Steve Vanderheiden, *Atmospheric Justice: A Political Theory of Climate Change*, Oxford University Press, New York, 2008, pp. 173-80
[4] Carbon dioxide removal methods would be too slow in the case of a climate emergency, leaving SRM interventions only. Among the various SRM methods the Royal Society report describes sulphate aerosol spraying as the most promising (Royal Society, *Geoengineering the Climate: Science, governance and uncertainty*, The Royal Society, London, 2009, p. 58).
[5] Royal Society, *Geoengineering the Climate: Science, governance and uncertainty*, The Royal Society, London, 2009

either from political paralysis (due, for instance, to a prisoner's dilemma problem[6]) or from the power of vested interests. The log-jam can only be broken by the development of a substantially cheaper alternative to fossil energy because countries will then adopt the new technologies for self-interested reasons. SRM would allow the effects of warming to be controlled while this process unfolds. Geoengineering is therefore a necessary evil deployed to head off a greater evil, the damage due to unchecked global warming.

Table 1 Reasons for developing SRM technologies

Reason	Rationale	Implications for abatement	Timing of deployment	Moral status of geoengineering
Buy time	Time is needed to develop cheaper abatement technologies to overcome policy inertia	Abatement is essential but will be easier later	As soon as it's ready and for as long as it takes to develop better abatement technologies	A necessary evil
Climate emergency	We need to have the tools ready to deal quickly with an imminent catastrophe	Abatement is essential but may not happen in time	When necessary and for as long as the emergency lasts	A necessary evil
Best option	If it's cheaper than abatement we should use it instead or as a complement	Geoengineering is a substitute for abatement	As soon as it's ready and then indefinitely	A good thing because it widens choice

The climate emergency argument was Crutzen's motive for breaking the silence over geoengineering. Sulphate aerosol injection, he wrote, should only be developed "to create a possibility to combat potentially drastic climate heating".[7] Today it is the dominant argument, reflecting growing understanding of and concern about climate tipping points.[8] It envisages rapid deployment of SRM in response to some actual or imminent sharp change in world climate that cannot be averted even by the most determined mitigation effort. Instances might include the beginning of rapid melting of the Greenland ice sheet, acceleration in permafrost thawing or a prolonged and severe heatwave. By inducing an overall cooling of the globe, sulphate aerosol injections would be able to respond to any of these, a bit like a broad-spectrum antibiotic. Blackstock et al. argue that different kinds of emergencies would require different kinds of SRM intervention, with longer or shorter ramp-ups, and that some emergencies, such as the breaking off of the Ross Ice Shelf, could not be reversed by any kind

[6] See, eg., Ross Garnaut, *The Garnaut Climate Change Review: Final Report*, Cambridge University Press, Melbourne, 2008, pp. 184, 288-9

[7] Crutzen, Albedo Enhancement by Stratospheric Sulfur Injections. In fact, Crutzen's primary justification for researching geoengineering was the need to offset the warming pulse that would follow from efforts in developing countries to clean up air pollution. The "brown haze" of urban air pollution has been suppressing warming due to rising CO_2 concentrations.

[8] See, eg., Granger Morgan and Katherine Ricke, Cooling the Earth Through Solar Radiation management: The need for research and an approach to governance, An opinion piece for the International Risk Governance Council; Ken Caldeira and David Keith, The Need for Climate Engineering Research, *Issues in Science and Technology*, Fall 2010

of intervention.[9] Those who anticipate deployment of SRM in a climate emergency favour sustained research so that, once developed and refined, the technology could be "put on the shelf" to be used as necessary.[10]

As in the case of buying time, the best-option argument would see geoengineering deployed pre-emptively. Rejecting the understanding of geoengineering as an inferior Plan B, it argues that there is nothing inherently good or bad in any approach to global warming. The decision rests on a comprehensive assessment of the consequences of each approach, which is often reduced to the economist's assessment of costs and benefits.[11] In this consequentialist approach the "ethical" decision is the one that maximises the ratio of benefits to costs.[12] Some early economic modelling exercises have concluded that geoengineering is cheaper than mitigation and almost as effective and is therefore to be preferred.[13]

2. Some initial ethical implications

Those economists and philosophers who adopt the best-option argument see geoengineering as a potential *substitute* for mitigation rather than as a complement. They do not accept that geoengineering represents a necessary evil. If Plan B proves to be cheaper than Plan A then it would be unethical *not* to use it. They thereby avoid accusations that their advocacy undermines the incentive to choose the better path; geoengineering *is* the better path.

Philosophically, this requires the adoption of a narrow consequentialist ethical viewpoint. It is possible to by-pass the "necessary evil" anxiety and maintain that geoengineering may prove to be a good thing only when the positive and negative effects of all plans are commensurable. Commensurability of effects is necessary because it permits one option to be traded off against another. More precisely, it permits them to be traded off without feelings of guilt, regret or anguish.[14] We all at times have to make forced choices; but what makes some choices forced is that the decision entails a moral struggle. For the consequentialist no choices are forced because all effects can be traded off on rational grounds.

One implication of the best-option argument is that it implies that the ethics of geoengineering can be reduced to a disagreement over scientific and economic facts. An important philosophical aspect of this utilitarian position is that it rejects the view, implicit in the other two arguments and commonly held in the community, that motives count when making ethical judgments. Those who adopt this approach see themselves as pragmatic—what matters, practically and ethically, is what works.

Each of the three justifications for geoengineering has implications for the governance and political legitimacy of SRM. A report published under the auspices of NASA argues that, in the climate emergency framing of the problem, there is no point thinking about political

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[9] J. Blackstock et al., Climate Engineering Responses to Climate Emergencies, Novim Group, 2009 pp. 6-7

[10] Lee Lane, Ken Caldeira, Robert Chatfield and Stephanie Langhoff, Workshop Report on Managing Solar Radiation, Ames Research Center, NASA, California, April 2007, p. 11

[11] E.g., Steven D. Levitt and Stephen J. Dubner, *Superfeakonomics: Global Cooling, Patriotic Prostitutes, and Why Suicide Bombers Should Buy Life Insurance*, HarperCollins, 2009.

[12] J Eric Bickel and Lee Lane, An Analysis of Climate Engineering as a Response to Climate Change, Copenhagen Consensus Center, Copenhagen Business School, Denmark, undated. The paper was released by Bjorn Lomborg's Climate Consensus Centre.

[13] Scott Barrett, The Incredible Economics of Geoengineering, *Environmental and Resource Economics*, vol. 39, pp. 45-54, 2008

[14] On this see Charles Taylor, Review of *The Fragility of Goodness* by Martha Nussbaum, *Canadian Journal of Philosophy*, 18(4), December 1988, p. 807

objections and popular resistance to SRM because, in a crisis, "ideological objections to solar radiation management may be swept aside".[15] The authors count the ability to sweep aside objections to deployment of SRM as an "obvious political advantage".

SRM involves intentionally altering the global climate. Is there any moral difference between unintended climate change flowing from other activities and intentionally altering the climate? Most people believe that intentions matter morally, which is why courts judge manslaughter less severely than murder. Against this everyday intuition, some philosophers argue that there is no defensible distinction between a harm caused intentionally and the same harm caused unintentionally, that the degree of "wrongness" of an action has no bearing on its degree of "badness".[16]

The issue is complicated by the fact that, since we know that continuing to burn fossil fuels will cause harm, it could be said that global warming is now "deliberate" even if warming is not the intention. Continued release of greenhouse gases is undoubtedly negligent, but I think there is a moral, and certainly an attitudinal, leap to a conscious plan to modify the Earth's atmosphere. In the case of geoengineering, those who make the decision to deploy will argue they are doing so with the best intentions, to prevent a greater harm, unless it can be shown that they knew that more harm could be caused to some. This is the moral import of studies like that of Robock et al. that suggest that sulphate aerosol spraying could disrupt the Indian monsoon.[17] Certainly, one would expect the law to take the view that damage to someone arising from a deliberate action carries more culpability. In law liability for harms caused by an action depends in part on *mens rea*, literally "guilty mind".

3. Moral corruption

Stephen Gardiner describes as moral corruption calls "the subversion of our moral discourse to our own ends".[18] The psychological strategies we use to deny or, more commonly, evade the facts of climate science—and thereby blind ourselves to our moral responsibilities or reduce the pressure to act on them—include wishful thinking, blame-shifting and selective disengagement.[19] For selfish reasons we do not want to change our behaviour or be required to do so by electing a government committed to deep cuts in emissions.

Geoengineering itself may be a form of moral corruption. If we are preparing to pursue geoengineering for self-interested reasons then the promotion of geoengineering can provide a kind of absolution. But if Plan B is inferior to Plan A (in the sense of being less effective and more risky) then merely by choosing B instead of A we succumb to moral failure. At least, this is the case unless we are constrained in our actions, so that pursuing A is beyond us, sometimes called the "control condition" for moral responsibility.[20] This presents a moral dilemma for environmental groups: if they believe that Plan B is inferior to Plan A, then

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[15] Lane et al., Workshop Report on Managing Solar Radiation, p. 11

[16] For a discussion see Steve Vanderheiden, *Atmospheric Justice: A Political Theory of Climate Change*, Oxford University Press, New York, 2008, pp. 207-08

[17] Alan Robock, Luke Oman and Georgiy Stenchikov, 'Regional climate responses to geoengineering with tropical and Arctic SO_2 injections', *Journal of Geophysical Research*, vol. 13, 2008

[18] Stephen Gardiner, Is "Arming the Future" with Geoengineering Really the Lesser Evil?, in Stephen Gardiner, Simon Caney, Dale Jamieson and Henry Shue (eds), *Climate Ethics: Essential Readings*, Oxford University Press, New York, 2010, p. 286

[19] Clive Hamilton and Tim Kasser, Psychological Adaptation to the Threats and Stresses of a Four Degree World, A paper for "Four Degrees and Beyond" conference, Oxford University 28-30 September 2009 (http://www.clivehamilton.net.au/cms/media/documents/articles/oxford_four_degrees_paper_final.pdf)

[20] For a discussion see Vanderheiden, *Atmospheric Justice*, p. 144 passim

supporting geoengineering can be justified only if they believe they can no longer effectively advance Plan A. The dilemma deepens if it proves that supporting Plan B actually makes Plan A less likely to be implemented.

But these arguments are too blunt to give a full understanding. Scientists who defend geoengineering research mostly see themselves as exempt from the moral failings that have given rise to the situation. After all, many are among those who have supported strong abatement action and have become alarmed and frustrated at the failure of political leaders to act. It's not their fault and they are looking for ways of saving the world from the consequences of institutional failure. For both environmentalists and researchers who see geoengineering as a necessary evil, to maintain their integrity they must continue to argue that mitigation is to be preferred. Thus, like Crutzen, the Royal Society declared resolutely that mitigation is to be strongly preferred and geoengineering cannot be "an easy or readily acceptable" alternative.[21]

Nevertheless, simply to restate this belief may not be enough; unless one continues to act on it the declaration can become merely a means of deflecting the censure of others. This draws attention to the position of governments and major fossil fuel corporations, for it would be hollow for them to argue that they are pursuing Plan B even though they believe Plan A is superior. They have the power to implement, or not to block, Plan A and their reluctance or obstructiveness is the reason Plan B is being considered in the first place. To adopt Plan B they must convince others that it is not in their power to reduce emissions, a tactic that is frequently attempted. Even in the United States some argue that there is no point cutting US emissions if other major emitters do not do the same, an appeal to the "prisoner's dilemma" from those for whom the jail door is not locked. This presents a moral danger to geoengineering researchers who might accept financial support from reluctant governments or recalcitrant fossil fuel corporations seeking to avoid their obligations.[22]

It's worth noting that when the time arrives at which they feel they can back geoengineering governments and fossil fuel corporations are unlikely to appeal to the climate-emergency justification because high-lighting the severity of global warming would only underline their moral failure. As we saw, those able to implement Plan A will lack credibility if they defend Plan B with the buying-time argument, which leaves them with the best-option economic argument. In the case of solar radiation management the empirical basis for it remains speculative, not least because the risks of unintended consequences appear so high. Moreover, the appeal to economics as the basis for making such a momentous decision risks accusations of abandoning ethical concerns and treating the atmosphere as a commodity.

The same moral failure arguments could be used by poor countries against rich ones. As it will probably be rich nations that invest in geoengineering research and, if the time comes, deployment of the technologies that result, poor countries will accuse them of evading their responsibilities to reduce emissions. Studies that indicate that some poor countries may suffer harms from solar radiation management techniques reinforce the likely sense of grievance. The ethical situation would be reversed if a small, poor and vulnerable country decided to protect itself by engineering the climate with sulphate aerosol spraying (something that may

[21] Royal Society, *Geoengineering the Climate*, p. ix

[22] In 1962, noting the amount of money poured into universities by chemical companies, Rachel Carson observed: "This situation … explains the otherwise mystifying fact that certain outstanding entomologists are among the leading advocates of chemical control. Inquiry into the background of some of these men reveals that their entire research programme is supported by the chemical industry." Rachel Carson, *Silent Spring*, Penguin, London 1965 [1962], p. 225

prove technically and financially feasible). The Maldives, for example, would have a strong moral case to argue that the threat to its citizens' survival caused by the refusal of major emitting nations to change their ways, and its own inability to influence global warming despite sustained efforts, leave it with no choice.

4. Moral hazard

It is widely accepted that having more information is uniformly a good thing as it allows better decisions to be made. Research into geoengineering is strongly defended on these grounds.[23] Yet for many years research into geoengineering, and even public discussion of it, was frowned on by almost all climate scientists. When Paul Crutzen made his intervention in 2006 calling for serious research into Plan B because Plan A, cutting global emissions, had been "grossly unsuccessful" he was heavily criticised by fellow scientists.[24] They felt that researching Plan B would reduce the incentive to reduce emissions, the response to global warming strongly preferred by scientists including Crutzen himself.

In other words, they were worried about "moral hazard", a concept developed by economists to capture the impact on incentives of being covered against losses. For example, it is argued that the incentive to drive carefully may be reduced if the driver is insured because the costs of an accident are spread across all who are insured. Although commonly used in the climate change context, the argument mistakenly transposes an understanding of incentives developed for private market behaviour into the realm of public policy decision-making. There are a number of ethical and practical objections to this move,[25] perhaps illustrated most starkly by the unwitting *reductio ad absurdum* embedded in the claim by economist Martin Weitzman that assessing the worth of "life on Earth as we know it" is "conceptually analogous" to deciding how much to pay for extra air-bags in a car, for example.[26]

Nevertheless, the idea of moral hazard, suitably modified, is useful for drawing attention to political incentives. The availability of an inferior policy substitute that can be made to appear superior may make it easier for a government to act against the national interest. We know that those whose financial interests would be damaged by abatement policies have been using their power in the political system to slow or prevent action.[27]

So does geoengineering research create moral hazard? Geoengineering researchers tend to be vague and somewhat dismissive of the likelihood, as though it is only of theoretical concern.[28] Yet in practice any realistic assessment of how the world works must conclude that

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[23] See, eg., Royal Society, *Geoengineering the Climate*; Ralph Cicerone, Geoengineering: Encouraging Research and Overseeing Implementation, *Climatic Change*, 77: 221–226, 2006; Bipartisan Policy Center, Task Force on Climate Remediation, October 2011

[24] On criticism of Crutzen see Mark Lawrence, The Geoengineering Dilemma: To Speak or Nor to Speak, *Climatic Change*, 77: 245–248, 2006

[25] Explained in Clive Hamilton, "The Worldview Informing the Work of the Productivity Commission: A Critique", A talk to a Productivity Commission, Victoria, 11 May 2006, www.clivehamilton.net.au

[26] Martin Weitzman, On Modelling and Interpreting the Economics of Catastrophic Climate Change, REStat Final Version, July 7 2008 p. 18

[27] Naomi Oreskes and Erik Conway, *Merchants of Doubt*, Bloomsbury, 2010; Clive Hamilton, *Scorcher: The dirty politics of climate change*, Black Inc., Melbourne 2007; James Hoggan, *Climate Cover-Up*, Greystone Books, Vancouver, 2009

[28] The Royal Society report, dominated by geoengineering researchers, treated it as an uncertain effect that may even work the other way and refers to some distinctly unpersuasive focus group work suggesting implausibly that individuals may increase their efforts to cut their emissions if government invested in geoengineering. Overall, the report saw moral hazard as a "factor to be taken into account", but in no way decisive. (Royal Society, *Geoengineering the Climate*, pp. 39, 43)

geoengineering research is virtually certain to reduce incentives to pursue mitigation. This is apparent even now, before any major research programs have begun. Already a powerful predilection for finding excuses not to cut greenhouse gas emissions is apparent to all, so that any apparently plausible method of getting a party off the hook is likely to be seized upon. For the moment, governments and energy companies are staying at arm's length from geoengineering research, precisely because they fear being accused of wanting to evade their responsibilities.[29] But the day when it becomes respectable to support geoengineering research cannot be far off. Already, representatives of the fossil fuel industry have begun to talk of geoengineering as a *substitute* for carbon abatement.[30] Economic analysis is in general not interested in the kind of judicious technology mix or emergency backup defended by some scientists, but will readily conclude that geoengineering should be pursued, even as the sole solution, if that's what the "cost curves" show.[31] Indeed, the popular book *Superfreakonomics* insists that the prospect of solar radiation management renders mitigation unnecessary: "For anyone who loves cheap and simple solutions, things don't get much better." [32] For the authors, economics renders moral concerns redundant: "So once you eliminate the moralism and the angst, the task of reversing global warming boils down to a straightforward engineering problem: how to get thirty-four gallons per minute of sulfur dioxide into the stratosphere?"

Conservative think-tanks are joining the fray. The Heartland Institute and the American Enterprise Institute deny the existence of human-induced climate change yet support geoengineering.[33] Republican presidential candidate and former House Speaker Newt Gingrich declared: "Geoengineering holds forth the promise of addressing global warming concerns for just a few billion dollars a year. Instead of penalising ordinary Americans, we would have an option to address global warming by rewarding scientific invention… Bring on the American ingenuity."[34] For these advocates the problem of moral hazard evaporates because there is nothing wrong with reducing abatement incentives if a cheaper means of responding to climate change is available.

Gardiner has suggested another, despairing argument for the irrelevance of moral hazard.[35] After the Copenhagen failure, the prospects for substantial emissions abatement policies in the foreseeable future are so low that the availability of a substitute could not drive them any

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[29] For example, in 2010 the UK Government was required to respond to a report by the House of Commons Science and Technology Committee that urged it to promote discussions within the UN towards the development of an international regulatory framework. The Government took the view that such moves would be "premature" and that, as a great deal of preparation would be needed, a regulatory framework is many years away. At the same time it reiterated its position that mitigation should be the priority. See Secretary of State for Energy and Climate Change, Government Response to the House of Commons Science and Technology Committee 5th Report of Session 2009-10: The Regulation of Geoengineering, The Stationery Office, September 2010. In a personal communication a senior British official has confirmed this interpretation.

[30] Alex Steffen, 'Geoengineering and the New Climate Denialism', *Worldchanging*, 29 April 2009 http://www.worldchanging.com/archives/009784.html

[31] Bickel and Lane, An Analysis of Climate Engineering as a Response to Climate Change

[32] Steven D. Levitt and Stephen J. Dubner, *Superfeakonomics: Global Cooling, Patriotic Prostitutes, and Why Suicide Bombers Should Buy Life Insurance*, HarperCollins, 2009. For a discussion see http://www.guardian.co.uk/environment/2009/oct/19/superfreakonomics-geoengineering-wrong

[33] "Geo-Engineering Seen as a Practical, Cost-Effective Global Warming Strategy", Heartland Institute, 1 December 2007 (http://news.heartland.org/newspaper-article/2007/12/01/geo-engineering-seen-practical-cost-effective-global-warming-strategy). For the AEI see http://www.aei.org/event/1728.

[34] http://www.met.reading.ac.uk/Data/CurrentWeather/wcd/blog/at-the-controls-should-we-consider-geoengineering/

[35] Stephen Gardner, Some Early Ethics of Geoengineering the Climate: A Commentary on the Values of the Royal Society Report, *Environmental Ethics*, 20 (2011); 163-188

lower. Against this, in some parts of the world—notably the European Union and China—substantial efforts are being made to reduce emissions and accelerate the development of alternative energy technologies. Parliamentary support for the Australian Government's carbon tax was on a knife-edge. These efforts depend on a level of political resolve that could be weakened. Moreover, in reluctant countries government and public incentives to act could change rapidly as the effects of climate change become more obvious over the next decades. The availability of an apparently effective alternative to emission cuts could determine the kind of action taken.

That in practice moral hazard is a powerful ethical argument against the development of geoengineering technologies is suggested by the highly germane case of carbon capture and storage.

5. Case study: carbon capture and storage

The risk is that policy makers will use the promise of geoengineering research as a reason for further delay in pursuing abatement policies now. But if geoengineering research proves unsuccessful (because, for example, the risks of deployment are shown to be too high) then the world may be worse off. This is the moral hazard. The history of carbon capture and storage (CCS) suggests that governments are indeed likely to latch on to geoengineering as an excuse for further delay.

Soon after the 1997 Kyoto agreement, the governments of the two nations that refused to ratify it, Australia and the United States, began talking up the benefits of CCS, a technology that aimed to extract carbon dioxide from the flue gases of coal-fired power plants, pipe it to suitable geological formations and bury it permanently. Burning coal would be rendered safe so there was no need to invite "economic ruin" with policies mandating emission reductions. Quickly branded "clean coal" the promise of the technology was increasingly relied on by the world coal industry to weaken policy commitments and spruce up its image.[36]

The promise of CCS has been used repeatedly by both governments and industry as a justification for building new coal-fired power plants. In the United Kingdom, then-Prime Minister Gordon Brown declared that Britain must have it "if we are to have any chance of meeting our global goals".[37] US President Barack Obama's public endorsement of "clean coal" was featured in PR videos made by the coal lobby.[38] German Chancellor Angela Merkel backed industry plans to build dozens of new coal-fired power plants, expecting that at some point they would be able to capture the carbon dioxide and send it to subterranean burial sites.[39] In Australia, the world's biggest coal exporter and the nation most dependent on coal for electricity, Prime Minister Kevin Rudd declared CCS "critical" to generating jobs and bringing down greenhouse gas emissions.[40]

Economists also seized on the opportunity. The Stern report described CCS as "crucial".[41] Jeffrey Sachs, Director of the Earth Institute, repeated the common opinion that there is no

[36] See, for example, the World Coal Association, "Failure to widely deploy CCS will seriously hamper international efforts to address climate change". http://www.worldcoal.org/carbon-capture-storage/
[37] Anon., 'Trouble in store', *The Economist*, 5 March 2009
[38] http://www.youtube.com/watch?v=GehK7Q_QxPc
[39] Roland Nelles 'Germany Plans Boom in Coal-Fired Power Plants Despite High Emissions', *Der Spiegel Online*, 21 March 2007
[40] Matthew Franklin, 'Obama supports Rudd on clean coal', *Australian*, 26 March, 2009
[41] Nicholas Stern, *The Economics of Climate Change*, Cambridge University Press, Cambridge, 2007, p. 251

way China will stop building coal-fired power plants, so the technology "had better work or we're in such a big mess we're not going to get out of it".[42] The Garnaut report wrote that the success of "clean coal" will ensure that any negative impacts of greenhouse policies on coal-dependent regions are "many years away".[43] The International Energy Agency promoted it enthusiastically, describing an ambitious roadmap for the deployment of the technology, led over the next decade by developed countries after which "CCS technology must also spread rapidly to the developing world", because without it costs of emissions reductions will be 70 per cent higher.[44]

Torrents of public funding flowed to CCS research. The Obama Administration's 2009 stimulus bill allocated US$3.4 billion and the US Department of Energy announced it would provide US$2.4 billion to "expand and accelerate the commercial deployment of carbon capture and storage technology".[45] In the same month, the Rudd Government in Australia announced it would commit A$2.4 billion to an industrial-scale demonstration project.[46] The high hopes invested in CCS provoked the conservative business magazine *The Economist* to comment that "the idea that clean coal … will save the world from global warming has become something of an article of faith among policymakers".[47]

Yet from the outset impartial experts argued that the promise of CCS was exaggerated.[48] Even supporters of CCS conceded that the technology, if it worked, would have no impact on global emissions until at least the 2030s, well after the time scientists say deep emission cuts must begin. The most damning assessment was made in 2009 by the *Economist* in an editorial titled "The illusion of clean coal":

> The world's leaders are counting on a fix for climate change that is at best uncertain and at worst unworkable. … CCS is not just a potential waste of money. It might also create a false sense of security about climate change, while depriving potentially cheaper methods of cutting emissions of cash and attention—all for the sake of placating the coal lobby.[49]

The *Economist* was echoing the warnings of critics who had identified one of the major risks as the way in which CCS would undermine global mitigation efforts by giving national governments an excuse to do nothing in the hope that coal plants could be rendered safe. Greenpeace described CCS as "a smokescreen for building new coal-fired power stations".[50]

Events seem to have proven the critics right. Despite the hype and public investment, the promise of CCS is now collapsing. Its leading experts are expressing disappointment at the

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[42] Jeffrey Sachs, 'Living with Coal: Addressing Climate Change', Speech to the Asia Society, New York, 1 June 2009.
[43] Ross Garnaut, *The Garnaut Climate Change Review*, Cambridge University Press, Melbourne, 2008, p. 392
[44] International Energy Agency, *Technology Roadmap: Carbon Capture and Storage*, IEA, Paris, 2009
[45] Anon., 'Trouble in store'; http://www.themoneytimes.com/20090518/carbon-capture-storage-projects-funded-id-1068423.html
[46] Christian Kerr, 'Carbon capture to save industry', *Australian*, 13 May 2009
[47] Anon., 'Trouble in store'
[48] Vaclav Smil, Long-range energy forecasts are no more than fairy tales, *Nature* 453, 154 (8 May 2008) | doi:10.1038/453154a
[49] Anon., 'The illusion of clean coal', *The Economist*, 5 March 2009
[50] Greenpeace, *False Hope: Why carbon capture and storage won't save the climate*, Greenpeace International, Amsterdam, 2008, p. 35

failure of governments and the coal industry to follow through on their commitments.[51] In October 2011 a major CCS project at the Longannet power station in Scotland was cancelled on concerns about its commercial viability without further subsidies.[52] In November 2010 Shell's Barendrecht carbon capture project in the Netherlands was cancelled due to local opposition.[53] A month later ZeroGen, a huge project identified by the Australian government as a "flagship" carbon capture project and promoted as "one of the first commercial-scale IGCC with CCS projects in the world",[54] was shelved because of cost blow-outs and technical difficulties.[55] The *New York Times* commented: "Australia's experience with CCS mirrors technical, financial and political hurdles experienced in the United States."[56]

The case of CCS is a vivid illustration of moral hazard, yet it is into this political and commercial environment that geoengineering arrives as the next "great white hope". It is presented as a solution to the same global warming problem, to the same politicians, with the same resistant industry, and the same public prone to wishful thinking. The conditions seem perfect for moral hazard.

There is no sign that political leaders have been chastened by the experience of CCS. If they are resolved to avoid difficult decisions and protect the coal industry, why would they not move on to the next technological boondoggle? Once the political threshold that currently restrains governments and coal companies from publicly backing geoengineering is crossed, warnings such as that made by the Royal Society—"None of the methods evaluated in this study offer an immediate solution to the problem of climate change and it is unclear which, if any, may ever pass the tests required for potential deployment"[57]—are likely to be watered down. The caveats at the front of geoengineering reports declaring that mitigation is the best solution will quietly disappear.

6. The slippery slope

The slippery slope is an ethical concern closely related to moral hazard. Moral hazard applies to policy-makers while the slippery slope applies to those who back geoengineering. If Plan B is inferior to Plan A the moral hazard is that its political attractions will undermine the incentive to pursue Plan A. So Plan B is deemed preferable despite the evidence. With the growth of a lobby group of researchers, investors and, perhaps, regulators backing geoengineering, the slippery slope refers to the process of exaggerating the benefits of Plan B and downplaying its costs and risks. In 1962 Rachel Carson wrote:

> The chemical weed killers are a bright new toy. They work in a spectacular way; they give a giddy sense of power over nature to those who wield them, and as for the long-

[51] In August 2011 Peter Cook, Australia's leading expert advocate for CCS, resigned as Director of the flagship CO2 Co-operative Research Centre declaring that he was disappointed with progress and that the technology had reached a crisis point (http://www.abc.net.au/lateline/content/2011/s3285864.htm).
[52] Hanna Gersmann and Fiona Harvey, Longannet carbon capture project cancelled, *Guardian*, 19 October 2011
[53] http://www.businessweek.com/news/2010-11-04/shell-s-barendrecht-carbon-capture-project-canceled.html
[54] http://www.carboncapturejournal.com/displaynews.php?NewsID=499&PHPSESSID =d2hv0cjlmijbes2p17jmelllp6
[55] http://www.carboncapturejournal.com/displaynews.php?NewsID=707&PHPSESSID= d2hv0cjlmijbes2p17jmelllp6
[56] http://www.nytimes.com/cwire/2010/12/23/23climatewire-australias-desire-for-cleaner-coal-falls-pre-84066.html?pagewanted=1
[57] Royal Society, *Geoengineering the Climate: ...* Royal Society, London, 2009, p. 61

> range and less obvious effects—these are easily brushed aside as the baseless imaginings of pessimists.[58]

A constituency of supporters adds to the pressure on policy-makers to choose the less desirable option. There are good grounds for thinking that research and testing of SRM technologies would set the world on a slippery slope to ultimate deployment. Technological lock-in is a well-recognised problem.[59] Already, patents in geoengineering techniques are being issued and start-up companies are attracting significant investors, including Bill Gates. A lobby group of scientists and investors is beginning to form and it is likely to become more influential as geoengineering becomes normalised in the public debate, not least with the publication of the next IPCC report. Scientists engaged in geoengineering research have argued vigorously against any early regulation of their activities, insisting that society should take a hands-off approach until there is a risk of significant harm from tests and experiments.[60] There is therefore a legitimate concern that the knowledge generated by geoengineering research will be misused in foreseeable ways.

However, the strength of the moral hazard and the slippery slope danger depend in part on the absence of undeniable technological hurdles that appear insurmountable. While the experience with CCS points to the strength of the moral hazard concern about geoengineering, it also suggests a limit to the slippery slope argument. A powerful constituency formed around the promise of CCS, perhaps reaching its pinnacle with the creation in 2009 of the Global Carbon Capture and Storage Institute.[61] CCS is not dead yet, but as the technical difficulties become more apparent, CCS is waning as a credible alternative to emission reductions, and the CCS lobby's momentum is stalling. The slippery slope towards the deployment of, say, sulphate aerosol spraying will depend on continued research and testing not turning up some insuperable risk or obstacle that its more open-minded supporters cannot ignore.

The moral hazard and slippery slope arguments are framed in consequentialist terms, that is, as dependent on outcomes alone. As solar radiation management is certain to be environmentally less effective than carbon abatement (especially as it does not reduce, and may hasten, ocean acidification), to the extent that political leaders succumb to the temptation to avoid abatement measures and take the easy way out, solar radiation management is ethically dubious. But there is a non-consequentialist moral hazard objection—geoengineering may facilitate the continuation of bad behaviour and on that basis would be wrong. If we resort to Plan B then the climate-policy obstructionism of ExxonMobil, for example, would be rewarded.[62] More generally, those most negligent would be able to use geoengineering to escape their responsibilities for causing climate change. This helps to explain why some who actively debunk climate science also support geoengineering—it can serve as a means of covering over deception. The wrong would be compounded if rich countries with high emissions pursued climate engineering instead of abatement. Solar

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[58] Carson, *Silent Spring*, p. 73.

[59] See, for example, Richard Perkins, Technological "lock-in", International Society for Ecological Economics Internet Encyclopaedia of Ecological Economics, February 2003 http://www.ecoeco.org/pdf/techlkin.pdf

[60] See Morgan and Ricke, Cooling the Earth Through Solar Radiation Management. The 2010 Asilomar Conference of geoengineering researchers was held to develop a set of voluntary guidelines. See Alexis Madrigal, Climate Hackers Want to Write Their Own Rules, *Wired*, March 23, 2010.

[61] http://www.energymatters.com.au/index.php?main_page=news_article&article_id=400

[62] In a long history, see, for example, the unprecedented letter sent by the Royal Society to ExxonMobil calling on the company to desist from funding organisations committed to denying climate science. See also Oreskes and Conway, *Merchants of Doubt*, pp. 246-7

radiation management would entrench the failure of the North in its duties towards the global South. This is another way of making the case that what matters ethically about geoengineering is not only the outcome but also the human virtues or faults it reveals.

The deepest disagreement over the ethics of geoengineering is in fact a dispute about what "ethics" means. The three reasons for geoengineering are all based on a consequentialist view in which the morality or otherwise of climate regulation depends solely on the consequences, compared to alternative actions. In its narrow utilitarian version (the best-option argument), the question of whether it is ethically justified intentionally to shift the planet to a warmer or cooler climate depends on an assessment of the costs and benefits of the new state compared to the old one, where costs and benefits are evaluated in terms of their effects on human well-being.[63] But the two "necessary evil" arguments, although more nuanced, are also confined to assessments of consequences more broadly defined.

For those who reject narrow consequentialism, the idea that the "ethical" can be decided solely by instrumental calculation is itself unethical. For consequentialism it is always *in principle* ethically justified to engineer a different climate, even though the process of calculation may show that it is imprudent. If SRM proves cheaper then it would be unethical *not* to deploy it. In the same way, torture can by justified using consequentialist arguments (the famous "ticking time bomb" situation) but no amount of argument will dispel the belief of some that torture is inherently wrong and that arguments justifying torture are themselves unethical, not least because they may serve to absolve torturers.

One immediate implication of the consequentialist approach is that there is nothing inherently preferable about the natural state, including the pre-industrial climate. Depending on the assessment of human wellbeing, there may be a "better" temperature or climate as a whole. In other words, it is ethically justified for humans to "set the global thermostat" in their interests. It is these kinds of concerns that motivate another, more fundamental, ethical problem with geoengineering—"playing God".

7. God's domain

Despite its moniker, the concern about playing God is not confined to theists but may resonate just as strongly with atheists. For the latter, "playing God" is a metaphor either for humans assuming God-like attributes or for humans attempting to occupy a domain that is not properly theirs. In the first conception, the idea is that there are certain qualities that humans cannot and should not aspire to, both because they are beyond us and because aspiring to them invites calamity. Tony Coady identifies three features of God or the godhead that are beyond human capabilities,—omniscience, omnipotence and supreme benevolence, which seem to capture the commonsense understanding.[64] We will return to God's powers in section 8.

Beyond the idea of an actual or notional higher being, the second conception reflects a "spatial" understanding of the world. Playing God entails crossing a boundary to a domain of control or causation that is beyond the proper realm of human capabilities or rightful roles. In this view, there is a boundary around what humans should attempt or aspire to because of our

[63] An overview of the field of climate ethics can be found in Stephen Gardiner, Ethics and Global Climate Change, in Stephen Gardiner, Simon Caney, Dale Jamieson and Henry Shue (eds), *Climate Ethics: Essential Readings*, Oxford University Press, Oxford, 2010

[64] C. A. J. Coady, Playing God, in Julian Savulescu and Nick Bostrom (eds), *Human Enhancement*, Oxford University Press, Oxford, 2009, p. 163

intellectual, emotional or moral limitations or because, in a stronger claim, the distinction between domains is part of the proper order. For theists, this other domain may be the dwelling place of God. For atheists, the domains are contained in an intuitive metaphysical order that defines "the scheme of things" within which one can find what it means to be human.

So what in practice is God's domain? In the debate over human genetic enhancement the playing-God argument has been prominent. Biologically, DNA is the essence of life, coding all of the information that makes an individual unique. As such, tinkering with genes (and especially the germ-line, or changes to DNA that can be passed on) can be seen by the theist as invading the sacred or by the atheist as disturbing the essential dignity of the human. Michael Sandel argues that it is the gifted character of human capacities and potentialities that incites a natural regard, and that there is something hubristic and unworthy about attempting to overrule or improve upon this gift through genetic enhancement.[65] Manipulating genes to human ends is "a Promethean aspiration to remake nature, including human nature, to serve our purposes and satisfy our desires".[66] Life is reduced to a manipulable genetic code.[67]

The particulars are not of much help in the case of solar radiation management because we are not talking about transforming humans but the world in which humans live. Yet global dimming via sulphate aerosol injections is a similarly Promethean aspiration to remake "nature" to serve our purposes, this time not at the microscopic level of DNA but at the macroscopic level of the Earth as a whole. The domain being invaded is not that of the essential code of each life but the sphere in which all life was created or emerged. With solar radiation management the concern is not so much a lack of gratitude for a unique and precious gift, but the invasion of and dominion over the atmosphere that encompasses the planet, the benevolent ring that makes it habitable, supplies the air breathed by all living things and sends the weather. In most cultures for as long as humans have lived, the sky has been the Heavens, the dwelling place of the gods. Global dimming would not only transform the atmosphere but also regulating the light reaching the Earth from the Sun. The Sun has its own god-like character because it is the source of all growth, the food of plants and thus all living things. It is the origin of the most primordial rhythms that have always governed human life—the cycles of day and night and the annual seasons. For many cultures the Sun *is* God, and attempting to regulate it would surely be out-of-bounds. The popular preference, revealed by many surveys, for solar energy over nuclear power can probably be traced to a felt distinction between using a natural source that flows freely to the Earth and relying on an unnatural and dangerous contrivance that has diabolical connotations. In general, people are more inclined to support technologies that appear to work with rather go against nature.[68]

So the intuition is that in planning to regulate the atmosphere we are crossing over into a domain properly beyond the human. To cross over successfully would require a degree of omniscience and omnipotence that has always been reserved for God or the great processes of

[65] Michael Sandel, The Case Against Perfection: What's Wrong with Designer Children, Bionic Athletes, and Genetic Engineering, in Julian Savulescu and Nick Bostrom (eds), *Human Enhancement*, Oxford University Press, Oxford, 2009
[66] Sandel, The Case Against Perfection, p. 78
[67] Although Coady sets up the playing-God argument more clearly than others, the arguments he considers against genetic engineering—the idea that choosing the future is beyond human limits, the sense that interfering in human nature is wrong, a worry about human "autonomy" and a claim that human nature has some intrinsic value—tend to be vague and at best point only indirectly to aspirations to god-like characteristics.
[68] Ipsos MORI, "Experiment Earth? Report on a Public Dialogue on Geoengineering," August 2010. http://www.nerc.ac.uk/about/consult/geoengineering-dialoguefinal-report.pdf

Nature that are rightly beyond human interference. To make matters worse, in this view, we want to supplant the gods in order to counter the mess we have made as faulty humans. Instead of embarking on a vain quest to emulate the gods, it seems safer and more within our powers to face up to our failures and attempt to become better humans. The usual appeals to the power of reason and science make little headway because they are deployed in the service of the same conquering spirit that drives the desire to play God, as if human ratiocination can function as a battering ram to enter the gods' domain there to dethrone them and elevate humans in their place.

So the argument is not so much that the consequences of playing God might be horrible, but that playing God betrays a deep fault in the human character, one Coady describes as "an unjustified confidence in knowledge, power, and virtue beyond what can reasonably be allowed to human beings".[69] Although science and reason are in modern times presented as the means of exposing the "superstitions" that underpin anxieties about playing God, over the last two decades or so advances in Earth system science have actually provided grounds not for allaying but for reinforcing the unease.[70] They challenge human aspirations to omniscience, omnipotence and supreme benevolence, and we consider each in turn.

8. God's powers

In modern times, we have come to believe that the relentless accumulation of scientific knowledge is taking us closer to complete understanding. Recent developments in Earth system science have increased our knowledge substantially, but they have also uncovered yawning gaps. We have come to see more clearly that the climate system is extremely complex both in itself and because changes in it cannot be isolated from changes in the other elements of the Earth system—the hydrosphere, the biosphere, the cryosphere and even the geosphere.[71] Human-induced warming is expected to have large effects on global precipitation patterns, but predicting regional changes in rainfall patterns is very crude. The importance of "tipping points" that define rapid shifts from one climate state to another have become apparent from the Earth's geological record, but our understanding of why and when they occur is rudimentary. Predicting when or how thresholds might be crossed is extremely imprecise. Moreover, it is well-understood that sulphate aerosol injection, while effective at suppressing warming, would do nothing to slow the acidification of the oceans, which is interfering with the process of calcification or shell-formation on which a wide array of marine animals depend for their survival. What this will mean for ocean ecosystems is barely grasped. In this light, omniscience appears as far away as ever, which only reinforces anxieties about playing God.

Apart from these the uncertainties, unknowns, and threshold effects arising from the complexity and non-linearity of the Earth system, the dominant fact is that carbon dioxide persists in the atmosphere for many centuries. So it is possible—indeed, likely—that before the larger impacts of warming are felt and measured humans will have committed future generations to an irreversibly hostile climate lasting thousands of years. Yet some economists are telling us that they can use their models to estimate future streams of the money values of

[69] Coady, Playing God, p. 165
[70] This is spelled out in Clive Hamilton, The Ethical Foundations of Climate Engineering, in Wil Burns and Andrew Strauss (eds) *Climate Change Geoengineering: Legal, Political and Philosophical Perspectives*, Cambridge University Press, Cambridge, forthcoming
[71] Described in Hamilton, The Ethical Foundations of Climate Engineering

costs and benefits to determine the optimal temperature of the Earth over the next two centuries, as if we know enough to install and begin to operate a "global thermostat".[72]

After reflecting on anxiety about playing God, it is hard to read Rachel Carson's' famous denunciation of the "universal chemical contamination of the environment" as "another symptom of our exaggeratedly technological and quantitative approach"[73] without thinking that the essential attitudes she described still prevail. With global warming and geoengineering it seems a new and more risky battleground in "man's war against nature"[74] is now being opened up.

What of omnipotence? Gods are powerful. Humans are powerful, too. But what kind of power do we aspire to with geoengineering? Beyond deliberate management and exploitation of particular resources or geographical areas, and beyond the unintentional degradation of land, rivers and oceans, we now aspire to take control of and regulate the atmosphere and climate of the planet as a whole. For many millions of years the temperature of the Earth and the amount of carbon dioxide in the atmosphere have moved together, with rises or falls in one closely followed by rises or falls in the other. Solar radiation management would be an attempt to sunder this primordial link. It is the first conscious formulation of a "planetary technology", a plan to take control of and regulate the Earth's climate system through manipulation of the flow of primary energy to the planet as a whole. The energy that sustains all living things and ecosystems would become subject to human supervision.

Geoscientists are now arguing that humans have so transformed the face of the Earth as to justify the naming of a new geological epoch to succeed the Holocene, the 10,000 year period of unusual geological stability that allowed civilisation to flourish. The Anthropocene is defined by the fact that the "human imprint on the global environment has now become so large and active that it rivals some of the great forces of Nature in its impact on the functioning of the Earth system".[75] And the scale of this impact is now destined to increase by orders of magnitude.

Using knowledge of the great planetary cycles that over millions of years regulate the amount of solar radiation reaching the Earth, climatologists are able to predict that Earth is due for its next ice age in about 50,000 years' time.[76] However, given the persistence over millennia of increased carbon dioxide in the atmosphere, human-induced global warming, due mostly to burning fossil fuels over the period 1950-2050 is expected to cancel out the next ice age. Nothing humans have ever done comes close to the momentousness of this conclusion. If emissions rise to the higher level of expectations, which seems likely, then a century or so of economic activity will stop the subsequent ice age as well, expected in about 130,000 years, and indeed all glaciations for the next half a million years.[77] The enormity of these facts calls on us to pause and reflect deeply on what they might mean. Yet, unfazed, the scientists who have uncovered these astonishing facts immediately begin to speculate about whether preventing ice ages for the next half a million years will be, on balance, a good thing or not,

[72] Bickel and Lane, An Analysis of Climate Engineering as a Response to Climate Change
[73] Carson, *Silent Spring*
[74] Carson, *Silent Spring*, p. 24
[75] Will Steffen, Jacques Grinevald, Paul Crutzen and John McNeil, The Anthropocene: conceptual and historical perspectives, *Philosophical Transactions of the Royal Society A* 369: 842–867, 2011
[76] On ice ages and the effect of global warming see David Archer in *The Long Thaw*, especially Chapter 12, and Curt Stager, *Deep Future: The Next 10,000 Years of Life on Earth*, Thomas Dunne Books, New York, 2011, especially Chapters 1 & 2.
[77] Stager, *Deep Future*, p. 26

as if the appropriate response to knowledge of cosmic significance is to conduct a cost-benefit analysis.[78]

Omnipotence implies not just enormous power but the ability to direct and control that power. While humans have for centuries worked towards exercising control over a changeable world, with the arrival of the Anthropocene it has become apparent that we have exercised so much influence that we have tipped the Earth into an entirely new era. Our aspiration to omnipotence has had the opposite effect, transforming a relatively stable and controllable world (the Holocene) into an unstable and uncontrollable one (the Anthropocene). It seems that, just as the ancient myths warned, instead of allowing the climate crisis to teach us a lesson about technological hubris, we plan to extend our power to subdue those parts of the Earth system that refuse to cooperate.

If humans were sufficiently omniscient and omnipotent would we, like God, deploy solar radiation management benevolently? Earth system science cannot answer this question, but it hardly needs to, for we know the answer already. Given that humans are proposing to engineer the climate because of a cascade of institutional failings and self-interested behaviours, any suggestions that deployment of SRM would be done in a way that fulfilled the strongest principles of justice and compassion would lack credibility, to say the least. We find ourselves in a situation where geoengineering is being proposed because of our penchant to deceive ourselves and exaggerate our virtues. If a just global warming solution cannot be found, who can believe in a just geoengineering regime? It is believed that SRM would offset some of the impacts of climate change more effectively in some parts of the world than others. In some areas it may even exacerbate droughts.[79] The temptation of those in control of SRM to implement it in a way that suited their interests first would be ever-present. And at no forum will non-human species have a voice.

One of the more serious concerns about the development of geoengineering technologies is the risk of unilateral deployment, that is, the decision by one nation, or even a wealthy individual, to transform the Earth's atmosphere. In this case, one agent would assume the role of climate regulator, one man playing God, a proposition so fraught with dangers that they do not need spelling out. Mention of this risk is often followed by suggestions that disputes over where to set the global thermostat could escalate into wars.

The playing-God argument is not necessarily a categorical injunction against SRM but it does ring a warning of Promethean recklessness, calling for utmost caution and deep reflection. On one view, reflection is enough. On another, our attitudes and beliefs about ourselves and the nature of the world are so deeply ingrained that they necessarily constrain the most careful reflection to a narrow range of outcomes. According to this view, if we are so mistaken in our understanding of the world and our role in it that we are drawn into playing God with the future of the planet as a whole then thinking cannot be enough; thinking must be grounded in a different relationship between humans and the natural world, one that recognises the boundary between the domain of humans and the domain of God. By reinforcing the technological approach to social problems, recourse to geoengineering can be a means of avoiding serious contemplation of the deeper reasons for humanity's inability to respond to the threat.

[78] See Stager's painfully simple-minded epilogue (pp. 228-42) which mars an otherwise admirable *Deep Future*.
[79] Robock et al., Regional climate responses to geoengineering

9. Technology as a substitute for politics

While ethical analysis typically focuses on the motives for, and consequences of, individual actions, ethics should also concern itself with social and institutional structures that influence behaviour. Indeed, the moral hazard and slippery slope problems are embedded in those structures. And in a deeper way, it might be argued that because technological hubris and God-emulation are deeply embedded in Western social structures, so is the concern about playing God. Recognising this is of the greatest importance, for as long as ethical concerns are read as personal failings attention is diverted from the social, institutional and cultural forces that lead individuals to behave in certain ways. This is not to deny individuals moral agency but to point to the greater resolve often needed to act in the right way and to direct attention to the structures that need to be changed if higher ethical standards are to be met.

Previously, following Gardiner, I described political inertia arising from denial or evasion of the implications of climate science as moral corruption. This moral failure is attributable to our psychological weaknesses (such as the tendency to shift blame onto others or filter the science to make it less worrying) and to the failure of political systems that are heavily influenced by sectional interests, dominated by parties that put the economy before all else and populated by individuals too timid to act on the scientific warnings. Elsewhere I have attempted to explain widespread denial and evasion in terms of the self-preoccupation and comfortable conservatism of consumer society.[80]

Yet there is a tendency to view these as immutable facts of modern life. Instead of promoting change in political and social structures, which are acknowledged as the source of the problem, we resort to technological solutions that we hope will bypass the blockages. In addition to the modern preoccupation with techno-fixes, advocating far-reaching social change is dismissed as utopian. Yet from the time of the French Revolution until the 1980s thinking about and advocating radical social change was part of the daily discourse of Western society, so the unwillingness to consider changes to economic, social and political structures is all the more striking in the face of a threat as grave as the climate crisis. Shunning deeper questioning of the roots of the climate crisis avoids uncomfortable conclusions about social dysfunction and the need to directly challenge powerful interests. In this way, global warming becomes no longer a profound threat to our future security and survival but just another problem that must be approached like others. Calls for a techno-fix, including geoengineering, are thus deeply conformable with existing structures of power and a society based on continued consumerism.

In his critique of the Royal Society's 2009 report on geoengineering, Gardiner poses the question bluntly:

> if the problem is social and political, why isn't the solution social and political as well [and] if, as the report asserts, we already have adequate scientific and technological solutions, why assume that research on alternative solutions will help?[81]

In the end, the answer from geoengineering supporters must lie in an implicit judgment that social change is not on the table so the only answer is to buy time for the costs of renewable energy technologies to fall far enough, or to prepare to deal with an inevitable climate emergency. Even though they will accept that the source of the problem is political, engaging

[80] Clive Hamilton, *Requiem for a Species: Why we resist the truth about climate change*, Earthscan, London, 2010

[81] Gardiner , Some Early Ethics of Geoengineering the Climate

in political activity as concerned citizens is shunned by most scientists. A few, like James Hansen, combine the two, but they are frowned on by most of their colleagues for sullying science with politics.[82] What is surprising is that the advice of scientists who advocate geoengineering research because they are afraid of stepping outside of their professional comfort zones should be given so much weight in the public debate. At least, it is surprising until we remember that conservatism is what established political systems always prefer.

[82] Another criticism of Hansen is not that he acts as a concerned citizen but that he acts as if his scientific expertise gives him a special status as a citizen and thus permission to pontificate on matters well beyond his areas of expertise.