The Ethical Foundations of Climate Engineering

July 2011

Clive Hamilton[1]

> "The time is coming when the struggle for dominion over the earth will be carried on. It will be carried on in the name of fundamental philosophical doctrines."
>
> Friedrich Nietzsche

1. Introduction

After years of agonizing among scientists over the dangers of discussing "Plan B", the dam broke with the publication in 2006 of an editorial essay by Nobel Prize winning atmospheric scientist Paul Crutzen, in which he called for serious consideration of geoengineering.[2] Within the expert community, work on geoengineering is now vigorous, with a sharp leap in the number of academic papers published. The debate is poised to move to centre-stage when the IPCC for the first time includes assessment of geoengineering solutions in its Fifth Assessment Report, due out in stages in 2013 and 2014. Some have been disturbed at the ease with which worries about the morality of openly considering geoengineering seem to have been left behind in favour of a focus on research and governance arrangements. The growing interest in alternatives to mitigation perhaps justifies the fears of those who criticized Crutzen for letting the cat out of the bag, although someone was bound to do it sooner or later.[3]

Whether climate engineering becomes a substitute for carbon abatement, instead of a complement or a back-up, remains to be seen. But there can be no doubt that in the wider

---

[1] Charles Sturt Professor of Public Ethics at the Centre for Applied Philosophy and Public Ethics, Canberra (mail@clivehamilton.net.au). This paper was written while I was a visiting academic in the Department of Philosophy and Centre for the Environment, University of Oxford. I am grateful to Alice Bows, Steve Clarke, Andrew Glikson, Myra Hamilton, Clare Heyward, Andrew Parker, Ingmar Persson, Julian Savulescu, Falk Schmidt and participants in a seminar at the Oxford Martin School for very helpful comments on a draft of this paper. Although it has been greatly improved as a result of their comments, all remaining mistakes and misinterpretations remain mine.

[2] Paul Crutzen, Albedo Enhancement by Stratospheric Sulfur Injections: A Contribution to Resolve a Policy Dilemma? *Climatic Change*, 77: 211-220, 2006

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

debate over climate policy technological intervention is everywhere a substitute for social change. Despite the fact that the world's emissions have for some years been tracking at levels higher than the IPCC's worst-case scenario of the early 2000s, any challenge to the primacy of economic growth is strictly excluded from the official agenda.[4] The whole burden must fall on technology.

Recourse to more and bigger technologies to solve perhaps the most severe threat that modern society has ever faced vitiates any serious reflection on the deeper reasons for humanity's inability to respond to the threat posed by carbon emissions. If the science is only half right—and it's more likely that the scientists have been unduly cautious[5]—then the transformation of the earth's life-support systems, and schemes to engineer the planet's atmosphere, call for sustained moral reflection. Yet work on the ethics of climate change and climate engineering is desultory and rarely seems to recognise the enormity of what is unfolding.[6]

The failure to appreciate the scale of the threat of climate change or to take in the Promethean nature of geoengineering is reflected in the question that "climate ethics" believes it must answer, viz., what are the consequences for human wellbeing of transforming the earth's climate? It is not so much the anthropocentrism of the question that is of interest, but the unrecognized assumption about the kind of *anthropos* that asks such a question—a rational being who gathers evidence on the good and bad consequences, evaluates it and decides on how to act in a way that most improves human wellbeing. In short, climate ethics (including geoengineering ethics) is dominated by a consequentialist approach that naturally shies away from questions about how we ended up in this mess and what it means for humanity. In so doing, I will argue, it risks entrenching the very ways of thinking that lie at the heart of the climate crisis.

In the consequentialist view, the question of whether it is ethically justified to intentionally shift the planet to a warmer or cooler climate—either by deliberate intervention or by allowing greenhouse gas emissions to reach a target level— depends

4 Clive Hamilton, *Requiem for a Species: Why we resist the truth about climate change*, Earthscan, London, 2010, Chapter 2

5 James Hansen, 'Scientific reticence and sea level rise', *Environmental Research Letters*, April-June 2007

6 James Garvey, in *The Ethics of Climate Change* (Continuum, London, 2008), is an exception.

on an assessment of the costs and benefits of the new state compared to the old one.[7] This seems to exhaust ethical concerns.[8] Thus Gardiner claims that the “core ethical issue concerning global warming is that of how to allocate the costs and benefits of greenhouse gas emissions and abatement”.[9] Peter Singer also defines climate ethics in consequentialist terms: “Climate change is an ethical issue, because it involves the distribution of a scarce resource – the capacity of the atmosphere to absorb our waste gases without producing consequences that no one wants.”[10]

One immediate implication of this approach is that there is nothing inherently preferable about the natural state. Thus Powell et al. declare that “there is no prima facie justification for attempting to preserve the current climate, if some other climate might be better for humans and animals”.[11] Depending on the assessment of human wellbeing (Singer would extend it to other sentient beings but this is only an extension of the utilitarian frame), 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 apparent that this consequentialist approach to the ethics of climate change, which dominates writing on the topic, is essentially the application of neoclassical economic analysis with a distributional gloss, so that the question of “climate justice” is reduced to the distribution of economic effects. Reflecting the subtle influence of the neoliberal revolution of the last three or four decades, philosophers (even “radical” ones like Singer) have often adopted uncritically the central categories of free-market economics. The most

---

[7] A comprehensive 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

[8] A number of environmental philosophers have developed alternatives to the consequentialist approach, but their voices are not heard in the public debate. See, for example, the discussion of eco-phenomenology in Iain Thomson, Ontology and Ethics at the Intersection of Phenomenology and Environmental Philosophy, *Inquiry*, 47: 380-412, 2004

[9] Stephen Gardiner, Ethics and global climate change. *Ethics*, 114 (3), 555–600, 2004, pp. 578–579. See the commentary by Menno Kamminga, The ethics of climate politics: four modes of moral discourse, *Environmental Politics*, Vol. 17, No., 4, August 2008, 673-692

[10] Peter Singer, Ethics and climate change: a commentary on MacCracken, Toman and Gardiner. *Environmental Values*, 15 (3), 415–422, 2006, p. 415

[11] Russell Powell, Steve Clarke, Mark Sheehan, Tom Douglas, Bennett Foddy, Julian Savulescu, “The Ethics of Geoengineering” (working draft), Oxford Uehiro Centre for Practical Ethics, 2010, p. 6. See http://www.practicalethics.ox.ac.uk/__data/assets/pdf_file/0013/21325/Ethics_of_Geoengineering_Working_Draft.pdf

obvious, and most revealing, borrowing is the concept of the atmosphere as a "common resource" or, more properly, a "common property resource".[12] Singer's words quoted above explicitly define climate ethics as a problem of allocating a scarce resource. When we remember that every neoclassical economics textbook defines economics as the analysis of how best to allocate scarce resources we can see how this kind of "ethics" can become a branch of free market economics. Among other things, characterising the atmosphere as a resource implies that it is subject to ownership by humans—it is our property—and that it is available for our use.

2. The consequentialist worldview

The consequentialism of climate ethics is built on an unstated (and mostly unrecognized) understanding of the natural world, one that grew out of the Scientific Revolution in the 17th century and the European Enlightenment philosophy that went with it. The transition from an organic conception of nature to a mechanical one in the 17th and 18th centuries is a history that has been well told.[13] In the modernist view a human being is a distinct subjective entity that is separate from the world around it, a world on which, guided by its cognitive abilities, it acts to pursue its own individual and collective interests. Through Descartes, and Kant in particular, philosophy responded with the idea of the autonomous subject and the objective external world as a representation. In the Kantian view, the grounding for ethical judgment is the self-legislating moral subject who recognises no external moral authority. This is a vast topic that cannot be considered here.[14] It is a model in which rational and willing subjects—discrete egos existing inside bodies—exercise control over an inert environment.

---

[12] Other concepts imported willy-nilly into climate ethics from economics are "moral hazard", "public goods" and the idea that the social is no more than the aggregation of the individual. And the claim that climate change is an "externality" goes unchallenged. These concepts only make sense when the world is the kind of entity that has as its ideal form a collection of perfect markets, with all of the assumed individualism, self-interest and equilibrium tendencies embedded in them. In other words, when you begin with perfect markets you begin with a certain conception of the human being, *homo economicus,* the unexamined starting point of free market economics.

[13] By, for example, Carolyn Merchant, *The Death of Nature: Women, Ecology, and the Scientific Revolution*, 2nd edition, HarperCollins, New York, 1990; also Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*, Princeton University Press, Princeton, 1985.

[14] A way into this subject might begin with Jerrold Seigel, *The Idea of the Self,* Cambridge University Press, Cambridge, 2005.

This understanding brings to thinking about climate change and geoengineering certain assumptions about the earth, humans and the relationship between them.

- The earth consists of a collection of resources, that is, materials and energy available for human consumption or other uses.
- This collection of resources can be thought of as a system or collection of systems whose workings can be exposed by inquiring minds.
- Through the mobilization of sufficient intellect and technology the natural world is subject to human control.
- Humans have a right to control the earth and the only constraint on our dealings with the earth is imposed by enlightened self-interest and perhaps the "interests" of other sentient beings.
- Humans are distinct subjective entities who come to the ethics of climate change as rational calculators whose objective is to pursue their own interests, individual or collective.[15]
- Because climate ethics is grounded in the self-legislating subject, there is nothing *inherently* desirable about a natural state, and there is no ethical distinction between natural harms and anthropogenic harms.
- There is nothing special about global warming and geoengineering that would prevent the standard ethical framework being applied.

While these assumptions have been contested in the past, in this paper I argue that modern developments in Earth system science, including climate science, are undoing the very conceptions of the earth and the human being constructed in the Scientific Revolution and which now guide ethical thinking about climate change. In particular, I

[15] Although Singer's concern for animal welfare seems to contradict this, in fact by treating animal welfare in the same way that economists treat human welfare Singer is more economical than the economists. Whatever the case, extending the field of concern to encompass animals makes no difference to the critique developed in this paper.

will argue that the meaning of the facts thrown up by Earth system science challenge climate ethics by suggesting that there is a source of moral authority beyond the self-legislating Kantian subject.

It may seem contradictory that I deploy the results of Earth system science to critique the worldview given to us by the Scientific Revolution. I am suggesting that advances in Earth system science expose the limits and contradictions of the mechanical and systems understanding of the world and the technological thinking that goes with it. The problem is that we have not grasped the implications of Earth system science because we are "too scientific", that is, too habituated to thinking of the world as a systematic totality that we can know and control. If this is so science itself now challenges the understanding of the world as comprised of resources that are at our disposal and can be grasped with our minds and manipulated with technology. The foundations of climate ethics based on the autonomous moral subject are destabilized.

To make the argument, I will assess the consequentialist approach against one of the several geoengineering technologies being proposed, viz. a program of spraying sulphate aerosols into the upper atmosphere in order to reflect back into space a greater proportion of incoming solar radiation.[16] This form of "solar radiation management" is designed to offset warming by mimicking the cooling effect of large volcanic eruptions. Currently around 23 per cent of solar radiation is reflected back into space by the earth's atmosphere.[17] It's estimated that the warming associated with a doubling of CO_2 concentrations could be offset if an additional two per cent were reflected.[18] Such a program of "global dimming" would require a fleet of high-flying aircraft fitted with special tanks and spraying devices to inject aerosols into the atmosphere on a continuing

[16] The various technologies are reviewed in the benchmark Royal Society report—Royal Society, *Geoengineering the Climate: Science, governance and uncertainty*, The Royal Society, London, 2009.
[17] Royal Society, *Geoengineering the Climate*, p. 29. The figure includes the effects of sulphate aerosols due to industry.
[18] Royal Society, *Geoengineering the Climate*. Or 1.8 per cent according to T.M. Lenton and N.E. Vaughan, The radiative forcing potential of different climate geoengineering options, *Atmospheric Chemistry and Physics*, 9, 5539-5561, 2009, p. 5546

basis. Alternatively, a long hose held aloft by balloons could perform the task.[19] There are more benign geoengineering proposals than solar radiation management through sulphate aerosol injection, including various forms of carbon dioxide removal; but aerosol spraying is currently regarded as the cheapest, most effective and most likely method to be deployed,[20] especially in a so-called climate emergency.

3. Conception of the Earth

Analysis of the ethics of climate change is built on a particular understanding of the earth, one in which the earth is represented as a collection of discrete ecosystems or components that can be conceptually grasped. The assumed discreteness and well-defined properties of these systems allow the idea that technological intervention aimed at manipulation can generate certain defined outcomes. It is a cybernetic conception of the earth as a set of functional systems that are subject to control.

Up to a point, this conception works when applied to particular ecosystems, where an argument can be made that nature can be sufficiently understood and regulated. But Earth system science shows that this conception is especially misleading when trying to understand climate change and planet-wide interventions such as solar radiation management. Several factors come into play.

First, solar radiation management envisages manipulation of the flow of primary energy to the planet as a whole, energy that sustains all living things and ecosystems. The atmosphere acts as the mediator between sun and earth, transferring heat and mass to the biosphere, the hydrosphere (the planet's mass of water), and the cryosphere (the ice masses).[21] By influencing the planet's energy balance, solar radiation management will affect all ecosystems and their interactions. It represents a leap to something entirely new

[19] See Clive Hamilton, "The Return of Dr Strangelove: The politics of climate engineering as a response to global warming", June 2010, available at http://www.clivehamilton.net.au/cms/media/documents/articles/dr_strangeloves_return.pdf

[20] See, for example, Lenton and Vaughan, The radiative forcing potential of different climate geoengineering options; Scott Barrett, 'The Incredible Economics of Geoengineering', *Environmental and Resource Economics*, vol. 39, pp. 45-54, 2008; and Martin Bunzl, "Geoengineering Research Reservations", Presentation to AAAS, Feb. 20th 2010 San Diego http://sites.google.com/site/mbunzl/GeoengineeringResearchReservations.docx?attredirects=0

[21] On the relationship to the biosphere, the hydrosphere, the cryosphere see, for example, IPCC, *Fourth Assessment Report*, Working Group 1.

in human history. Beyond deliberate management and exploitation of particular resources or geographical areas, and beyond the unintentional degradation of land, rivers and oceans, solar radiation management seeks to take control of and regulate the atmosphere and climate of the planet as a whole.

On this point, and the five that follow, I ask the reader to take note of the sentiments stimulated by this fact. For some, the Promethean nature of solar radiation management arouses deep misgivings about human capacities.

Secondly, climate science has shown us 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.[22] Thus it is well-understood (but nowhere answered) that sulphate aerosol injection, while probably effective at suppressing warming, would do nothing to slow the acidification of the oceans. Indeed, if by relieving pressure to reduce emissions, global dimming meant carbon emissions grew more quickly then it would lead to faster acidification. Ocean acidification interferes with the process of calcification or shell-formation on which a wide array of marine animals—including corals, crustaceans and molluscs— depend for their survival.

For some, recognising the mystifying complexity of the earth provokes a sense of trepidation at the thought of interfering with it.

Thirdly, as it is not possible to carry out a test of the effects of sulphate aerosol spraying on the global climate system, any deployment will be embarked upon under conditions of great uncertainty. The risks are multiplied by the fact that scientists will be unable to observe the effects of global dimming for at least 10 years into the program because many years of data will be needed in order to separate the effects of aerosol spraying from other influences on global climate.[23] It would matter, for example, if the program

[22] One indicator of this complexity is the huge size of the mathematical models that are being built in an attempt to simulate the global climate. The most powerful computers in the world take several days to complete a single model run.

[23] Bunzl, Geoengineering Research Reservations; Hauke Schmidt, Presentation to a workshop on climate engineering, Institute for Advanced Sustainability Studies, Potsdam, 9 June 2011. Estimates of the cooling caused by a large eruption like Mount Pinatubo vary widely (from 0.2°C to 0.5°C) because of the difficulty of separating in the data the influence of the eruption from other influences on world temperatures.

were begun during an El Nino event.[24] If, after at least a decade of suppressed warming, it is decided that solar intervention was bad idea it would in all likelihood be impossible to stop it for fear of the so-called termination problem, the rapid rebound of global temperatures.[25]

For some, the idea of going into solar regulation blind, and of being unable to stop, stirs feelings of horror and an intimation that we would pay dearly for our audacity.

Fourthly, the Earth system that solar radiation management would seek to control is marked not only by complexity but also by non-linearities. The "tipping points" that define rapid shifts from one climate state to a quite different one are not well understood, but two facts are known well enough.[26] First, the dangers of tipping points are not theoretical but are of immediate concern. We may have crossed one or two them already and we will likely cross two or three more if the temperature reaches 4°C above pre-industrial levels,[27] as is now expected before the end of the century.[28] In addition, tipping points generate irreversible changes, not just to the climate but to the biosphere. The idea of smooth trade-offs between costs and benefits implicit in the utilitarian framework cannot easily accommodate irreversible impacts. What is a lost species or ecosystem worth? The rate of extinction today is 100 to 1,000 times higher than the natural level, due increasingly to human-induced climatic change.[29] It is expected that up to 30 per cent of all mammal, bird and amphibian species will be threatened with extinction this century.[30]

---

[24] Hauke Schmidt has asked: If sulphate aerosol spraying had begun in 1998, a year of record temperatures, would the fall in temperatures in 1999 have been attributed to solar intervention?

[25] Royal Society, *Geoengineering the Climate*, p. 35

[26] T. M. Lenton et al., Tipping elements in Earth's climate system. *Proceedings of the National Academy of Sciences*, 105:1786–1793, 2008

[27] Lenton et al., Tipping elements in Earth's climate system

[28] See, for example, K. Anderson and A. Bows, Reframing the climate change challenge in light of post-2000 emission trends. *Phi. Trans. R. Soc.* A, 366, 3863-3882, 2008, and the overview in Hamilton, *Requiem for a Species*, Chapter 1.

[29] Johan Rockström, et al. A safe operating space for humanity, *Nature* 461, 472-475, 24 September 2009. This is a summary version of Johan Rockström, et al., Planetary Boundaries: Exploring the Safe Operating Space for Humanity, Stockholm Resilience Centre, 2009 http://www.stockholmresilience.org/download/18.8615c78125078c8d3380002197/ES-2009-3180.pdf

[30] Rockström et al., A safe operating space for humanity

For some, the abrupt nature of climate change intimates that the earth operates according to its own laws whose unpredictability mocks our plans for control and makes us shrink before the power of natural forces.

Fifthly, apart from the uncertainties, unknowns, and threshold effects arising from the complexity and non-linearity of the Earth system, the dominant fact is that CO_2 persists in the atmosphere for many centuries. So it is possible—indeed, likely—that before the larger impacts of warming are felt humans will have committed future generations to an irreversibly hostile climate lasting a thousand years.

For some, recognising that what we are doing commits the future inhabitants of the planet to a transformed and less friendly climate rouses a sense of shame for failing to fulfill our responsibilities.

Finally, unless accompanied by sharp reductions in emissions, a continuing program of aerosol spraying would entail the more-or-less permanent transformation of the chemical composition of the earth's atmosphere, a kind of "chemotherapy" for an ailing atmosphere. 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 followed by rises or falls in the other.[31] Solar radiation management is 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 as a whole.

For some, the idea that humans in the 21st century should make themselves a planetary force of geological scale is supremely reckless and invites retribution.

4. Calculation *versus* humility

How do these facts emerging from Earth system science change the way we think about geoengineering? For the consequentialist, each of these facts—the attempt to regulate

[31] Those rises and falls have sometimes been triggered by other events, such as volcanic eruptions and asteroid impacts, so that at times increases in CO_2 have followed warming. While climate deniers present this fact as if it disproves warming due to anthropogenic carbon emissions, the reverse conclusion should be drawn—by showing that warming changes the biosphere to release more CO_2 we have a positive feedback effect that exacerbates warming caused by humans.

primary energy flow, unfathomable complexity, the untestability of solar radiation management, irreversible tipping points, the permanence of a changed climate, and interference in geological processes—becomes a "risk"; the science just provides better data to be fed into the calculations that allow ethical conclusions. Those consequentialists more in tune with the *zeitgeist* of technological hubris respond to the reluctance of the earth to submit to human mastery as a spur to more cunning and greater efforts. So when it is pointed out that sulphate aerosol spraying may suppress warming but will not prevent ocean acidification, some geoengineers immediately look for a solution to this "side effect", proposing that we develop a program of adding lime to the oceans in order to return them to a state more friendly to our interests.[32]

Less-hubristic consequentialists may come to accept that the risks and uncertainties are so pervasive that cost-benefit calculation is unable to reach plausible decisions about what to do. This instrumentalist dumbfounding leaves them applying despairing phrases like "diabolical" and "a devil's stew".[33] But as long as one cleaves to the cybernetic conception of earth and the authority of rational calculation there is nowhere for the humble consequentialist to go. The recalibration of risks on the basis of new evidence does not challenge the objectification of the earth or the calculating mode of reaching ethical conclusions by autonomous subjects.

For others, recent developments in Earth system science generate or reinforce a quite different conception of the earth and the ethics of climate change, one that stimulates a very specific moral sense, that of humility in the face of nature. What do we mean by humility in the face of nature? We feel humility when we recognise our own intellectual, physical and moral limitations and acknowledge a greater power than ourselves.[34] It requires us to temper our self-belief, to acknowledge limits to our ability to control the

[32] David Victor, 'On the regulation of geoengineering', *Oxford Review of Economic Policy*, 24:2, 2008, p. 327

[33] The possibility of catastrophe, including the destruction of civilization, has led Martin Weitzman, an economist with a superior grasp of climate science but no insight into the worldview in which economics is grounded, to conclude that this factor overwhelms all others in trying to assess the threat of climate change. Martin Weitzman, On Modelling and Interpreting the Economics of Catastrophic Climate Change, REStat Final Version, July 7 2008

[34] "Humility" derives from the Latin *humilis,* which also means grounded or from the earth (related to humus).

environment, to accept our insignificance as actors in the cosmos and to abandon the belief that our future is in our own hands. In the past, the chief grounds for humility has been acceptance of the infinitely greater power of a mysterious and omnipotent god. I am suggesting that Earth system science has revealed that the earth as a whole, our living environment, is vastly more complex, enigmatic and uncontrollable than we had come to believe, and that taking in these facts causes us to cease thinking we can master the earth and to scale back our ambitions. It means recognising that the power relation between humans and the earth is the reverse of the one we have assumed for three centuries. In sections 6 and 8 below I will argue that this challenges not just our conception of the earth but our understanding of ourselves as moral subjects.

It might be thought that my argument is essentially the same as Michael Sandel's criticism of genetic enhancement.[35] 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. Although the urge behind both genetic engineering and geoengineering is "a Promethean aspiration to remake nature, including human nature, to serve our purposes and satisfy our desires",[36] Sandel finds the source of humility in gratitude for what we have been given whereas I find the source of humility in acceptance of our limitations in the face of the superior power, complexity and enigmatic character of the earth.

Since consequentialist ethics judges the rightness of an action by the sum of effects on humans (and perhaps other sentient beings), any moral feeling can come about only after the act of calculation. How the numbers turn out tells us how we should feel; if the costs of an action exceed the benefits then perhaps we are permitted to feel indignant.[37] Economists are unapologetic about this; the most ethical course is the best one determined by summing the value of the costs and benefits, perhaps weighted by risks,

---

[35] 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

[36] Sandel, The Case Against Perfection, p. 78

[37] Within a worldview built on the idea of mastery over the environment, humility is seen as an expression of weakness. After all, we adopt a position of humbleness before forces we accept are more powerful and beyond our control. Yet if we bring to mind those historical figures renowned for their humility we recognise that they were also pillars of strength.

and maybe with some account of distributional effects. The process of rational calculation is especially attractive to those who feel a greater need for a sense of control.

In the case of solar radiation management, the exclusion of moral feelings towards the object of analysis is easier if the object in question, in this case the earth as a whole, is objectified, that is, regarded as a separate entity—abstract, removed, emotionally distant, and of no ethical concern except insofar as the object can satisfy one's own needs. The objectification of the earth means regarding it as a collection of resources that have instrumental value only, that is, value only as means to human ends. Viewing the earth in instrumental terms, so that the ethics of acting on it are to be judged purely by their effects, requires a certain wonderlessness and estrangement from the earth.

Paul Crutzen's call for investigation of geoengineering did not spring from an extreme case of instrumentalism and a cavalier faith in human mastery but from "despair",[38] a deep anxiety about the failure of the world to act on climate change. He made his call because he is one among a small number of scientists who fully appreciate the implications of humanity's failure to act. For him, geoengineering may be an evil, but it may be the lesser one. What has now become apparent is that the recourse to geoengineering has been taken up by many who do not share Crutzen's understanding of the implications of climate science or his despair. For them geoengineering is not the lesser of two evils, but a possible alternative strategy for better meeting human goals. If geoengineering were an evil it could not be turned into a good through cost-benefit analysis.

5. Preferring the natural

As it invests its faith in rational human decision-making, consequentialism is intrinsically predisposed to elevate the power of humanity over that of nature. Central to its position is the rejection of the idea that the natural exercises any sort of ethical pull; it must do this because any such ethical pull would be a source of moral authority outside the realm of human calculation. So the popular belief that there is something special about the natural world, perhaps because it is delicately balanced and benevolently configured, is incorrect

[38] Paul Crutzen, pers. comm.

because natural systems are both inherently unstable (so that human-induced changes are not exceptional) and robust against human interference. Powell et al., for example, refer to research that apparently shows that human interference in natural systems has fairly weak ecological impacts.[39] The point of these claims seems to be to establish the case that, since what humans do cannot disturb the delicate balance of nature, because there isn't one, the risks of intervention are lower than many believe.

Earth system science shows otherwise. Not only has it destabilised the idea of the earth as a knowable and controllable system but it supports the notion that the natural has a privileged position. How? It is true that over geological time scales the earth's climate system has been highly variable. Yet the last 10,000 years, the epoch known as the Holocene, has been a period of unusual stability for the earth's environment.[40] This time of benevolent constancy has permitted human civilization to flourish.[41] As *Homo sapiens* spread across the continents, settlement was heavily influenced by the climates they found; it is not accidental that deserts and the Antarctic are largely uninhabited and most cities are located near rivers and oceans. The infrastructure for nearly seven billion people to live as they do today has taken several hundred years to develop (a few thousand if we include agriculture), and has been possible because of the relatively stable and sympathetic climate that marks the Holocene.

Nor is it true that this stable and benevolent climate is resilient against human interference. Contrary to claims that the natural world is robust in the face of human interference, 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 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".[42] Ellis writes:

[39] Powell et al., The Ethics of Geoengineering
[40] For example, W. Dansgaard et al., Evidence for general instability of past climate from a 250-kyr ice-core record, *Nature* 364: 218 – 220, 15 July 1993
[41] Rockström et al., A safe operating space for humanity
[42] 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

> … the terrestrial biosphere is now predominantly anthropogenic, fundamentally distinct from the wild biosphere of the Holocene and before. … nature is now human nature; there is no more wild nature to be found, just ecosystems in different states of human interaction, differing in wildness and humanness …. by the latter half of the twentieth century, the terrestrial biosphere made the transition from being shaped primarily by natural biophysical processes to an anthropogenic biosphere in the Anthropocene, shaped primarily by human systems.[43]

The most important features are the huge increase in human numbers, up from 800 million in 1750 to nearly seven billion today, and the transformation of the atmosphere due to anthropogenic greenhouse gas emissions.[44]

While the Holocene was relatively stable, the Anthropocene is likely to be very unstable, depending on decisions made by humans. In a landmark intervention in 2009, 27 experts wrote in *Nature*:

> Many subsystems of Earth react in a nonlinear, often abrupt, way, and are particularly sensitive around threshold levels of certain key variables. If these thresholds are crossed, then important subsystems, such as a monsoon system, could shift into a new state, often with deleterious or potentially even disastrous consequences for humans.[45]

They are referring mainly to climate tipping points. Contrary to the comforting conception of robust nature, these scientists believe the upheaval of the Anthropocene "could see human activities push the Earth system outside the stable environmental state of the Holocene", and the focus on past resilience may "lull us into a false sense of security because incremental change can lead to the unexpected crossing of thresholds

---

[43] Erle C. Ellis, Anthropogenic transformation of the terrestrial biosphere, *Philosophical Transactions of the Royal Society A*, 369: 1010–1035, 2011

[44] Jan Janzalasiewicz, Mark Williams, Will Steffen and Paul Crutzen, The New World of the Anthropocene, *Environmental Science and Technology*, 44: 2228-2231, 2010

[45] Rockström, et al., A safe operating space for humanity

that drive the Earth System".[46] Abrupt changes are those that happen too quickly for humans and some other species to adapt.[47]

6. The meaning of facts

How do we react to these startling new facts—the arrival of a new geological epoch under human influence and the dangerous instability of the Anthropocene compared with the Holocene? Do we attempt to quantify the risks they pose and incorporate them into a cost-benefit analysis, or do they cause us to examine our presuppositions about the relationship of humans to the earth? In other words, should we not reflect on what these new facts *mean*? The conception one has of the world (and one's place in it) carries with it sentiments about the earth beyond utilitarian thinking. Before risks are calculated one asks what is worth risking and whether we have the right to take certain sorts of risks.

This is not merely a contrast between people with differing personalities. The difference arises from divergent understandings of the nature of the world and the self—what the earth *is*, and what a human being *is*—so that we are contrasting what might be called ontological arrogance with ontological humility. This idea is reflected, although only indirectly, in the distinction drawn by psychologists between those with an *independent self-construal*—whose conception of self emphasises individual uniqueness and values autonomy and self-enhancement—and those with a *metapersonal self-construal*—whose self is in some sense inseparably connected to all living things or some wider notion of the Earth or cosmos.[48] These are not so much personality characteristics but ways of experiencing the self. Studies show that the kind of self that thinks about the ethics of climate in an instrumentalist way is historically and culturally distinctive.[49]

Here it is vital to understand the way scientific arguments are used to establish an ethical position. Those who argue that the delicate state of nature demands that we "tread lightly on the earth" draw on ecological science not as a form of proof but as a means of evoking

[46] Rockström, et al., A safe operating space for humanity
[47] See especially, National Research Council, *Abrupt climate change: inevitable surprises*, Committee on Abrupt Climate Change, National Research Council, 2002.
[48] See the discussion in Hamilton, *Requiem for a Species*, Chapter 5
[49] Wendi Gardner, Shira Gabriel and Angela Lee, "I" Value Freedom, But "We" Value relationship: Self-construal priming mirrors cultural difference in judgment, *Psychological Science*, 10: 4, July 1999

a certain sensibility towards nature—one of respect, humility, and even reverence. Images of "nature in the balance", "the majesty of whales" and "the blue planet" are symbols that draw attention to the kind of relationship humans have to the natural world. How the individual arrives at a position on the scale from extreme instrumentalism justifying domination of nature to extreme reverence inviting humility—from, say, Gary Becker (the Nobel Prize winning economist whose economic analysis of the family defined love as "a non-marketed household commodity) to Mahatma Gandhi—is a complex question not considered here, although we know there are strong cultural factors involved.

The critique of climate ethics is in fact a dispute about what "ethics" means. For those who reject instrumentalism, the idea that the ethical can be decided from instrumental calculation is itself unethical. For instrumentalism it is always ethically justified to engineer a different climate, even though the process of calculation may show that it is imprudent. The procedure is analogous to resolving the ethics of destroying a sacred site by asking how much money the traditional owners would be willing to accept as "compensation". Simply posing the question this way puts the issue outside genuine ethical judgment. The question itself is morally offensive and, when posed, elicits not a calculative reflex but a sense of outrage.

One of the most commonly expressed ethical concerns about climate engineering arises from the possibility that the availability of an alternative to carbon abatement will reduce the incentive to cut emissions. Borrowed from private market behaviour, this "moral hazard" argument is framed in consequentialist terms—as solar radiation management is likely to be environmentally less effective (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.[50] But there is a non-consequentialist moral hazard objection—

[50] While moral hazard is usually listed as a potential problem, in my view the pressure to make climate engineering a substitute for abatement will prove irresistible. Already, representatives of the fossil fuel industry have begun to talk of geoengineering as a substitute for carbon abatement. 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" (Steven D. Levitt and Stephen J. Dubner, *Superfreakonomics: Global Cooling, Patriotic Prostitutes, and Why Suicide Bombers*

geoengineering may facilitate the continuation of bad behaviour and is therefore wrong. Exxon's environmentally damaging activities and support for climate denial would be rewarded by resorting to climate engineering. If we have a responsibility for the damage we cause then geoengineering may allow us to opt out of our responsibility for causing climate change. The wrong would be compounded if rich countries with high emissions pursue climate engineering instead of abatement. Solar 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 disposition it reveals.

7. Identifying "winners and losers"

When a consequentialist framework is brought to the ethics of geoengineering it is natural to identify winners and losers. For example, it is sometimes claimed that citizens of Canada and Russia will benefit overall from global warming.[51] Those who imagine themselves basking in a more temperate climate are likely to be in for a rude shock because the effects on people of climate change will arise not so much from gradual warming but from extreme events. Russian enthusiasm for warming cooled in 2010 after the unprecedented summer heat-wave, drought and devastating forest fires.[52]

The scientific question is not whether an altered climate would be better or worse (the usual consequentialist frame) but whether it would be safe or dangerous. The objective of the 1992 UN Framework Convention on Climate Change is "to prevent dangerous

---

Should Buy Life Insurance, HarperCollins, 2009). For anyone who recognizes the dangers of technological hubris, things don't get much cruder. And Republican presidential candidate and former House Speaker Newt Gingrich has declared: "Geoengineering holds forth the promise of addressing global warming concerns for just a few billion dollars a year. Instead of penalizing ordinary Americans, we would have an option to address global warming by rewarding scientific invention… Bring on the American ingenuity."

[51] E.g. Gregg Easterbrook (e.g. http://blogs.reuters.com/gregg-easterbrook/2010/07/23/on-top-secrets-and-climate-change/). Easterbrook's suggestion that readers should ask of global warming "What's in it for me?" may be morally equivalent to urging others to profiteer in a disaster zone.

[52] The scale of the 2010 heat wave is discussed here: http://www.hzg.de/science_and_industrie/klimaberatung/csc_web/010253/index_0010253.html.en. Moreover, it is not possible to isolate Canada and Russia from the rest of the world. A financial collapse in the United States or China induced by extreme weather would cause global dislocation. Food price rises due to crop failures in major suppliers cascade through all markets. And a water-war between India and Pakistan could have worldwide fall-out.

anthropogenic interference with the climate system".[53] The boundary between safe and dangerous levels of warming is believed to be "what is required to avoid the crossing of critical thresholds that separate *qualitatively different* climate system states".[54] It is in the nature of the climate system that scientists have found it difficult to decide on a safe level of climate change.[55] The European Union adopted the objective of limiting warming to 2°C above preindustrial levels, but many scientists believe that is too dangerous.[56] Some advocate limiting CO_2 concentrations to 350 ppm, associated with warming of around 1.7°C above the pre-industrial average, although even here there are risks, and value judgments are necessary.[57] Despite the difficulties, the idea of a threshold above which warming would be dangerous means that a "safe minimum standard" is a more appropriate decision rule, with cost-effectiveness analysis replacing cost-benefit framework.

Once again we ask: What is the effect on us of the lack of certainty over what constitutes a safe level of warming in a non-linear world and the potentially very harmful or even catastrophic consequences of exceeding the safe level? Of course the facts call for greater caution; but do they cause us only to calculate differently, to recalibrate risks, or do we reconsider our understanding of the earth and our approach to it? The complex and volatile interactions of Earth systems, and our meagre understanding of their workings, means that the idea that humans can choose an optimal global average temperature and "set the thermostat" at that level appears increasingly deluded. Any "optimal" degree of

---

[53] United Nations, United Nations Framework Convention on Climate Change. Bonn, Germany: United Nations, 1992

[54] Rockström, et al., Planetary Boundaries (emphasis added)

[55] See, for instance, Stephen H. Schneider and Janica Lane, An Overview of "Dangerous" Climate Change, Stanford University, Stanford, California
http://stephenschneider.stanford.edu/Publications/PDF_Papers/Schneider-lane.pdf

[56] "Beyond 2°C, the possibilities for adaptation of society and ecosystems rapidly decline with an increasing risk of social disruption through health impacts, water shortages and food insecurity." K. Richardson et al., *Synthesis report. Climate change: global risks, challenges & decisions. Summary of the Copenhagen climate change congress*, University of Copenhagen, Copenhagen, 10–12 March 2009, p. 12. Paleoclimatologists have shown that the Antarctic ice-sheet began to form when CO_2 concentrations fell below 450 ppm, suggesting it would begin perhaps irreversible melting once the concentration rose above that level.

[57] http://www.nature.com/climate/2009/0912/full/climate.2009.124.html; J. Hansen et al., Dangerous human-made interference with climate: A GISS modelE study. *Atmospheric Chemistry and Physics*, 7: 2287-2312, 2007. Warming of 1.7°C is an average that may be "safe" for most countries or regions and dangerous for others.

warming may prove to be only a temporary way-station on a path to more warming, and it is well-established that the amount of damage caused by warming is an increasing function of the degree of warming.[58]

8. Technological thinking

> … when we try to see and conceptually come to terms with a certain phenomenon we also have to pay close attention to *how* we approach it … For there will always be a risk that we let ourselves be guided by a thought model which in the end makes us blind precisely to the phenomenon which we are trying to interpret and understand.[59]

I have argued that the beliefs that there is no *prima facie* justification for attempting to preserve the current climate and that the optimal temperature should be set through a process of calculation reflect a particular conception of the world and the nature of humans that emerged with the Scientific Revolution and Enlightenment philosophy. It was not just a new conception of the earth that emerged but a new conception of the human being, the modernist view of a distinct, self-legislating subjective entity separated from the world around it and on which, guided by its cognitive abilities, it acts to pursue its own interests. The proposed deployment of solar radiation management to offset the effects of anthropogenic global warming is the culmination of the transition to the mechanical conception of nature and the parallel emergence of philosophies built on the idea of the autonomous rational subject exercising control over an inert environment.

The type of thinking embedded in the framework of systems analysis, risk assessment and cost-benefit analysis can be called "technological thinking". Technological thinking understands the world as a collection of more or less useful resources. According to this view technology transforms potentially useful things into useful things without asking

---

[58] Current climate models "do not include long-term reinforcing feedback processes that further warm the climate, such as decreases in the surface area of ice cover or changes in the distribution of vegetation. If these slow feedbacks are included, doubling CO_2 levels gives an eventual temperature increase of 6°C (with a probable uncertainty range of 4–8°C). This would threaten the ecological life-support systems that have developed in the late Quaternary environment, and would severely challenge the viability of contemporary human societies." Rockström, et al., A safe operating space for humanity

[59] Hans Ruin, Technology as Destiny in Cassirer and Heidegger, in Aud Sissel Hoel and Ingvild Folkvord (eds), *Form and Technology: Reading Ernst Cassirer from the Present*, Yale University Press, 2010

about the origins of the world as a collection of potentially useful things. Modern technology therefore challenges nature to supply materials and energy for extraction and storage, to open itself up as possibilities for human progress, providing a path to the fulfillment of human existence. As such, modern technology reveals something essential to the nature of modern humans—the determination to shape the world around us to suit our desires, desires that have no limit.

Plans to engineer the earth through the deployment of contrivances to manipulate the atmosphere represent the fulfilment of three and a half centuries of objectification of nature. The earth as a whole is now represented no longer simply as a collection of objects but as an object in itself, one open to regulation through the "management" of the amount of solar radiation reaching the earth. Earth-as-object also underlies the idea that we can adjust the volume of greenhouse gases in the atmosphere to a level calculated to be "optimal". Climate engineering represents a conscious attempt to overcome resistance of the natural world to human domination, the last great stride towards total ascendancy. Yet, as I have already suggested, the sheer complexity and unpredictability of the natural world resists attempts at total mastery.

In order to evoke a sense of the way in which climate change and geoengineering prompt a reconsideration of technological thinking, I have pointed to the emerging understandings of the world and our role in it emanating from Earth system science. The idea of the Anthropocene is put forward because humans are now the dominant force in the global biosphere. Yet the earth under the Anthropocene is not mere putty to be shaped at will by humans. We have already seen in the discussion of thresholds, uncertainties, intricate interactions and unknowns that the earth does not behave obediently according to the systematic, predictable frame we have projected onto it since the Scientific Revolution.

At the same time, climate change is destabilising this understanding because science itself is pointing towards the inherent uncontrollability, and perhaps the unknowability, of the natural world. We have seen how global warming is affecting the biosphere, the hydrosphere and the cryosphere. Scientists are now beginning to grasp the way in which human-induced climate change can affect the lithosphere (the outer crust of the Earth) and the geosphere (the deeper structures of the planet), including the movement of tectonic plates. It is now emerging that, by shifting the distribution of ice and water over the surface of the earth, human-induced global warming is likely to provoke geological and geomorphological responses, including seismic, volcanic and landslide activity.[60] Changes in the seasonal snow-load, for example, affect seismic activity in Japan by changing the compression on active faults. According to a recent scientific review of the field, in Iceland and Alaska "melting of ice in volcanic and tectonically active terrains may herald a rise in the frequency of volcanic activity and earthquakes".[61] When glaciers melt the earth "rebounds". The earth's crust may rise by hundreds of meters with a decline in ice load of one kilometer. Moreover, although anthropogenic effects on the climate and biosphere are far more important impacts, the melting of polar ice due to global warming can be expected to alter slightly the earth's rotation speed and its orientation in the solar system.[62]

So we can see that, far from being a phenomenon limited to changes in the weather, human-induced climate change is bringing everything into play in ways that appear increasing complex and beyond control. Yet plans for solar radiation management challenge the earth as a whole to present itself to us as a system that can be understood, manipulated and regulated. These facts call not for more calculation of risks but for a radical change in the modern conception of the earth and a repudiation of the idea of the modern subject that founds climate ethics. It is a call for a new kind of subject, the heteronomous subject who recognises sources of moral authority beyond human calculation in the understanding of the world suggested to us by Earth system science. It is a moral authority that calls on us to reground ethics in some idea of right behaviour.

Instead we now have governments and scientific societies beginning to deliberate on the "governance" of solar radiation management,[63] that is, the appropriate political institutions for regulating the amount of light reaching the planet. Since the formation of

---

[60] For a review see B. McGuire, Potential for a hazardous geospheric response to projected future climate changes, *Philosophical Transactions of the Royal Society A*, March 28, 2011
[61] McGuire, Potential for a hazardous geospheric response to projected future climate changes
[62] "How the Japan Earthquake Shortened the Earth Day", www.space.com
[63] See the Royal Society's Solar Radiation Management Governance Initiative (http://www.srmgi.org/)

the earth 4.5 billion years ago the amount of solar radiation reaching it has been determined by the Sun mediated by the earth's atmosphere. It seems we are no longer happy with the arrangement and want to assume control ourselves. Although individuals may endorse a program of sulphur injections as a regrettable necessity arising from our previous failure, solar radiation management nevertheless represents the extension of a relentless process of mastery rooted in entrenched social and economic institutions.

Is there any force that can temper this drive for mastery? Are we able today, after all of our astonishing technological accomplishments, to understand the meaning of the ancient Greek stories warning of hubris—the stories of Icarus, of Narcissus, and of Achilles debasing Hector? Most tellingly, are we attuned to the message of the myth of Phaeton who, against all warnings, decided to take control of the forces of the Sun, accidentally causing the earth first to freeze then to burn up before he had to be killed? Are the geoengineers modern-day Phaetons, who dare to regulate the Sun, and must be struck down by Zeus before they destroy the earth? Or has the perfection of our rational capabilities forever silenced Nemesis?