Re-Thinking the Unthinkable: Environmental Ethics and the Presumptive Argument Against Geoengineering

The rapid rise in interest in schemes to geoengineer the climate as a response to anthropogenic global warming presents a clear and significant challenge to environmental ethics. After a brief introduction to the two main types of geoengineering, this paper articulates what it calls the "presumptive argument" against geoengineering from environmental ethics, a presumption strong enough to make geoengineering almost "unthinkable" from within that tradition. Two rationales for suspending that presumption are then considered. One of them focuses on a "lesser evil" argument, the other on connections to ecofacism and the anthropocentrism/non-anthropocentrism debate. The discussion draws attention to the question of how environmental ethicists should orient themselves to geoengineering and what they should think about the moral significance of natural, large-scale biogeochemical processes.

Keywords: geoengineering, presumptive argument, environmental ethics, lesser of two evils, anthropocentrism, fundamental processes.

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Within the last year, climate engineering has secured a prominent place at the table in the discussion of what to do about anthropogenic global warming. Prior to the December 2009 Conference of the Parties meeting in Copenhagen, the idea of deliberately geoengineering the climate stood well outside of the mainstream.[1] The failure of the Copenhagen meeting to produce a binding agreement on carbon dioxide emissions, however, has rapidly propelled the discussion of geoengineering out of the shadows. In the absence of effective plans to limit atmospheric carbon, the question of what the global community will do to mitigate the harm caused by global warming is becoming increasingly urgent. As a result, interest in geoengineering has soared. No fewer than four books on the topic have been published in 2010 with a number of conferences, workshops, and studies taking place in the same short period. Discussion about the merits of prospective field trials and the appropriate regulatory mechanisms is already taking place.[2] Technologies that only recently were viewed as entirely in the realm of science fiction are now being talked about as realistic policy options.

The recent push to move geoengineering in the direction of field trials is not surprisingly coming first and foremost from the scientific community. Despite several years of computer modeling on the various geoengineering technologies, much uncertainty remains. Scientists need not only to test techniques for possible deployment, they also need to gain real world data on their efficacy for cooling the planet, together with much better knowledge of their side-effects (for example, on precipitation patterns). If the global community were to reach the point where it became serious about pulling

the trigger on geoengineering, they would need considerably more confidence about how (and whether) it was going to work.

Despite the considerable scientific questions and challenges that remain, it is probably not the state of the science that provides the biggest barrier to the implementation of geoengineering. A report from Britain's Royal Society points out that the "greatest challenges to the successful deployment of geoengineering may be the social, ethical, legal and political issues associated with governance, rather than scientific and technical issues" (Royal Society, 2009: xi). Many of the most pressing ethical issues mentioned in the Royal Society report lie in the challenge of how to develop just, legal, and fair processes for implementing geoengineering. Additional quandaries lie in questions concerning how the prospective benefits and burdens will be distributed and how to compensate those who suffer the greatest burdens. For many of the technologies in question, the desired reductions in temperature and the side-effects on local weather patterns are likely to be uneven and somewhat uncertain, leading to great potential for geopolitical unrest.[3] As numerous observers have pointed out, nations will want to know 'whose hand is on the thermostat?'

There is no doubt that these procedural and political challenges are substantial. Most of the work that lies ahead in the ethics of geoengineering will (and rightly should) be focused here. But a different kind of ethical challenge is also created by the prospect of geoengineering. This is the challenge that geoengineering presents to environmental ethics itself. The moves that are being made in the direction of geoengineering are of clear concern to those who work in this field. The intention to alter some of earth's basic

biogeochemical parameters runs counter to much of what environmental ethics has been about for the last 40 years.

This paper is designed to bring focus to the implications of geoengineering for environmental ethics. What should the response of environmental ethicists be to geoengineering? How does the technology sit with some of the core beliefs in the field? Do any of these core beliefs require revision in the face of today's discussion of climate engineering? Is environmental ethics equipped to deal with the prospect of geoengineering? These and related questions require serious attention if the environmental ethics community is to find a place at the table in the burgeoning discussion of geoengineering.

A Very Quick Overview of Geoengineering

Geoengineering has been coarsely but helpfully defined by Canadian researcher David Keith as "the intentional, large scale manipulation of the environment" (Keith, 2000: 245). Keith adds that current discussion of geoengineering is almost exclusively targeted towards the question of what can be done to steer the planet away from the most harmful effects of climate change.[4] The two categories of geoengineering for climate change under consideration are carbon dioxide removal (CDR) and solar radiation management (SRM).[5] While there is disagreement about what legitimately counts as geoengineering, Keith's rather broad definition is helpful for grasping the types of projects currently being considered.

What turns a carbon removal project into "geoengineering" is typically a matter of scale. Small scale removal of carbon dioxide (CDR) from the atmosphere has been

taking place at the hands of humans for centuries. The planting of a tree in someone's garden could be construed as a small, personal effort at carbon dioxide removal, though the amount of carbon removed and the time frame during which it would be sequestered are both too small to have any effect on global climate. On the other hand, a global project to plant 5-10 billion acres of trees may make enough of a difference to earth's carbon budget to warrant the label.[6] Other CDR schemes involve deploying hundreds of thousands of CO_2 scrubbing machines (sometimes called "artificial trees"), adding iron to thousands of square miles of nutrient rich (but iron deficient) regions of the world's oceans to create vast phytoplankton blooms, enhancing the natural weathering process of rocks, increasing the alkalinity of the oceans, and producing billions of tons of biochar for sequestering carbon in agricultural soils. Each of these CDR technologies could theoretically be scaled up to cause a significant reduction in atmospheric carbon.[7] When pursued expressly for this purpose, such efforts become examples of climate engineering. At a large enough scale, they meet Stephen Schneider's more technical definition of geoengineering as the "manipulation[s] of stocks and flows of components of the Earth's biogeochemical processes to alter the radiative balance of the atmosphere" (Schneider, 2008: 3850).[8]

CDR technologies have a number of considerations in their favor and a number against. They have the advantage of directly treating the cause of the climate change problem. As the name suggests, CDR technologies physically remove carbon from the atmosphere. Most CDR schemes also have the advantage of being capable of starting on a small scale. This would allow those managing the geoengineering project to monitor and evaluate their effects as the scale is ramped up. An additional advantage of CDR is

that most of the technologies (with the exception of ocean fertilization) could proceed without new international regulations or agreements. If carbon dioxide is regulated as a pollutant, then CO_2 removal can be viewed simply as a variation on familiar pollution control.[9] The distinction between carbon capture at, say, a coal fired power plant (traditional pollution control) and carbon scrubbing in the adjacent two states (geoengineering with CDR) is not a dramatic one. For these and other reasons, CDR is often viewed as the less controversial of the two main types of geoengineering.

On the down side, CDR is likely to be relatively slow acting. Not only would it take time to bring carbon levels down to pre-industrial levels by removing carbon incrementally from the atmosphere but there is also a built-in inertia to global temperature change due to the huge mass of the oceans and the relatively high specific heat of water. Even as the carbon gets removed, global temperatures are unlikely to fall fast. Another disadvantage of CDR is that some of the carbon removal schemes (e.g. CO_2 scrubbing with artificial trees and enhanced weathering of rocks) are relatively expensive. Challenges concerning how to sequester the captured carbon in the long-term and worries about the ecological effects of ocean fertilization and enhanced weatherization of rocks mean that CDR schemes raise their own environmental concerns. It was worries about ecological side-effects that caused two recent ocean fertilization projects to be abandoned, in one case, even after the ships for deploying the iron had left port.[10]

Solar radiation management (SRM), the second major type of geoengineering, tends to be even more controversial than CDR. SRM technologies seek to reflect back some of the short-wave solar energy reaching Earth's surface and/or the atmosphere. The

introduction of a difference between the amount of solar energy being introduced to a system and the amount leaving it (measured in W/m^2) creates what is known as "radiative forcing." During this forcing, components of the system have to either warm or cool to ensure that radiative balance between incoming and outgoing solar radiation is restored. With anthropogenic climate change, the atmosphere and the surface of the planet are currently warming to compensate for the reduction in outgoing long-wave radiation caused by the accumulation of greenhouse gases.

Some SRM strategies are very low tech. For example, a person could paint the roof of their house or the driveway of their home white to increase the amount of solar energy reflected back into the atmosphere rather than absorbed by their property. Some of this reflected solar energy would end up back in space. In so doing, this person would make their house cooler and, if all their neighbors did the same, they might also do something to counter the urban heat island effect in the neighborhood. On the scale of a few roofs and driveways, this is not going to qualify as geoengineering. Scaled up to hundreds of millions of roofs and asphalt surfaces, it might.[11]

A more technically complex SRM technique that works on similar principles is to brighten existing ocean clouds to prevent solar energy from being absorbed into the world's oceans (Latham *et al*., 2008). Marine clouds can be brightened by increasing the number of the condensation nuclei around which moisture forms. One proposal for doing this is to spray a fine mist of sea water into the natural convective currents above the ocean and let the mist rise into existing clouds. To be have a real influence on earth's solar budget, cloud brightening advocates estimate it would require about 1500 spray producing vessels operating continuously across the ocean commons (Salter *et al*., 2008).

Cloud brightening has the advantage, say these supporters, of swift reversibility. The cooling effects would cease within a day or two if the spray nozzles were turned off.

Two more SRM schemes to reflect sunlight, the injection of stratospheric aerosols and the deployment of space-based mirrors, generate considerably more controversy than cloud brightening or white roofs. With both of these schemes, a reflective agent is place high in (or above) the stratosphere to act as a barrier to incoming short-wave radiation. In the case of stratospheric aerosols, this agent is most likely to be sulphate particles formed as a consequence of the intentional delivery of sulphide gases to the upper atmosphere. Once the particles are in place, they would instantly reduce the amount of solar radiation penetrating the atmosphere, most likely on a global scale.

Using SRM as a strategy to combat global warming has a number of factors in its favor as well as a number against it. Some of these technologies (e.g. stratospheric aerosols) could be deployed relatively cheaply (Barrett 2008). With all of them, the radiative forcing effect is almost immediate, leading to rapid reductions in temperature. On the negative side, shielding the sun does nothing to reduce concentrations of atmospheric carbon leading to the likelihood of very rapid warming if deployment were suddenly stopped (a worry known as the "termination problem"). The maintenance of high levels of atmospheric carbon would also ensure continued ocean acidification with serious effects on the ability of marine life to form shells and corals. To add to the problems, stratospheric sulphur aerosols appear to facilitate ozone depletion – as witnessed after volcanic eruptions – and they have relatively unpredictable effects on precipitation patterns. A major political disadvantage presented by the fact that they take place on the global commons is that maritime cloud brightening, stratospheric aerosols,

and space mirrors would all require the creation of new international mechanisms to ensure that the process could be managed legally and in an open and transparent way.[12]

Though most geoengineering schemes have not, for obvious reasons, been tested on a global scale, advocates of stratospheric aerosols claim that this experiment has already been run. When Mount Pinatubo in the Philippines erupted in 1991, it sent 20 million tons of sulphur dioxide and many additional tons of pyroclastic debris into the atmosphere. The dust and the sulphur dioxide (which soon formed sulphuric acid droplets) caused a stratospheric haze which effectively shielded a portion of the sun's rays for two years. Temperatures in the northern hemisphere fell by 0.5-0.6 degrees Celsius for nearly two years.[13] Earlier eruptions such as El Chicon (1982), Krakatau (1883), and Tambora (1815) showed similar, if less finely documented, effects. Of all the SRM strategies being discussed, stratospheric aerosols are considered by some to be capable of creating the fastest and most reliable drops in temperature (Royal Society, 2009).

It is widely acknowledged, even by those who advocate in their favor, that the CDR and SRM schemes described above would all require careful ethical analysis before implementation. This analysis would have to include consideration of the likelihood of negative side-effects, the distribution of costs and benefits, the efficacy of the technology in actually reducing temperatures, the balancing of risk and uncertainty, and planning for long-term governability. As indicated above, these concerns (and others like them) are clearly the most pressing ethical concerns that geoengineering faces.[14] Each concern, as well as numerous legal and political ones, would require serious consideration as part of the complex decision-making process about whether (and how) to proceed with

geoengineering. But none of these concerns on their own reach to the foundation of environmental ethics. To reach these foundations, one needs to consider what is sometimes discussed as the most startling "philosophical" consequence of climate engineering, the implications of extending human management of the planet beyond the land and into the global atmosphere.

Climate Change and Managed Skies

Interviewed for Jeff Goodell's book How to Cool the Planet, David Keith made a comment about using geoengineering to save Arctic sea ice that gives a hint of the problem. Keith stated that we need to think very seriously before initiating geoengineering. Why? Because geoengineering represents, he claims, "…the end of wildness – or at least our idea of wildness. It means consciously admitting that we live on a managed planet" (Goodell, 2010: 45). For Keith, managing the skies is tantamount to managing the planet as a whole since the climate is a key determinant of the fate of everything from rocks to rivers, to polar bears, people, and larval hatches. As someone with a long personal history of time spent in the Arctic, Keith fears the change that geoengineering would create. The Arctic would become "a museum piece, a place for the elites to go someday and remember what the real Arctic used to be like" (ibid.). Keith goes on to say that humanity would henceforth need to acknowledge that they were living in a zoo, playing the role simultaneously of the animals and the zookeepers.

Keith sees grave danger in extending human management in this fashion. Goodell interprets Keith as mainly being worried about the psychological impact of a constructed climate. Geoengineering would sever "that primal link with nature that has

shaped human evolution" (Goodell, 2010: 45-6). On this view, our original connection to nature – one of an evolved organism progressively learning how to cope with the vicissitudes of an unpredictable and often challenging environment – is a connection with great psychological and philosophical import. It has served to establish our place in the natural order, a place that has allowed humans to explore their unique abilities and to learn how to prosper. This original connection is one against which the whole of human history has been crafted and within which humans have striven to find meaning in their lives. The proposal to sever that connection with geoengineering would create what environmental writer Jason Mark has called an "existential anxiety" (Mark, 2009).

Despite the fact that Keith talks about the end "wildness" and not "nature," his worries clearly resonate with Bill McKibben's twenty year old discussion of anthropogenic climate change in The End of Nature.[15] In that widely read book, McKibben argued that it is not just species but also ideas that can go extinct. In this case, he suggested, it is the idea of nature untouched by human hand that is rendered extinct by anthropogenic climate change. In a warming world, said McKibben, "…each cubic yard of air, each square foot of soil, is stamped indelibly with our crude imprint, our X (McKibben, 1989: 96)." The loss of nature – land McKibben characterized in a sentence very reminiscent of Keith's as, "the separate and wild province, the world apart from man to which he adapted and under whose rules he was born and died" (McKibben, 1989: 48) – generates a crisis of self-understanding. With anthropogenic climate change, McKibben suggested, "the *meaning* of the wind, the sun, the rain – nature – has already changed" (ibid.).

Keith's and McKibben's worries are clearly related, but they differ in at least one significant respect. McKibben's End of Nature alerted readers to a change that was wholly unintentional. In the year McKibben's book was published, the idea of *deliberately* engineering a cooler climate had hardly been broached. Unintended anthropogenic climate change at the hands of greenhouse gases was the only game in town.[16] Since a geoengineered climate of the future would, in contrast, be intentionally manufactured, it would create a different type of change in meaning than the change created by unintentional anthropogenic climate change. There is every reason to think that this change in understanding would be even greater than the change caused by inadvertent warming. The reason for this greater change lies in the concept of *artificity*.

In her book *The Natural and the Artifactual*, Keekok Lee offered an extended discussion of the impact of biotechnology and nanotechnology on our basic understanding of nature. Lee put the whole focus of her argument on the negative disposition of environmentalists towards artificity. She contrasted the natural and the artifactual using distinctions first articulated by Aristotle:

> "'[T]he natural … refers to whatever exists which is not the result of deliberate human intervention, design, and creation in terms of its material efficient, formal, and final causes … The natural comes into existence, continues to exist, and goes out of existence entirely independent of human volition …[B]y contrast, 'the artifactual' embodies a human intentional structure" (Lee 1999, 82).[17]

To put Keith's point in Lee's/Aristotle's terms, a geoengineered climate, in contrast to one affected merely by unintentional anthropogenic climate change, would contain

human intentional structure. It would be an artifact in a way that an unintentionally altered climate could never be. While humans certainly still bear responsibility for an accidentally altered climate, they assume a much more pro-active responsibility for a climate they alter deliberately.

If geoengineering were implemented, humanity would from that moment onwards live within a climate of their own design. At the same time, they would assume primary responsibility for making that climate hospitable. As a result, rather than viewing our surroundings as a deep source of meaning, suggests Jason Mark, we might start to view them as a constant, potential threat (Mark 2009). The climate would require careful and continuous management to maintain the delicate balance of solar radiation, greenhouse gases, and cloud cover needed to keep us safe. The skies themselves, a sacred space previously thought to be the "domain of the Gods" (Donner, 2007), would have become simply another human artifact. The behavior and, ultimately, the meaning of everything subject to their influence would shift, becoming less natural and more a product of human works.[18]

Environmental Ethics and Managed Skies

Both Keith's and McKibben's laments appear, in essence, to be laments about loss. They both worry that something previously cherished – valued for being outside the human sphere – would be lost. Lee called this phenomenon (in somewhat technical language) "ontological impoverishment," the elimination of a category of thing that previously held significance (Lee, 1999: 119). The application of certain types of technology, even when embarked upon with the best intentions, can come with this

deeper cost. Not just a superficial impact such as when air and water pollution sully the surface, but a deeper impact that reaches all the way down to the very meaning of the natural.

In the face of these worries about loss, it is tempting to reply that all this might simply be an unhelpful wistfulness, a mourning for Arcadia. Perhaps McKibben and Keith (and Lee) should simply "get over it" and get used to living under managed skies. After all, one might argue (as many have done in the wilderness debates[19]) that the idea of living in "virgin" or "pristine" nature is mostly a fantasy anyway. Humans have been influencing and managing various portions of the earth for millennia. Most Europeans have been living on largely managed landscapes for centuries and even McKibben admits that humans have been living in an altered climate since they first started pumping large quantities of greenhouse gases into the atmosphere during the industrial revolution. The idea of completely untouched nature has receded far into historical memory throughout most of Europe. Perhaps a geoengineered Earth is little more than a grander version of the European experience that simply needs to be accepted as the new normal.

To counter the "get over it" reaction, one needs to find an argument that managing nature on such a grand scale is wrong in itself. To put this another way, one needs a strong argument that an artifactual climate is inherently wrong and should not simply be "got over." Dale Jamieson, in one of the first articles on the ethics of what he called "intentional climate change," at one point gestured towards such an argument. In the final of his three ethical considerations relevant to geoengineering, Jamieson cited the worry that "modern societies have erred on the side of excessive intervention" (Jamieson, 1996: 331). He continued by calling intentional climate change a "very grand gesture"

that takes us in the opposite direction of "learning to live with nature." In an era when environmentalists have sought a relationship that interferes progressively less with the natural world, Jamieson suggested that intentional climate change has the effect of "reinforcing human arrogance and the view that the proper human relationship to nature is one of domination" (ibid., 332). While Jamieson did not delve deeply into it in his own paper, the arrogance he gestured towards fit with what he earlier called a "common sense" presumption that "it is wrong to interfere dramatically with fundamental natural processes" (ibid., 325).

Whether one chooses to find fault in the demonstration of a human vice or in the interference with natural processes itself, are there grounds suspect that climate engineering might in itself be a particularly egregious action from the perspective of environmental ethics? It is clear that humans manage nature in countless ways every day, from diverting water, to planting crops, to harnessing solar radiation, and building homes. So if one scales up these local management practices to management of the climate itself, has one crossed a new moral line?

The suggestion that management of nature on such a grand scale is wrong arguably lies close to the core of numerous positions in environmental ethics. It is hard to imagine almost any of the familiar positions in environmental ethics endorsing the alteration of earth's *fundamental* biogeochemical systems. While most environmentalists acknowledge the necessity of managing some portion of the earth in order for humans to survive at all, the emphasis has usually been on keeping that management minimized. In the earliest work in modern environmental ethics, heavy-handed management was the subject of criticism by Aldo Leopold. His request for "gentler criteria" when

"remodeling the Alhambra with a steam shovel" exhibited this sentiment (Leopold, 1970: 226), as did Lynn White's rejection of the "dogma of man's transcendence and rightful mastery over nature" in his critique of Christian attitudes towards the environment (White, 1967: 1206). In a 1973 article, which some think set out the criteria for an ethic being truly environmental, Richard Routley stated that policies of "complete interference" are wrong since they fail to acknowledge that "some worthwhile parts of earth's surface should be preserved from substantial human interference, whether of the 'improving' sort or not" (Routley, 1973: 205). Tom Regan, also seeking to define the parameters of a genuinely environmental ethic, advocated a "preservation principle" which cashed out as "a principle of nondestruction, noninterference, and, generally nonmeddling" with nature (Regan, 1981: 32). Similarly, Paul Taylor articulated a *prima facie* duty of non-interference which stated "we must not try to manipulate, control, modify, or 'manage' natural systems or otherwise intervene in their normal functioning" (Taylor, 1986: 175). All of these sentiments suggested that the management of nature on a grand scale is wrong. Assuming that management of the climate amounts to management of nature on a grand scale, then geoengineering must run counter to a basic environmental intuition.

Many of the philosophers just mentioned end up subscribing to non-anthropocentric positions in environmental ethics. Since non-anthropocentrists generally believe that there is moral significance to the earth independent of human interests, it is perhaps not surprising that they all lean towards some version of a principle of non-interference. However, the same leanings are also widespread within anthropocentric positions in environmental ethics. Eugene Hargrove, for example, promoting his own

"weak anthropocentric" argument to preserve natural beauty, states that this duty "does not make sense if it calls for human involvement in the creative process of nonhuman nature" (Hargrove, 1996: 195). He further claims that our duty is to promote natural beauty "through action and inaction that does not restrict, impinge on, redirect, or bring to an end the geological and biological activity on which the indifference of natural creativity depends" (ibid.). Earth's basic geological and biological processes must be left alone, Hargrove thinks, to continue creating the forms that humans find beautiful.

Another well-known anthropocentric environmental ethicist, Bryan Norton, argues for the maintenance of desirable options within human culture but adds that "…culture can be perpetuated only if it respects limits inherent in the land context" (Norton, 1994: 219). All human activity, in other words, takes place within basic biological limits that humans must learn to understand and live within. Endorsing Aldo Leopold for his principles of environmental management, Norton suggests that Leopold knew that "management for human welfare must be limited and that the limits must be scientifically determined through careful observation and controlled studies whenever possible" (ibid., 53). The environmental position with which Norton ends his book on the preservation of natural variety rests on the view that "...it is bad to thwart…natural processes, to interrupt well established patterns, to introduce irreversible changes" (Norton, 1992: 207). For both Hargove and Norton, earth possesses some fundamental biogeochemical parameters within which all human interests must be pursued.

While these few selected quotes are not intended to form a watertight case, they do indicate the entirely unsurprising position that both anthropocentric and non-anthropocentric environmental ethicists have generally advocated finding ways to live

within the limits that the earth presents. In a paper that investigates the moral significance of a different emerging technology, synthetic biology, Christopher Preston suggested that one only has to look at the numbers to find the source of this environmental intuition.

> "Nature unmodified by human intention may be increasingly hard to find today but, as a matter of historical fact, there were close to 4.6 billion years of geological history on Earth that preceded the arrival of our first, artifact-creating ancestor, *Homo habilis*, approximately 2 million years ago. During these 4.598 billion years of earth's history there were independent processes at work ultimately responsible for creating everything environmentalists find of value today" (Preston, 2008: 27).

This long stretch of geological and evolutionary processes occurring independently of human interference serves, Preston thinks, to anchor a central environmental intuition.

This intuition about the moral significance of earth's history independent of human interference is supported in numerous places in the environmental ethics literature. Part of the reason we protect wildlands, claims Holmes Rolston, III, is that they provide "the profoundest historical museum of all, a relic of the way the world was during 99.9% of past time" (Rolston, 1988: 14). Having a connection with this history is deemed important. Robert Elliot, arguing for why restored ecosystems can never have as much value as naturally occurring ecosystems suggests that causal continuity with the historical evolutionary past counts for something. The value of places such as Hetch

Hetchy to John Muir, claims Elliot, lay in the fact that they were "…part[s] of the world that had not been shaped by human hand" (Elliot, 1982: 90)." It is their relationship to processes with their origin deep in earth's history that confers significance upon them. Eugene Hargrove points out in a similar vein that "when we interfere with nature, regardless of whether our intentions are good or not, we create a break in [that] natural history" (Hargrove, 1996: 195). Clearly, not everything an environmentalist values has to be more than two million years old. However, this relationship to ancient processes appears to be of central significance.

In all of these cases, the presumption is that the human-intentional processes need to be circumscribed in such a way that the human-independent processes are left intact.[20] This position is arguably central to a good deal of environmental ethics. If it is human-independent processes that environmentalists generally value, then geoengineering will obviously be a cause for concern. Deliberately altering the climate creates artificial conditions – in the Aristotelian sense of conditions that embody human intention – under which all of earth's biological processes must operate. The moral significance of earth's history independent of humans suggests that this is a *prima facie* reason, or a presumptive argument, for opposing many geoengineering projects. Growing environmental opposition to geoengineering, such as the opposition found in the Hands off Mother Earth (H.O.M.E) movement, likely rests in something close to this rationale.[21] The presumptive deontological argument is bolstered by environmental ethicists' recognition of the extraordinary complexity of earth's ecological system and their suspicion of scientists' ability to manage it.[22] With this additional prudential argument in mind, one could probably take the presumptive argument further and suggest that, for many in

western environmental ethicists, the prospect of geoengineering the climate qualifies for the category of what Stephen Gardiner (citing Bernard Williams) has called "the unthinkable," action that is dishonorable or morally absurd to even think about (Gardiner, 2010: 299). Henceforth it will be assumed that there is a "presumptive argument" against geoengineering in environmental ethics.

Two Responses to the Presumptive Argument

It should be entirely unsurprising that the leading positions in environmental ethics appear to oppose geoengineering. If climate change shows that humans have failed to live within Earth's fundamental limits and if environmentalists typically find humans culpable for that failure, then geoengineering hardly demonstrates a break with the past. As Audre Lourde pointedly put it in another context, "the master's tools will never dismantle the master's house" (Lourde, 1984).[23] Environmentalism for the last 40 years has maintained as one of its key tenets the idea that humans must change their ways and learn to live within the ecological parameters presented to them. In contrast, geoengineering the climate is a way to change earth's parameters so that humans do not need to change their own ways.[24] All other things being equal, it seems highly unlikely that environmental ethicists of any stripe could approve.[25]

If geoengineering runs so contrary to the basic tenets of many positions in environmental ethics, then the fact that geoengineering has so rapidly become a topic of serious policy consideration should bring many environmental ethicists pause. The recent rush of climate policy in the direction of geoengineering suggests that the presumptive argument in environmental ethics must either be, 1) so far off the

mainstream that it can be safely ignored, 2) relatively unknown, or 3) defeasible in part, under the right circumstances. Option 1 is obviously unpalatable to those in the environmental ethics community. Forty years after the first Earth Day, option 2 is simply implausible. Nor does it seem adequate for environmental ethicists to simply shout more loudly the reasons why they oppose geoengineering on principle. A better strategy might be to focus on the third alternative and explain why the basic environmental intuition may be partially defeasible under circumstances in which all other things are no longer equal.[26] Doing so would at least allow environmental ethicists to be active participants in the discussion of the social, ethical, and legal issues that the Royal Society identified as being the most urgent. Participating in these discussions may also provide environmental ethicists with the opportunity to explain why some types of geoengineering should not happen at any cost.

In what remains of this paper, two possible rationales enabling environmental ethicists to maintain the presumptive argument but accept a partial defeasibility condition will be briefly offered. One rationale suggests that geoengineering may, under the right circumstances, be justified as the lesser of two evils. The other suggests that, even within environmental ethics, the idea that humans can take urgent steps to protect their vital interests is already accepted. These two rationales are not entirely separable from each other (the lesser evil argument may come into play exactly when large numbers of human lives are at stake), but they warrant separate consideration due to the different ways they bear on existing literature in environmental ethics. The discussion below is not

intended to be complete, but it is intended highlight potential trade-offs between the value of fundamental natural processes and the value of human lives.

a) The Lesser of Two Evils

The only work published by an environmental ethicist entirely on geoengineering since Dale Jamieson's 1996 paper is Stephen Gardiner's essay investigating the claim that geoengineering is "the lesser of two evils" (Gardiner, 2010). The framing of the case for geoengineering as the lesser of two evils – or the "option of last resort" – has been widespread since Nobel Laureate Paul Crutzen gave climate engineering new legitimacy with his paper in *Climatic Change* in 2006. Few of those who advocate for geoengineering would confess to liking the idea of geoengineering for its own sake. Those who favor it tend to cast it as an emergency measure in a bad situation. Before discussing the benefits of albedo enhancement, Crutzen was careful to state unequivocally in his paper that "[b]y far the preferred way to resolve the policy makers' dilemma is to lower the emissions of the greenhouse gases" (Crutzen, 2006: 211). A major report by the Council on Foreign relations displays similar thinking in its title: "The Geoengineering Option: A Last Resort Against Global Warming" (Victor *et al.*, 2009). Even Samuel Thernstrom, a proponent of increased geoengineering research based at the politically conservative American Enterprise Institute acknowledges that "…[y]ou'd have to be crazy to consider this a first, best option."[27] But as a last option before an impending crisis, it is argued that geoengineering may indeed be the lesser of two evils. Editors of the Royal Society special issue on geoengineering, Launder and Thomson, offer a version of the lesser evil argument when they write "…[w]hile such

geoscale interventions may be risky, the time may well come when they are accepted as less risky than doing nothing" (Launder and Thompson, 2010: xv). In the more near term, it is argued that commencing serious geoengineering research now is the only way to "arm the future" should the decision to pull the trigger on geoengineering eventually need to be made.

Gardiner's paper has a fairly narrow goal. It is not intended to argue for or against the decision to deploy any particular geoengineering scheme. Nor does it take a position on geoengineering in general. The purpose is to look at the moral context in which the decision to undertake serious geoengineering research takes place today. Pronouncing geoengineering the lesser of two evils in advance and then initiating research today, he claims, demonstrates a peculiarly culpable form of bad faith.

To make the case, Gardiner borrows and extends some of the arguments from his seminal "Perfect Moral Storm" paper on climate change (Gardiner, 2006). In this earlier paper, Gardiner convincingly showed that the perfect storm of climate change encourages moral corruption in the present generation. Even when we are willing to acknowledge that anthopogenic climate change is a problem, its intergenerational nature, the geographically dispersed nature of its agents and its effects, and the lack of theoretical and institutional resources to address the problem make it tempting to defer action, to seek out uncertainty in the science, and to avoid what would otherwise be seen as manifest moral obligations. Climate change, he argued, is the type of problem that "provides each generation with the cover under which it can seem to be taking the problem

seriously…when really it is simply exploiting its temporal position," a position that allows it to evade responsibility for taking the actions it knows it should take (Gardiner, 2006: 408).

Gardiner compellingly argues in his paper on geoengineering that the language of "lesser evils" or "last resort" skews the debate and opens the door to a continuation of the same moral corruption that has plagued climate change policy to date. The decision to initiate geoengineering research is portrayed by its backers as one that demonstrates the "heroic seriousness" of someone investing resources towards solving a worrying problem. Gardiner argues at length that, given the political inertia known to govern climate policy as a whole, initiating research on geoengineering in fact serves as a mask for a number of vices. These vices include moral corruption, laziness, and buck-passing, as well as knowingly putting the future generation that would actually initiate geoengineering in an untenable position. The decision to pursue research in geoengineering shows that we have

> "failed to take on the challenge facing us, and instead have succumbed to moral corruption. Indeed, the decision to geoengineer might reveal just how far we are prepared to go to avoid confronting climate change directly, and this may constitute a tarnishing, even blighting, evil" (Gardiner, 2010: 304).

For the lesser evil rationale for geoengineering to be sustained, Gardiner's claims about moral corruption need not be proven wrong, but they must be shown to be surmountable.

As a first response, one might grant everything that Gardiner has said about the decision to engage in geoengineering research demonstrating moral corruption and comprising a tarnishing evil. At the same time one could still insist through a weighing of costs and benefits that this tarnishing evil may not be as bad as the evil of subjecting millions of people to increased drought, disease, and food shortages caused by unabated anthropogenic climate change. Admittedly, this would be an almost impossibly complicated cost-benefit analysis to perform. An accounting that was global in scale, intergenerational in nature, projecting many centuries into the future, and ranging across both human *and* environmental goods would present almost insurmountable practical problems. However, there is nothing theoretically at odds with the idea that geoengineering would, at the end of the day, remain the lesser evil.[28] One could agree that Gardiner's paper is successful at inching the burden of proof back towards the would-be geoengineer, but still insist that climate engineering may at the end of the day prove to be the lesser of two evils.

There is a second aspect of Gardiner's observations about the lesser evil rhetoric that warrants critical scrutiny. This is the question of whether he slightly misrepresents the context in which the proposal to pursue geoengineering research is usually offered. The body of his paper includes five main arguments why the lesser of two evils rationale is problematic. In "Which Nightmare?" (1) Gardiner suggests that policy-makers do the world a disservice by preparing for a contentiously constructed choice that might be avoidable if different decisions were made today. In "Other Options" (2) he suggests that 'geoengineering or

climate catastrophe' is a false dichotomy. In "Other Liabilities" (3) he suggests that we might owe the future something better than merely a technological way out of a problem that could probably be fixed in different ways. "Fatal Silence" (4) suggests that the failure of would-be geoengineers to address the political challenges already known to be present in climate debates means that any decision to geoengineer is "likely to be illegitimate" (Gardiner, 2010: 294). Finally, "Lingering Inertia" (5) suggests there is moral corruption involved in refusing to discuss anything beyond modest investment in research (including, most notably, a huge and immediate Manhattan project in geoengineering research or substantial deposits today in a climate refugee fund).

While space considerations make it impossible to pick apart the many layers of Gardiner's five arguments here, it is worth noting that four of these five (1,2,3, and 5) to some extent involve the assumption that the option under consideration today is "modest geoengineering research only."[29] The moral corruption that Gardiner is primarily concerned about is most manifest when all we do to prepare for climate change is to "spend a few million dollars on research our generation will probably not have to bear the risks of implementing" (Gardiner, 2010: 295). Our ducking of responsibility is at its most egregious when we do nothing but a bit of research relevant to some future person's dilemma. But is "modest geoengineering research only" really the proposal that is on the table?

While there is no question that we are currently failing to pursue the non-modest path that might free us from Gardiner's accusation of moral corruption, there exist at least two considerations to suggest that geoengineering supporters may not be quite as

culpable as he suggests. The first is that very few advocates of geoengineering research have posed it as a stand-alone strategy for addressing the challenge of climate change. The Royal Society Report includes up front as a key recommendation that "[g]eoengineering methods of both types [SRM and CDR] should only be considered as part of a wider package of options for addressing climate change" (Royal Society, 2009: x).[30] At the same time as affirming the "essential" nature of "further research" on geoengineering, the statement of the scientific organizing committee at the March 2010 Asilomar Conference on Climate Intervention Technologies made it clear that "a strong commitment to mitigation of greenhouse gas emissions, adaptation to unavoidable climate change, and development of low-carbon energy sources" remained necessary (Asilomar 2010). Even the most enthusiastic geoengineering scientists appear understand that it is not just the science that needs researching. The political and ethical issues raised by the technology are mentioned throughout the literature, by scientists as well as policy experts. Furthermore, investigation of both the policy challenges and the ethical questions is already being funded and pursued at a national level.[31] Climate policy, both inside and outside of the geoengineering community, already appears to be much broader than Gardiner's "modest geoengineering research only" characterization suggests.[32]

The second consideration is that it is no longer plausible to think that geoengineering advocates propose research only for the benefit of future generations. The bad faith Gardiner identifies is displayed most prominently when the "lesser evil" strategy is an excuse for passing the buck. But those researching geoengineering today appear not to be looking to pass the buck, but to pursue geoengineering as one of a suite of possible responses to today's climate crisis. It is becoming increasingly likely that

there is not enough time left in which the buck might be passed.[33] If climate response strategies are looking increasingly to the near term and if they already include mitigation, adaptation, and compensation components, then Gardiner's arguments lose considerable power.[34] While research on climate engineering technology certainly has the potential to divert attention from necessary action on other fronts today (part of what is known as "the moral hazard" of geoengineering), very few advocates of the technology are suggesting those other fronts can be safely ignored. While there is no doubt the current responses to greenhouse gas emissions are inadequate, it is clear that the more broad and the more aggressive are the climate strategies today, then less vulnerable to the accusation of moral corruption we become.

A final comment about Gardiner's challenge to the lesser evil argument concerns his discussion of "marring evils" and individuals (or collectives) that are "tarnished" or "blighted" by their performance of them. A "marring evil" in Gardiner's technical sense is an evil that results in "a negative moral evaluation of an agent's action…that is licensed when the agent (justifiably) chooses the lesser evil in a morally tragic situation, and which results in a serious negative moral evaluation of that agent's life considered as a whole" (Gardiner, 2010: 301). If the negative evaluation is irredeemable, Gardiner calls it a "blighting" evil. This part of the discussion is designed to illustrate how, even if climate engineering were the lesser of two evils, it still might be something that comes with a very high, and perhaps unacceptable, moral price. He suggests that, not only might the deployment of geoengineering be a blighting evil, so might be merely *the pursuit of research* that, by detracting from the job at hand, ultimately has the effect of pushing a future generation in the direction of geoengineering.

To support this position, Gardiner draws on arguments similar to Jamieson's to complain about the "hubris," "recklessness," and "obstinate resistance to look at the central problem" of the kind of people who might knowingly go down this path. With geoengineering we "cross a new threshold on the spectrum of environmental recklessness" demonstrating "continued" and "deepening" failure (ibid., 303). The decision to pursue geoengineering may blight humanity for ever.

While there is no doubt that the decision to pursue geoengineering does indeed reflect a moral failure on climate change, a plausible response to this argument can begin by considering the use of the word "continued." Gardiner acknowledges that pursuing geoengineering is a sign that "…we, as a species, have failed to meet a basic challenge and should be saddened or ashamed for that reason" (ibid., 304). It needs to be noted that this shame and whatever blighting accompanies it results from our *existing* failure to address greenhouse gas emissions despite full awareness of the path down which this was taking us. Gardiner reveals that he concurs with the basic environmental intuition described above (pps. 16-19) when he states "…[a] basic question that faces us as humans, then, is whether, amidst all this, we can meet the challenge of adapting to the planet on which we live" (ibid.). Our failure to address greenhouse gas emissions means that the answer to this question is already clear and the blighting has already occurred even before geoengineering is considered. Any discussion of the tarnishing or blighting that might result from the decision to geoengineer may be moot. The moral damage has already been done.

Clearly the fact that we are already blighted does not provide free reign to compound our moral condition by performing additional evils. However, if

geoengineering is researched as a positive agenda, with the intention to lessen human suffering, to protect non-human species, and to preserve environmental values, then it is not clear that geoengineering necessarily adds to the blight. Rather, it could be a serious attempt to make amends. Some might even view climate engineering as an admirable attempt at ecological restoration, providing a possible argument from environmental ethics in favor of geoengineering, despite the presumptive argument against it.[35] As Gardiner capably demonstrates, the context of the argument is what matters.

In sum, then, one might find Gardiner's paper to be wholly successful at illustrating how lesser evil arguments can be "dangerously shallow," "opaque," and a cover for continued "moral corruption." However, it might still be the case that, under the right circumstances, geoengineering remains the lesser evil. Gardiner's arguments against this rationale cannot be ignored but they can be blunted. Gardiner knows this and acknowledges as much. He states that it is not possible to conclude from his arguments that "…no lesser evil argument for research on, or deployment of, geoengineering can ever succeed" (ibid., 305). He also acknowledges that arguments similar to the ones above may be available to counter his paper. At the very least, it remains an open question as to whether geoengineering should be pursued despite the further tarnish it might add our lives. To think about why this might be so, it helps to consider a second line of thinking that adds weight to the defeasibility argument.

b) Prioritizing human well-being.

A second way to probe the presumptive argument against geoengineering is suggested by the following counterfactual thought experiment.[36] While this

thought experiment takes us some distance from the anthropogenic warming scenario and eliminates Gardiner's primary concerns about moral corruption, it is useful for thinking about how the human role in nature presumed by many environmentalists might shift under the right circumstances.

> *If it were the case that humans had not released large quantities of greenhouse gases into the atmosphere and that the world was warming naturally at the same dangerous rate that it is now warming due to anthropogenic greenhouse gases, would the environmentalist presumption against geoengineering be enough to preclude taking measures to keep the planet livable?*

It is far from clear that an environmentalist could maintain their opposition to geoengineering under these circumstances. It appears unlikely that humans would – or should – sit back and watch the disruption and suffering caused by rapid natural warming on the basis of any presumptive argument against climate engineering from environmental ethics. When you add the environmental values that would also be at stake in this situation, it seems probable that the presumptive argument would become defeasible.[37] If the alternative were to watch all the prospective disvalues associated with runaway climate change unfold before one's eyes, including drought, starvation, disease, forced migration, and international conflict – to say nothing of the effects on

existing wildlife species – it is reasonable to assume that humans ought to attempt to engineer an alternative.

The evidence for this intuition in favor of geoengineering comes from the existing response of the environmental ethics community to the possibility of ecofascism. To refuse to engineer an alternative to rapid warming, would be in effect to embrace ecofascism by omission rather than by act. It would be ecofascism because the preservation of systemic processes and values would trump human lives. In this case, it would involve knowingly letting people die – and perhaps even letting the human species disappear[38] – in order to ensure that earth's fundamental systems remained unperturbed. Even if it is maintained that there is a moral difference between acting and omitting to act – a position that has its own philosophical challenges[39] – the omission here would come with considerable culpability. It would be to value the integrity of the existing system over the lives of millions of humans.

If this is ecofascism by omission, then the reaction against ecofascism in the environmental literature has been vigorous enough to suggest that even those who shared the presumptive environmental intuition would baulk. Outside some of the misanthropic ideas advocated in the *Earth First! Journal* in the nineteen-eighties, there has been very little in the environmental ethics literature that argues in favor of letting people die in order to protect environmental values. The closest environmental ethics has come outside of marginal elements of the deep ecology movement to this position is Holmes Rolston, III's suggestion that there are certain tightly circumscribed occasions when one should save nature rather

than save people (Rolston, 1996). The rapid negative reaction to Rolston's piece by (amongst others) Robin Attfield (1998), Anthony Brennan (1998), Ben Minteer (1998), Alan Carter (2004), and Victoria Davion (2007) suggests that Rolston's views lie well outside of the mainstream. In other writing, Rolston has insisted (more in line with his critics' views) that the emergence of culture out of nature marks a fundamental break from natural processes. As a result of this break, Rolston suggests that humans have a strong obligation to lessen human suffering. "Different rules do apply to persons," he states, "…and even to persons in exchange with nature" (Rolston, 1988: 82). This is why humans (for the most part) don't sit back and watch each other die from curable bacterial infections and drown in annual floods. They try to do something about it. The significant obligations we have to other humans suggest that even those who value the natural processes that have characterized earth's history thus far would be prepared to interfere with these processes if enough human lives and human suffering were at stake.

If this intuition about the defeasibility of the presumptive argument from environmental ethics is correct, then one obvious implication is that, in these extreme circumstances, the anthropocentric position in environmental ethics appears to have won out over the non-anthropocentric one. The values embodied in earth's basic biogeochemical systems are not so high that they trump human interests in this tightly circumscribed scenario. Alligators would not be allowed to reappear in Greenland if the consequences included an extinct, or a dramatically reduced, human population. When the human values at stake are no

longer trivial ones but vital interests affecting the whole of the human population, the terrain of the debate has shifted.

It should also be noted that the anthropocentric/ non-anthropocentric debate has lost some of its clarity at this point. Many of the environmental values cherished by non-anthropocentrists – polar bears, glaciers, migratory songbirds – would also be at risk under extreme warming. In a rapidly changing climate, human interests *and* wildlife interests would be pitched against the value of the fundamental climatic processes. Only the most extreme of environmental positions would advocate for great harm to people *and* the extinction of many species in order to protect earth's fundamental biogeochemical processes. It seems more likely that an environmental intuition towards saving species would align with the humanistic intuition towards saving persons. As mentioned above, a more positive, competing narrative about climate engineering might then emerge as geoengineering started to be viewed as an act of ecological restoration rather than reckless, environmental meddling.[40]

Conclusion

The two arguments above are designed to illustrate ways that the presumptive argument against geoengineering from environmental ethics may be defeasible under the right circumstances. Even though there is a grave risk of moral corruption when advocating geoengineering, it remains theoretically possible that climate engineering might, under the right circumstances, be the lesser of two evils. The right circumstances are those in which severe warming poses a devastating threat – perhaps including the

threat of extinction – to the human population and to familiar environmental values. It may then be appropriate to proceed with geoengineering.

Even if the presumptive argument is defeasible, something that should not be lost in this discussion is that the presumptive argument must be accorded the weight that forty years of environmental ethics provides it. The circumstances must be conclusively shown to be appropriate for the presumption to be waived. There is clearly plenty of room for moral corruption in the way that a lesser evil argument gets presented. As Gardiner pointed out, advocates of any necessary evil strategy always have an interest in dramatizing the current situation. "Part of the point of claiming that one is in morally exceptional circumstances," he says, "is in order to secure an exemption from the usual norms and constraints of morality…morality sometimes seems inconvenient to us" (Gardiner, 2010: 291). There is no doubt that Gardiner's arguments need to be heeded, especially given the track record on climate change and the moral corruption that has already been displayed.

However, a second important conclusion to draw from the discussion in this paper is that, tempting as it is, environmental ethicists need to do more than simply insist upon their presumptive rejection of geoengineering *tout court*. There are pragmatic reasons for this, including the fact that important ethical discussions about geoengineering are already taking place that environmental ethicists need to join. Being party to these discussions will allow environmental ethicists to have some influence on policy that is already being formed. As David Victor points out, making geoengineering taboo in precisely those countries where open, sophisticated, and transparent discussion and

research is most likely to occur risks leaving geoengineering research to only those countries where it is not (Victor, 2008).

In addition to these pragmatic reasons, there are also theoretical reasons. The presumptive argument has limits to its usefulness, limits that we may be fast approaching. Climate change and the possibility of geoengineering not only forces environmental ethicists to confront questions of the relative value of human interests against those of nature. It also forces them to confront questions concerning the value of existing wildlife species as they stack up against the value of the fundamental processes responsible for creating them. How important is the integrity of fundamental processes relative to the value of species under threat? If the limits to the presumptive argument are indeed approaching, this may not only say something about the necessity of changing some initial reactions to geoengineering. It may also say something about the necessity of scrutinizing certain fundamental assumptions in environmental ethics itself.

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[1] For the purposes of this paper, the terms "climate engineering" and "geoengineering" will be used interchangeably.

[2] Geo-Engineering Climate Change: Environmental Necessity or Pandora's Box? by J. Michael T. Thompson and Brian Launder (Jan 2010: Cambridge University), How to Cool the Planet by Jeff Goodell (April 2010: Houghton Mifflin), Hack the Planet: Science's Best Hope – or Worst Nightmare – for Averting Climate Catastrophe by Eli Kintisch (April 2010: Wiley), Fixing the Sky: The Checkered History of Weather and Climate Control by James Roger Fleming (Aug 2010: Columbia University). See also

meetings and discussions by the Royal Society, the US House Science and Technology Committee, the Asilomar International Conference on Climate Intervention Technologies, the UK's Natural Environment Research Council's study, the US's National Commission on Energy Policy Task Force on Geoengineering, the New America Foundation Conference, and the University of Montana Workshop on the Ethics of Solar Radiation Management.

[3] For example, models suggest that the deployment of stratospheric aerosols might cool the poles but disrupt monsoon patterns in Asia and Africa. This could lead to devastating crop failures in the populations that are least prepared to handle it. Robock A, Oman L & Stenchikov GL (2008). "Regional climate responses to geoengineering with tropical and Arctic SO2 injections." *Journal of Geophysical Research* 113, D16101. doi: 10.1029/2008JD010050. For a discussion of the potential tensions, see Stephen Schneider, "Geoengineering: Could We Or Should We Make It Work?" *Philosophical Transactions of the Royal Society* A 366 (2008):3843-3862, 3857.

[4] Keith (2000) notes that in earlier times, geoengineering the climate was discussed in both the US and the USSR as a means of enhancing the development potential of cool or arid regions, as a potential weapon of war, and even as a method of terraforming other planets. See also Fleming, *Fixing the Sky* (2010).

[5] Articles by experts on the most prominent geoengineering proposals can be found in a special issue of a journal by The Royal Society (2008) (reprinted as Launder and Thompson (2010)). A general overview and evaluation of different schemes also appears in The Royal Society (2009).

[6] To really sequester the carbon, steps would need to be taken to ensure that the carbon taken up by the trees was not released straight back into the atmosphere when the trees died and decomposed.

[7] See the critical discussion of these schemes in The Royal Society (2009).

[8] According to Schneider's definition, the large-scale, inadvertent addition of carbon dioxide to the atmosphere since the industrial revolution counts as its own (unintentional) geoengineering project.

[9] On 9th December 2009, US EPA administrator Lisa P. Jackson announced that the EPA would henceforth regulate CO_2 (and five other greenhouse gases) under the Clean Air Act as pollutants harmful to human health.

[10] For a description of how these events unfolded, see Kintisch (2010), chapter 8.

[11] Even if the whitening of urban surfaces were scaled up to its limit, the amount of Earth's surface covered with roofs is tiny compared to the amount covered by relatively dark oceans and forest. For this reason, while it is a good energy conservation measure, it is not generally thought to be an effective geoengineering scheme (Royal Society, 2009). Some have suggested that these albedo-enhancement efforts could become more effective if biotechnology was used to develop paler colored crops and forests.

[12] The pluses and minuses of SRM and CDR are documented in the Royal Society report of 2009. Additional pluses and minuses of stratospheric aerosols are documented in Robock *et al*., 2009. See also G. Bala, 2009.

[13] An additional (if surprising) benefit of a stratospheric haze is that it increases the amount of diffuse sunlight reaching earth's surface leading to an increase in the productivity of plant life . Mercado, L. M., et al**.** (2009), and Gu, L.D., *et al*., 2002.

[14] Other ethical considerations might also warrant discussion. For example, stratospheric aerosols would likely reduce the effectiveness of photovoltaic panels. They would also create a visually appreciable whitening of the sky. The deployment of reflective mirrors in space would introduce an additional form of space junk. Hundreds of thousands of artificial trees would presumably have an aesthetically negative impact across the landscape.

[15] Bill McKibben (1989). Keith's mention of 'wildness,' 'museum pieces,' a 'managed planet,' and the 'elites' also sounds like the complaints made by Tom Birch and Jack Turner about what the latter calls "Wilderness-Act wilderness," land governed according to certain strictures of law to maintain characteristics deemed important by humans. Wilderness-Act wilderness is managed land and, as such, according to Turner, has already lost the very essence of what made it special. Turner calls such land "a caricature of its former self" (Jack Turner, 1996: 27). Birch similarly complains of the attempt to turn wild lands into something "objectified into [a] human resource…and allocated by law to specific uses" (Birch, 1990: 8). Both Birch and Turner are troubled by the attempt to turn wild areas into something tailored to human desires. Keith thinks a geoengineered Arctic is similarly diminished in important ways, in this case managed not just legally but also climatically. The wider context of Keith's remarks, however, reveal that

he thinks the problem of climate engineering goes deeper than the question of how one particular piece of wild land gets managed. It reaches down to the very concept of nature itself.

[16] Even though there had been plenty of discussion of weather modification techniques prior to 1989 (See Fleming (2010) and Keith (2000) for a discussion), only a few articles specifically discussing geoengineering to combat anthropogenic climate change had been published. See Kellogg, W. W. & Schneider, S. H. (1974) and Schneider, S. H. & Mesirow, L. E., (1976).

[17] Lee draws a very stark contrast between everything natural and everything artifactual. A more moderate position would acknowledge degrees of artificity. For example, a Bartlett pear, bred and cloned over many years to grow well in a certain type of soil, is probably more natural than, say, a Dell PC.

[18] There is, of course, a great deal of complexity to the question of what sort of artifacts environmentalists should really be opposing. A mud hut is a different kind of artifact from an i-pod but an artifact nonetheless. Restored wetlands and solar panels are both artifacts containing human intention. These complexities about the natural and the artifactual will largely be set aside from this discussion so that the focus can stay on the philosophical significance of living under managed skies.

[19] See a number of the articles in *The Great New Wilderness Debates* by J.B.Callicott and M.Nelson (Athens, GA: University of Georgia Press, 1998) and *The Wilderness Debate Rages On* by M.Nelson and J.B.Callicott (Athens, GA: University of Georgia Press, 1998).

[20] One could add that human-independent processes need also to be protected from unintentional human harm. Examples of unintentional harm might be a containment pond for mining waste that bursts in a hundred year flood or a species rendered extinct by over-zealous hunters.

[21] See the H.O.M.E. website at www.handsoffmotherearth.org.

[22] The inability of scientists to recreate a habitable ecosystem in the Biosphere II project in Arizona amply demonstrated the complexity.

[23] Albert Einstein similarly remarked that we are unlikely to solve problems with the same kind of thinking we used when we created them. In the same vein, indigenous American scholar Kyle Powys Whyte titled his presentation at a recent workshop on geoengineering "'Oh, We've Seen this Before'…: Indigenous Communities, Environmental Justice, and Geoengineering."

[24] Admittedly, almost all advocates of geoengineering insist that the technology is only a way of 'buying time' until such a point that greenhouse gas emissions have been reduced enough for the climate to stabilize. However, with uncertainty about the course of both anthropogenic climate change and of geoengineering, coupled with future, perhaps extreme natural fluctuations in earth's climate (see the thought experiment discussed below), the distinction between geoengineering as 'buying time' and geoengineering as a tool to permanently manage for a desirable climate may prove very slippery.

[25] There are, of course, other ways to make the presumptive argument against geoengineering that do not rely on beliefs in environmental ethics. See Stephen Gardiner (2010), 287-290.

[26] The word 'partially' is included here because it may be the case that under exceptional circumstances some limited geoengineering proposals will be acceptable to environmental ethicists conditional upon on the results of further research. For example, it is plausible that, when coupled with aggressive efforts at emissions reductions, carbon dioxide scrubbing and marine cloud brightening may turn out to be acceptable geoengineering strategies even if stratospheric aerosols are not.

[27] Quoted in Mark (2009).

[28] Gardiner is fully aware of this, which is why he directs his argument mainly towards the morality of the decision to engage in research now. He states that "…[e]ven if one accepts in principle that one should make a lesser evil choice in some highly stylized case, such as the nightmare scenario, this fails to justify a policy of preparing to make that choice" (Gardiner, 2010: 292). Furthermore, as Gardiner points out on p.299, from the fact that something is the lesser of two evils it does not follow that it should be done. Both evils could be morally prohibited.

[29] Ibid., 295, 296, 305.

[30] In the case of solar radiation management, the continuation of ocean acidification is one obvious reason why.

[31] There are numerous examples of this work in ethics and policy. For example, the UK parliament science and technology committee and the Royal Society are both funding research into the relevant social, political and ethical considerations. US National Science Foundation recently funded a team from the University of Montana to investigate the ethics of solar radiation management. The US National

Commission on Energy Policy Task Force on geoengineering will include a section on ethics and policy in its recommendations.

[32] Gardiner maintains (personal communication 9/14/2010), probably correctly, that nothing currently being done comes close to freeing us from the accusation of moral corruption.

[33] The question of whether certain important tipping points have already be reached remains subject of much scientific debate. The IPCC goal of limiting climate change to 2 degrees centigrade may be impossible to meet. The 80% cut in global carbon emissions from 1990 levels by 2050 deemed necessary to meet this goal at this point seems equally improbable. Recent events, including the hottest January-June (2010) period in history measured by NASA, the hottest summer on record in the Eastern United States (2010), and the breaking off the Jacobshavn and Petermann Glaciers in Greenland (January and August 2010) all point towards the need for geoengineering action to occur in the current generation. Gardiner acknowledges that it may not be a future generation that is forced to pull the trigger on geoengineering but the current one. In this case, the "arm the future" argument becomes an "arm the present" argument. While the would-be present generation geoengineer is no longer involved in intergenerational buck-passing, he or she remains guilty of "avoiding confronting climate change directly" and therefore remains guilty of a "tarnishing evil." Gardiner suggests, however, that the "arm the present" view is "not yet mainstream" (2010, 13 and personal communication 9/14/2010).

[34] Gardiner briefly considers the possibility that he has been uncharitable in characterizing climate engineering advocates as being so narrow (16-17) only to rapidly offer a counter-argument against this view.

[35] A position that was articulated to me by Ned Hettinger in comments on a draft of this paper.

[36] This counterfactual was suggested to me in casual conversation by Ned Hettinger. While the scenario may appear to be too hypothetical for a conversation about climate policy, it does usefully illuminate some helpful intuitions. It also connects the geoengineering discussion with some familiar topics in environmental ethics such as ecofascism and anthropocentrism.

[37] A few environmental ethicists may insist that no environmental values are at stake since natural warming, however extreme, is inherent in the operation of the system and hence has only positive value.

[38] The very richest people would presumably find a way to engineer their own survival, whatever resources it took. The remainder of the population of the planet would suffer the consequences.

[39] See, for example, a special issue of the *Journal of Medical Ethics* **26** (2000) for a discussion of the acts/omissions debate.

[40] See an unpublished paper by Holly Jean Buck ("What can geoengineering do for us? Public participation and the new medial landscape") for ideas about how to generate a positive narrative surrounding geoengineering.