

CONSEQUENTIAL PRINCIPLES CONCERNING  
THE MORALITY OF GEOENGINEERING

By

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## ABSTRACT

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*Consequential Principles Concerning the Morality of Geoengineering*

*Thesis directed by Associate Professor Alastair Norcross*

The earth is presently warming at a dangerous and potentially catastrophic rate. While attempts to mitigate the effects of the industrial processes that lead to this warming are necessary, some have advocated for direct, intentional intervention in our climate's processes as a way to prevent disastrous warming. Such interventions are called geoengineering. In this thesis I discuss the kinds of geoengineering technologies that presently exist, and argue that geoengineering is a member of a moral class called *earth altering actions*. I hold that the only way to consistently morally evaluate geoengineering is by understanding it as a member of this continuous class. I review the sorts of moral principles philosophers have offered to govern geoengineering, then turn and provide an alternative set of principles for this governance that are consistent with consequentialism: (1) EAAs are not different in moral kind from other "accidental" forms of earth alteration; (2) governance of EAAs need not be different from governance of other public goods that have potential costs; (3) the degree to which an EAA is wrong is a function of its expected consequences; (4) overwhelmingly preferable consequences ought to overrule other moral considerations.

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## Introduction

This thesis will address the following question: what makes it morally permissible, if ever, to significantly, intentionally alter the state of the natural world on earth? More specifically, I will ask, under what conditions can various forms of geoengineering (and similar strategies) be employed to mitigate or ameliorate the deleterious effects of climate change? To answer this question, an in-depth exploration of a few domains is in order. In the first section, I will explain what geoengineering is and explain a few different proposed plans for intentionally altering earth's climate and environments. I will also make the case that geoengineering is a member of a moral category of actions that share the feature of *altering earth's environments* in some way. Such earth altering actions (EAAs, hereon) raise a number of significant and challenging moral questions pertaining to justice, respect, distribution of harms and benefits, and humanity's attitude toward nature more broadly. Both for humanitarian and for environmental reasons, some authors oppose geoengineering outright, or else have extremely high standards for morally permissible cases, due to non-consequential values. This thesis will examine these issues in turn. After I explore the various views advanced by different authors, I will advance my own positive argument. I will develop my own principles for the morality of geoengineering from intuitive, non-consequential theses, which ultimately support consequential moral constraints (in favor of non-consequential or absolutist ones). Importantly, I will argue that, when understood consequentially, not all geoengineering is correctly morally considered the same. The moral limitations germane to some kind of EAA will vary based on its expected

consequences. I will make use of a few thought experiments to demonstrate the importance of prioritizing human wellbeing-based considerations in geoengineering decision-making over non-consequential values. More plainly, in many cases of geoengineering, it may turn out that prioritizing the public *good* over other duties – like justice or universal consent or respect for the progress of nature – may turn out to be *right*. I will then consider some objections to consequential moral analyses broadly that might threaten the principles I develop.

## Section I: geoengineering an earth altering actions

Presently, the world is getting warmer. It is getting warmer at a terribly fast pace, and this is almost certainly the result of the increased amount of CO<sub>2</sub> in the atmosphere, along with other greenhouse gasses (GHGs), the current rates of which have not been seen on earth for millions of years.<sup>1</sup> The world's average temperature is expected to rise by at least 2 degrees C by 2100.<sup>2</sup> As current attempts to mitigate this warming are failing – and might not even have been sufficient, had the goals for mitigation been actually met – some have hypothesized that the only solution to this potentially catastrophic problem (apart from adapting our societies to meet the new climate) is to directly and intentionally alter the earth's climate. Such direct global intervention is called *geoengineering*. Geoengineering is a broad class of technological solutions to global warming (and potentially other problems, though global warming is the issue presently at hand) that includes many different types of technologies. Thus, the category of geoengineering is a category of action more than it is a type of technology – rather like *construction* is a category of activity rather than any one technology in particular; hammers, saws, and power drills are all different technologies that can be used for the activity construction. So, I will focus here on geoengineering as a kind of action rather than as any specific technology. I will, however, now explain a few different kinds of technologies proposed for the purposes of engineering the earth's

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<sup>1</sup> Ye Ge Zhang et al. "A 40-million-year history of atmospheric CO<sub>2</sub>" *Philosophical Transactions of the Royal Society A* vol 371, issue 2001. (October 2013).

<sup>2</sup> Adrian E Raftery et al. "Less than 2 °C warming by 2100 unlikely," *Nature Climate Change* 7 pages 637–641 (2017).

climate in order to illustrate an important point often overlooked in the moral scholarship discussing geoengineering: that it is a diverse set of actions admitting many kinds of climate alterations and changes to the natural world.

### **Stratospheric sulfur injections (SSIs)<sup>3</sup>**

SSIs are perhaps the most commonly discussed form of geoengineering, as the technology to do it already exists and it would be relatively inexpensive. Basically, it is exactly as its name suggests: the injection of sulfur particles into the stratosphere. These would serve to increase the albedo of our planet (its shininess). If the planet were shinier, it would reflect more sunlight back into space, and so lower the average global temperature: hence, SSIs are considered a form of solar radiation management (SRM). The precedent for such a venture is the effect that volcanic eruptions have on the planet's climate. Volcanoes inject huge amounts of sulfur dioxide into the atmosphere when large ones explode, like Pinatubo island in the Philippines in 1991. When they do, the average temperature of the planet cools for a while. Some scientists think this would be, provided a few years of experimentation prior to any large-scale attempt, a simple, cheap, and effective way to stave off the worst effects of climate change. Unfortunately, SSIs would not thwart *every* unwanted effect of climate change. As this only affects the albedo of the planet, and does not affect the underlying causes of climate change,

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<sup>3</sup> David Rotman, "A Cheap and Easy Plan to Stop Global Warming" *MIT Technology Review*, February 8 2013

URL= <<https://www.technologyreview.com/s/511016/a-cheap-and-easy-plan-to-stop-global-warming/>>



carbon's effects on other aspects of our planet's processes would continue unabated; for instance, the oceans would continue to acidify as they absorb more atmospheric carbon.

For this reason and others – particularly the fact that some fear that beginning SSIs would effectively commit us to continuing to use them *ad infinitum*, as it is possible that if we stopped doing it, the earth would rapidly return to whatever climate conditions would have been present had the SSIs not been done<sup>4</sup> – SSIs are not seen as any sort of *solution* to climate change, but instead a strategy to buy us time while other, more long-term and stable solutions can be worked out.

As with any emerging technology, there is a fear that attends the unforeseen consequences that might come pass. No one knows for sure in what way the presence of sulfur particles in the atmosphere will affect global precipitation patterns. There is also the concern that SSIs will deplete the ozone. Sulfur dioxide is known to interact with ozone in ways that might decrease its atmospheric concentration, and the degree to which this might happen (if at all significantly) is currently unknown.

### **Direct carbon capture<sup>5</sup> & ocean fertilization<sup>6</sup>**

SSI's are a more extreme form of geoengineering, as such a course of action would be effectively experimenting with our atmosphere in an attempt to positively add to its chemical makeup and change the climate. Carbon sinks are seen as much less

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<sup>4</sup> That this might happen is controversial. Many scientists do not agree that this is a legitimate worry.

<sup>5</sup> David Roberts, "Sucking carbon out of the air won't solve climate change," *Vox*, July 6, 2018. URL = <<https://www.vox.com/energy-and-environment/2018/6/14/17445622/direct-air-capture-air-to-fuels-carbon-dioxide-engineering>>

<sup>6</sup> "Climate Change 2007: Working Group III: Mitigation of Climate Change," *IPCC Fourth Assessment Report: Climate Change 2007*. URL = <[https://www.ipcc.ch/publications\\_and\\_data/ar4/wg3/en/ch11s11-2-2.html](https://www.ipcc.ch/publications_and_data/ar4/wg3/en/ch11s11-2-2.html)>

invasive. Global warming is largely caused by the increased amount of carbon dioxide in the atmosphere, which is there because people have been removing carbon from the geosphere (the part of the earth's systems that are comprised of its geologic processes) and injecting that carbon as a gas into the atmosphere by burning fossil fuels. Carbon sinks seem, then, like an intuitive solution: just suck the carbon back out of the atmosphere and stick it back into the geosphere. There are fewer uncertainties, and fewer global political and moral quandaries associated with carbon sequestration in principle (which I'll talk more about in sections 2 & 3). However, it is not as likely to have immediate effects as SSIs would, and presently, the technology necessary to suck the amount of carbon out of the atmosphere that would be necessary to have an effect is not yet available. A natural suggestion is to simply plant more trees, as their biomass is comprised of carbon, which they draw from the atmosphere. While this may serve as a mitigation technique, it is implausible that the sheer amount of carbon dug up and burned by human activities could really be scrubbed from the atmosphere by only trees, and anyway this mode of sinking carbon has many other significant effects — such as *decreasing* albedo due to dark leafy canopies — that make it not quite the quick fix some hope for.<sup>7</sup>

A significant amount of carbon sequestration is done as a preventative measure, taking carbon from, say, an energy plant's carbon-rich exhaust and turning it into rock to be buried.<sup>8</sup> There exist political and tax incentives for firms to reduce carbon emissions, and so application of sequestration technologies at these sources makes

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<sup>7</sup> David Whitehead, "Forests as carbon sinks — benefits and consequences," *Tree Physiology*, Volume 31, Issue 9, 1 September 2011, Pages 893–902, URL= <<https://doi.org/10.1093/treephys/tpr063>>

<sup>8</sup> David Roberts, "Sucking carbon out of the air won't solve climate change"

financial sense. There presently exist few if any economic incentives to extract carbon from the significantly less densely carbonated atmosphere, a process that is costly and also not directly beneficial to a particular company. As such, it may be some time before any companies begin the universally beneficial and highly unprofitable venture of removing carbon from the atmosphere just for the sake of the public welfare.

In addition to the more innocuous-seeming practices of reforestation and direct carbon capture, which appear only to remove something from the atmosphere rather than add something to it,<sup>9</sup> there are other, more invasive plans for potentially removing vast amounts of carbon from the atmosphere. Capitalizing on the same fact lately mentioned (that pulling carbon out of the atmosphere is likely to reverse the effects of its having been there), some wish to fertilize the ocean in such a way that massive populations of phytoplankton erupt, thus capturing atmospheric carbon in their shells as they grow. Ideally, buildups of these phytoplankton shells would sink down to the ocean floor, sequestering the carbon far from the atmosphere where it is presently doing damage. The IPCC reports that such a strategy is uncertain, as only about 30% of ocean is amenable to this kind of fertilization, and the amount of plankton that would eventually sink to the bottom of the ocean, sequestering carbon, might have been overestimated.

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<sup>9</sup> Reforestation is, in a sense, not adding anything. However, there is a possibility that adding forest where it did not used to be is something of a direct alteration of the natural world. This is discussed later in this section.

## Ecological modification, de-extinction, & ecosystems solutions

Climate change poses problems to be solved not only at the global scale, but also problems that will need to be addressed at the smaller, local scale in places all over the earth. Targeted instances of environmental engineering of different kinds will be needed to address the problems created by a generally warmer climate. Some places will become dramatically hotter and drier; other places will experience long droughts followed by intense rainy seasons; still others might become wetter year round; different natural disasters, like hurricanes and extreme droughts, will become more common.<sup>10</sup> For those concerned with conservation of the world's wild places, this is especially concerning. Thousands of species will likely go extinct; many already have.<sup>11</sup> For those concerned with individual species as well as entire ecosystems, there will be much work ahead in attempting to migrate species to new locations with more suitable climates, or else adapting ecosystems to meet the warming world. All of these things are, as many philosophers and environmentalists point out, morally freighted courses of action.

Some species of plants and animals that humans have come to hold dear are threatened by climate change, and the populations of many such organisms have already begun to shrink. Examples include, pika, clownfish, elephants, rhinos, and plant species like the Torrey pine and *Torreya yew* tree. These species, apart from whatever role they play in their respective ecosystems, are deeply important to people,

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<sup>10</sup> NASA, "How Climate is Changing," *Global Climate Change: Vital Signs of the Planet*. URL = <https://climate.nasa.gov/effects/> >

<sup>11</sup> Abigail E. Cahill et al, "How does climate change cause extinction?" *Proceedings of the Royal Society* vol 280, issue 1750. (January 2013).

and some have proposed that in order to save them from extinction in their native ranges they ought to be relocated.<sup>12</sup>

Another similar proposed option in the management of the decline of important species and ecosystems is assisted evolution. Some agencies wish to assist coral reefs in evolving to be better equipped to handle the new climates they will be living in as the ocean warms and acidifies.<sup>13</sup> Such efforts seek to change the genetic composition of a species or an ecosystem so as to make it more viable in a (usually warmer) climate. This kind of effort is generally smaller in scope, and seeks to restore either charismatic organisms or important ecosystems, as is the case with the cited attempt to restore coral reefs in Australia through augmenting their acid tolerance.

Some wish not only to help prop up existing ecosystems through careful management, but also to revive ancient ecosystems (sometimes called rewilding), or create novel ecosystems, to aid in mitigating the worst of climate change. Perhaps the most famous example of this is the ongoing quest to restore the woolly mammoth. While this is, perhaps, the holy grail of de-extinction, smaller-scale projects are already underway.<sup>14</sup> One organization, Revive & Restore, is also trying to bring back from extinction the passenger pigeon, the heath hen, and potentially others. The aim of such projects is not only to revive an interesting creature – either for the sake of further scientific discovery or because, as some hold, we have a responsibility to do so if we (humans) were responsible for its demise – but also because of some purported

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<sup>12</sup> Mary I. Williams and R. Kasten Dumroese, “Preparing for Climate Change: Forestry and Assisted Migration,” *Journal of Forestry*. (July 2013).

<sup>13</sup> “Assisted Evolution” *Australian Institute of Marine Science*. (© 1996- 2018) URL= <<https://www.aims.gov.au/reef-recovery/assisted-evolution> >

<sup>14</sup> “What We Do” *Revive & Restore*, URL=<<http://reviverestore.org/what-we-do/> >

ecological benefits. Some contend that many of the species presently alive, like the North American pronghorn, are missing an evolutionary counterpart (in this case, the American cheetah), and so introduction of functionally similar animals would restore an ecosystem to its older, presumably more optimal, functions.<sup>15</sup> Others favor such rewilding as this because of its more general, climatic benefits. For instance, Russian scientist Sergey Zimov has built an ecosystem in Siberia called Pleistocene Park. This space is an enormous rangeland where large, herbivorous mammals stampede. The aim is twofold: one, to keep darkly-colored, light- (and so heat-) absorbing forests from growing, and so to allow lightly-colored, reflective grasslands to flourish; and two, to prevent snow from building up and acting as an insulating blanket, causing the permafrost beneath the snow to melt, releasing methane – a dangerous greenhouse gas – into the atmosphere.<sup>16</sup> Zimov also hopes to release revived mammoths onto his range, once that becomes available.

Other examples of constructing novel ecosystems are present in plans to reforest or construct new forests. One such plan is the Great Green Wall.<sup>17</sup> The aim is to plant a giant wall of trees and plants across the entire Sahel-Sahara region of Africa to act as a barrier against desertification. It also has the added benefits of providing jobs, increasing arable land, and sequestering carbon. A similar project is underway in China,

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<sup>15</sup> Donlan et al., “Pleistocene Rewilding: An Optimistic Agenda for Twenty-First Century Conservation,” *The American Naturalist*, vol 168, No 5. (2006)

<sup>16</sup> “Scientific Background,” *Pleistocene Park*, URL= <<http://www.pleistocenepark.ru/en/background/>>

<sup>17</sup> “The Great Green Wall” *Great Green Wall*, URL= <<http://www.greatgreenwall.org/about-great-green-wall/>>

called the Three-North Shelter Forest Program.<sup>18</sup> These are more minor attempts at ecosystem and climate alteration, as they only immediately affect the climate of the area near where they are implemented, but they nonetheless retain the quality of changing the global climate by a small margin, as they serve to offset carbon emissions by the nations that implement them, or even, if fully successful, positively sequester carbon.

### **Earth Altering Actions**

I will caution at the start that there is a danger in overgeneralizing when making moral claims about or even normatively categorizing an entire set of actions. However, in the above cases, there *is* something relevantly shared: they each seek to alter the state of the natural world on earth in some way. Injecting sulfur into the atmosphere to lower global temperatures, fertilizing the oceans, and reviving woolly mammoths all have the shared, perhaps intuitively recognized, feature of more-or-less permanently altering the state of nature. The concept *nature* is obviously ambiguous. Of course I do not mean the sum total of all events and entities in the universe, which is one plausible definition. Instead, I mean something like the state of the earth's ecosystems and biotic processes occurring outside the technological intervention of human beings. This is only a heuristic definition, a sort of Wittgensteinian cluster-concept, but it will do, I think.

That in place, an EAA occurs when nature has progressed in such-and-such way, and humans step in and intentionally change the course of its development to suit our ends. Some people meet such a prospect immediately with disdain. Others find that

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<sup>18</sup> Alexandra E. Petri, "China's 'Great Green Wall' Fight Expanding Desert," *National Geographic*, April 1 2017. URL= <<https://news.nationalgeographic.com/2017/04/china-great-green-wall-gobi-tengger-desertification/>>

disdain overly sympathetic and naïve. The morality of such actions is multifaceted and complicated, and so I will spend the next section parsing the different kinds of concerns people have with such actions. However, I will first need to specify just what exactly counts as an EAA. EAAs are the set of actions that (more or less) permanently alter the natural world and are done intentionally. They are the sorts of actions that suspicious onlookers might call “playing God.” In much of the discussion surrounding the morality of geoengineering, EAAs are considered a somewhat morally homogenous class of actions. Whether the discussion surrounds solar radiation management (SRM) or ocean fertilization, the kinds of moral principles employed are generally the same. In the moral argument that will come later in this work, I will differentiate among the various kinds of geoengineering options that exist and attempt to show that the sorts of consequences one can expect from each technology are essential to understanding the morality of their deployment. More simply, the kinds of moral principles that govern the previously described geoengineering technologies will differ based on what the technology is supposed to do to the earth. This is the justification for my invented acronym: EAA. While all acts of geoengineering are EAAs, not all EAAs are acts of geoengineering. This distinction, I hope, will clarify the moral justifiability of various kinds of earth alterations, so as not to end up with some truly counterintuitive conclusions (to be shown in my main argument). My distinction between the two is intended to show that intentionally changing the earth’s climate and ecosystems is a kind of action that admits of degree. A large public park, for instance, that is constantly watered, will have a different set of biotic processes occurring within it than an



undisturbed area. This will in turn create a microclimate – consider the cooling effect of grass and shady trees. And, all of this can be done intentionally. But clearly making public parks is not an act of geoengineering. There is a continuum of actions that starts at public parks and ends at SRM: these are EAAs. The EAAs that have obvious or explicit global effects are forms of geoengineering, but as I will later argue, geoengineering is not different in kind from other EAAs. This move is crucial to my argument, as it is probably obvious to most that an EAA like public urban green-spaces are far from morally problematic. So, by finding the result that more invasive forms of earth alteration, like SRM, are in fact not different in kind from providing green spaces, I am able to show that what distinguishes them is their likely consequences – but more on this later.

Before I offer my own arguments, I must explain what problems scholars have had with geoengineering in general. In the section that follows this one, I will explore the humanitarian and environmental reasons that one might be morally opposed to geoengineering and other EAAs: what reasons do we have to refrain from altering the state of the earth for the sake of people or for the sake of the environment in itself?

## Section 2: Concerns with EAAs

There is a rich body of scholarship addressing the morality, political feasibility, economic, and social costs of geoengineering. The majority of this work is concerned with geoengineering specifically for the reason that people stand to be materially affected, or else stand to be wronged in some other way: the victims of injustice, most often. Others are concerned that we act without respect for nature, or fail to conduct ourselves virtuously with respect to the earth's environment. This section will address some current popular and plausible candidates for moral principles that guide geoengineering, or outright forbid it. A theme that I hope will emerge from the discussion to follow is that geoengineering is considered an act morally of its own kind. This is probably due to the fact that it stands to affect nearly everyone on earth. However, as I will show later, this is not sufficient in its own right to justify any sort of absolute injunction against geoengineering. From the following list, then, I will illuminate some contenders for such an absolute injunction – or at least a highly stringent injunction – against geoengineering.

### **Violation of widely held principles**

Perhaps the first influential philosopher to consider geoengineering is Dale Jamieson. In his work “Ethics and Intentional Climate Change” he lays out and justifies four conditions which must be met if an act of geoengineering is to be morally permissible. They are these:

- (1) The project is technically feasible;

- (2) its consequences can be predicted reliably;
- (3) it would produce states that are socioeconomically preferable to the alternatives;
- (4) implementing the project would not seriously and systematically violate any important, well-founded ethical principles or considerations.<sup>19</sup>

The first three principles are quite plain and are, given the stated aims of those considering geoengineering, easily satisfied at least in the abstract.<sup>20</sup> The fourth is the one that is much less permissive. It is also, seemingly, somewhat ambiguous; what exactly counts as a well-founded ethical principle or consideration is not entirely clear. Jamieson does expand upon this by offering plausible candidate principles and considerations: democratic decision-making, a prohibition on irreversible environmental alteration, and the virtuousness of learning to live in harmony with nature. In the scholarship since Jamieson, others have attempted to specify just what such ethical principles and considerations might be suitable in the case of geoengineering. The next subsections will review a few plausible contenders for these principles and norms. However, from Jamieson I will take principle (4) to be the absolute principle argued for in his treatment: *it is wrong to geoengineer if it seriously and systematically violates any well-founded ethical principles*.

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<sup>19</sup> Dale Jamieson, "Ethics and Intentional Climate Change," *Climatic Change* 33. (1996).

<sup>20</sup> By this I mean that the scientists who are hoping to engineer the climate are only doing so because they are justified in believing it will work, are hoping to develop the technology such that its consequences can be predicted reliably, and hope to ameliorate the expected damages of climate change (many of which are socioeconomic).

## **The Oxford and Tollgate principles: consent and participation**

One particularly prominent set of moral guidelines for developments in geoengineering are the Oxford Principles.<sup>21</sup> They are moral principles by which governments should abide if they wish to conduct research into or actually deploy a geoengineering scheme. There are five principles:

- (1) Geoengineering is to be regulated as a public good.
- (2) Public participation is required for geoengineering decision-making.
- (3) Disclosure and open publication of research and results are required.
- (4) Independent assessment of impacts is required.
- (5) Government structures must be in place before any scheme is deployed.

The authors (Rayner et. al.) elaborate on each principle as well as offer justification.

These principles are not committed to any specific deontological or axiological scheme, however. That's to say, a committed utilitarian or committed Kantian might both support these principles, each for their own reasons. The arguments that I ultimately make will leave open the possibility – which I think is likely – that principles like the Oxford ones will be the best practice for governments to follow. Principle (2) however, is, like Jamieson's (4), ambiguous. The constraints I will now review are more normatively robust. They are grounded not only in what would be the best practice for governments to follow, but in beliefs about the actual rightness or wrongness of actions of geoengineering. The authors of the Tollgate Principles, Gardiner and Fragniere, elaborate on the Oxford principles by providing a more robust normative account that results in a more demanding set of conditions for the permissibility of any geoengineering scheme: these are the Tollgate Principles. The motivation for this

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<sup>21</sup> Rayner et al., "The Oxford Principles," *Climatic Change* 121, (2012), 499 – 512

expansion on Oxford is the fact worry that geoengineering will be carried out in such a way that very few people have a say in whether it is done and how it is done. In Jamieson's original work, he holds that one of the necessary conditions for permissible geoengineering is that it be done using democratic decision-making procedures, and that it would be impermissible to deploy geoengineering technologies without obtaining the consent of the world's poorest, who are likely to be the most affected by any changes to the earth's climate.<sup>22</sup>

While the Oxford Principles do require (in principle 2) that public participation in decision-making is required, this might be ambiguous and not stringent enough to ensure that geoengineering is done in a truly morally permissible fashion. The Tollgate Principles offered by Stephen Gardiner and Augustine Fragniere, expand upon the (in their view) limited and ambiguous Oxford Principles. Their modification of principle 2 states:

2nd Tollgate Principle (Authorization): Geoengineering decision-making (e.g., authorizing research programs, large-scale field trials, deployment) should be done by bodies acting on behalf of (e.g., representing) the global, intergenerational and ecological public, with appropriate authority and in accordance with suitably strong ethical norms, including of justice and political legitimacy.<sup>23</sup>

They spend a good deal of time unpacking the specifics of this proposed principle of governance. In sum, this proposal requires the near universal consent of all those affected (and even those *not* materially affected) for any act of geoengineering to be carried out morally permissibly. Deliberations on a given act of geoengineering would

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<sup>22</sup> Jamieson 1996, 329

<sup>23</sup> Stephen M. Gardiner and Augustin Fragniere, "The Tollgate Principles for the Governance of Geoengineering: Moving Beyond the Oxford Principles to an Ethically More Robust Approach," *Ethics, Policy & The Environment* 21, (2018).

have to incorporate principles to protect the interest of future generations and also be consistent with some set of ecological morals. This is, of course, further complicated by the diversity of moral norms that exist cross-culturally. An important take-away from these normative principles (as pertains to my later discussion) is that geoengineering (even, potentially, conducting research into geoengineering) is *impermissible* without satisfying these norms. That means that no matter the circumstances, intentionally altering the earth's climate without the kind of consent stipulated by the Tollgate authors would result in a serious moral wrongdoing. Thus, the absolute principle to take away from this discussion is that *it is wrong to geoengineer without the (near) universal consent of all those possibly affected, even those not affected, and including future generations and the environment per se.*

## **Compensation**

Another proposed moral constraint on the practice of geoengineering is that it ought not to be done unless those who might be harmed by it are appropriately compensated. Two treatments of this issue are Svoboda & Irvine (2014) and Wong, Douglas, & Savulescu (2014).<sup>24</sup> The former pair argues that compensation for any harms caused by an act of geoengineering (they focus on SRM) is a necessary condition for permissible geoengineering, but, that a just compensation scheme is far from available

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<sup>24</sup> Toby Svoboda & Peter J Irvine, "Ethical and Technical Challenges in Compensating for Harm Due to Solar Radiation Management Geoengineering," *Ethics, Policy & the Environment* (2011); Pak-Hang Wong, Tom Douglas, & Julian Savulescu, "Compensation for Geoengineering Harms and No-Fault Climate Change Compensation," Climate Geoengineering Governance Working Paper Series: 008, (April 2014).

due to two features unique to geoengineering: the inherent scientific and ethical uncertainty. These, respectively, are the facts that the actual effects of SRM technologies are uncertain once deployed – no one *really* knows what will happen – and that there is moral uncertainty in what a just compensation scheme for those harmed by such technology ought to look like. This, they think, is a particularly damning issue. No one knows (1) who ought to pay compensation, (2) whom ought to be compensated, and (3) how much compensation ought to be provided. Further complicating this is the fact that SRM might change the earth's climate in such a way that cultural practices need to be changed in some irredeemable way. If that should be the case, then it is unclear what, if anything, might compensate for such a loss.

Wong & Irvine argue that the foregoing problems are not truly unique to geoengineering. Certainly, the foregoing problems are brought about by climate change too. (Given that rising seas are likely to force mass migrations away from coastal areas, and a huge proportion of humans live in coastal areas, it seems fairly likely that massive amounts of compensation – including the morally complicated cultural compensation – will turn out to be morally obligated anyway.) They do, however, hold that compensation remains a necessary condition for morally permissible geoengineering.

Compensation is already a significant problem with respect to climate change justice. Assuming that the same problems transfer to cases of *intentional* climate change, then certainly the moral problems appear only increase and intensify. There already exists argument over principles like Polluter Pays, or Ability to Pay, and others, when deciding on what the appropriate compensation scheme ought to be for remediating the

damages done by (largely Western-caused, and non-Western-affecting) anthropogenic climate change. If the governments of the world decided to act upon a geoengineering scheme, these same requirements for compensation will entail that all those affected need to be paid their due. Presumably, geoengineering without the ability to fulfill this duty constitutes a violation of this important moral requirement and so would be impermissible. Thus, the principle I will take from this body of scholarship is that *it is impermissible to geoengineer without first establishing a morally just compensation scheme for those who may be harmed*.

### **Moral norms & respect**

In discussing ocean fertilization, Hale & Dilling (2011) articulate their moral argument as such.<sup>25</sup> First, in view of the fact that there was an initial moral wrong committed in polluting the atmosphere with CO<sub>2</sub> in the first place, simply fixing this with more pollution (fertilizing agents in the ocean) is not a morally satisfactory response. Second, one is insufficiently justified in this action without obtaining consent from all affected parties (presumably, inhabitants of earth, which is a tall order), and so fails to respect them. Such respect would require acting in accordance with a principle that any reasonable person would accept (this bit is brought in from Habermas). Third, ocean fertilization moves the world into a third, unknown state rather than simply returning it to how it was pre-pollution. Doing that is risky and irresponsible. In brief, it

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<sup>25</sup> Benjamin Hale & Lisa Dilling, "Geoengineering, Ocean Fertilization, and the Problem of Permissible Pollution," *Science, Technology, & Human Values* 36(2) 190-212 (2011).



seems direly unlikely that geoengineering could be deployed without violating important norms of respect and responsibility.

I take their position to be a well-articulated version of a class of objections to geoengineering. It seems terribly unlikely that it could be done while respecting the rights, autonomy, and due respect demanded by any agent with interests living in the world. The moral situation is worsened by the fact that even a candid appraisal of the world's diversity will yield the observation that there will be thousands (if not more) of different views on the permissibility of EAAs. It may be that some cultures hold the natural world sacred in such a way that does not permit geoengineering. In the West alone there are those who hold such views. That will be the next source of objection that I will outline. From this discussion I find two more principles against geoengineering: One, *it is disrespectful to those it affects due to its moral similarity to pollution*, and two, *it is irresponsible as it moves the world into an unknown state*.

### **Environmental Constraints on EAAs: Hubris & Virtue**

There exists an entire class of objections to EAAs that are based on value found in the natural world itself. In this general domain, there exist a few different classes of principles that justify such objections. One is based on our epistemic position: it would be wrong for us to intervene in the processes of the natural world because we simply do not have enough information to be sure we don't miserably ruin the ecosystems and geologic or climatic systems we interfere in. Objections along this line will not be the focus of this section. The principles that I will ultimately support are sensitive to

consequentially relevant features of moral problems like epistemic situation. Suffice it to say that if scientists really couldn't sort out what would happen if they started pumping sulfur dioxide into the atmosphere, they probably shouldn't do it.

The other class of objections, which I *will* be focusing on, are those that state that there is something wrong *per se* with meddling with nature. This can be due to (1) the belief that playing God is simply too dangerous and hubristic, or (2) the belief that humans ought to act in accordance with certain virtues that would disallow intentionally altering the climate (or ecosystems, etc.).

One objection that I think many people would have if polled about geoengineering is that it is simply hubristic as an enterprise. Stephen Gardiner argues as much in his 2010 contribution to Oxford's *Climate Ethics* journal.<sup>26</sup> Such a view can be understood as follows. Humans have, through our ignorance, already seriously damaged the environment and climate on earth. We have little justification for thinking that we can fix that problem by meddling more. What's more, it is simply in poor character to think that we can intentionally change the climate to suit our needs.

Hubris amounts to a failure in some specific virtues: epistemic virtues, perhaps, or moral ones, like having respect or reverence for the environment. Jamieson (1996) rounds out his critiques of geoengineering by discussing the possibility that this "techno-fix" attitude toward a problem brought about by an excess of technological development is something that is, in one way or another, bad. While he does seem to

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<sup>26</sup> Stephen Gardiner, "Is 'Arming the Future' with Geoengineering Really the Lesser Evil? Some Doubts about the Ethics of Intentionally Manipulating the Climate System." *Climate Ethics*, Oxford University Press, 2010.

appeal to consequences in his justification for this view (“Although it is difficult to assess precisely, in the long run this attitude may be more destructive of both humans and the rest of nature than global warming itself,”<sup>27</sup>), there are others who might not. One might consider the environmentalist canon, including authors such as John Muir, Aldo Leopold, and Arne Naess. These authors extol the virtues of a harmonious relationship with nature, one that is necessarily reverent and does not suppose nature to be something to be dominated, as some view the scientific worldview to attempt to do. (Jamieson cites Francis Bacon as having considered the purpose of knowledge to be to dominate nature, for instance.)

There is a rich body of work on such environmental principles. Ostensibly metaphysical beliefs in something like a balance of life, or sacredness in nature, or perhaps some virtue in *naturalness*, are certainly germane to my discussion. However, I simply do not have the time to fully appraise and discuss the intricacies of such views here. Admittedly, I do find them pretty *prima facie* implausible. Often such appeals extend beyond a naturalistic understanding of the world. For instance, in recounting shooting a wolf, Aldo Leopold explains,

“We reached the old wolf in time to watch a fierce green fire dying in her eyes. I realized then, and have known ever since, that there was something new to me in those eyes—something known only to her and to the mountain. I was young then, and full of trigger-itch; I thought that because fewer wolves meant more deer, that no wolves would mean hunters’ paradise. But after seeing the green fire die, I sensed that neither the wolf nor the mountain agreed with such a view.”<sup>28</sup>

While such poetic musings likely are not without moral importance and can contribute to virtues that we would do well to cultivate in people (probably), arguing

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<sup>27</sup> Jamieson 1996, 332

<sup>28</sup> Aldo Leopold, *A Sand County Almanac*, (New York, NY: Oxford University Press, 1949).

against the metaphysical or epistemic possibility that Leopold could have learned something like that that way (or that a mountain can *want* anything) is beyond the scope of this thesis. I will just stipulate that such things are not literally true.

That said, there are a couple of (presumably) absolute injunctions against geoengineering (and perhaps all EAAs) that can be inferred from such views. Of course, classic environmentalist authors were not speaking about geoengineering when they wrote their treatises, but it's not much of a stretch to suppose that the values they advocated for would not permit intentionally engineering the climate as a quick solution to the damage that we have so far done to it. So, injunctions against EAAs based on this line of reasoning might go something like, *it is wrong to act hubristically when affecting nature*, and, *it is wrong and without proper virtue to attempt to dominate nature*. For the purposes of my discussion, anyway, such admittedly truncated oppositional statements will suffice.

## **Upshots**

I will not systematically object to the principles that I inferred from the lately discussed views. The point of all the preceding is to establish that there exist a diverse and large number of views that support absolute injunctions against geoengineering for, at first sight, very compelling reasons. Rather than attempt to deal with each one individually, then, I will advance my own views and develop justifications for them that should then justify my rejection of any of the foregoing absolute prohibitions on

geoengineering; viz., if my arguments are sound, then they simply entail in virtue of that that the foregoing principles are false, one way or another. I will do that now.

## Section 3: Consequential Principles

In this section, I will explain the normative principles that guide my argument, then deliver my argument in favor of geoengineering under certain conditions. As suggested by the title, I will be arguing a consequentialist view. Consequentialism is a class of moral theories that holds that the moral rightness or wrongness of an act (or rule) is decided by its consequences and only its consequences: an act is right if and only if it yields better net consequences than any alternative. That initial rough formulation must be made much more precise, and of course various consequential theories serve to do this; the most famous of these is Utilitarianism: the view that happiness is the only good, pain the only bad, and the two are opposite ends of a scale reducible to the single unit *utility* such that the total amount of happiness brought about by an act minus the total pain equals the net utility, and in turn the degree to which the action is right, or better than any alternative.<sup>29</sup> My argument will not be a fully utilitarian one, though it should probably be compatible with utilitarianism. I will admit that there is some epistemic ambiguity regarding the ultimate axiology of our world. The precise nature of value, whether value as a broad category admits of different irreducible kinds, and whether various (possible) kinds of value and disvalue are additive and subtractive are all deeply uncertain. For example, is there a quantity of knowledge that is equal to seven days of happiness? — or, is there an amount of biodiversity in a rainforest that is worth more than the cultural values held by a people

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<sup>29</sup> There is some disagreement over the nature of rightness and wrongness of actions in consequentialism due to, among other things, the unknowable nature of all consequences. For further discussion, see: Alastair Norcross, "Good and Bad Actions," *Philosophical Review*, Vol. 106, 1997

who must log it to graze their cattle? Such questions are vexed and deeply frustrating, especially for those in the environmental community. In addition to these complications about kinds of value, the degree of obligation and quantity of good that must be caused are contentious matters. For instance, some utilitarians are maximizing utilitarians: they think one is obligated to produce the greatest amount of happiness one has the ability to. Others believe that simply choosing the option in which the least suffering occurs and more pleasure occurs is sufficient for rightness (even if there exist only options wherein a net total of suffering occurs, like the classic trolley problem).

Rather than adjudicating among the various species of consequential theory and then applying the correct one to the problem at hand, I will develop a few consequentially grounded principles relevant to EAAs, and then discuss their relative merits and the degree to which they are preferable to the foregoing discussed principles. In this way, the strategy in my argument is to build up to consequentialism from more practical grounds, rather than bluntly asserting that consequentialism is true and then deriving the practical principles from the ideal theory. However, in order to be grounded by at least a few ideal moral principles, I offer the following sketch of my moral theory.

As stated, consequentialism is a family of theories that hold in common that the morality of an act (or of a rule guiding an act) is decided by its consequences. There is some disagreement about whether it is the *actual* or the *expected* consequences that fix the act's rightness or wrongness.<sup>30</sup> In this thesis, I hold that the *goodness* or *badness* of an

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<sup>30</sup> This is a terminological proposal that is quite common, and goes back at least to Mill's view in *Utilitarianism*.

act is decided by the actual consequences, but the *rightness* or *wrongness* of that act, insofar as the praise or condemnation of an agent is concerned, is fixed by the expected consequences.<sup>31</sup> This terminology is not universal, but it is well understood enough and captures many reflected-upon intuitions well enough to warrant its use here.

This set of criteria will function as follows: an act A is morally best if it causes the best net consequences (often considered in terms of wellbeing) for all the individuals affected.<sup>32</sup> It is worse if it fails to do this, and worst if it should cause a net total of bad consequences (or suffering). An agent S who performs A is right to do so if and only if S is justified in believing that A will produce better consequences for all involved. This means that an act can turn out to be good for the world but was wrong to do, and vice versa. Given that the *actual* consequences of an act are unknowable until it has been performed, the locus of moral evaluation for an actor's decision is her epistemic situation prior to acting. Doing something that seems overwhelmingly likely to produce good consequences but ends up by some fluke yielding bad ones does not render the actor blameworthy. As this criterion depends strongly on the aforementioned epistemic position, a word on that topic is necessary. I will suppose a broad evidentialist justificatory view. For S to be justified in believing P, S must have some evidence E that

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<sup>31</sup> Sinnott-Armstrong, Walter, "Consequentialism", *The Stanford Encyclopedia of Philosophy* (Winter 2015 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/entries/consequentialism/#WhiConActVsExpCon>

<sup>32</sup> Two important controversies that I must elide for brevity and also because they are just entire theoretical issues of their own: First, what counts as good consequences is vexed, but I will simply hold that wellbeing is most important here — other things like preserving the natural world are considered good things too; Second, the beings whose wellbeing I am concerned with includes human beings, but also for most consequentialists, all sentient creatures. I will, for the purposes of my thesis, discuss humans primarily. As an aside, however, you should really stop eating animals.



supports belief in P.<sup>33</sup> In the case of EAAs, such evidence often comes via scientific and statistical methods. These admittedly rough criteria should all the same be enough to justify the moves I make in what will follow.

I can now turn to develop my principles.

**Principle 1: EAAs are not different in moral kind from other “accidental” forms of earth alteration.**

As I have argued elsewhere, there already presently exist acts of geoengineering occurring accidentally.<sup>34</sup> Actually, the degree to which these acts can be accurately called “accidental” is dubious. As most everyone is aware of the warming effect greenhouse gasses have on our atmosphere and global climate, the continued use of fossil fuels and continued consumption of methane-producing animals are in many respects a form of geoengineering. Perhaps oil and gas companies do not have the primary goal of altering the global climate, but they certainly cannot be unaware of this feature of their industries.

Some moral clarification is in order. Consider two scenarios: in the first, an agent *S* commits a morally wrong act  $\Phi$  intentionally and with knowledge of its most probable consequences. In the second, an agent *R* commits  $\Phi$  with knowledge of its consequences, but to a different intended end than *S* had had in mind. I take it to be a plausible principle that there is no relevant difference in responsibility each actor must

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<sup>33</sup> Matthias Steup, "Epistemology", *The Stanford Encyclopedia of Philosophy* (Fall 2017 Edition), Edward N. Zalta (ed.), URL = <<https://plato.stanford.edu/entries/epistemology/#EVR>>

<sup>34</sup> Lorenzo Nericcio, "Examining the Implications of the Tollgate Principles for the Governance of Geoengineering," *Ethics Policy & the Environment* 21, (2018)

bear for her actions. Suppose *S* kills a dog for fun, and then eats it. *R* on the other hand kills it because she wants to eat it. In either case, the dog endures horrible pain and is denied the remainder of its probably quite pleasant existence – and further, both *S* and *R* are fully aware of this harmful consequence. While we might find *S*'s moral character more repugnant, it seems reasonable to conclude that in each case the act was quite wrong, and perhaps even equally wrong. Either way, there is no good reason to believe that *S*'s action and *R*'s are fundamentally different kinds of action. Both result in the painful death of a dog and are done with full knowledge of this result. I will call this the principle of *single effect*, as it is clearly just the denial of the doctrine of double effect (which is the view that intentions matter even when known consequences are the same). I believe the same principle carries over to the case of unintentional-but-known geoengineering.

Consider such cases of “accidental” geoengineering in view of some of the previously described normative constraints. The continued use of fossil fuels violates Dale Jamieson's 4<sup>th</sup> condition – that altering the climate ought not violate any systematically held ethical norms; and the second Oxford Principle – that public participation is required for geoengineering decision making. Many people hold the value that we ought not contribute to potentially catastrophic global warming by continuing to burn fossil fuels, and the public certainly were not involved in the decision making processes that lead to fossil fuels being the primary energy source for industry, which violated each principle respectively.<sup>35</sup> Worse still, now that accidental

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<sup>35</sup> I guess you might say they “voted with their dollar” but I don't think that's very plausible given that their choices were limited at the time of oil, gas, and coal's development.

geoengineering is already underway, there is no compensation scheme being widely developed and deployed to assist those who will bear the worst of the consequences. And if one considers not the consequences but the moral character of the actions taken, any large corporation or group of people that can afford not to burn fossil fuels but continues to do so is acting in a disrespectful way toward those who are likely to be affected by the deleterious results of global warming. According to *single effect*, there is no relevant difference between all of these ill effects of global warming, and any that might result from intentional geoengineering.

Understanding the moral equivalence of “accidental” and intentional EAAs has the consequence that they must be considered the in the same way when restrictions are being developed. That is, if one believes that geoengineering is wrong in virtue of its being disrespectful, or because there is not a democratic decision making procedure behind its implementation, they must also hold that these are problems for everyday industries that happen to be altering the earth’s climate knowingly. This does not speak to what exactly ought to be done, however. For that, I will need to explore further principles.

**Principle 2: governance of EAAs need not be different from governance of other public goods that have potential costs.**

In much of the scholarship discussing geoengineering, climate-altering acts are considered in a moral class of their own. Jamieson, Hale & Dilling, and the Tollgate

Principles' authors all seem to refer to them this way.<sup>36</sup> However, I have argued that such acts are not of a fundamentally different moral character to other forms risky person-affecting action (unintentional geoengineering). By fundamentally different moral character, I mean something like the following. Suppose that one can distinguish something different in *kind* between the act of lying to their mother and the act of kicking a cat. Perhaps both are wrong, but they seem to be wrong for different reasons. (Of course, there is also reason to deny this; a utilitarian will just point out that both actions cause pain to their victims.) Whether there are fundamentally different normative categories requiring independent analysis and respectively attendant injunctions is a complicated matter. For the purposes of my argument, I hold only that geoengineering is no different in kind from, say, mass agriculture, fossil fuel use, building a housing development, international trade deals, planning a conservation scheme, logging a forest, etc., as these are all simply different kinds of EAA.

To justify this, consider the cases reviewed in my discussion of Principle 1. If one accepts *single effect*, then any act that has similar effects to geoengineering that are known by their perpetrators will be subject to the same kind of moral evaluation. Whatever that evaluation turns out to be, the requirements for governance will turn out to be the same. That means that whatever one holds about any other large governed practice should hold for EAAs.

This may seem trivial or obvious, but I don't think that it is given the nature of extant scholarship on the matter. Something about the novelty of this technology — or its

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<sup>36</sup> Actually, elsewhere Hale does acknowledge and discuss the moral distinctions among various kinds of EAA; but the kind of principle developed in his work I've cited here is still subject to my critique, I think. (See "Remediation vs. Steering" in *Designer Biology* 2013.)

scope of application – imbues discussion of it with an apocalyptic character. While it is true that the scope of effects are large, and that the reason anyone even wants to do it is because global warming is going to cause massive catastrophe in the next hundred or so years, the moral principles that govern it need not be of a fundamentally new kind. Thus, requiring universal global consent in this case but not in the case of, say, the continued production of animal meat or continued use of cars for mass transit is inconsistent. The sorts of governing measures that authors require for geoengineering could easily be turned around to govern these other acts. There are two moves at that juncture. One could take it as a *reductio ad absurdum* of the more stringent objections to geoengineering, or else they could simply accept that presently the regulatory landscape is not nearly restrictive enough. Indeed, before building a power plant or new car factory, governments *should* have to consult the natives of low-lying coastal areas globally. Once one appreciates the scope of such injunctions and requirements, I think she ought to reevaluate the principles that support them. Thus, while Principles 1 and 2 are intended to show that intentional EAAs are not fundamentally different from ones that merely have the side effect of altering the earth in some way, and so whatever one believes about governance in one cause ought on pain of inconsistency apply to the other, my second two principles will serve to expound upon what I believe the principles underlying restrictions and governance ought to be. To aid in this I will include some topical thought experiments based upon implementations of the technologies discussed in my first section.

**Principle 3: the degree to which an EAA is wrong is a function of its expected consequences.**

Principle 3 is not just a statement of consequentialism; I do not say that degree of wrongness is *only* a function of expected consequences. In my argument for Principle 4, I will explicitly argue against anti-consequential constraints on geoengineering. For now, consider Principle 3 to state the conclusion to the following argument.

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- (1) The expected consequences of an act  $\Phi$  are at least morally relevant to its rightness or wrongness.
- (2) Different consequences of an act  $\Phi$  result in different degrees of wrongness; rightness and wrongness are functions (at least) of consequences.
- (3) Different forms of EAA have different expected consequences.

*Therefore,*

- (4) The degree to which an EAA is wrong is a function of at least its expected consequences.

Whatever one's theoretical moral commitments, it seems deeply implausible to state that the consequences of an act are *entirely irrelevant* to its rightness or wrongness. I take such views to be plainly and uninterestingly wrong and not worth entertaining. Premise (1) simply states that the rightness or wrongness of an act  $\Phi$  is at least sensitive to the consequences of that act. One need not accept that they are the *only* conditions relevant to rightness or wrongness (which would just be consequentialism); perhaps rights violations or instantiating a virtue also are added to one's total moral considerations. All the same, if an act results in the predictable deaths of 1000 people, it seems uncontroversial to say that that is at least a morally important feature of that act, whatever spirit that act is done in.

Premise (2) is more controversial. It implies that rightness or wrongness is a scalar feature of an act rather than a binary one. This is relevant though not essential to my argument, but in any case I think it is probably true.<sup>37</sup> In a clear sense, killing 1000 people is worse than killing one. If one wishes to maintain that right and wrong are absolute binary terms, they may satisfy themselves to simply think of morally preferable and less preferable outcomes in such cases. Either construal works for my argument.

Consider the following cases for comparison. Assume that Great Green Wall program discussed in Section 1 has the effect of positively changing the global climate, however slightly. There will be, at the end of its planting and the growth of the trees and plants, *that* much less carbon in the atmosphere than there would have been had the Wall not been planted. Furthermore, if the project is successful, the climate in the areas near the wall will be affected. Forests are likely to affect rainfall patterns, for instance.<sup>38</sup> The *kind* of effect this will have is sufficient to trigger the conditions listed in Jamieson, Oxford, and Tollgate, and any compensation account (consider that the increased rainfall results in flooding that ruins someone's crop). However, if the claims listed on the project's website are to be believed, the benefits are expected to be many and significant: the Wall will contribute to the local economy by providing new, green jobs, prevent desertification, which increases crop yields, empowers women with new opportunities, increases resilience to climate change, and increases interfaith and cross-

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<sup>37</sup> Again, see the Norcross 1997 article cited earlier for more on this.

<sup>38</sup> Douglas Shiel & Daniel Murdiyarso, "How Forests Attract Rain: An Examination of a New Hypothesis," *BioScience* 59: 4, 341-347. (April 2009).

cultural harmony through collaborative efforts on the construction and maintenance of the wall.<sup>39</sup>

Another case is that of SSIs, also discussed in Section 1. There are, of course, benefits and burdens to this approach to climate engineering as well. More briefly (return to Section 1 for a full discussion of the likely outcomes), the benefits are that the global temperature is likely to decrease, offsetting some, but not all, of the effects of global warming. A burden is that sulfur dioxide is known to deplete ozone, and it is unclear the extent to which this will happen with SSIs. We may interpret that risk as a substantial burden, as the effects of depleted ozone are quite dangerous.

Imagine that you are a member of a panel organized to govern instances of EAA. If you are not sensitive to the conclusion of argument EC above, your verdict on each instance of earth alteration is likely to be the same. That is because any principle that does not recognize the scalar nature of EAAs will be forced to consider anything that has the effect of altering the earth's climate as the same kind of action. However, it is clear that in the two examples described just now, the scope and scale of the projects vary widely, and the sum total of their respective expected consequences are vastly different. While the Great Green Wall will likely not have any tangible effect on the inhabitants of, say, Seattle, SSI's very well might. Additionally, the deleterious consequences yielded by the Wall are likely to be significantly fewer and less severe than the deleterious consequences possible if SSIs are implemented. These features of each program must be evaluated if the morally optimal result is to be reached. Thus,

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<sup>39</sup> "2030 Ambition," *Great Green Wall*, URL = <<http://www.greatgreenwall.org/2030ambition>>



any principles that fail to recognize that acts of geoengineering admit of degree of moral seriousness are incorrect. This may seem so obvious as to not be worth stating. No doubt the authors of geoengineering ethics papers discussing SSIs and ocean fertilization will reply that they don't consider cases like Zimov's Siberian experiment or the Great Green Wall because they are not legitimate cases of geoengineering. But this belief, held or not by those authors, is not clearly a component of the moral principles they arrive on. As stated before, both of those smaller scale ecological projects have the right kinds of effects necessary to trigger the Oxford, Tollgate, and other principles. They might even violate norms of environmental virtue. Thus, though perhaps seemingly obvious, this point must be stated. And the moral principles developed to govern EAAs really ought to reflect that there is not a difference in *kind* among EAAs. I'll argue more explicitly for that last point in the course of developing Principle 4.

**Principle 4: overwhelmingly preferable consequences ought to overrule other moral considerations.**

This final principle is my most controversial and obviously my most aggressively consequentialist. To lend credence to the argument that I will ultimately make, permit me to start by expanding my previous two thought experiments.

Suppose that in 2045 the Great Green Wall is near completion. It has helped lift two million people out of poverty by giving them jobs maintaining the Wall, and by

significantly increasing the amount of arable land in the region, allowing agriculture to expand significantly and allowing communities to thrive in the newly possible farmable regions. What's more, due to certain policy features of the initiative, the relative social status of the poorest in the area has improved; they are now capable of owning their own farms and earning their own substantial incomes. With the improvements to the local economy come expected benefits like improved medical care and education, which have increased the life expectancy and quality of the inhabitants of the Sahel region significantly.

However, in the course of this process, there have been some moral complications. The increased rainfall brought about by the recently forested areas has caused some expectable increases in flooding during rainy seasons. Due to this effect, a few people who otherwise would not have drowned or whose livelihoods would not have been swept away did suffer these fates. The total damage is significantly less, however, than the accumulated goods.

That said, those who were negatively affected by the increased rainfall had opposed the project from the start for that reason. They had suspected that they might (due to their living in low-lying areas, say) become victims of flooding. They had a substantial claim against the project: their right to live in the land they always had would be infringed upon by the increased probability of flooding. They did not consent to the project. Their personal livelihood and autonomy were threatened by the project, and so it disrespected them and their interests.

In light of this tradeoff, the question is raised: was the Great Green Wall the right thing to do?

I think that it very much is right. I believe that it is right in virtue of the good consequences that have been brought about, and in spite of the ill fortune of some due to the plan. I think that this also shows that EAAs that hurt people – of which geoengineering is an extreme example – are not *in principle* wrong, only conditionally wrong.

While it is tragic that in the scenario I laid out, a small number of people died due to excess flooding brought about by the increased rainfall the Green Wall attracted, I do not believe that this loss is enough to say the act was wrong – even if it was foreseen. (If the losses were not foreseeable, then the acts that lead to them were not, on my terminology, *wrong* but instead simply *had bad outcomes*.) As a result of enacting any possible policy scheme, there will occur things that would not have happened if the measure had not been implemented. Consider cases where a policy is an obvious moral good, like the institution of universal public healthcare that saves tens of thousands of people yearly. There might be cases where patient A sees doctor B in the world where the policy is implemented, and that leads to his death due to a mistake on doctor B's part, whereas in the world where the policy is not implemented A sees doctor C instead – at great financial cost – but does survive. This is because of the following. If the authorities analyzing the proposed policy foresee that, should the status quo be kept, a certain number of people will die that is higher than the number of people that will die should the policy be implemented, then in choosing to maintain the status quo,

they are in effect choosing the deaths of the people who die in the status quo scenario rather than the smaller number that die in the policy scenario.

Consider a seatbelt law is implemented in a state, and while thousands fewer people die yearly, there are – by chance of circumstance – people who will die who otherwise would not have. Imagine that someone is leaving their home and takes an extra 10 seconds to put on their seatbelt. In doing so, they end up just barely, by 10 seconds, being on a bridge that collapses – which, had they not taken time to put on their seatbelt, they would have escaped. Such cases clearly do not make the implementation of a seatbelt law impermissible. It is simply unrealistic to hold that a policy morally ought to result in zero instances of suffering or death. Further, there isn't a good moral reason to differentiate between cases where the implementers of the policy know who is being killed and cases where they do not. Norcross 1990 provides convincing arguments to this effect.<sup>40</sup> (Briefly: suppose an evil government wanted to eliminate a portion of its citizens, if they (i) did so by way of random bombing, or (ii) did so by way of death squads who kept a record of those killed, it wouldn't matter. Both are wrong for the same reason (*that people are murdered*); it doesn't matter that in (ii) the names are also recorded.) However, even if such a distinction is held, there is still no such certainty with EAA policy implementation; we simply don't know who will be negatively affected ahead of time.

More germane to the Great Green Wall issue is the result that, given the enormous benefits of choosing to implement that plan, it is morally right to do it. And if

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<sup>40</sup> Alastair Norcross makes this point in "Killing, Abortion, and Contraception: a Reply to Marquis," *The Journal of Philosophy* vol 87: 5, (May 1990), 269.

that is so, and the Wall is an EAA, then there is nothing in principle wrong with EAAs causing some harm. That is, an act being such that it alters the state of affairs of the natural world in a way that it stands to put people at risk is not sufficient for it to be wrong. The Great Green Wall serves as a plausible example of this because it would seem quite wrong to forbid people from constructing it due to the fact that it will plausibly have *some* ill consequences for people. To see whether this sort of reasoning regarding smaller scale cases expands to cases of geoengineering, consider now this thought experiment.

Imagine now a dystopian future; the year is 2075. Global warming has continued as expected, with some unexpected feedback loops exacerbating the process to a greater extent than initial projections had accounted for. Suppose that the temperature has risen by 5 degrees Celsius. Globally, low-lying coastal areas have become submerged as the oceans rise. Entire cities like Mumbai, Miami, London, and Tokyo have lost significant land to the advancing sea. Desertification of land in arid areas has also increased, and vast portions of Africa and South America with large and increasing populations have become completely unusable for agriculture, leading to frequent famines as well as conflicts over water. Summers in the Middle East, North Africa, and American Southwest have become unbearable as temperatures frequently reach 115 degrees Fahrenheit during the day for weeks at a time. Mortalities due to heat-related illnesses rise globally, and many tropical diseases expand their range into temperate zones. Polar bears go extinct in the wild.

Suppose that as this horribleness is going on, the UN convenes and decides that something simply must be done to lower the average temperature on earth. I now invite you at this juncture to consider two possible worlds.

In the first possible world, call it W1, they put it to a vote, and the majority decides that the implementation of SSIs is the best possible option. However, there is a minority of countries who – citing the doctrine of the double effect or the precautionary principle<sup>41</sup> – cannot agree with this decision. Nevertheless, the policy goes through, and UN jets are scrambled to start pumping the atmosphere full of sulfur dioxide. As a result of this decision, over the course of the following ten years, the world’s climate begins to cool dramatically. Of course, the SSIs do nothing to address the actual carbon in the atmosphere or the acidification of the oceans, but no panacea was promised. As global temperatures go down, the rate of desertification in arid regions slows and in some places begins to reverse as rainfall increases, incidents of heat waves begin to decrease both in frequency and severity, and perhaps most importantly the arctic begins to refreeze over, lowering the sea levels globally and opening up land that had previously been inundated. In this scenario, however, there are undeniable downsides. Due to the changes in weather patterns brought on by engineering the climate, some areas become victims of extreme flooding. Further, other areas lose a significant amount of yearly sunlight, reducing crop yields. Holding constant all deaths and instances of human suffering not related to changes in climate, say that in W1 100,000 people die due to geoengineering.

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<sup>41</sup> A full discussion of this principle will be featured in the Objections portion of this thesis.

In W2, the UN decides instead not to enact the plan: there are too many widely held moral principles that are violated in engineering the climate. Instead, they ratify a new pledge to decrease emissions further and encourage nations to provide tax exemption incentives to renewable energy companies. Naturally, this plan is not followed, the US withdraws after a month, and warming continues. Within ten years, seven million people have died due to climate related causes (again holding constant all non-climate related deaths), and tens of millions more are displaced, or else severely inconvenienced.

Of course, I am not saying that this is what will happen. This is only a pair of plausible possibilities. It may be that the world never comes to the way I describe it. All the same, it very well could be that this happens. If it should come to pass that such an emergency decision needs to be made, I argue that there are significant reasons why choosing W1 is preferable. The first reason is this: 6,900,000 fewer people die in W1. All else equal, that seems to be a powerful moral consideration.

Another reason is that it is not clear that the UN in W2 avoids violating non-consequential principles. The reason for this is as follows. Recall Principles 1 and 2 above: **EAs are not different in moral kind from other “accidental” forms of earth alteration, and governance of EAs need not be significantly different from governance of other public goods that have potential costs**, respectively. In my argument in favor of these principles, I did not rely on consequentialist premises. However, they yield results that are compatible with consequentialism and so favor the situation with better consequences. The UN has a decision to make and a body of

knowledge to draw from in my thought experiment. In my argument for Principle 1, I concluded that knowing about the effects of continuing on our course of emitting fossil fuels and changing the climate, and yet continuing to do so, is not morally different from intentionally changing the climate. Further, policies governing these EAAs must be, on pain of inconsistency, the same for each case. So, in W2, the UN chooses knowingly to continue on a path (however half-heartedly slowed by attempted regulation) that will result in a changing climate. This action violates the rights, if any there should be, of those who are subject to the disasters brought about by continued global warming. I believe that even if one is not a fully-fledged consequentialist, accepting that consequences matter is sufficient to guarantee, provided my preceding principles, that there exist cases where consequences ought to overrule other moral considerations. This is for two reasons: (1) for any case where a choice must be made between outcomes both of which lead to bad consequences, many reasons *against* geoengineering can be construed in favor of it, as I have just done when stating that choosing not to geoengineer in knowledge of the effects that will have is a violation of the rights of those who will be killed by the continually warming climate—a consequence of accepting *single effect*; and (2) as I’ve just done, for any principle against geoengineering, I can come up with a ridiculous number of people that will die if it is not implemented and say that in that case it is clearly right to implement in spite of that principle.<sup>42</sup>

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<sup>42</sup> This is just an instantiation of a family of objections to absolutist views (sometimes called the Paradox of Deontology: <https://plato.stanford.edu/entries/ethics-deontological/#WeaDeoThe>): put crudely, would a deontologist seriously object to violating the rights of one individual if doing so meant saving seventy trillion people from slow and torturous deaths (for example)?



To establish this further, first observe what has been already argued: If the foregoing arguments are correct, then there is nothing *in principle* wrong with geoengineering.<sup>43</sup> That is, though one might hold that killing an innocent person for no reason is in principle wrong (and so an injunction against this act does not need further justification), I have sought to show that changing the earth's environment is not in principle wrong. This is most clearly true in the cases of minimal EAAs, like the Great Green Wall or resurrection of the mammoth steppe ecosystem. These serve to change the course of earth's climatic processes, but do so in such a minimally invasive way that it cannot be justifiably disallowed. Similarly, perhaps one person's use of her car on her morning commute is not impermissible. The degree to which she is changing the global climate is so small as to be negligible, both chemically and morally. If we can accept that EAAs are not *in principle* wrong, then there must be other features of its manner of implementation that are what causes its wrongness in cases where it is wrong.

One concern germane to the principles developed by Jamieson, Hale, Gardiner and Fragnier, and others, is that geoengineering will be carried out in a fascistic or authoritarian way.<sup>44</sup> For perhaps obvious reasons carrying out any wide-spread public policy through fascistic or authoritarian political mechanisms is morally reprehensible, and something that changes the very nature of the earth's climate even more so. But, there are probably other ways that a governing body or other institution of power can implement policies that a significant proportion of people disagree with without it constituting a violation of morality.

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<sup>43</sup> Or, if there is, then it is just as wrong to convert grasslands into farms or drive one's car to work or paint roofs white, etc.

<sup>44</sup> I also owe this consideration to a conversation with David Boonin, CU Boulder.

One comparison case is the fluoridation of water. Many nations add fluoride to their water supply in order to prevent cavities in their populations. And, according to the CDC, it seems to work quite well as a public health measure.<sup>45</sup> Overall incidence of cavities is much lower than it otherwise would be, which also leads to other health benefits associated with improved dental health. Many people are unaware of the fluoridation of their water, however, and would likely object to this practice if they did know, despite its being overall beneficial both to themselves and to others in their community.

Perhaps a famous and frustrating example of this irrational resistance to public health measures is borne out in the anti-vaccination movement. There exists a small but vocal minority of silly people in the US who oppose vaccination of children on the grounds that it causes autism (and other health issues, like sudden infant death syndrome).<sup>46</sup> In this case, it seems reasonable that violating the bodily autonomy, for instance, or consent of those who would refuse vaccination is permissible on the grounds that they are endangering others through their refusal. Vaccines work best when a significant proportion of the population is vaccinated. By lessening that number, they increase the chances that viruses will gain a foothold in a population once more, and that those who are unable to be vaccinated for one reason or another are

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<sup>45</sup> "Cost Savings of Community Water Fluoridation," *Centers for Disease Control and Prevention*, (June 21, 2018), URL = <<https://www.cdc.gov/fluoridation/statistics/cost.htm> >

<sup>46</sup> German Lopez, "Why do some people oppose vaccination?" *Vox*, (August 21, 2018), URL = <<https://www.vox.com/2018/8/21/17588104/vaccine-opposition-anti-vaxxer> >

made vulnerable to viruses once again.<sup>47</sup> Vaccines are not currently forced on the population, but many schools, for instance, disallow students to be enrolled without being properly vaccinated. This is more obviously plausibly permissible than *forcing* vaccines on people. However, the move from the moral justifiability of forcing fluoridated water on people to requiring vaccination does not seem a stretch.

In these cases, it must be that there is some intervening principle between those of consent that seem plausible in some of the restrictions on geoengineering I discussed, and the permissibility of forcing fluoridated water and vaccines on people. So, perhaps a plausible candidate intervening principle is this:

*PG: Violations of moral norms are permissible in cases where failing to do so would seriously compromise the public's claim against harm.*

PG is a consequential-compatible principle, but does not entail the truth of consequentialism. I can further support it through a simple thought experiment. Suppose that one person has contracted a very serious and extremely contagious plague for which there is an easily administered cure that requires only one injection. This person refuses treatment due to a skeptical attitude toward Western medicine and a hatred of the government. He also refuses to quarantine himself, and insists on going about his daily habits, which include going to the grocery store and carefully examining the produce there, then getting on a crowded bus, and heading to a public park and greeting people he passes while stopping to drink at every drinking fountain. In such a case, it is *prima facie* plausible to state that whatever moral norms require that he be

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<sup>47</sup> Frighteningly, this has already begun happening to at least some degree: Alexandra Sifferlin, "4 Diseases Coming Back Thanks to Anti-Vaxxers," *Time*, (March 17, 2014), URL= < <http://time.com/27308/4-diseases-making-a-comeback-thanks-to-anti-vaxxers/> >

allowed full bodily autonomy ought to be overridden here. It seems right to say that law enforcement and health professionals would be doing the right thing by apprehending him and forcing the injected cure upon him, or at least quarantining him against his will. In fact, there already exists a common practice of quarantining people who are infected with highly contagious diseases.<sup>48</sup> Presumably this is legal (and also morally permissible) in virtue of the good public benefit it brings about.

To the extent that that appears to be morally right, we have some clear justification for violating norms like consent and bodily autonomy in cases where the public would greatly benefit, or rather, would avoid some serious harm. It may come to pass that the earth's climate poses a significant risk to a vast number of people. Tropical diseases may spread, ecosystems may move northward or higher in elevation, and agriculture that depends on the current state of the climate may become impossible in its current locations. Without serious adaptation and mitigation efforts, the effects of such climatic changes will be disastrous. If those efforts to adapt and mitigate damage should fail – and a sober appraisal of global politics may yield that such a grim prediction is not overly pessimistic – there may yet come a point where the health and safety of a huge proportion of the world's population is reliant on some sort of mass geoengineering scheme. It would, I hold, be a horrible moral crime to insist that such a scheme is impermissible on the grounds that it violates norms like universal consent, acting virtuously, acting before an adequate compensation scheme has been developed, or otherwise. Put more bluntly, if your child caught the plague that the man in my

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<sup>48</sup> "History of Quarantine," *Centers for Disease Control and Prevention*, (July 31, 2014), URL = <<https://www.cdc.gov/quarantine/historyquarantine.html>>

thought experiment carried, it would be neither of comfort nor a suitable explanation to say that the cure could not be forced upon him because he did not want it. It would be analogously awful to have to tell the beleaguered inhabitants of a flooding coastal community that the climate could not be altered to save them because there was a portion of the population that remained skeptical about intentional climate alterations and so did not consent. I think that, if I were to tweak the numbers in my thought experiment a bit—say that two million people will die as a result of the sick man's plague—it would become plainly justifiable to kill him, were that the only option. So, even if the deaths of a few thousand people were to be caused by geoengineering, there would remain good reason to implement it if millions more would be saved from catastrophe they would otherwise experience.

## Section 4: Two Objections

The structure of this thesis is an objection to anti-consequential conditions on the permissibility of EAAs, and to provide my own principles that support consequential moral evaluations. I will now consider further objections to consequential evaluations more broadly.

### **The precautionary principle**

One decision-making tool relevant to geoengineering is the precautionary principle. Perhaps frustratingly, there is no single straightforward statement of the principle.<sup>49</sup> Generally, it is employed in situations where outcomes of an action are uncertain but plausibly *could* lead to disaster. Basically, attempts to develop the precautionary principle hope to codify the intuition in the thought *better safe than sorry*. In the case of solar radiation management, Lauren Hartzell-Nichols develops a set of precautionary principles intended to regulate this technology.<sup>50</sup> Her general claim is that it should only be used when the threat of catastrophe is clearer and greater if SRM were *not* implemented. This is, however, a more permissive take on the issue than other precautionary ones and also basically just what I'm arguing here.

The European Union, alternatively, has a more conservative take on the principle, stating that: "Where there are threats of serious or irreversible damage, lack

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<sup>49</sup> Stephen M. Gardiner, "A Core Precautionary Principle," *The Journal of Political Philosophy*, Vol 14: 1, 33 – 60, (2006).

<sup>50</sup> Lauren Hartzell-Nichols, "Precaution and Solar Radiation Management," *Ethics, Policy & Environment*, Vol 15: 2, (June 2012).

of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.”<sup>51</sup> The strong version of this principle can be understood as something like the following:

*Where there are threats of serious or irreversible damage, lack of certainty should not prevent action to stop that irreversible damage.*

The principle was originally intended to curb processes that might (though not certainly) harm the environment or public health, like the use of genetically modified organisms in food. It could be turned toward geoengineering, however. There is a threat of serious and irreversible damage associated with changing the planet’s climate and ecosystems. It could very well happen that we trigger a new ice age, or that some ecosystems will collapse causing a domino effect and ruin global agriculture, or cause the ozone to dissipate and everyone on earth to get skin cancer.

The problem with this kind of precautionary approach, which Hartzell-Nichols’s principles address, is that there is also the very real possibility that all those things will happen even if we *don’t* geoengineer. The processes that humanity’s current actions are affecting are just as uncertain and poorly understood as those that might be affected if geoengineering was used. The precautionary principle, whatever its formulation, is intended expressly to deal with uncertainty: situations where the odds of an event occurring are not known. That means that, necessarily, a decision to let the world continue to warm, or to not implement any geoengineering technologies, is also subject

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<sup>51</sup> “Future Brief: The precautionary principle: decision-making under uncertainty,” *European Commission: Science for Environmental Policy*, Issue 18, (Sep 2017). URL = [http://ec.europa.eu/environment/integration/research/newsalert/pdf/precautionary\\_principle\\_decision\\_making\\_under\\_uncertainty\\_FB18\\_en.pdf](http://ec.europa.eu/environment/integration/research/newsalert/pdf/precautionary_principle_decision_making_under_uncertainty_FB18_en.pdf) >

to the precautionary principle, as we still do not know the full extent of effects that will come about as a result of the climate's warming.

This might serve as a sort of *reductio* of the principle more generally, as understood broadly enough, it might be sufficient to prevent any action by anyone at all whatsoever. After all, sitting at my desk, it could very well happen that a truck drives through my window and runs me over. I am uncertain about the likelihood of this event, and for sure it would be catastrophic, so my lack of certainty should not prevent my acting to prevent its coming to pass. But clearly that seems far too restrictive. It might even come to nonsense if one considers that no matter what they are doing, there is a chance an airplane or a truck or an asteroid might fall on their head.<sup>52</sup>

Understood more weakly, as some have proposed, the principle does not seem to state much of anything at all. Daniel Steel considers these ways of stating it: "Weak versions of PP assert that scientific certainty of impending harm should not be a precondition for precaution. Another way to put the same idea is to assert that precautions in the face of uncertain environmental hazards are permissible."<sup>53</sup> These are truisms. Scientific certainty is, along with any other form of epistemic certainty, probably impossible. All actions are taken under some degree of uncertainty. So, a weak version of the principle does not seem to guide action in the case of EAAs any more helpfully than does a strong version. Until a more robust and consistently applicable version of the principle is developed (and whether that can even be done is, perhaps,

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<sup>52</sup> Cass Sunstein makes a similar point in "Beyond the Precautionary Principle," *University of Pennsylvania Law Review*, Vol 151: 1003, (2002)

<sup>53</sup> Daniel Steel, "The Precautionary Principle and the Dilemma Objection," *Ethics, Policy & Environment*, Vol 16: 3, (2013).



doubtful), I think that relying on it as a source of objection to geoengineering is not a fruitful path.

### **Killing and letting die**

A specter that has loomed over my argument thus far is the distinction between killing and letting die, or action and inaction, more broadly. All of the principles that I've developed thus far, insofar as they support my final consequential view, rely on its falsity to some extent. So, an obvious point of objection then is simply to hold that the distinction is not false: that there is in fact a significant moral difference between killing and letting die, between action and inaction. If that's the case, then perhaps continued use of fossil fuels can be understood as a kind of inaction. Perhaps there is actually something worse about committing the action of altering the earth's climate than there would be if we simply let it continue to warm and worsen, as is the status quo. It may seem implausible at first pass, but there might be some reason to this view. So far as any reasonable sense can be made of a distinction between action and inaction, it's at least sensible to say that thus far humanity has continued on a path that makes use of fossil fuels to power our industries, industries that we require in order to keep the normal progression of life and civilization. Keeping on this "business as usual path" is a sort of lack of action. Attempts to curb emissions through slow and steady divestment from fossil fuels may also be construed as not violating some injunction against positive climate action, as all humanity is doing in that case is ceasing to do the thing that has caused the problem in the first place. If I were ruining your garden by dumping my

trash into it, perhaps it would be morally preferable for me to stop doing this so regularly than it would be for me to hire a crew to come by once a week and clean up all the trash I dump. So, in the case of climate, even if the outcomes would be overall better if geoengineering were deployed – your garden would be cleaner if a crew were picking up the trash regularly – it is still morally preferable to turn to less invasive measures to improve the climate because the positive action required to geoengineer is not permissible where ceasing to use carbon is.

My first response to this objection is to state that it is false. There is no reasonable basis on which to make a distinction between action and inaction, as the choice not to act is itself an action, so any statement to the contrary is stuff and nonsense. There is a large body of scholarship on this distinction and not much consensus except among those on each side of the opposing camps. I will not try to adjudicate this debate as that is beyond the scope of this thesis. Instead, and without just rejecting the distinction out of hand, I will argue that, *at least in the case of geoengineering*, failing to implement it is a positive action. That is for the plausible epistemic reasons discussed before.

Imagine the case of an alcoholic who has a choice put before him. He can attempt to stave off his addiction with traditional methods that have thus far failed him repeatedly, or take an experimental drug that will likely end his alcoholic cravings. This drug is, according to all the data thus far produced, quite safe. There are some known side effects, but the nastiest of these are only very remotely likely to occur – though it would be catastrophic if they did. If the alcoholic man continues to drink, he will slowly ruin his life even further than he already has done. His wife has vowed to leave him if

the problem continues to worsen and has a social worker and lawyer standing by waiting to take custody of their children. He has already been fired from several jobs and stands little chance of keeping another without ending his illness. After several attempts at talk therapy and group counseling, during the course of which many pledges to stop or dramatically reduce drinking by a certain date were made, he is hardly less troubled than he was upon starting. In discussion with his family and therapist, it seems he has two choices: either try out the experimental drug, or try again to make a pledge to quit drinking.

In case you missed it, the alcoholic man is civilization, and alcohol is fossil fuels. The experimental drug is geoengineering. Again, I don't think we are presently to the point where geoengineering is the best option available. The alcoholic man is much further gone than we are just yet. Suppose him to be an analogy for civilization in 2100.

There is a clear sense in this case that choosing not to take the experimental drug *is* a positive action, whatever one's general view on action and inaction is. He knows full well that the usual, less invasive measures have not helped in the past. A choice to use those measures made in good faith and with knowledge of their overwhelming likelihood of failure couldn't possibly be anything other than a positive choice to continue being addicted. In a case where we understand the repercussions of not implementing some geoengineering scheme and yet choose not to, I think the result is the same. That is a positive choice to bring about worse consequences — which, obviously, is wrong.

## Section 5: Concluding Discussion

I will now take a moment to consider what I hope I have established, and what distinguishes my view from other treatments of the issue. First, I have identified that geoengineering falls within a broader category: earth-altering actions. EAAs are actions that in some way change the state of the natural world. Considering geoengineering as an extreme end of this scale throws light on the best ways to morally appraise it. Rather than considering geoengineering a brute category of action with its own attendant moral limitations, as it seems some authors are prone to do, I hope to make more nuanced the discussion pertaining to this emerging technology by observing that technological interference with the earth's natural processes come in degrees of severity. No adequate moral account of geoengineering and related efforts can be had without recognition of this fact.

Second, I have argued that the best way to distinguish the morally different kinds of EAA is by taking into account their respective expected consequences. Recreating a Pleistocene ecosystem in Siberia has different expected outcomes than building carbon-sucking machines, but both are undeniably earth altering in significant ways. The moral judgments made about each act should reflect these differences in expected outcomes. I also hope to have convincingly argued that, once the forgoing is established, and it is seen that geoengineering does not significantly differ from any other kind of action that stands to affect many people, sufficiently beneficial consequences are enough to override other moral considerations, even if one remains

skeptical of the truth of consequentialism qua ideal moral theory. This is because, due to the nature of climate change, choices not to act in situations where catastrophe is imminent are positive choices for worse expected outcomes than those expected if some form of geoengineering is used (provided, of course, that the expected outcomes are in fact better in the latter case). These considerations hold up against two objections to consequential moral methods in general, the Precautionary Principle and distinction between killing and letting die, as the former is not well-formed enough to be informative, and the latter is either wrong outright or simply not applicable to the situation given that our state of knowledge is such that considering failing to act in the case of a climate catastrophe an *inaction* (of the purportedly morally distinct kind) is profoundly implausible anyway. In sum, acts of geoengineering: (1) are not different in kind from other acts that change the environment in some way and so (2) should not be governed differently, (3) have expected outcomes that are of essential importance in deciding what the morality of implementing a given scheme might be, and (4) are permissible if sufficiently net-beneficial to enough people, even in spite of other moral norms and constraints.

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