**The Tollgate Principles for the Governance of Geoengineering:**

**Moving Beyond the Oxford Principles to an Ethically More Robust Approach**

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**Abstract**

This article offers a constructive critique of the Oxford Principles for the governance of geoengineering, and proposes an alternative set of principles, the Tollgate Principles, based on that critique. Our main concern is that, despite their many merits, the Oxford Principles remain largely instrumental and dominated by procedural considerations; therefore, they fail to lay the groundwork sufficiently for the more substantive ethical debate that is needed. The article aims to address this gap by making explicit many of the important ethical questions lurking in the background, especially around values such as justice, respect and legitimacy.

It is widely accepted in the scientific community that climate change poses a severe threat to current and future generations, as well as to the rest of nature (IPCC, 2014).[[1]](#footnote-1) Nevertheless, the countries of the world are not currently on track to meet their stated goal of avoiding dangerous anthropogenic interference with the climate system (UNFCCC, 1992), understood in terms of the internationally agreed targets of limiting average global temperature rise to 2 degrees Celsius and pursuing efforts to achieve 1.5 degrees (Climate Action Tracker, 2015; UNFCCC, 2015; UNEP, 2017). Moreover, the political prospects for further robust action remain questionable. Consequently, many scientists are concerned that in practice deliberate large-scale technological interventions into the climate system (‘geoengineering’) are already, or may soon become, unavoidable if the 1.5 or 2 degrees targets are to be met (Anderson & Peters, 2016; Bawden, 2016; Shepherd, 2016; EASAC, 2018; Kriegler et al., 2018). At the same time, it is generally recognized that a drive towards geoengineering would have serious social implications, that “ethical considerations are central to decision-making in this field”, and that “analysis of ethical and social issues associated with research and deployment” should be a central research priority (Shepherd et al., 2009, pp. 39, 53).

One of the earliest interventions comes in the form of the ground-breaking Oxford Principles (Rayner et al., 2009; Rayner et al., 2013), which remain influential.[[2]](#footnote-2) In this paper, we build on the Oxford proposal, focusing on its ethical dimensions and in particular the ethical adequacy of its framing of geoengineering.[[3]](#footnote-3) First, we offer a detailed constructive critique of the Oxford Principles. Second, we propose an alternative set of principles based both on that critique and also on some standard work in practical ethics. We name these ‘the Tollgate Principles’, in part after the village pub in which the guidelines were originally developed, but also because in our view respecting the principles is “the price that must be paid” by any attempt to frame and introduce an ethically defensible geoengineering policy.[[4]](#footnote-4) One upshot of the Tollgate Principles is that geoengineering becomes a much more ethically-demanding enterprise than is often suggested. This has implications for how geoengineering policy is likely to evolve and especially for the prospects for “ethical geoengineering”.

**I. The Oxford Principles**

One approach to generating principles is broadly “bottom-up”. It proceeds by identifying the ethically salient features of geoengineering based on existing reports, experience from related cases, and so on. Another approach is broadly “top-down”. It confronts the issue of geoengineering from the perspective of foundational or mid-level theory (e.g., in moral philosophy, international political theory, global justice, etc.) and seeks to apply such theory directly to geoengineering. In our view, both approaches have a role to play, and ideally will ultimately become integrated. As a way to push debate forward, we employ the bottom up approach. In doing so, we also identify some of the issues relevant to a top-down strategy.

Our starting point is the influential Oxford Principles (OP), first put forward by a small group of distinguished academics at Oxford University in 2009. These principles were given qualified endorsements by the UK House of Commons report (House of Commons Science and Technology Committee, 2010) and the Asilomar report (ASOC, 2010), and their spirit and content were subsequently fleshed out in an article in *Climatic Change* (Rayner et al., 2013). The principles have played a pioneering role in the geoengineering debate, and we have a great deal of respect for the authors’ contribution. Our hope is to continue their necessary and important work by enriching the ethical discussion and preparing the ground for a wider, and possibly top-down, debate. Our background concern is that, despite the explicit intention to foster the debate about the “overarching societal values” that should govern geoengineering policy (Rayner et al. 2013, 503), the original Oxford Principles are largely instrumental, and dominated by procedural considerations. As a result, they do not sufficiently lay the groundwork for the more substantive ethical debate that is needed, especially around values such as justice, respect and legitimacy.[[5]](#footnote-5)

The Oxford authors summarize their principles as follows:

(OP1) Geoengineering to be regulated as a public good.

(OP2) Public participation in geoengineering decision-making.

(OP3) Disclosure of geoengineering research and open publication of results.

(OP4) Independent assessment of impacts.

(OP5) Governance before deployment.[[6]](#footnote-6)

Before assessing these principles directly, we offer some quick clarifications about our approach. First, the Oxford group follow the Royal Society in defining geoengineering as: “the deliberate large‐scale manipulation of the planetary environment to counteract anthropogenic climate change” (Shepherd et al. 2009, 1). While some would reject this definition (e.g., as too permissive and overly vague) and others are skeptical of the term ‘geoengineering’ itself (e.g. Heyward, 2013; Jamieson, 2013), we aim to sidestep definitional discussions in this paper by assuming that we are discussing the paradigm case of stratospheric sulfate injection (‘SSI’)**.** The extent to which other interventions share the features that make all or some of the Tollgate Principles appropriate, and the question of whether these deserve the label ‘geoengineering’ are topics for another occasion (cf. Gardiner 2016).[[7]](#footnote-7)

Second, in their original form, each Oxford principle was accompanied by a brief text (Rayner et al, 2009), and in the later article, each is supplemented by a longer comment (Rayner et al 2013). While it is not entirely clear whether the supplements are intended to define the principles, draw out implications, or something else, we shall assess each principle in conjunction with its accompanying remarks.

Third, one background question concerns the scope of the Oxford principles, and in particular whether they are intended to guide research and deployment, research alone, or even just early, small-scale research (e.g., excluding large-scale field trials). We believe that these tasks are not entirely separable, since governance of research (even near-term research) cannot help but be influenced by the wider aspiration of potential deployment and the norms that would govern such deployment. Nevertheless, in this paper we will not take a stand on the interpretive issue. Instead, we assume that the ultimate aim of developing principles is to frame geoengineering - from early research through deployment - in ways that facilitate successful governance. Seen in this light, the question is how far the Oxford Principles assist in this project, however they were initially intended.

Fourth, the Oxford principles are often criticized as being too high-level or abstract to be useful (e.g., Nature Editorial 2012). This is a common concern about governance principles in all areas. However, we agree with the Oxford authors that abstraction in this context need not be a problem and may be an advantage (Rayner et al., 2013). For instance, offering high-level principles often allows one to avoid prejudging more specific issues prematurely, to identify such issues, and to facilitate appropriately formed, justified and authoritative judgments about them. These are important elements of successful governance. Hence, our Tollgate principles will also be high-level.

Finally, in any case, our primary intention is to influence the framing, tone and direction of geoengineering governance, rather than focus on the specific designation or wording of particular principles. Again, our aim is to enrich the ethical dimensions of the conversation and prepare the ground for a wider, and possibly top-down, discussion. Although we believe that the Tollgate principles are useful, we do not see them as the final word, but rather as another step on an ongoing journey.

1. Regulating a Public Good

The first Oxford principle states:

**Oxford Principle 1 (OP1): Geoengineering to be regulated as a public good**

“While the involvement of the private sector in the delivery of a geoengineering technique should not be prohibited, and may indeed be encouraged to ensure that deployment of a suitable technique can be effected in a timely and efficient manner, regulation of such techniques should be undertaken in the public interest by the appropriate bodies at the state and/or international levels.” (Rayner et al., 2009)

Unfortunately, this principle provides a problematic framing of geoengineering.[[8]](#footnote-8) As John Virgoe put it in his testimony to the UK House of Commons, “once you peer below the surface of the public good, it becomes quite hard to define it and you get into some difficult ethical territory” (House of Commons, 2010, Ev 12). Primarily, this is due to an awkward ambiguity. The phrase ‘public good’ has informal, colloquial uses, but also a number of closely-related technical meanings in economics and international relations, often with specific, but potentially conflicting, policy connotations.[[9]](#footnote-9) This threatens to make framing geoengineering as a “global public good” seriously misleading, especially in the public sphere. Consequently, we will advocate for a more transparent, and explicitly ethical, approach which emphasizes central values, such as justice and political legitimacy.

Let us begin with three uses of ‘public good’ and ‘global public good’. First, one minimal colloquial understanding is that of something that is not (or not primarily) a private concern, but a public one that should be governed or regulated as such. This sense of ‘public good’ is suggested by the 2009 text accompanying OP1 (above).

Second, in economics and public policy the common technical conception of ‘public good’ defines a pure public good as a good that is both nonrival and nonexcludable. A good is *nonrival* if and only if one person’s consumption of the good does not limit or inhibit another person’s consumption. A good is *nonexcludable* if and only if, once it is available to some, others cannot be prevented from consuming it. A standard example is the good provided by a lighthouse. It is nonrival: one sailor’s being able to see the rocks does not limit or inhibit others being able to do the same thing, and *vice versa*. It is also nonexcludable: once the lighthouse is illuminating the rocks for some sailors, others cannot be prevented from seeing them too. These features of pure public goods are also emphasized in the geoengineering context, including by the Oxford authors (Rayner 2011, p. 11).

Third, a further colloquial conception of ‘public good’ envisions something that is “good for everyone” (i.e., universally beneficial), or at least benefits everyone affected. This claim is also often invoked in more technical discussions in international relations and economics, in that it motivates both the standard examples (such as the lighthouse) and the basic interest in public goods more generally. Indeed, importantly, for some the universal benefit claim becomes a matter of definition, such that it is included alongside the claims of nonrivalness and nonexcludability in the technical meaning of ‘global public good’ or ‘public good’.[[10]](#footnote-10) Most notably, in its seminal work the United Nations Development Program defines a global public good as “a public good with benefits that are strongly universal in terms of countries … people … and generations”.[[11]](#footnote-11) Similarly, Scott Barrett, who thinks of geoengineering as a global public good, includes universal benefit in his definition, stating “when provision succeeds, global public goods make people everywhere better off” and “global public goods are thus universally to be desired” (2007b, p. 1). Notably, in their 2013 description of the first Oxford Principle and its notion of public good, the Oxford authors also write: “the global climate must be managed jointly, *for the benefit of all*, and with appropriate consideration for future generations” (Rayner et al., 2013, p. 505).

Universal benefit conceptions of ‘global public good’ and ‘public good’ are highly relevant to geoengineering, since versions of the claim that geoengineering in general, and SSI in particular, are “good for everyone” are popular among some scientific advocates of pursuing research. For instance, Ken Caldeira claims: “… for most reasonable climate change metrics, if any party acted in their own self-interest [in implementing SSI] *every party would be better off* than if no party had acted” (Caldeira 2012; emphasis added) Similarly, others claim that in their model simulations “*all regions benefit* by deployment of solar geoengineering at the level of any other regions preference” (Ricke et al. 2013, 5; emphasis added).

Now, there is a lively philosophical debate about how the terms ‘global public good’ and ‘public good’ are usually understood in international relations, economics and public policy, how they should be defined, whether some definitions are deflationary – including perhaps radically so – and what this means for calling geoengineering, and especially SSI, a global public good (Gardiner, 2013b, 2014b; Morrow, 2014). Here, however, we shall set such concerns aside and instead focus on the ethical significance of the various public good framings.

A central concern is that framing geoengineering as a global public good risks painting too rosy a picture of the governance challenge.[[12]](#footnote-12) First, the universal benefit conception is most naturally read as making an overt appeal to a fundamental ethical consideration, the promotion of human welfare, and so as making ethics central. However, paradoxically, framing geoengineering as universally beneficial often has the effect of marginalizing ethical concerns. Probably this is because it is initially tempting to assume that universal improvements in welfare are so attractive as to render further ethical discussion idle. In particular, it may be thought that, if a public good is universally beneficial, no one has good reason to object to its supply.[[13]](#footnote-13) Since no one suffers (indeed all benefit), what could the objection be? Moreover, even if an objection could be found, wouldn’t it be overridden by the weight of the universal benefit?

Second, conceptions of ‘global public good’ that appeal to the technical features of nonrivalness and nonexcludability encourage a similarly optimistic view of the prospects for, and ethics of, provision. For instance, in the lighthouse case, the supply of the lighthouse can be achieved by a small group of sailors motivated to secure their own safety. In providing the light for themselves, they also procure it for all sailors who travel in that area. Moreover, the fact that the others do not contribute (but “free ride”) need not undermine provision. The action and motivation of the small group suffices to supply the relevant good to all. In addition, if one assumes that the intervention is universally beneficial, providing the public good appears not only ethically unobjectionable, but also laudable. Finally, given this, if for some reason no group emerges to provide the lighthouse, there are strong reasons for government intervention to fill the gap. Since (by hypothesis) provision is in everyone’s interest, such intervention should not be controversial. Moreover, this conclusion is reflected by experience, given the tradition of *public provision* for many public goods (Barrett, 2007b, p. 3; Bodansky, 2012, p. 20).

 Third, the lighthouse paradigm seems highly relevant to many forms of geoengineering. For one thing, in reducing incoming radiation (SRM) or lowering the atmospheric concentration of carbon dioxide (CDR) for itself, an actor simultaneously reduces those things for others, even if they do not cooperate. If such action is universally beneficial, this seems not only unobjectionable, but also ethically laudable.

For another thing, if the intervention is one that can be provided by an individual actor or a small group following its own self-interest (a “single-best effort public good”), then it appears either that such actors should be permitted and encouraged to intervene, or else (if none emerge) that governments (individually or collectively) should fill the gap themselves. This is highly relevant to geoengineering since SSI in particular is often described as a “single best effort” public good (e.g. Barrett, 2007a).[[14]](#footnote-14) This encourages the thought that widespread cooperation in the *supply* of the public good may not be needed.

Putting these ideas together, the rosy picture is that if geoengineering (understood as SSI or something relevantly similar) is a global public good, then: (1) it *benefits everyone*; (2) it is (therefore) ethically unobjectionable; (3) some may be motivated to *supply it for all*; (4) failing that, there are strong grounds for (and a corresponding tradition of) *public provision*; and (5) unilateral or small group provision is ethically both permissible and laudable, even without wider cooperation.

Unfortunately, this rosy picture is seriously misleading. One sign of this comes from the minimal conception of a public good as something that is a public concern that should be governed or regulated as such. While this seems correct for paradigm cases of geoengineering, it is important to emphasize that this is mainly because the deep ethical issues (e.g., justice, political legitimacy) raised by SSI imply that geoengineering should not be treated merely as a private concern, and in particular ought not be left to the mechanisms of an unfettered economic market, as if it were a paradigm example of a private good. In short, the minimal conception tends to imply that ethical concerns ought to be central to governance. But why might this be the case?

*a. Universal Benefit*

Let us begin with the universal benefit claim. Traditional public goods such as the lighthouse provide unambiguous benefits for all those affected. In such cases, the claim of universal benefit is meant to be descriptive. However, descriptive claims of universal benefit are likely to be false for geoengineering in general, and for specific paradigm cases of geoengineering, such as SSI.

On the one hand, the scope is much too wide. There is nothing about injecting sulfates into the stratosphere *as such* – i.e., just any old injection, done in any way, and in any amount - that guarantees that everyone will benefit from that injection. Thus, the universal benefit claim is false for SSI considered as such, and could only be made for specific implementations of SSI.

On the other hand, even if one restricts the scope to specific implementations, the descriptive claim is so strong as to be implausible. The very idea that a particular geoengineering intervention could benefit *absolutely everyone* affected by it is an extremely demanding one, given that the effects of climate engineering are, and are intended to be, global and also to span multiple generations, possibly over thousands of years. Indeed, the whole idea of truly universally beneficial geoengineering might be thought so descriptively demanding as to be fanciful. Moreover, despite what some advocates maintain, there are clear reasons for believing that some will suffer. For instance, early work suggests that SSI introduces new global risks that threaten severe impacts for some populations, such as a disruption of temperature and precipitation patterns, a net decrease in precipitations globally, and a risk of termination shock (National Research Council, 2015). Even if there might be net benefits to many, the universal benefit claim seems likely to be overblown.[[15]](#footnote-15)

Things are not much better if one assesses the universal benefit claim as a normative standard rather than an empirical claim. At one point, the Oxford authors suggest a normative interpretation when they write: “the global climate *must* be managed jointly, *for the benefit of all*, and with appropriate consideration for future generations. In short, geoengineering *must* be regulated *so as* to promote the general good” (Rayner et al., 2013, p. 505; emphases added). This passage appears to imply that the first Oxford principle expresses an *ethical requirement*: that the kinds of geoengineering that *ought* to be considered – i.e., that should be the subject of scientific research and public policy – are those that benefit all those affected (as well as having the other characteristics of genuine public goods).

Unfortunately, universal benefit seems not to be the most reasonable standard from an ethical point of view. On the one hand, to insist that a purely physical and technological intervention satisfies the universal benefit requirement seems *unduly demanding*. Not only does insisting on net benefits to all those affected (future generations and possibly non-human nature included) impose a very strong and perhaps empirically unsatisfiable requirement, but it seems highly plausible that some geoengineering interventions would be morally justifiable even if they allow for some harm. For example, schemes that protect basic human rights at some net economic costs to the more affluent might nevertheless be ethically defensible.

On the other hand, paradoxically, the universal benefit requirement also seems in some ways *excessively permissive*. Specifically, even if universal benefits were possible, this would not suffice to justify implementation, since there may be other grounds for opposing geoengineering (e.g., political legitimacy, procedural and distributive justice, relationship to nature, etc.). Indeed, doing something that is good for someone’s welfare is often impermissible, as, for instance, when violates other rights that they have.[[16]](#footnote-16) For example, Americans might claim that China, Russia or Iran have no right to implement a form of SSI without their consent, even if such geoengineering would clearly benefit the United States.

In light of such concerns, making universal benefit a strict requirement for the permissibility of geoengineering appears hasty and unreasonable, at least at this early stage.[[17]](#footnote-17) Moreover, the concerns suggest that much more needs to be said about what ethical requirements geoengineering interventions should meet. This pushes us in the direction that we are suggesting: full-blown moral and political philosophy.[[18]](#footnote-18)

*b. Rivalness*

Let us turn now to the more technical claims associated with public goods, beginning with nonrivalness: that one person’s consumption neither limits nor inhibits another person’s consumption. This is often seen as the most central technical characteristic of a public good.

At first glance, paradigm cases of geoengineering such as SSI do appear to be nonrival in one sense. Once a specific intervention is provided, all “consume” the effects of that intervention without prejudice to others doing the same. Considered as an overall bundle, the effects of a specific geoengineering intervention are not “used up” when one party experiences them. They are not a scarce resource. For example, temperature reductions in Haiti do not “use up” reductions in Bangladesh; droughts in India do not “use up” floods in Northern Europe.

Still, it is worth noticing that this is a peculiar sense of ‘nonrival’, and (whatever its technical credentials) it is not clear how normatively relevant it is, especially in the case of geoengineering. To see this, consider another sense in which geoengineering is rival. There are many possible geoengineering policies. Consequently, those contemplating the implementation of geoengineering are likely to face choices between many particular kinds and levels of intervention. This creates rivalry that is normatively relevant. Suppose, for example, that Russia prefers SSI that caps global temperature rise at +2.4C, and Tuvalu prefers a cap of +1.5 degrees. Both cannot be satisfied at the same time. Hence, the different interventions are rival in that *the selection of one scheme precludes the implementation of others*.[[19]](#footnote-19) Consequently, groups favoring interventions that are not chosen may see their interests marginalized.

This seems the more important kind of rivalry, both politically and ethically. In particular, the former sense of rivalry – effects in one area do not “use up” effects in another – loses its intuitive importance when the effects are no longer universally beneficial, but cover important losses as well as gains. For instance, it seems deeply misleading to characterize a global cap at 2.4C as “nonrival” just because the benefits of a longer growing season in Siberia do not “use up” or preclude the loss of Tuvalu through sea level rise. Notably, such cases raise central issues of justice, political legitimacy, and other values. To obscure this behind the rhetoric of “nonrivalness” is a serious moral failing.

We conclude that, even if geoengineering is nonrival in a narrow technical sense, it is not clear that this has particular normative significance. Instead, ethical concerns, especially of justice, are central and unavoidable.

*c. Excludability*

Let us turn now to the question of whether geoengineering is *nonexcludable*. Technically, for some good *x* to be nonexcludable means that “once *x* is available to some, others cannot be prevented from consuming *x*”. On the one hand, from the point of view of the provider of the good, there is a clear reason for thinking that geoengineering is nonexcludable. Since it is – by definition – a global intervention, none are shielded from the effects of a specific geoengineering scheme, and so cannot in some sense be “prevented from consuming it”. This is important since, in the absence of proper regulation, the providers of at least some SSI schemes might choose interventions that disproportionately benefit them, and disproportionately harm others. Interestingly, this might be construed as a more morally relevant form of exclusion, as it gives providers a level of control over geoengineering outcomes denied to those who merely consume the effects. As has already been suggested, this raises numerous issues of justice.

On the other hand, the issue can also be approached from the point of view of the nonproviders. Nonproviders cannot exclude themselves from the effects of a geoengineering scheme: *there is no opting out*. Consequently, nonproviders are vulnerable to the decisions of providers, and this raises serious ethical questions, including those of justice, domination, rights and responsibility. For one thing, for most interventions there are risks and costs, as well as benefits, to be distributed, and their imposition on some people rather than others requires ethical justification. For another, nonexcludability raises the worrying possibility of hostile interventions, such as predatory geoengineering (e.g., aiming to damage one’s political rivals) or parochial geoengineering (e.g., discriminating against future generations). Once again, geoengineering requires regulation not because of the (probably fanciful) universal benefits it could provide, but because of its potential for harm, injustice and other ethical infractions.

*d. the Relevant Public*

Let us close with two more general concerns about the framing of the first Oxford Principle. First, there is the question of how to understand the relevant “public” and so the scope of the related public good. From an ethical point of view, the relevant public is global, intergenerational and ecological, so that the first principle should refer to the global, intergenerational and ecological good. In our view, this point should be emphasized in the principle itself. Still, it is not clear that the conventional framings even have it in mind. For instance, in its original version, the first Oxford Principle used only the phrase ‘public good’. This might be understood in various ways, including as referring only to the national good, or the good of the current generation, or the short-term economic good. In the later version, the Oxford authors make it clear in their comments on the first Oxford principle that they believe that considerations of global and intergenerational justice must be taken into account (Rayner et al., 2013, p. 524). However, in our view these considerations are so central that they should appear in the principle itself.

*e. Injustice*

The second concern is that framing the first principle in terms of regulating a public good implicitly marginalizes other morally-relevant understandings of the climate problem. For example, there is a huge difference between framing geoengineering as the *supply of a universal benefit*, and framing it as *a rectification of injustice*. Note, for instance, the “supply of universal benefit” framing tends to be perceived as exclusively forward-looking. By contrast, in many cases, climate engineering is best understood as a *response* to the infliction of some risk or damage. Plausibly, this involves an important backwards-looking component, and one which strongly encourages questions of responsibility, including of who should do what, and how it should be done.

Given the above, what should we conclude? Notice that we have not argued that it is impossible that some geoengineering scheme could be found that is a genuine global, intergenerational and ecological public good including in the technical sense of being nonrival and nonexcludable, nor have we claimed that such a scheme would necessarily be ethically undesirable if it could be found. Nevertheless, the existence of such a scheme seems empirically unlikely in the real world, and (much more importantly) the focus on the technical senses of ‘global public good’ and ‘public good’ threatens to be seriously misleading. Instead, the real bite of the first Oxford Principle is in its claim that geoengineering should be subject to public oversight and on behalf of the public interest. This is a common, but nontechnical understanding of ‘public good’, and is justified largely by the importance of ethical issues such as justice, political legitimacy and the human relationship to nature. In light of this, we suggest that a better framing principle would be:

**1st Tollgate Principle (Framing)**: **Geoengineering should be administered by or on behalf of the global, intergenerational and ecological public, in light of their interests and other ethically-relevant norms**.

Geoengineering raises complex issues of global, intergenerational, and ecological ethics – including issues of justice, legitimacy, domination, rights, responsibility and the human relationship to nature. It should be framed as such and administered by or on behalf of the global, intergenerational and ecological public in light of relevant norms. This has implications for deployment, governance and research.

The first Tollgate Principle helps to bring into focus an important, but neglected question (that OP1 does not): what are the primary objectives of geoengineering governance?[[20]](#footnote-20) Moreover, while it allows for the possibility of a pure public good solution, it also includes much else. As well as being much more realistic, it puts the emphasis in the right place.

2. Public Participation

The second Oxford principle is labeled “public participation in geoengineering decision-making”. This suggests some concern for legitimacy and justice. However, closer examination reveals that the principle is much more narrowly construed than the surface language implies, and so is likely to mislead. The principle states:

**Oxford Principle 2 (OP2): Public participation in geoengineering decision-making.**

“Wherever possible, those conducting geoengineering research should be required to notify, consult, and ideally obtain the prior informed consent of, those affected by the research activities. The identity of affected parties will be dependent on the specific technique which is being researched - for example, a technique which captures carbon dioxide from the air and geologically sequesters it within the territory of a single state will likely require consultation and agreement only at the national or local level, while a technique which involves changing the albedo of the planet by injecting aerosols into the stratosphere will likely require global agreement.”[[21]](#footnote-21)

Despite its name, this principle risks sharply limiting the role of the public in geoengineering decision-making in at least five ways. The first limitation is that it appears that the principle applies only to research and *only to one kind of research*, studies that actually affect people. It does not advocate for public participation in decisions either about research more generally, or about deployment. For example, the principle does not suggest that the public should be consulted about (a) whether to engage in an aggressive, dedicated research program on geoengineering (such as a Manhattan or Apollo-style project), or (b) whether to pursue emergency-oriented research (such as atmospheric SRM) or longer-term projects (such as some CDR) or both, or (c) whether to push forward with a global governance scheme for geoengineering, and so on. Instead, the sole area for consultation seems to be “field testing” that has tangible implications for particular people or groups. This restriction is unmotivated and puzzling.[[22]](#footnote-22)

The second way in which the principle is limited is that it applies *only to those affected* by research. In their discussion of Principle 2, the authors of the OP acknowledge that further discussion is needed about precisely what “affected” means in this context. However, the text suggests that they lean toward a narrow interpretation that includes only those direct and enduring *material* effects (e.g. Rayner et al., 2013, p. 505). This suggests that those who are not materially affected are excluded from decision-making both in these cases and (given the first point) from geoengineering decision-making in general.

This approach encourages three presumptive objections. First, given that this is the only Oxford principle concerning public participation, it implies that *those who are not directly and materially affected have no say at all*, on either field testing or geoengineering research more generally. This assumption seems deeply objectionable, yet no reason is offered for it. This exclusion of the “unaffected” is surprising if (as the first Tollgate principle states) geoengineering involves major issues of legitimacy, justice, and ecological values on a global and intergenerational scale. Is this not their (i.e., your) planet as much as anyone else’s?

The second objection is the flip-side of this. The narrow scope of the principles suggests a further covert assumption: that *some* (e.g., researchers, the organizations that sponsor them) *have the right to do whatever they like to the planet*, so long as either they do not materially affect other people currently alive, or else reach an agreement with those directly and materially affected that they can proceed. This assumption is not just striking but also deeply contentious. Intentionally messing with the basic physical structure of the planet arguably means much more, morally and politically, than is captured just in terms of its direct material effects on specific people. This worry is especially relevant in cases of large-scale experiments, and in a context when many of those affected, such as future generations and other species, have no voice.

The third objection is that the principle brings on serious practical issues with a strong ethical edge. For one thing, since we are talking about *prior* consent, it raises questions about how we identify before doing the experiment who will be materially affected and who not, and (more importantly perhaps) who gets to make that call. For another thing, given the complexity of the climate system, it may be difficult to identify the victims even after the experiment, since (for example) this requires being able to pin down what would have happened otherwise. (For more on both issues, see below.) In addition, notice that there is no *ex post* principle – e.g., for dealing with a process for compensating people who we didn’t know in advance would be affected.[[23]](#footnote-23)

Returning to the main narrative, the third way in which the second Oxford Principle sharply limits the role of the public in geoengineering decision-making is that the requirement is to “notify, consult, and ideally obtain … prior informed consent”. However, given that geoengineering is a global, intergenerational and ecological issue, *many of those affected are not available* to be notified or consulted or informed, and are not in a position to consent. Moreover, given that the principle mandates that the requirement holds only “when possible”, the default assumption seems to be that those who cannot be consulted will not have their concerns taken into account.

We think this implication should be resisted. Specifically, there might be other ways to take the interest of future generations and nonhuman beings into account, such as appropriate representative institutions (Gardiner, 2014a; Gonzalez-Ricoy & Gosseries, 2017). In mentioning prior consent only, the Oxford Principles risk brushing them aside (see discussion under point 5 below).

The first three limitations suggest that the title of the second principle is deeply misleading. The notion that it advocates for robust “public participation” is illusory. Moreover, the limits suggested do nothing to address, and may even encourage, the threat of a pronounced bias in geoengineering policy, globally, intergenerationally, and across species. Since the second principle is one of only two political principles in the Oxford set, this is a serious matter. However, there are also issues about the requirement itself. These emerge in the fourth and fifth limitations.

The fourth limitation concern the second Oxford principle’s *description of the parties in charge of applying it.* According to that description, the requirement applies to “those conducting geoengineering research”. To begin with, this is most naturally read as the research scientists themselves. However, the Oxford Principles are supposed to advise governments and other socio-political entities on how to govern geoengineering. This raises a problem. Obviously, scientists wanting to carry out field trials have some ethical responsibilities. Still, it would be bizarre to claim that it is *solely* the responsibility of these specific scientists to ensure that adequate public participation occurs, and that governments and other bodies should simply step aside except to enforce that requirement. Such a move would seem a serious abdication of responsibility.

 Given this, it seems wise to reject the natural reading, and instead to understand “those conducting geoengineering research” as the social and political bodies in authority. However, here we must emphasize that one of the central issues of geoengineering ethics is that it is not clear that we currently have such bodies, or that existing authorities are either equipped or authorized to take on the task (e.g., Gardiner, in press). Since the second Oxford principle obscures this issue, it is urgently in need of clarification and reframing. In our view, such a reframing would emphasize the need to develop governance institutions alongside research, and not just before deployment (see our critique of Principle 5).

The fifth limitation concerns the *notion of consent*. The first thing to notice is that prior consent is just one way of securing political legitimacy. Even though it is a widely-held principle, there are circumstances where it fails to deliver the expected normative benefits (for example, as already mentioned, with respect to future generations and the rest of nature). Therefore, what we should be after with this second principle is not consent per se, but a wider conception of political legitimacy (within which consent might play a significant role).

The second thing to notice is that the participation principle is silent on the grounds for consent. It offers no guidance on what is *relevant* for consent in this case.[[24]](#footnote-24) The reason for this is likely that the Oxford authors argue in their 2013 comment on OP2 that the understanding of consent, and public participation in general, varies greatly across political cultures, so that the measures necessary to insure public participation should not be specified at the level of principles (Rayner et al., 2013, p. 506).

Still, this may be unnecessarily pessimistic. Moreover, whatever the form that consent actually takes, the *relevant grounds* are important both to current advocates of geoengineering and their critics. For example, on the one hand, advocates will not be happy with refusals to consent – effectively vetoes – that rest on spurious, deeply self-interested or ideological reasons. On the other hand, critics will claim that ethically serious consent will occur only when important values have been respected, including legitimacy of decision-making, compensation provisions, ecological values, and so on.[[25]](#footnote-25) Again, the notion of consent seems only to scratch the surface of the problem and cannot be adopted as a principle without more substantive discussion.

These concerns raise a background worry about the Oxford approach. Namely, on too many issues that really matter, it remains silent, shifting the responsibility elsewhere. For instance, importantly, the second principle might be accused of *placing undue burdens on research subjects*. When asked for consent, are they really expected to determine by themselves when and how geoengineering is acceptable? *Is it fair to make them the sole custodians of this responsibility?* Isn’t this an abdication of responsibility by social and political institutions and the wider public?

If the second Oxford Principle is too narrow, what should we say instead? The first Tollgate principle states that geoengineering should be administered by or on behalf of the global, intergenerational and ecological public, in light of their interests and ethically-relevant norms. So, a new second principle ought to deal with the initial implications of this in terms of how decisions should be made and by whom.

The first point to be made is that, although the *moral subjects* of geoengineering are those affected by it across the globe, time and species, the *agents* properly speaking are (a) a particular generation of humans that chooses to initiate a geoengineering scheme, and then (b) the successive generations charged with managing the scheme (and its consequences) over time. This is important because most schemes are expected to last at least many decades, and probably several centuries.

The second point is that, given the first, it is far from clear that a simple informed consent model, drawn from medical contexts and based on the consent of those currently alive who are directly and materially affected, is at all appropriate (Gardiner, 2013a). Arguably, the kind of ‘public participation’ needed involves much more substantial moral and political norms, including those of appropriately global and intergenerational procedural justice (Gardiner, 2014a, 2017).

The third point is that these norms should include political legitimacy (not forgetting inclusion and diversity), justice, ecological values, and much else. Hence, institutions are needed which are capable of administering geoengineering and subject to appropriate checks and balances.

Given these points, we suggest two principles:

**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.[[26]](#footnote-26)**

Ethical geoengineering would be the task of a sequence of generations (or their agents) operating on behalf of a wider global, intergenerational and ecological public. Institutions would be needed that are ethically authorized to carry out, and capable of managing, such a task (a) in light of and in accordance with appropriate norms of global, intergenerational and ecological ethics, including those pertaining to political legitimacy, justice, the human relationship to nature and especially the perspectives of the most vulnerable groups, while (b) ensuring reasonable relationships with other institutions (e.g., through suitable checks and balances).

Since it is also true that people materially affected by field tests might have a special say about the where, what and how of those tests, we propose supplementing the authorization principle with a more specific consultation principle modeled on the second Oxford principle:

**3rd Tollgate Principle (Consultation): Decisions about geoengineering research activities should be made only after proper notification and consultation of those materially affected and their appropriate representatives, and after due consideration of their self-declared interests and values.**

Consultation can be achieved through a variety of deliberative procedures. However, a priority should be placed on methods that stress full information and autonomy, and are well-placed to provide genuinely representative feedback that is neither superficial nor easily manipulated. The process should be especially sensitive to respecting the self-determination and self-understanding of affected groups, taking particular care in eliciting responses from historically marginalized or oppressed populations (cf. Whyte 2013, 2016). Indeed, there is a strong presumption that such groups should play a central part in deliberation, including by participating in leadership roles.

At this point, it starts to become clear that the first three Tollgate principles are much broader than the first two Oxford Principles and likely to be more demanding. Possibly, they are so demanding as to cast doubt on the prospect of highly ethical geoengineering being achievable in the context of our current geopolitical environment. In our view, this is not an objection to the new principles. Indeed, it is an advantage that they highlight what is really at stake. In addition, if ultimately our approach casts doubt on whether geoengineering can satisfy high ethical standards, this at least makes it clear that we should also investigate whether there are lower, perhaps very minimal, ethical standards that specific proposals might more easily satisfy, whether these too are realistically achievable, and what that means for how we understand the risks of geoengineering (Gardiner & Fragnière 2017). Unfortunately, the Oxford Principles obscure these important questions.

3. Full Disclosure

The third Oxford principle presses for full disclosure of geoengineering research and open publication of results, including negative results:

**Oxford Principle 3 (OP3): Disclosure of geoengineering research and open publication of results.**

“There should be complete disclosure of research plans and open publication of results in order to facilitate better understanding of the risks and to reassure the public as to the integrity of the process. It is essential that the results of all research, including negative results, be made publicly available.”

The House of Commons accepts this “requirement” and proposes that it “should be unqualified” (House of Commons 2010, 32).

The first thing to notice is that the third Oxford principle raises important questions, especially when understood in a completely unqualified way. Full disclosure is not endorsed in all settings and might also create risks. For example, one of the main concerns in geoengineering policy is that of a rogue actor (or actors) implementing a scheme by themselves and for their own purposes.[[27]](#footnote-27) The usual assumption is perhaps that openness should at least ensure that the type of geoengineering attempted by a rogue actor would be well-informed and so more likely to avoid the worst consequences of geoengineering. However, this thought assumes that “worst consequences” will mean the same thing to the rogue as to the researchers. This need not be the case. For example, suppose the mainstream geoengineering community investigates technique X but then abandons it because X inevitably involves negative consequences for some region or another. Full disclosure of this might reveal to rogue actor A that X is good for it but bad for its main rival B. In that case, the openness of the research may facilitate A’s choice of X. The mainstream reason to reject X is in fact not a reason against it for A, and may even be a reason in its favor. Consequently, there are at least two notable risks of full disclosure: facilitating rogue geoengineering, and facilitating geoengineering with problematic consequences.

The Oxford authors discuss a similar case involving articles discussing a mutation of the avian flu virus (H5N1), and point to the decisions of the US National Science Advisory Board for Biosecurity to rule in favor of open publication. They conclude that security concerns do not always trump the benefits of full disclosure. Specifically, they say that, as in the bird flu case, closed geoengineering has risks of its own, and there are benefits on the other side. The third Oxford principle emphasizes two: facilitating a better understanding of the risks, and reassuring the public of the integrity of the process. These emphases suggest that the goals of the disclosure principle are both *epistemic* and *ethical*. Full disclosure brings all the available knowledge into the public arena to inform and be scrutinized by researchers and the general public alike. This can be valuable in numerous ways. For instance, disclosure can help to ensure that analysis is rigorous and that technical mistakes are not made; it plays a role in ensuring that important possibilities are not overlooked[[28]](#footnote-28); and it can help to create a wider community of inquiry, and especially one that is more diverse (intellectually, nationally and socially) than a closed approach would produce.[[29]](#footnote-29)

The thought, then, is that full disclosure can facilitate a high quality scientific and public discourse. However, we should notice that concealed information is not the only threat to this discourse, and scientific rigor not its only object. Full disclosure is intended to promote inclusion and diversity, and thereby trust and accountability, as well as reliability.

Once the nonepistemic reasons for openness are pointed out, this has further implications. If the concern is with inclusion, trust and accountability as well as reliability, this suggests that matters such as appropriate authorization of research projects, checks and balances, and so on, become important. If the question is how to create and facilitate a reliable, inclusive, trustworthy and accountable research process, unconditional openness is *only one answer*, and only a partial one at that. This issue is pressing if climate change involves a serious risk of moral corruption, especially when it comes to intergenerational issues (Gardiner, 2011a). For example, openness about scientific research will not directly aid the global poor or future generations in securing inclusion, trust and accountability, since they are not around to press their claims. Others must do this for them, and more thought is needed about how this is to be done. Again, the relevant Oxford Principle seems both insufficient to the task and to obscure this issue.

This discussion suggests an expanded version of the third principle:

**4th Tollgate Principle (Trust): Geoengineering policy should be organized so as to facilitate reliability, trust and accountability across nations, generations and species.**

Geoengineering policy should be organized so as to facilitate reliability, trust and accountability. This suggests high-levels of openness and disclosure in publication of research plans and results, and in geoengineering decision-making more generally. It also suggests that geoengineering policy should accept demanding norms of inclusion, across nations and other demographic groups, at all levels, including the basic design of policy and institutions. In addition, if any material is protected, it should be subject to a review process involving stakeholders or their representatives to maximize trust. Special attention should be paid to the concerns of those groups affected by geoengineering decisions who cannot be effectively represented, such as future generations and nonhuman nature.

4. Independent Assessment

These concerns resurface when we come to the fourth Oxford principle**.** This calls for independent assessment of impacts of geoengineering research, encompassing both environmental and socio-economic impacts.

**Oxford Principle 4: Independent assessment of impacts**

“An assessment of the impacts of geoengineering research should be conducted by a body independent of those undertaking the research; where techniques are likely to have transboundary impact, such assessment should be carried out through the appropriate regional and/or international bodies. Assessments should address both the environmental and socio-economic impacts of research, including mitigating the risks of lock-in to particular technologies or vested interests.”

The central concern of this principle, that is ensuring the integrity and reliability of the research and development process, seems to fall under the 4th Tollgate principle just discussed, albeit here with a specific focus on environmental and socio-economic impacts. Nevertheless, there are some more specific issues worth identifying.

The first is what counts as a geoengineering impact. This involves contentious questions, since what counts as geoengineering, what counts as geoengineering-specific research, what counts as a geoengineering “experiment”, and what would count as relevant impacts are all matters of dispute. The last issue is particularly important. It echoes one that already arises in the climate change discussion. In adaptation policy, there is an issue about how to separate out global warming impacts from other impacts. For example, how do we decide how many of the deaths and diseases inflicted during a particular hurricane are the results of global warming when (say) global warming only increases the frequency of such extreme events, and other factors, such as background poverty, poor infrastructure, and so on, are such that the hurricane has worse effects than might have occurred elsewhere? As Dale Jamieson memorably remarks: no one’s death certificate will ever read “climate change” (Jamieson, 2005).

In general, to attribute impacts to global warming or to geoengineering involves making decisions on what constitutes the natural and socio-economic baselines against which they will be judged, and also what normative baselines of reasonable claims should be presupposed. On the face of it, these matters are even more difficult in the geoengineering case, and likely to be severely contested. One reason for this is that the relevant baseline for assessment of impacts applied by advocates of SSI is often the severe climate change avoided, rather than “normal” conditions. Yet catastrophic baselines tend to obscure the underlying ethical issues (Gardiner 2013a).[[30]](#footnote-30)

The second issue is what counts as “independent” assessment, and who is to do it. Clearly, it cannot be the original researchers. But can it be researchers from the same discipline, nation, or international research community? Or do those affected by geoengineering research have the right to independent assessment, and also the authority to assess according to their own values and then demand compensation on their terms for negative impacts? And who will decide that? In short, the fourth Oxford Principle raises major conceptual, epistemic and political issues, and values are at the heart of them.

In addition to these “internal” questions, there are wider issues. Why is the review to which research subjects are entitled limited to the impacts and their assessment? On the one hand, one might have expected a review of the objectives, methods and assumed constraints on the geoengineering research as well. On the other hand, “assessment” seems too limited. As already suggested, affected countries, for example, might reasonably ask for a procedural role in the generation of research plans and the design of geoengineering institutions before accepting any transboundary impacts.

Some of these issues are mentioned by the Oxford authors, but without specific answers being provided. In their view, the role of the principles is to provide general rules that have to be “interpreted and implemented in different ways” according to the specific technology under consideration (Rayner et al., 2013, p. 504). Although we agree that it is unreasonable to expect robust answers to these questions from a single article, we nonetheless think that the principles should reflect such complexities and not obscure them. We shall return to this issue in a moment. First, let us turn to the fifth principle.

5. Governance

The fifth Oxford principle makes a claim about the necessity of governance. It states:

**Oxford Principle 5: Governance before deployment**

“Any decisions with respect to deployment should only be taken with robust governance structures already in place, using existing rules and institutions wherever possible.”

This principle is straightforwardly endorsed by the House of Commons report, which also advocates for further research domestically and internationally. Nevertheless, there remain serious concerns.

First, while the idea that deployment requires robust structures of governance seems correct, the principle is striking for what it does not say: namely, that field-testing and perhaps some other forms of research require governance too. The previous discussion suggests ample grounds for this (e.g., inclusion, trust, accountability, values in design).

Second, the narrowness of the Oxford governance principle is all the more surprising since the distinction between deployment and research is not secure when it comes to field testing (e.g. Parson & Ernst, 2013, p. 326). In particular, some have argued that there is no real difference between the more important kinds of field testing and actually deploying geoengineering (Robock et al. 2010). This is acknowledged by the Oxford authors in the accompanying text. Still, it is surprising that the Oxford principles themselves are silent on this issue, and that they insist on treating the two topics so differently. In particular, whereas deployment is to require “robust” governance, field testing is treated as if a sharply limited approach will do: only those who can be shown to be materially affected in advance have a voice, and only insofar as they are entitled to independent assessment of the impacts and to be “notified, consulted”, and “ideally” provide informed consent.

Third, a drift away from the fifth Oxford principle is already suggested by our previous discussion of the second (participation) and fourth (independent assessment) principles, since it is not clear that these can do without some substantial level of governance. For example, there is the issue of who decides when transboundary effects are likely (second principle) and who is responsible for getting the independent assessment done (fourth principle). Since this cannot be the original researchers - otherwise it would not be independent - these principles seem to presuppose a social project that already requires a significant level of governance.

Fourth, arguably there are reasons for thinking that the Oxford authors should have taken a much stronger stance, along these lines:

*“*No deployment or field testing before governance, and strong priority to the governance issue, including perhaps only limited scientific and technical investment in geoengineering before it is clearer whether ethical governance is feasible and what the constraints are.”

One such reason is that (as the Royal Society says) the ethical and governance obstacles might be more difficult to overcome than the scientific and technical ones. Another reason is that we might want to avoid the conjurer’s trick scenario, where the research is undertaken by an exclusive group according to their own values, objectives, constraints, and conception of the problem (e.g., conditions of deployment), and then put forward for action at the last minute, under pressure of a quickly emerging crisis.

Fifth, and more generally, we have to be cautious about the word ‘governance’, as it may be interpreted in more or less extensive ways (Gardiner, 2011b). In our view, the question goes beyond the mere monitoring and control of geoengineering technologies, and is instead one of moral and political *justification*. Indeed, the core question is whether and how the decisions made about geoengineering can be defended, especially to those seriously affected by them. Thus, a distinct term such as ‘ethical accountability’ may be required.

Rather than focusing too much on the sheer architecture of institutional arrangements, the most urgent task for geoengineering policy is arguably to work out the content of the normative criteria, such as political legitimacy and justice, that governance institutions should meet. The devising of a new institutional arrangement that is suitable to the governance of geoengineering has to proceed from these normative criteria, not the other way around. However, those that are especially vulnerable to climate change and geoengineering (the global poor, future generations and nonhuman nature) are largely voiceless and difficult to represent in a purely procedural way. This makes the need for ethical accountability at the same time morally necessary and theoretically challenging.

In light of this discussion, we propose an alternative to the fifth Oxford principle:

**5th Tollgate Principle (Ethical Accountability): Robust governance systems (including of authority, legitimacy, justification and management) are increasingly needed[[31]](#footnote-31) and ethically necessary[[32]](#footnote-32) at each stage from advanced research[[33]](#footnote-33) to deployment.**

Robust structures of consultation, administration and justification are ethically necessary before deployment, but a significant level should also be in place prior to commencing field testing (domestic and international), and some governance is desirable even before that, as advanced research programs emerge. These structures should be flexible in light of new information and socio-political-ecological realities, and should aim to avoid lock-in and the entrenchment of vested interests (Jamieson, 1996; Lin 2016; McKinnon 2018)

**II. Jamieson’s Principles**

At this point, we might note a more general way in which the Oxford principles, on which the first five Tollgate principles are based, seem lacking: namely, none of them speak directly to the *substance* of a justifiable geoengineering program.[[34]](#footnote-34) This is a surprising omission.[[35]](#footnote-35) Fortunately, we do get some guidance from elsewhere. First, we will discuss principles for geoengineering offered more than a decade earlier in a classic article by Dale Jamieson, but curiously ignored by the Oxford principles and most other reports. Jamieson proposes that geoengineering should be *technically feasible*, *reliably predictable*, *socio-economically preferable*, and *respect well-founded ethical norms*, such as democratic decision-making, a prohibition on irreversible changes, and respect for nature (Jamieson, 1996). We shall build on and add to this approach. Second, we will consider some more general resources in practical ethics. Given constraints of space, we will only gesture at the relevant issues very briefly, to give a sense of the direction we believe should be pursued. We defer a deeper discussion to another time.

1. Technical Feasibility

Jamieson’s first principle requires that geoengineering be “technically feasible”. In one way, this requirement looks trivial. Suppose climate engineering is defined as “intentional intervention in the climate system to address global climate change”. If the question is: ‘Is it possible for humans to intervene in the climate system and make a difference?”, the answer seems highly likely to be ‘yes’. The phenomenon of anthropogenic climate change already implies that humans are capable of having influence unintentionally, and so do have the power to have effects. The real question is thus not whether large-scale intervention is technically feasible, but whether *desirable* forms of large-scale intervention are technically feasible.

Jamieson’s other three principles speak to this. Hence, the first must be understood in terms of them, as demanding that desirable forms of geoengineering must be technically feasible. However, this is not to say that the first principle lacks bite. In particular, some believe that ethically reasonable forms of geoengineering are not technically feasible. For example, some claim that we will not be able to produce reliable and socio-economically preferable techniques in the time available. If this is so, then even if ethical geoengineering is possible in principle, in practice it is not, and so pursuit of it is likely to be wasteful, of (scientific and political) time and energy. Given the scarce (scientific and political) resources available to address climate change, this would be a significant concern. Consequently, Jamieson’s first principle has a role to play even as the focus turns to the other three.

**6th Tollgate Principle (Technical Availability): For a geoengineering technique to be policy-relevant, *ethically defensible forms* of it must be technically feasible on the relevant timeframe**.

Since geoengineering is defined with respect to specific policy goals (counteracting anthropogenic climate change), relevant techniques must be technically feasible ways of both addressing these goals, and satisfying appropriate parameters and constraints (internal and external). Both the goals themselves and the associated parameters and constraints are heavily ethical (cf. Gardiner & Weisbach, 2016, chapters 2-3). Therefore, the central concern with technical feasibility is with the (potential) availability of ethically defensible forms of geoengineering. These include techniques that may plausibly be deployed to counteract climate change on a timeframe relevant to meeting core ethical objectives, such as moderating threats to human and nonhuman welfare, or protecting basic human rights. That being said, ethically defensible forms may also include ethically laudable, decent, and perhaps even “tolerably indecent” approaches, which raises issues of its own (Gardiner & Fragnière, 2017).[[36]](#footnote-36)

2. Predictability

Jamieson’s second principle is that acceptable geoengineering should be reliably predictable. While this condition may initially seem uncontroversial, in the geoengineering context it is sometimes violated. For instance, some emergency arguments for stratospheric sulfate injection may implicitly set aside reliable prediction (e.g., framing SSI as a “Hail Mary” pass undertaken in the *hope* that it will push the climate in a better direction, without side-effects that are too bad). We agree with Jamieson that a reasonable level of evidence is required (e.g., mere hope does not suffice), and in particular that serious assurance is needed that intervention will not make matters significantly worse. While we also acknowledge that what counts as a reasonable level of evidence might vary with the circumstances, including the nature of the threat and the available alternatives, we would still insist that interventions meet scientific standards appropriate to the circumstances. Given this, we propose:

**7th Tollgate Principle (Predictability): For a geoengineering technique to be policy-relevant, ethically defensible forms of it must be reasonably predictable on the relevant timeframe and in relation to the threat being addressed**.

The policy relevance of particular geoengineering techniques depends in part on whether ethically defensible forms are (or may plausibly become) reasonably predictable, including on a timescale relevant to useful deployment and with suitable assurances that deployment would not involve additional threats or levels of risk comparable to or more severe than those the intervention is intended to alleviate (cf. Gardiner 2006; Shue 2010; Hartzell 2012). The assurances should be grounded in comprehensive scientific appraisals that meet standards of evidence appropriate to the proposed action and situation. What that would mean under specific scenarios is a matter for further deliberation in accordance with the other Tollgate Principles.

3. Preferability

Jamieson’s third principle – that geoengineering be socio-economically preferable to its alternatives - gets closer to the heart of the issue. It raises the question of how we should assess the desirability of a given scheme. First, the principle raises the point that it is not really the climate indicators (e.g., global temperature, precipitation patterns) that matter, ultimately. What matters is the effects on, and treatment of, ethically significant subjects in terms of indicators such as welfare, human rights, justice, political entitlements, and so on. In light of this, we should be careful about adopting too narrow an account of the indicators. For instance, one adjustment we would make is to frame the indicators more widely to include ecological values, such as the interests of nonhuman animals and ecosystems.

Second, Jamieson’s principle suggests that the partial truth in the universal benefit principle – and so latent in the public good framing – is the idea that the kind of geoengineering we are most interested in is one that treats all those affected well, or at least decently, in terms of ethical parameters, and especially the most basic parameters, such as their fundamental rights and interests. Instead of “universal benefit” then, what we are looking for, or aspiring to (if we are considering geoengineering at all), is a geoengineering policy that protects those affected better than any alternative, and protects them at a fundamental level. The relevant alternatives here are presumably allowing severe climate change to occur unchecked, or any other feasible policy interventions that do not include some geoengineering.

However, third, and most importantly of all, this need not mean that the *technical intervention alone* provides the right kind ofprotection *all by itself*. Instead, the requirement should apply to the overall global social, economic and political system. This system should interface with the intervention in an integrated way, so as to provide the best protection available (Gardiner 2013a, 513). In other words, it is the *overall social world* in which geoengineering occurs that should satisfy the requirement, and this can be done even if the intervention standing alone does not. In particular, the global social, economic and political system can intervene directly or indirectly to protect those affected by both climate change and geoengineering from negative impacts (e.g., though aid, migration programs, etc.). Offhand, this seems at least as feasible as attempting to provide protection exclusively through technical means, and perhaps much more so. Yet it involves a very different vision of what dealing with climate change, including in part through geoengineering, actually involves.[[37]](#footnote-37)

In our view, these points suggest:

**8th Tollgate Principle (Protection): Climate policies that include geoengineering schemes should be socially and ecologically preferable[[38]](#footnote-38) to other available climate policies, and focus on protecting basic ethical interests and concerns (e.g., human rights, capabilities, fundamental ecological values).**

Geoengineering interventions should be understood as parts of more general climate policies, and such policies should be assessed comparatively. For example, we should avoid framing the relevant question as one of which kind of action (e.g., geoengineering, mitigation, adaptation) or technique (e.g., SSI, CDR, building sea walls) is to be preferred. Instead, the attention should be on overall policies, where these are likely to include several kinds of action and techniques, and on the social system as a whole, including whether fundamental social change is warranted to address the climate threat, either instead of or in conjunction with any geoengineering interventions. Policies should be evaluated on broad ethical grounds, reflecting social values (including political and economic values) as well as ecological values, and with a central focus on protecting basic interests and concerns.

4. Respecting Ethical Norms

Jamieson’s fourth principle requires that geoengineering interventions *respect well-founded ethical norms*, such as democratic decision-making, a prohibition on irreversible changes, and respect for nature.

*a. General Norms*

We begin by proposing a more general approach, initially grounded in W.D. Ross’ pluralistic approach to ethical values (Ross, 2002). Ross provides a list of principles that he thinks of as “*prima facie* duties”. These are often thought to provide a “default” list of generally morally salient concerns for ethical deliberation (e.g., Timmons 2002, 208), and this is the sense in which we invoke them here.[[39]](#footnote-39) One advantage of this approach is that the relevance of such concerns is a matter of wide and overlapping consensus across different normative theories and ethical traditions. Another is that they provide a foundation on which developments of “top down” approaches to the ethics of geoengineering and its governance can occur, not least because they anchor discussions within and between contrasting theories and traditions.

Since their initial appearance, Ross’ duties have been interpreted, updated, and supplemented by others. A contemporary list of principles of ethical salience might read(see Resnik, 1998):

* **Non-maleficence:** Do not harm yourself or other people.
* **Reparation**: Repair harms you have done
* **Justice**: Treat people fairly: treat equals equally, unequals unequally.[[40]](#footnote-40)
* **Autonomy***:* Allow rational individuals to make free and informed choices.
* **Gratitude**: Appropriately acknowledge benefits that others have given you.
* **Beneficence**: Help yourself and other people.
* **Efficiency**: Maximize the ratio of benefits to harms for all people
* **Fidelity**: Keep your promises and agreements
* **Honesty**: Do not lie, defraud, deceive or mislead.
* **Self-improvement**: Strive to make yourself ethically better.

In our view, most of these principles are relevant to geoengineering[[41]](#footnote-41), and an ethically defensible approach to geoengineering would address them, showing how and why they should be incorporated in institutions and policies. We defer this for another occasion. Our main purpose here is merely to signal the claim, and point out that conventional proposals – such as the Oxford principles – seem to ignore most (if not all) of the Rossian concerns. We thus propose:

**9th Tollgate Principle (Respecting General Ethical Norms): Geoengineering policy should respect general ethical norms that are well-founded and salient to global environmental policy (e.g., justice, autonomy, beneficence).**

Ethical responses to climate change, including those involving geoengineering techniques, must be appropriately responsive to (i.e., fully take into account) general and well-founded ethical norms, many of which underlie the basic concerns, motivation, and parameters of climate policy in the first place. Such norms might initially be generated from common principles of ethical salience (e.g., Ross’ *prima facie* duties), but can also provide a grounding for more “top-down” discussions within and between different normative theories and ethical traditions.

*b. Ecological Norms*

In addition to the (revised) Rossian list, other matters become ethically salient in geoengineering and similar environmental cases that are worthy of inclusion. In particular, the list makes no mention of relevant environmental or ecological norms, yet these also seem of central importance to geoengineering governance. Consider two major areas.

First, one set of norms concerns the parameters and constraints of environmental governance. Jamieson’s prohibition on irreversible changes is one example. We are not confident in this specific constraint (e.g., given the rapid pace of climate change, it is not clear what “irreversible” means or why it is a particularly salient concern). Nevertheless, we believe that the category remains important. As better illustrative examples, we propose:

* **Sustainability**: Interventions should be compatible with and promote the long-term survival and flourishing of human and nonhuman forms of life.
* **Precaution**: Where there are threats of serious or irreversible harm, a lack of full scientific certainty should not be used as a reason for postponing suitably effective measures.[[42]](#footnote-42)

The second area is humanity’s relationship to nature. No mention is made of this in the Rossian list; yet it is a major concern in the ethics of geoengineering. One sign that this is a problem is that (presumably) there would be major ethical objections to a geoengineering intervention that protected current and future people, but only at the price of eradicating all other species and all natural places from the planet.[[43]](#footnote-43) Less drastically, concerns about mass extinction and the destruction of distinctive ecosystems are central to many peoples’ worries about climate change, and therefore also geoengineering. As a result, some – such as Jamieson – suggest that an appeal to respect for nature is crucial to spurring the motivation necessary for addressing climate change (Jamieson, 2010, 2014), and he includes this in his list of well-founded ethical norms**.**

In light of such concerns, we suggest adding two further principles of ethical salience to our list:

* **Respect for nature**: Respect natural organisms, ecological communities and wild places.
* **Ecological accommodation**: Seek to live within, among, and together with the rest of nature.

These principles require further specification. Still, arguably, this is no less so than for other principles, including the Oxford principles. More importantly, the lack of precision is not so important in this context. The role of the principles is merely to pick out ethical matters that should be taken into account. Working out what they mean in detail, how they should be incorporated into decision-making, and specifically how they can be integrated with other salient issues is a matter for subsequent discussion. Yet, importantly, none of this implies that the principles of ethical salience do nothing. On the contrary, they cast doubt on certain policies and help to remove blindspots. For instance, in some cases, there are clear violations of their spirit, as when some call for the wholescale domination and annexation of nature for the sake of human aggrandizement.

 We will conclude by proposing one further Tollgate Principle:

**10th Tollgate Principle (Respecting Ecological Norms): Geoengineering policy should respect well-founded ecological norms, including norms of environmental ethics and governance (e.g., sustainability, precaution, respect for nature, ecological accommodation).**

**III. Conclusion**

Our discussion of the Oxford principles has yielded the following set of conclusions and alternative proposals. First, we should reject the public goods framing of geoengineering because it is overly simplistic, obscures the choices to be made within and between geoengineering options, thereby conceals the ethical and especially justice dimensions of the issue, and is also misleading about the important question of public and private provision. Instead, we should replace the first Oxford Principle with:

**1st Tollgate Principle (Framing)**: **Geoengineering should be administered by or on behalf of the global, intergenerational and ecological public, in light of their interests and other ethically-relevant norms**.

Second, we should broaden the second Oxford principle concerning public participation, since its actual provisions are too narrow and more properly understood as requiring only consultation for a narrow range of research subjects of field testing. Instead, we should endorse:

**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 (e.g., justice, political legitimacy).**

**3rd Tollgate Principle (Consultation): Decisions about geoengineering research activities should be made only after proper notification and consultation of those materially affected and their appropriate representatives, and after due consideration of their self-declared interests and values.**

Third, we should subsume both the full disclosure and independent assessment principles under a wider principle highlighting trust and accountability. For one thing, we should enlarge the scope of concern to include not just disclosure of research plans and results and assessment of impacts, but also participation in design, inclusion and diversity of scientists, scientific discipline, nationality and demographic groups (including national, subnational, regional, etc.). For another, we should acknowledge that what counts as geoengineering research, deployment and the very notion of impacts needs to be understood in socio-economic and ethical terms as well as scientific. Hence, the domain will necessarily involve a range of value assumptions that should be deliberated on and endorsed within a wider process. For those reasons, it is better to replace these principles with:

**4th Tollgate Principle (Trust): Geoengineering policy should be organized so as to facilitate reliability, trust and accountability across nations, generations and species.**

Fourth, we should broaden the requirement of the fifth principle that robust governance structures be in place before deployment. On the one hand, serious structures are required prior to full deployment and in fact are presupposed by the Oxford principles concerning field testing. One important reason for this is that for at least some techniques, there is not a sharp separation between field testing and deployment for SRM sulfate injection. On the other hand, governance is too narrow a term for what is at stake, and the “wait and see” approach presupposes that reflection on these issues will not bring on serious constraints on what kinds of geoengineering are feasible. Hence, ideally we need a coevolution of consultation, administration and justification with scientific research. We would not want to see a large waste of research effort on socio-political-ecological unfeasible approaches, just as not of socio-political-ecological effort on scientifically unfeasible approaches.

**5th Tollgate Principle (Ethical Accountability): Robust governance systems (including of authority, legitimacy, justification and management) are increasingly needed and ethically necessary at each stage from advanced research to deployment.**

Finally, we need substantive principles speaking to the very core of the issue, namely questions of ethics and justice. Inspired by Dale Jamieson’s early work, the aim of these principles is to make sure that geoengineering policy is not biased in favor of the powerful of the current generation and not decided on the basis of shallow criteria such as economic efficiency alone.

**6th Tollgate Principle (Technical Availability): For a geoengineering technique to be policy-relevant, *ethically defensible forms* of it must be technically feasible on the relevant timeframe**.

**7th Tollgate Principle (Predictability): For a geoengineering technique to be policy-relevant, ethically defensible forms of it must be reasonably predictable on the relevant timeframe and in relation to the threat being addressed**.

**8th Tollgate Principle (Protection): Climate policies that include geoengineering schemes should be socially and ecologically preferable to other available climate policies, and focus on protecting basic ethical interests and concerns (e.g., human rights, capabilities, fundamental ecological values).**

**9th Tollgate Principle (Respecting General Ethical Norms): Geoengineering policy should respect general ethical norms that are well-founded and salient to global environmental policy (e.g., autonomy, justice).**

**10th Tollgate Principle (Respecting Ecological Norms): Geoengineering policy should respect well-founded ecological norms, including norms of environmental ethics and governance (e.g., sustainability, precaution, respect for nature, ecological accommodation).**

These revisions have implications. The first is that the Tollgate principles are more demanding than the Oxford principles at all levels between research and deployment. The second is that their objectives seem threatened by current socio-political realities. In particular, really fulfilling the objectives would require incorporating the concerns of and reasonable protections for the global population, future generations and nature. This is daunting task for which current institutions appear poorly prepared. One advantage of the Tollgate Principles is that they help to draw attention to the multiple dimensions in which this may be so, and so encourage us to wrestle with these difficult questions in a way that previous attempts do not.

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2. Since the first version of the Oxford Principles, a large number of reports have emerged, many of which propose their own principles (e.g. Shepherd et al., 2009; ASOC, 2010; Bipartisan Policy Center, 2011; Bodle & Oberthür, 2014; Schäfer, Lawrence, Stelzer, Born, & Low, 2015; National Research Council, 2015; for a useful synthesis, see Morrow, 2017). We focus on the Oxford Principles because of their historical role, continued relevance, strong overlap with many subsequent proposals, and ongoing influence, including in philosophical circles (e.g. Moellendorf, 2014). Additional relevant proposals have emerged while this article was under review (e.g. Hubert, 2017; UNESCO, 2017) and include some developments that accord with our Tollgate approach. We defer discussion of those proposals for another occasion. [↑](#footnote-ref-2)
3. We intend ‘ethical’ in a broad sense, to include the concerns of moral and political philosophy, as well as the normative dimensions of international relations, politics, law and economics. As philosophers, our concerns are primarily with underlying normative ideals and concepts. We are not, for instance, focused on assessing the legal dimensions of potential geoengineering governance or its relationship to existing international law, though our principles are relevant to the ethical foundations and implications of such law. We also do not attempt to provide details of implementation (including lower-level principles of implementation), but rather offer general guidance for that task. [↑](#footnote-ref-3)
4. Ironically, the Tollgate was subsequently bought out by a “fabulously wealthy”, “pioneering champion of luxury eco-chic” and transformed from a community pub into a gathering place for the social, economic and political elite (“the poshest pub in Britain”). See Moir 2013. [↑](#footnote-ref-4)
5. Notably, in their introduction the Oxford authors compare their proposal to the Belmont Principles governing medical research (2013, 504). Those principles – *respect for persons*, *beneficence* and *justice* – are very substantive. However, in the Oxford Principles themselves, the only substantive requirement lies implicitly in the public good framing of the first principle, which we criticize below. Since it is clear that paradigm forms of geoengineering pose acute issues of respect, beneficence and justice (and other values), we strive to include these considerations in our Tollgate principles. [↑](#footnote-ref-5)
6. Similar principles of public participation, transparency and independent assessment have been endorsed by virtually every subsequent report (Shepherd et al., 2009; ASOC, 2010; Bipartisan Policy Center, 2011; Bodle & Oberthür, 2014; Schäfer et al., 2015; National Research Council, 2015). They constitute what might be called the core procedural principles. However, as we will see, their interpretation is far from straightforward. [↑](#footnote-ref-6)
7. Notably, those who reject the term ‘geoengineering’ often propose instead separating ‘solar radiation management’ (SRM) techniques from ‘carbon dioxide removal’ (CDR) techniques. However, arguably, this simply recreates the problem of diversity at a lower level. For instance, some SRM techniques (e.g., painting roofs white) have few of the ethics- and policy-relevant features of SSI and more in common with some CDR techniques (e.g., reforestation). Similarly, the paradigm case of CDR - direct air capture on a truly massive scale - bears many similarities with SSI (Gardiner 2011, 344-5). [↑](#footnote-ref-7)
8. This section draws heavily on Gardiner, 2013b, 2014b. [↑](#footnote-ref-8)
9. Notably, several uses feature in presentations of OP1 by the Oxford authors (see below). [↑](#footnote-ref-9)
10. This is so for both ‘public good’ and ‘global public good’. For examples, see Gardiner, 2013b, 2014b. [↑](#footnote-ref-10)
11. This definition is repeatedly emphasized by the editors and motivates their identification of a minimum (Pareto-style) threshold for impure global public goods (Kaul et al. 1999, 510, 2–3, 11, 16; Kaul et al. 2003, 605; cf. World Bank 2001, 129). Nevertheless, it is worth noting that there is a fair amount of internal movement on the definitional issue, especially over time. Notably, (i) in the 1999 foundational work, the UNDP (a) includes universal benefit in the definition of ‘global public good’ even while (b) defining ‘public good’ itself narrowly, in terms of nonrivalry and nonexcludability alone (Kaul et al. 1999, 511); whereas (ii) in later work (a) they opt for a more neutral *definition* of ‘global public good’ that does not include the universal benefit claim, even though (b) the universal benefit claim continues to play an important role in motivating the interest in global public goods and their relevance for public policy. [↑](#footnote-ref-11)
12. This is not at all to say that this is what the Oxford authors intend. The point here is that the initial framing of geoengineering as a public good encourages the rosy picture, particularly when it constitutes the sole substantive principle. So, there is reason to favor a more transparent principle, particularly in the public sphere. [↑](#footnote-ref-12)
13. E.g., perhaps Barrett’s inference from “global public goods make people everywhere better off” to “Global public goods are *thus* universally to be desired” (2007b, p. 1; emphasis added). [↑](#footnote-ref-13)
14. Note that we do not assume that other forms of geoengineering, such as CDR, are also “single-best effort” public goods. [↑](#footnote-ref-14)
15. CDR technologies may also face significant drawbacks. For example, the currently most favored technology, known as BECCS, might result in “land grabs”, public health issues and carbon storage security (Shrader-Frechette, 2015). [↑](#footnote-ref-15)
16. Cf. Gardiner’s example of your breaking into my house in order to clean it (Gardiner, 2013b). [↑](#footnote-ref-16)
17. In the 2013 version, the OP authors mention two weaker interpretations of “for the benefit of all”. First, the Pareto principle requires that at least some benefit and no one be made worse off. Second, the Kaldor-Hicks criterion holds that some can be made worse off if those benefitting from the scheme can compensate them in principle. However, these principles run into similar objections as the universal benefit requirement. For instance, the Pareto requirement seems too strong: for example, why is it impermissible for very rich people to endure small costs if it saves the rest? Similarly, the Kaldor-Hicks requirement seems much too weak. As compensation need not actually be paid, there is no meaningful sense in which everyone benefits: some are simply sacrificed to benefit others. [↑](#footnote-ref-17)
18. Perhaps one could resurrect a universal benefit criterion by adopting a very expansive conception of universal benefit that includes other ethical considerations beyond welfare. In their later work, the Oxford authors may be suggesting something like this when they say “specifying exactly what counts as “the benefit of all” requires consideration of global and intergenerational justice” (Rayner et al., 2013). Nevertheless, this is almost all that they say, other than offering a couple of examples that highlight concepts (i.e., Pareto, Kaldor-Hicks) more familiar from welfarist approaches than theories of justice. Moreover, it is unclear how an expansive conception fits with other claims about public goods they appear to endorse (e.g., what would it mean to say that the expansive kind of global public good is nonrival and nonexcludable?). More importantly, the expansive conception would also push us towards full-blown moral and political philosophy, as it raises many of the same ethical questions. Finally, presupposing a nonstandard and expansive account conceals more than it reveals. It is therefore deeply misleading in the interdisciplinary policy context of geoengineering. Consequently, we favor a more transparent approach that makes clear the centrality and multiplicity of the ethical concerns (see below). [↑](#footnote-ref-18)
19. Similarly, different levels of carbon dioxide removal (e.g. 50 or 150ppm) cannot all be achieved simultaneously. [↑](#footnote-ref-19)
20. Morrow, 2017, 10. For instance, Morrow highlights that while existing reports “generally agree that a primary objective … is to manage the physical and political risks of [geoengineering] research and potential deployment … that agreement masks an important disagreement about the specific risk-risk trade-off involved in researching [geoengineering] as opposed to prohibiting or foregoing research” (Morrow 2017, 10). [↑](#footnote-ref-20)
21. The principles of public participation, transparency and independent assessment are endorsed by virtually every report so far (Shepherd et al., 2009; ASOC, 2010; Bipartisan Policy Center, 2011; Bodle and Oberthür, 2014; Schäfer et al., 2015; National Research Council, 2015). They constitute what might be called the core procedural principles. However, as we will see shortly, their interpretation is far from straightforward. [↑](#footnote-ref-21)
22. See also Blomfield 2015 and Smith 2017. [↑](#footnote-ref-22)
23. Compensation is mentioned with respect to deployment in the commentary of Principle 5. However, note that compensation after the fact for a harm from a project is very different from consultation in advance about whether the project should proceed. See below. [↑](#footnote-ref-23)
24. For different ways of understanding what would count as consent to geoengineering, see (Wong, 2015). [↑](#footnote-ref-24)
25. Note again the problem that only those directly affected will have any say. [↑](#footnote-ref-25)
26. Ultimately, principles of geoengineering governance, including our principles and the Oxford Principles, also require such authorization. In our view, the presenting of such principles (whether by academics, policy groups or organizations) is primarily a bottom-up process to promote discussion prior to, and as an aid to, eventual authorization. It would be ethically unreasonable, as well as politically unrealistic, to see such principles as “top down” impositions on the global order. [↑](#footnote-ref-26)
27. In practice, the relevant “rogues” may be restricted to actors with the implicit backing from major powers (e.g., Gardiner 2013a). [↑](#footnote-ref-27)
28. As well as technical possibilities, research choices are often strongly influenced by the nonscientific values of researchers or funding institutions. These values intervene at many levels, including in the basic design of the research program, and (as we are seeing) in the principles and institutions that govern it. Given this, it is very important that the process is scrutinized at every level, and from a variety of perspectives. This is well known in philosophy of science (e.g., medical research). [↑](#footnote-ref-28)
29. As well as assisting in the first two ways, this may play an important role in the development of the subject, and of wider scientific and social ties between participating institutions, disciplines and societies. For example, openness is assumed to facilitate and encourage global participation in geoengineering research. The hope is that this assists in making geoengineering research a genuinely global public project at least among researchers. Among other things, this may aid in disrupting attempts to create parochial or predatory programs, and so undermine the prospects for a geoengineering arms race. [↑](#footnote-ref-29)
30. David Morrow indicates to us that this suggests another way in which the Oxford approach is limited. The baseline concerns naturally arise for deployment and large-scale, long-term field trials, so perhaps OP4 should be restricted to very low-impact and near term research. [↑](#footnote-ref-30)
31. I.e., as the stakes get higher. [↑](#footnote-ref-31)
32. I.e., to satisfy basic normative requirements, such as of justice and political legitimacy. [↑](#footnote-ref-32)
33. Advanced, mission-driven, geoengineering research programs can benefit from governance even prior to field tests for various reasons, including to ensure that projects are directed towards appropriate ends and in light of the other Tollgate Principles (see also Blomfield 2015, Smith 2017). This is partly for the good for such programs, to ensure that their research remains relevant to their mission. [↑](#footnote-ref-33)
34. Tellingly, most reports on geoengineering are similarly limited. For instance, questions of justice are absent, or only mentioned in passing. The closest to a robust treatment of the question is the recent EuTRACE report which devotes five pages to issues of justice. However, even in this case, the only substantive element in the proposed principles of governance is a principle of harm minimization (Schäfer et al., 2015). [↑](#footnote-ref-34)
35. However, recall that this may partly be due to the framing effects of the public goods principle, which may implicitly assume that, because geoengineering is a public good, there will be no objections and that in principle geoengineering is an unambiguously good thing. [↑](#footnote-ref-35)
36. Some (especially advocates of geoengineering) worry that asking for ethical defensibility sets the bar too high; others (especially skeptics) are concerned that it may be compatible even with truly lamentable forms of intervention (cf. Gardiner & Fragnière, 2017). Still, much of this debate is really about what the ethical criteria actually are, and what the alternatives might be. One advantage of the Tollgate framework is that it highlights and thereby facilitates that debate. [↑](#footnote-ref-36)
37. One reason this approach is important is the tendency of some framings of geoengineering (e.g., as ‘Plan B’) implicitly to isolate geoengineering techniques from comparisons with other policy options(Fragnière & Gardiner, 2016)**.** [↑](#footnote-ref-37)
38. Ideally, the chosen policy would be superior on each dimension; however, the principle does not require this: it maintains only that these are the most central, ethically-relevant dimensions. [↑](#footnote-ref-38)
39. Ross maintains (i) that when only one duty is relevant, it holds sway, but when more than one are present, the concerns have to be weighed against each other. We shall not go this far and instead regard the relevant duties more weakly, as (ii) principles of ethical salience that capture concerns that should be taken into account when they arise, but which may not be decisive, even if they arise alone. However, Ross also (iii) does not order his principles according to any kind of priority rule, and (iv) does not assert that his list is complete, but leaves it open-ended. We follow him in these claims. [↑](#footnote-ref-39)
40. Note that for Ross, justice is “a distribution of happiness between (…) people in proportion to merit” (Ross 2002, 26). However, most contemporary conceptions of justice are considerably broader, and it is the broader notions we have in mind here. [↑](#footnote-ref-40)
41. E.g., Jamieson’s norm of democratic decision-making can be seen as grounded in autonomy and justice. [↑](#footnote-ref-41)
42. This characterization is based a common, minimal definition (e.g. UNFCCC, 1992; UNESCO, 2017). Our views on precaution are more complex and potentially more demanding (e.g. Gardiner, 2006; Shue 2010; Hartzell 2012); however, we set such issues aside here. [↑](#footnote-ref-42)
43. Cf. Gardiner’s “Dome World” scenario (Gardiner 2011a). [↑](#footnote-ref-43)