This is a preprint version. The final version of this paper is published in *Ethics, Policy & Environment 17 (2), 186-191.*. Please cite the final version at: <http://www.tandfonline.com/doi/abs/10.1080/21550085.2014.926090>

# *Maintenance Required: The Ethics of Geoengineering and Post-Implementation Scenarios*

Pak-Hang Wong

*Research Fellow*

*Institute for Science, Innovation and Society, University of Oxford****(a)***

*Oxford Uehiro Centre for Practical Ethics, University of Oxford****(b)***

|  |
| --- |
| **Email**: [pak.wong@insis.ox.ac.uk](mailto:pak.wong@insis.ox.ac.uk)  **Website**: <http://www.wongpakhang.com>  **Address**: ***(a)***Institute for Science, Innovation and Society, University of Oxford,   64 Banbury Road, Oxford, OX2 6PN, UK  ***(b)***Oxford Uehiro Centre for Practical Ethics, University of Oxford,  Suite 8, Littlegate House, 16/17 St Ebbe's Street, Oxford, OX1 1PT, UK |

**Abstract**

The ethics of geoengineering has gained momentum in recent academic debate. The current debates, however, is typically framed in terms of (i) the first-order question about the moral permissibility of geoengineering, and (ii) the second-order question about the distributive and compensatory issues associated with geoengineering. Both (i) and (ii) are central to decision-making about geoengineering, but they have not cover *all* ethical issues related to geoengineering. I argue that a preoccupation with (i) and (ii) may lead to an oversight of *post-implementation scenarios* (PISs), which introduce different ethical issues relevant to decision-making on geoengineering. More specifically, I use *the requirement of maintenance* for geoengineering as an example to draw attention to PISs, and to illustrate the limit of the existing discussion in the ethics of geoengineering.

**Keywords**: *Maintenance*, *Geoengineering, Post-Implementation Scenarios, Climate Ethics, Responsibility, Burden-sharing.*

**Acknowledgement**: *This work was conducted at the Institute for Science, Innovation and Society and Oxford Uehiro Centre for Practical Ethics as part of the Climate Geoengineering Governance Project (*[*http://geoengineeringgovernance.org*](http://geoengineeringgovernance.org)*) funded by the UK Economic and Social Research Council (ESRC) and the Arts and Humanities Research Council (AHRC) - grant ES/J007730/1*. *The author would like to thank for helpful comments from Julian Savulescu, Steve Rayner, Clare Hayward and Nils Markusson.*

# Maintenance Required: *The Ethics of Geoengineering and Post-Implementation Scenarios*

## Introduction

The ethics of geoengineering has gained momentum in recent academic debate, with new articles, special issues, and edited volumes devoted to ethical issues raised by research and development (R&D) and implementation of geoengineering.[[1]](#footnote-1) The current debate, however, is typically framed in terms of (i) the first-order question about the moral permissibility of geoengineering, and (ii) the second-order question about the (re)distribution of costs, risks, and (potential) harms and benefits associated with geoengineering as well as the compensatory issues arise from the (re)distribution. Both (i) and (ii) are without doubt central to decision-making about geoengineering, and thus researchers of the ethics of geoengineering are certainly right to focus on them, but (i) and (ii) do not cover *all* ethical issues relate to geoengineering. Here, I argue that a preoccupation with (i) and (ii) may lead to an oversight of *post-implementation scenarios* (PISs), i.e. possible scenarios in which a deployment of geoengineering has been *initiated*. PISs are important to the ethics of geoengineering as they introduce ethical issues pertinent to decision-making on geoengineering that are not fully captured by (i) and (ii), or so I argue. More specifically, I shall discuss the normative dimension of *the requirement of maintenance* for geoengineering as an example to draw attention to PISs, and to illustrate the limit of the existing discussion in the ethics of geoengineering.

## The Ethics of Geoengineering and the Normative Dimension of Maintenance

To illustrate the limit of the existing discussion in the ethics of geoengineering, it is helpful to begin with a summary of the types of questions in the current debate[[2]](#footnote-2):

(GE1) Is R&D of geoengineeringmorally permissible (or, (GE1\*) under what circumstances is the R&D morally permissible)?

(GE2) If R&D of geoengineering is morally permissible, how should the costs, risks, and (potential) harms and benefits be shared?

(GE3) Is an implementation of geoengineering morally permissible (or, (GE3\*) under what circumstances is the implementation morally permissible)?

(GE4) If an implementation of geoengineering is morally permissible, how should the costs, risks, and (potential) harms and benefits be shared?[[3]](#footnote-3)

For example, the discussion on the moral hazard or the moral corruption associated with geoengineering is, in effect, about the undesirable moral consequences for considering (or implementing) geoengineering. And, the discussion on whether geoengineering expresses a hubristic attitude, or on whether it is a quick fix that can diverge the humankind from the more serious ethical issues relate to anthropogenic climate change is essentially about the moral (dis)values of geoengineering. In short, they are about the moral permissibility of geoengineering, and they can be viewed as instances of (GE1) and (GE3).

In the ethical debate about R&D of geoengineering, the need of regulatory frameworks, the phenomenon of lock-in and path-dependency, and the importance of participation (of vulnerable and marginalized groups) are often mentioned. The debate about those issues, I think, aims primarily at specifying the criteria for the R&D to be morally permissible, i.e. (GE1\*). Similarly, an oft-mentioned topic associated with implementation of geoengineering, i.e. procedural justice, particularly public participation in and (global) consent for implementation, is too concerned with specifying the criteria for an implementation of geoengineering to be considered as morally permissible, i.e. (GE3\*).

Finally, distributive justice-related issues associated with R&D and implementation of geoengineering, i.e. (GE2) and (GE4), should be obvious enough. Questions about the distribution of research funding and the costs, risks, and potential harms and benefits arise from the R&D are clearly important topics in the ethics of geoengineering. And, the same is true of the distribution of the costs, risks, and potential harms and benefits result from implementation of geoengineering, too.[[4]](#footnote-4)

If the above summary offers a more-or-less accurate picture of the existing discussion in the ethics of geoengineering, it seems to show that researchers are presently preoccupying themselves with questions concerning whether to implement geoengineering (and, with questions about how can it be done ethically). This, I think, has created an unfortunate oversight of the ethical issues *after* an implementation.

Now, one might object to my claim that the ethics of geoengineering is currently biased toward the decision-making on implementation of geoengineering. Particularly, “the termination problem”, i.e. potential catastrophic consequences of subsequent failure or sudden halt of geoengineering techniques, especially of SRM techniques (Royal Society 2009, 24), underscores the possible consequences *after* an implementation of geoengineering. However, the termination problem is often being employed to highlight the possible catastrophic consequences of geoengineering, and then to question its moral permissibility (see, e.g. Burns 2011, 47-48; Svoboda *et al.* 2011, 167-171). So construed, the existing literature on the termination problem is *not* really about PISs but about implementation of geoengineering. In short, using the termination problem *only* as an argument against implementation of geoengineering will not help us to see the ethical issues *after* the implementation.[[5]](#footnote-5)

The lesson now I want to turn to have to do with maintenance for geoengineering techniques. It should be self-evident that *any* geoengineering technique – like any technological artifact or infrastructure – requires both *continuance* and *monitoring* once being deployed.[[6]](#footnote-6) By continuance, I refer to the continuing deployment of a geoengineering technique *required* by its proper functioning as a response to anthropogenic climate change; and, by monitoring, I refer to the regular observation and check-ups (and, possibly, adjustment) of a geoengineering technique *required* to ensure its proper functioning. For example, Naomi E. Vaughan and Timothy M. Lenton note that the "effect [of any Carbon Dioxide Removal (CDR) techniques] will decay over time […], and it will also decay if carbon storage is not permanent. In the long-term, the only way to return atmospheric CO2 to pre-industrial levels is to permanently store […] an equivalent amount of CO2 to the total emitted to the atmosphere” (Vaughan & Lenton 2011, 750). Yet, even if permanent carbon storage is available, the need of monitoring remains. The same is true of Solar Radiation Management (SRM) techniques as well. Space-based sunshades, aerosol stratospheric injection (SAI) and other SRM techniques too require continuous deployment and careful monitoring (for space-based sunshades, see, e.g. Angel 2006; for SAI, see, e.g. Bengtsson 2006; Archer & Brovkin 2008). In short, implementation of any geoengineering technique implies a multi-generational commitment for its continuance and monitoring (MacCracken 2009, 26-28). Let us call this requirement of continuance and/or monitoring for geoengineering techniques the *requirement of maintenance*.

The requirement of maintenance is of paramount importance to the ethics of geoengineering, because it points to a burden and a responsibility that our decision-making on implementation of geoengineering ought to account for, and without considering them an implementation of geoengineering *cannot* function as a proper response to anthropogenic climate change, because *every* geoengineering technique requires maintenance if it is to function properly. Yet, the existing discussion in the ethics of geoengineering, i.e. (GE1)-(GE4), does not inform us *how the burden of maintenance should be shared* and *who should be responsible for the maintenance.* In other words, the ethical issues raised by the requirement of maintenance are being left out in the ethics of geoengineering.

For instance, (GE4) aims to tell us how to justly (re)distribute the costs, risks, and (potential) harms and benefits associated with an implementation, and to compensate those who are being negatively affected when necessary. In short, (GE4) is concerned with *precluding* injustice caused by an implementation and with *rectifying* injustice it has caused. However, even if there is no longer a need for (re)distribution and compensation, we still have to consider who should bear the burden of maintenance and how this burden should be shared so long as the implemented geoengineering technique remains in operation. In this respect,the requirement of maintenance falls outside the scope of preclusion and rectification of injustice, and thus the normative questions about the burden-sharing of maintenance are distinct from the normative questions about (re)distribution and compensation associated with implementation of geoengineering. In short, (GE4) does not cover the normative questions raised by the requirement.[[7]](#footnote-7)

What about (GE2)? Does it cover the normative questions concerning the burden-sharing of maintenance? (GE2) aims to find out what allocations of resources (and burdens) associated with R&D of geoengineering is just and how it can be achieved, e.g. based on (a) contribution to anthropogenic climate change, (b) capacity, (c) benefits from R&D (and/or implementation), and so on. Indeed, I reckon the burden-sharing of maintenance is likely to be determined by one of those factors (or, some combinations of those). However, it is important to point out that R&D and maintenance are two different sets of activities, and there is no *a priori* reason to hold that the burden for R&D entails the burden of maintenance.

It is, of course, possible to provide *a posteriori* reasons to conjoin the burden for R&D and the burden of maintenance. Yet, it is important for the decision-making on implementation of geoengineering to set them apart carefully because the burden of maintenance goes well beyond the burden for R&D (and, I believe, the burden of implementation, too). Making the burden of maintenance explicit, therefore, requires us to reconsider the scope and nature of the burden of geoengineering. Particularly, the relations between different types of burden have to be examined more thoroughly. By distinguishing the burden of maintenance from the burden for R&D and the burden of implementation, we can avoid a negligence of the former resulting from a conflation of various burdens.

Similar normative questions arise for the responsibility of *performing* maintenance, too. Although it seems that those who *initiated* a deployment of geoengineering have a *prima facie* responsibility to perform the maintenance, not least because of the idea of “if you started it, you should finish it”, but also because they can exert directly or indirectly control over those technological artifacts and infrastructures. Yet, neither can serve to ascribe the responsibility to perform maintenance. First, starting an action does not by itself entail a responsibility for its future, continuing performance. Second, one being in a position to exert control over some technological artifacts or infrastructures is a contingent fact, which does not by itself entail the normative conclusion that they *ought* to perform the maintenance. What I am arguing here, of course, is not that there is no way to ascribe the responsibility to perform maintenance to those who have initiated the deployment, what I am arguing instead is that the responsibility must be ascribed with *normative* reasons, which the ideas of “if you started it, you should finish it” and the contingent fact of controllability do not suffice. However, since whether or not an implementation of geoengineering can function properly as a response to anthropogenic climate change hinges on the presumption that some states (or, some entities) will uphold the responsibility to perform maintenance. This responsibility is better made explicit during the decision-making on implementation of geoengineering. And, I think, it is an appropriate task for the ethics of geoengineering to examine who have this responsibility, and on what grounds they have it, which are inherently *normative* questions. Making explicit this responsibility also has an added advantage to allow us to (re)formulate questions about intergenerational justice not only in terms of costs, risks, and (potential) harms and benefits, but also as a moral obligation for action, i.e. to geoengineer, imposed on future generations.

## From Maintenance to Post-Implementation Scenarios: The Need to Expand the Ethics of Geoengineering

My aim so far has been to identify a gap in the ethics of geoengineering by showing that the requirement of maintenance presents a different burden and a different responsibility and that the normative questions arise from the requirement go beyond the existing debate, i.e. (GE1)-(GE4). To put it differently, my claim is that even if geoengineering is morally permissible, and *all* distributive and compensatory issues associated with R&D and implementation of geoengineering have been satisfactorily addressed, the normative questions related to maintenance of geoengineering techniques would remain, and therefore the existing discussion is inadequate.

Of course, as Stephen Gardiner rightly notes, specific technical details of a geoengineering technique can raise different ethical issues (Gardener 2010). For the requirement of maintenance, however, technical specificity will only affect the *magnitude*, but not the *type*, of ethical issues raised by the requirement, as the requirement comes from a general feature shared by *all* geoengineering techniques, namely they comprise (or, depend on) technological artifacts and infrastructures. Insofar as geoengineering is a “deliberate large-scale manipulation of the planetary environment” (Royal Society 2009, 1) that involves sufficiently sophisticated technological artifacts and infrastructures, my case for the normative significance of the requirement will stand.

I concede that the negligence of the requirement of maintenance may simply come from the nascent nature of the ethics of geoengineering. If it is indeed so, then this article can be viewed as an attempt to raise awareness of the normative dimension of maintenance in the ethics of geoengineering. However, the negligence may also be a result of philosophers being ‘insufficiently speculative’ (Lucivero *et al*. 2011), and thus missing some relevant normative considerations in their assessments. If it is so, then there is a genuine need to make explicit the requirement of maintenance in the ethics of geoengineering. Finally, an awareness of the normative dimension of maintenance should also enable researchers to reconceptualize the ethics of geoengineering from a long-term perspective, i.e. to see geoengineering not as an *one-off event* but as a *temporally extended process*. In doing so, it should also encourage researchers to explore the future ethical issues in the geoengineered world and to extend their ethical analyses to include PISs.

## References

Angel, R. (2006). Feasibility of cooling the Earth with a cloud of small spacecraft near the inner Lagrange point (L1). *Proceedings of the National Academy of Sciences* 103, 17184–17189.

Archer, D. and Brovkin, V. (2008). The millennial atmospheric lifetime of anthropogenic CO2. *Climatic Change* 90 (3), 283-297.

Bengtsson, L. (2006). Geo-engineering to confine climate change: is it at all feasible? *Climatic Change* 77 (3-4), 229-234.

Burns, W. C. G. (2011). Climate geoengineering: solar radiation management and its implications for intergenerational equity. *Stanford Journal of Law, Science & Policy*, May 2011, 38-55.

Gardiner, S. (2010). Is ‘arming the future’ with geoengineering really the lesser evil? Some doubts about the ethics of intentionally manipulating the climate system. In S. Gardiner, S. Caney, D. Jamieson & H. Shue (eds.), *Climate Ethics: Essential Readings* (pp. 284-312). Oxford: Oxford University Press.

Lucivero, F., T. Swierstra, and M. Boenink (2011). Assessing expectations: towards a toolbox for an ethics of emerging technologies. *Nanoethics* 5 (2), 129-141.

MacCracken, M. C. (2009). Beyond mitigation: potential options for counter-balancing the climatic and environmental consequences of the rising concentrations of greenhouse gases. *Policy Research Working Paper* 4938. Available Online at: <http://www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2009/05/19/000158349_20090519141020/Rendered/PDF/WPS4938.pdf>

Powell, R., S. Clarke, M. Sheehan, T. Douglas, B. Foddy, and J Savulescu (2010). The ethics of geoengineering (working draft). Available Online at: <http://www.practicalethics.ox.ac.uk/__data/assets/pdf_file/0013/21325/Ethics_of_Geoengineering_Working_Draft.pdf>

Preston, C.J. (2013). Ethics and geoengineering: reviewing the moral issues raised by solar radiation management and carbon dioxide removal. *WIREs Climate Change* 4, 23-37

Royal Society (2009). *Geoengineering the Climate: Science, Governance and Uncertainty*. London: Royal Society.

Svoboda, T., K. Keller, M. Goes, and N. Tuana (2011) Sulfate aerosol geoengineering: the question of justice. *Public Affairs Quarterly* 25 (3), 157-179.

Vaughan, N.E. and Lenton, T.M. (2011). A review of climate geoengineering proposals. *Climatic Change* 109 (3-4), 745-790.

1. For example, a recent issue of *Ethics, Policy & Environment* has a special section on “The Ethics of Geoengineering”. Due to the limit of space, I cannot offer a comprehensive list of examples here, for an excellent survey of the field, see Preston (2013). [↑](#footnote-ref-1)
2. The list, of course, is greatly simplified, but I think it has adequately summarized the *types* of questions being taken up by researchers in the field. [↑](#footnote-ref-2)
3. My discussion of the ethics of geoengineering is primarily based on Preston’s (2013) review of the field (also, see Powell *et al*. 2010, for another overview of the field). It is worth noting that Preston, in his review, has introduced a four-stage categorization for the ethics of geoengineering, i.e. “contemplating the prospect of geoengineering”, “research & development”, “implementation”, and “post-implementation”. Yet, if we view the ethical issues raised by geoengineering not from a temporal perspective as Preston does, the category of “contemplating the prospect of geoengineering” can be seen as one that is about the moral permissibility of geoengineering. [↑](#footnote-ref-3)
4. In his review, Preston discusses incidental impacts of geoengineering as a topic for the ethics of geoengineering in the stage of implementation. Yet, those incidentals are often enlisted by researchers to cast doubts on the moral permissiblity of implementation. In this respect, they should be viewed as instances of (GE3). [↑](#footnote-ref-4)
5. It is possible to argue that the termination problem presents a *decisive* argument against geoengineering. If this is plausible – and, for that matter, if there is *any* argument that can completely rule out the moral permissibility of geoengineering, then PISs are indeed redundant in the ethics of geoengineering. However, whether there can be such decisive arguments remained to be seen. My claim, minimally, is that if the second-order questions about (re)distribution and compensation are important in the field, then there is no reason to ignore PISs in the debate. [↑](#footnote-ref-5)
6. For a review of the technical details of various proposed geoengineering techniques, see Vaughan & Lenton (2011). [↑](#footnote-ref-6)
7. A plausible response is to include the burden of maintenance as part of the costs, risks, and (potential) harms and benefits of implementation of geoengineering. Doing so, however, already forces us to see implementation of geoengineering as a temporally extended process*,* which, in turn, requires us to move beyond the decision-making on implementation and to consider the ethical issues *in* PISs. [↑](#footnote-ref-7)