Slippery slope arguments as precautionary arguments: a new way of understanding the concern about geoengineering research*

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Abstract

It has been argued that geoengineering research should not be pursued because of a slippery slope from research to problematic deployment. These arguments have been thought weak or defective on the basis of interpretations that treat the arguments as relying on dubious premises. The paper urges a new interpretation of these arguments as precautionary arguments, i.e., as relying on a precautionary principle. This interpretation helps us better appreciate the potential normative force of the worries, their potential policy relevance, and the kind of evidence required by slippery slope arguments. Understood as precautionary arguments, it is clear that slippery slope arguments against geoengineering capture concerns that are worth taking seriously.

Keywords: geoengineering; slippery slope arguments; precautionary principle; ethics; climate change

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1 Introduction

This paper offers a new way to understand so-called 'slippery slope arguments' against geoengineering research. The key insight is that these arguments are best understood as having a precautionary spirit, i.e., relying on some form of precautionary principle. §2 introduces slippery slope concerns as they are raised in relation to geoengineering research. §3 motivates and outlines an interpretation of slippery slope arguments against geoengineering research which gives a central role to precautionary thinking. §4 outlines the key advantages to this interpretation. In particular, this approach helps us appreciate the potential normative force of slippery slope arguments against geoengineering research that extant treatments have missed, it helps us appreciate how the concerns expressed in slippery slope arguments against geoengineering research should feed into policy decision-making, and it directs our attention in productive ways—making clear what evidence is needed to assess the force of slippery slope arguments against geoengineering research. §5 then wraps up.

2 Slippery slope arguments against geoengineering research

Geoengineering is typically understood to include any large-scale deployment of technology to mitigate the effects of climate change as the result of anthropogenic greenhouse gas emissions. The technologies that have been proposed for geoengineering are many and varied. A top-level division is drawn between solar-radiation management (SRM) (e.g., sulphate aerosol injection) and carbon dioxide removal (CRD) (e.g., bioenergy and carbon capture and storage, and afforestation).[1]

[1] I use IPCC labels and acronyms. My argument doesn't require digging into the nature/merits of any particular technologies. But differences between technologies will matter a lot in a full ethical assessment.

This paper focuses on a specific kind of argument that has been called a 'slippery slope argument' against research into geoengineering. As Walton's intuitive gloss goes (Walton 1992):

> A slippery slope argument is a kind of argument that warns you if you take a first step, you will find yourself involved in a sticky sequence of consequences from which you will be unable to extricate yourself, and eventually you will wind up speeding faster and faster towards some disastrous outcome

Beyond this intuitive gloss, however, it is not clear that slippery slope arguments are a unified class of arguments or that a comprehensive definition can be given (Corner et al. 2011, cited in Walton 2015). Indeed, while Walton's gloss artfully elides a few key distinctions, it doesn't actually cover 'slippery slope arguments' against geoengineering research all that neatly.[2] Nonetheless, slippery slope arguments against geoengineering research certainly do have something of the same spirit that Walton's gloss picks out.

The basic structure of slippery slope arguments (SSA) against geoengineering is that they make recommendations to halt or limit research into geoengineering of certain kinds or scales on the basis that such research programmes involve an 'institutional momentum' towards the development to deployment readiness and then to morally problematic deployment of the relevant geoengineering technologies (these can be found in Jamieson 1996, McKinnon 2019, and Lin 2016).

Why might the deployment of geoengineering technologies be thought potentially morally problematic? The details will depend on exactly which technologies we are talking about.[3] The general fear however is that, due

[2]The focus on 'you' and the concern about speeding 'faster and faster' don't seem key parts of the arguments that concern us here.

[3]Ethical scrutiny typically targets SRMs rather than CRD, and commonly specifically SAI technology (e.g., Svoboda 2016). This pattern is replicated in discussion of SSA (e.g., Callies 2019b). SAI is seen as particularly concerning in part due to the side-effects of deployment and of sudden and sustained termination of SAI.

to being careless or unlucky, large-scale intervention in the composition of the atmosphere and/or reflectivity of the Earth could have dramatic and unpredictable effects which might result in considerable net harms to particular populations, regions or generations in a way that raises justice-based concerns, or even net harms to humanity overall.[4]

Why might one think that the establishment of a programme of research into geoengineering might establish an 'institutional momentum' towards deployment? Callies (2019b) provides a useful synthesis of considerations that have been raised in the literature (from Jamieson, Gardiner and Lin):

- 'our cultural imperative to develop technologies that are within our capabilities' (summarising Jamieson)
- 'scientists generally want their projects to continue' (summarising Jamieson)
- 'people like to justify their sunk costs' (quoting Gardiner)
- 'starting usually creates a set of institutions whose mission it is to promote such projects' (quoting Gardiner)
- '[e]ven very basic and safe research … [creates] a scientific lobbying constituency for development and eventual deployment' (quoting Lin)

Are SSA against geoengineering research good arguments? Some recent assessments suggest not. Callies concludes that the relevant SSA arguments rest on two claims he thinks are dubious: (i) that 'research will lead to deployment' and (ii) that 'we have decisive moral reasons not to deploy the

However, the side-effects of widespread deployment or sudden termination of other forms of geoengineering shouldn't be underestimated. The focus on SAI is not because SAI is *unique* in raising such concerns (see, e.g., González 2018).

[4]Other reasons include concerns about procedural justice and disrespect for nature. For an extensive list, see Pamplany et al (2020). For an excellent literature review on the ethics of geoengineering, see Pamplany (2020). And see this journal Gardiner 2011

technology' (Callies 2019b). Since these claims are questionable at best, Callies deems SSA arguments against geoengineering research to fail to justify a moratorium. He thinks the case for a moratorium would need to be made in light of 'all the morally relevant facts about the technology' and to be in such a position it is important to do a lot of research into geoengineering.[5]

I think we shouldn't dismiss SSA against geoengineering research just yet. Callies interprets SSA against geoengineering research as relying on a particular argument form. While Callies's criticisms are apt if SSA against geoengineering research are best understood as Callies understands them, I will suggest that we should understand SSA against geoengineering research in a different way. I will urge that we interpret SSA against geoengineering research as precautionary arguments. Understood in this way, SSA against geoengineering research are not so easily set aside by noting that it is questionable whether research will lead to deployment and whether deployment would be morally wrong (e.g., as the result of having catastrophic consequences).

Regardless of whether SSA against geoengineering research are ultimately to be understood as Callies understands them or as I propose understanding them, there are two things it is helpful to clarify about their nature. First, to avoid confusion, I want to reiterate that this paper is only about the kind of argument outlined above, and that the relation between these and any broader class of argument called 'slippery slope arguments' isn't straightforward.[6] In particular, it shouldn't be assumed that SSA against geoengineering research share certain characteristics with other 'slippery slope' arguments that might be more familiar to the reader.[7] For example, it

[5]Although his understanding of SSA against geoengineering research doesn't interpret them as precautionary arguments, Callies acknowledges in passing that such SSA are associated with precaution and describes measures that mitigate against slippery slopes around geoengineering as precautionary.

[6]Indeed, SSA are often defined so as to exclude the kinds of arguments considered here (e.g., Lode 1999). In any case, I will remain neutral on (a) whether SSA against geoengineering research share a common form with other SSA, and (b) what, if any, is the shared structure of other SSA.

[7]For a discussion of some more familiar SSA in this journal see Tanner (2009).

is typical to distinguish between 'logical' and 'causal' arguments that appeal to slippery slopes.[8] In logical slippery slope arguments, the fear is about a conceptual relation: a conceptual slippery slope, e.g., that once X is thought okay, there's no reason not to think Y is okay and, once Y is thought okay, there is no reason not to think Z is okay, where Z is morally wrong. The arguments made against geoengineering are not like this. Rather, the appeal that SSA against geoengineering research make to a slippery slope is an appeal to a *causal* slippery slope. They are concerned about a *causal* relation between geoengineering research and problematic deployment; the focus is not upon what inferences are licenced by particular normative foundations but rather on the causal effects of actions licenced by those foundations. For another example, it is common to characterise causal slippery slopes as involving a chain of incremental, analogous steps.[9] But the arguments made against geoengineering aren't concerned with this kind of causal relation. Their focus is not upon a causal 'momentum' within a chain of similar incremental actions each leading on from the other. SSA against geoengineering research instead make this distinctive central appeal to what I've called 'institutional momentum' (following Callies 2019b). The merits of SSA against geoengineering research will thus rest not on an examination of some specific causal chain of incremental steps towards deployment but rather on the claim about geoengineering research setting up an institutional momentum towards deployment.

Second, I want to reflect on the notion of 'institutional momentum' that plays a role in SSA against geoengineering research. Callies (2019b) deliberately sets aside the question of what exactly is meant by 'institutional momentum' while acknowledging its importance. Nonetheless, his treatment of the key premise clearly assumes that institutional momentum involves fac-

[8] Most authors do this, but, e.g., see Govier (1982). Although perhaps in many cases this distinction is somewhat superficial. The main reason to be concerned about logical SSA, is that one predicts or fears that people will in fact make the relevant inferences.

[9] Indeed, LaFolette (2005) proposes this as central to the general structure of all slippery slope arguments.

tors that mean that 'research will unavoidably lead to deployment'.[10] Callies treats the relevant worries as sufficiently 'quelled' by the provision of reasons to think that it is possible to design and regulate research institutions in ways that mean there is no *inexorable* slippery slope between research and problematic deployment. I think this is uncharitable to SSA against geoengineering research (whether or not I'm ultimately right that the arguments are best understood as precautionary arguments). It is true that there is some talk in the literature on slippery slopes and geoengineering about an 'inevitability' of deployment once a serious research project is up and running. Jamieson (1996), for example, explicitly talks of development and deployment being 'inexorable'. However, it is difficult to take such claims seriously if intended literally.

So, what does a more charitable understanding look like? What's the best understanding of this worry about institutional momentum (and any effect of factors like a 'cultural imperative', etc.)? The worry must be, I think, that the whole process determining whether some relevant programme of research results in deployment will be insensitive (or insufficiently sensitive) to whether moral concerns about deployment have been sufficiently addressed or assuaged.[11] That's the kind of momentum that would be troubling. One might have hoped that further research would mean we would one day be in a position to avoid careless deployment or deployment that relied on getting lucky: that doing the research would allow all moral concerns to be effectively assessed and taken into account. The concern about institutional momentum is in essence that this hope would be ill-founded.

[10] Given this understanding of institutional momentum, Callies's (2019b) criticisms are on point.

[11] This aspect of slippery slopes isn't widely recognised but is similar to what Walton (2017) has in mind in his discussion of SSA in general when he talks about 'lack of control'.

3 Uncertainty and precaution

This section provides some motivation for thinking SSA against geoengineering research are best understood as a form of precautionary argument. It begins by outlining the nature of precautionary arguments and their relation to uncertainty. And, after providing some motivation, it presents a precautionary version of the SSA against geoengineering research: the kind of argument against geoengineering research that I suggest deserves our attention.

What is a precautionary argument?[12] A precautionary argument is an argument that appeals to some form of precautionary principle. Precautionary principles are highly contested in terms of their precise formulation, use and merits. Here I focus on a generic form that I think is well-suited to capture the spirit of SSA arguments against geoengineering research. Precautionary principles commend a 'better safe than sorry' approach to policymaking: one doesn't need to wait to resolve uncertainty about whether a particular activity will have (or is having) morally catastrophic results; if there is a credible threat, it is appropriate to take precautions including to stop the relevant activity.

So the basic idea of the paper is that SSA against geoengineering research in part express a lack of confidence in the ability of the existing or expected processes and institutions around geoengineering research to be such that they ensure that geoengineering technologies are only deployed (if at all) when it is appropriate to do so taking into account risk of moral catastrophe, and recommend a moratorium or heavy regulation of research in this area as a way to take appropriate precautions in light of this uncertain but credible threat of moral catastrophe.

Why think of SSA against geoengineering research in this way? The rest

[12] For an overview of precautionary arguments see Steele (2006), Rechnitzer (2022), and for prior discussion in this journal, see Sandin (2016), and O'Riordan & Jordan (1995). The relation between precautionary thinking, as enshrined by 'precautionary principles', and geoengineering is far from straightforward. See Elliott (2010) for a survey of numerous aspects of that relation (although not the aspect considered here.).

of this section provides some motivation by reflecting on why SSA against geoengineering research might be framed in terms of a 'slippery slope' in the first place. The section proceeds through a dialogue with a paper by Hugh LaFolette who reflects in a similar way on the function of slippery slopes in moral discourse more broadly.[13] Readers who want to cut to the chase and see what a precautionary reading of slippery slope arguments looks like can skip ahead to the final couple of paragraphs of this section.

LaFolette (2005) observes that one would not cast one's argument in terms of a 'slippery slope' if one had a strong straightforwardly causal, consequentialist argument available. For example,

(1) The effects of geoengineering research (of a particular kind, scale, etc.) will be catastrophic (in terms of value loss, injustice, etc.).

(2) That which has catastrophic effects shouldn't be done.

(3) So, geoengineering research shouldn't be done.

Such an argument doesn't appeal to a 'slippery slope' from research to problematic deployment because it doesn't need to. So, why would one make an argument in terms of slippery slopes? What would the appeal to a slippery slope be doing? In SSA against geoengineering research, one main function of the 'slippery slope' framing might seem to be to draw attention to the grounds for accepting the first premise, i.e., the claim about institutional momentum.

But as LaFolette (2015) makes clear, this is odd. In other contexts, we wouldn't talk about cause and effect in this way.

> Frank intentionally drops a Ming vase from six feet … The vase breaks. It would have been silly to have mounted a slippery

[13] I don't take a position on whether he is correct in his analysis/assessment of the relevant arguments. I engage with his treatment simply to pick out themes that point towards a precautionary spirit for SSA against geoengineering research. He doesn't consider the 'institutional momentum' variety of argument that concerns us here.

> slope argument against his dropping the vase since dropping the vase … just is to break the vase. Increasing the temporal gap between x and y does not alter the facts: my detonating strategically placed explosives atop a Swiss mountain is not the first step down a slippery slope to killing people at the bottom. Rather, barring some freakish intervention, I kill villagers below by means of an avalanche. Adding a month-long timer does not relevantly change matters.

LaFolette notes that adding a month-long timer *does* increase the possibility that Y might not occur if X does but that this doesn't affect our understanding of the causal structure of the case. It would likewise (and here I depart from LaFolette perhaps) be silly to cast an argument based on expected value (weighting possible outcomes according to an assessment of how likely they would be to transpire) in terms of a slippery slope. If what is wrong with performing a certain action is that it results in considerable expected harm, the time elapsed between the action and the harm seems immaterial. The relevant nature of the relation between the normative status of the initial action and the relevant harm doesn't change when more time elapses. Hence, any 'slippery slope' appealed to, in the context of an argument aiming to settle the normative status of an action which results in considerable expected harm after some considerable time, is normatively irrelevant (or at least unnecessary).

What LaFolette sees as characteristic of worries described in terms of 'slippery slopes' is that (a) the causal structure of the relevant cases is disrupted as they involve a chain of agents (or at least actions) such that it would be odd to say that (to take the case of geoengineering research) the agents (or actions) that caused the catastrophic consequences of deployment are the same as those involved in the decision to pursue research, (b) (more or less relatedly) our assessment of the probability of catastrophic deployment given research should be far less than 1, and (c) the recommended normative attitude

to research doesn't seem to have been straightforwardly reduced (in any way that might have seemed appropriate in a causal argument) to accommodate the level of confidence in the claim that the catastrophic consequences of deployment will occur given research. These features, for LaFolette, mark arguments that appeal to slippery slopes apart from straightforward causal arguments (again, although note he doesn't consider the 'institutional momentum' kind of worry).

Walton's treatment of arguments that appeal to slippery slopes is subtly different.[14] His treatment suggests a further feature that might be thought typical to arguments that appeal to slippery slopes. Walton emphasises that the concern at the heart of such arguments is about a loss of control: that the key worry is a worry that at some point along the causal path—from the initial action through to possible catastrophe—control over the process is lost and the catastrophe becomes inevitable.[15] Walton also emphasises appeals to the presence of factors that make it harder and harder to exert control and resist progression along the causal chain to the point where control is lost (in his terms 'drivers'). Walton also emphasises that in such arguments no determinate claim is made about where in the causal chain control would be lost (he makes this point by talking of a 'gray zone').[16]

So, Callies's interpretation of SSA against geoengineering research is not the only one available. Although neither LaFolette or Walton, to my knowledge, have in mind or consider arguments that appeal to any form of 'in-

[14] Walton is perhaps the most prolific writer on SSA. E.g., Walton (1992, 2015, 2017). The details of his treatment vary over time, I mainly rely on the two later papers. The details of Walton's analysis of the central features of slippery slope arguments are different from LaFolette's in various ways. But this isn't the place for a detailed comparison. As with LaFolette, I don't take a position on whether Walton is correct in his analysis or assessment of slippery slope arguments and their use *in general*.

[15] Walton (e.g., 2015) just focuses on *the initial agent's* losing control and eventually doing something catastrophic. But there surely is no worry about a slippery slope if some other perfectly responsible agent will at some point gain control over the process, and it seems immaterial who directly brings about the catastrophe. I think the worry only gets going with a loss of control (of responsible agents) more generally. Walton's focus on a single agent also fits uncomfortably with the impression of other, e.g., LaFollette, that it is characteristic of SSA that the agents at the beginning and end of the envisaged causal chain are distinct.

[16] It might be possible to parse concerns about 'institutional momentum' within SSA against geoengineering research in Walton's terms as I've picked them out here. But Walton's full framework doesn't fit quite so well.

stitutional momentum,' their reflections of appeals to slippery slopes more generally suggest a slightly different way of looking at SSA against geoengineering research. Maybe the key worry isn't the causal *inevitability* of catastrophe given research. Maybe the key worry instead recognises a more subtle understanding of the causal relation. However, neither interpretation of the worry would cast SSA against geoengineering research in a particularly good light. The challenge for SSA against geoengineering research to make two plausible claims about connections between research and problematic deployment. The first is some kind of claim about a causal relation between research and problematic deployment. The second is a claim about the normative relevance of that causal relation. Neither interpretation does both.

Callies's treatment of SSA against geoengineering research treats the arguments as appealing to straightforward causal link between research and the kind of deployment to which there are decisive moral objections. But while such a link would be plausibly normatively relevant, it isn't terribly plausible that there is such a causal link. LaFolette or Walton-inspired interpretations, on the other hand, would have SSA against geoengineering research appeal to rather more plausible pictures of the causal relation between research and problematic deployment, but it is far from clear why such connections would be normatively relevant in the necessary way, e.g., to ground a moratorium.

What lesson should we take from this? I ultimately think the answer is to understand SSA against geoengineering research as precautionary arguments. However, without that option on the table, it is easy to see why one might dismiss appeals to 'slippery slopes' as mere rhetoric disguising bad causal arguments. The idea might be as follows: (a) a presentation of the concerns as a straightforward causal argument would make clear that it rests on questionable causal premises, e.g., that research causes the relevant catastrophe or makes it (almost) certain to occur; and (b) a presentation

of the concerns that adopted more acceptable causal premises would have to rely on questionable normative premises, e.g., that our attitude to that which *probably* causes X should be the same as to that which causes X, or present weakened conclusions (e.g., that research has some probability of being wrong).[17] The proponents' choice to present the concern in terms of 'a slippery slope' rather than to make any of these other moves might be suspected to be rhetorically minded, i.e., made in response to an understanding that any of those other moves would, as LaFolette puts it, 'diminish their arguments' ability to sway public opinion' (and we might add the opinions of policy makers and other key actors to that too).

If SSA against geoengineering research's appeal to a slippery slope were just a neat rhetorical device for disguising a bad causal argument, then ethical scrutiny of geoengineering and geoengineering should clearly move on from focusing on 'slippery slope' arguments. What approach should be taken to the ethics of geoengineering instead? LaFolette's likely approach is easy to guess.[18] Where there is some plausible causal link between X and Y (which would be catastrophic), LaFolette urges a conscientious cost-benefit analysis of X. LaFolette does caveat this recommendation, however (2015, my emphasis):

> I do not wish to suggest that cost-benefit analysis is a cure-all. It, too, is beset with problems. We typically lack the knowledge to make precise predictions about the outcomes of complex social policies. However, skepticism about cost-benefit analysis does not require us to embrace slippery slope arguments. Rather *we*

[17] Walton's argument schemas leave the key normative premise implicit (as in fact does Callies's). So, his analysis never ultimately explains why the features he thinks characterise the 'slippery slope' that SSA worry about might be thought to make it the case that what is morally called for is refraining from the initial action. So, it is difficult to assess exactly what kind of premise he thinks those who offer SSA are leaning on. It is *possible* that if pushed he'd elaborate the legitimacy of a concern about a 'loss of control', etc., using a precautionary principle of some kind.

[18] He doesn't really consider worries based on institutional momentum. But he does consider worries about the possible catastrophic consequences of policy decisions (e.g., to construct nuclear power stations). His response to these gives a clear sense of what his response would be to the case of geoengineering research.

might think about how to behave in cases where we cannot accurately predict the outcomes of available actions.

And this caveat points the way to my preferred understanding of what SSA against geoengineering research are up to in the first place.[19]

We don't need to see the use of an appeal to a slippery slope as mere rhetoric, obfuscation or as a 'poor substitute for a careful assessment of risk.' We can see the appeal as an expression of a moral concern that includes an already developed position on responding to risk: a commitment to a precautionary principle. We can see the proponent of the SSA against geoengineering research as having already thought *about how to behave in cases where we cannot accurately predict the outcomes of available actions:* when there is a credible threat of morally catastrophic effects, it is appropriate to take precautions. SSA against geoengineering research can be seen as expressing a lack of confidence in the ability of existing processes and institutions around geoengineering research to ensure that geoengineering research projects only (if ever) progress to deployment in ways that are appropriately sensitive to the *risk* of moral catastrophe and seeing that lack of confidence as warranting precautions.

Let's finally spell out what a precautionary interpretation of SSA against geoengineering research would look like. Whether or not those who endorse SSA against geoengineering research would recognise their argument in the following form or recognise it as better expressing their underlying moral concerns, I think something like this version of SSA against geoengineering research is the one that deserves our attention. It is these premises that deserve our scrutiny.

(1) There is a credible threat that establishing a serious programme of geoengineering research (of a particular kind or scale and without any regulation) will generate a kind of institutional momentum

[19] Indeed, one might suspect this is true of other SSA too. But I don't make that claim here.

such that the process from research to development to the decision to deploy will not be sufficiently sensitive to serious moral reasons not to deploy and thus have catastrophic results.

(2) The appropriate response to credible threats of catastrophic results is to take precautions, including to not do that which poses the threat.

(3) So, precautions should be taken against the credible threats of catastrophic results posed by serious programme of geoengineering research, including not establishing such a programme unless effective regulation or governance can be instituted to effectively mitigate against the problematic kind of institutional momentum.

Why is this the one that deserves our attention? In the next section, I elaborate on the advantages of understanding slippery slope worries about geoengineering research as precautionary arguments along the lines of the above.

4 Advantages

Why think SSA against geoengineering research are best understood as precautionary arguments like the one above? In this section, I outline the main reasons for thinking the precautionary interpretation is better than the standard interpretation (as it could be called at this point).

The first reason in favour of a precautionary reading of the concerns expressed by SSA against geoengineering research is that it understands SSA against geoengineering in such a way that the arguments capture some plausible grounds for objecting to geoengineering research. Without the precautionary reading, as discussed above, SSA against geoengineering research are difficult to interpret as having much merit: depending on either

implausible causal or normative premises. Where there are a number of interpretations of SSA against geoengineering research, we should focus our attention on those that involve the most promising objections to geoengineering research. The precautionary reading is that interpretation because it doesn't require implausible premises with respect to (a) the kind of causal relation between research and problematic deployment, or (b) the normative relevance of that relation. Precautionary principles are familiar guiding principles in the domain of environmental policymaking, and while they and their exact formulation isn't exactly uncontroversial, the idea that environmentally relevant policymaking should be guided by a precautionary principle of some form is certainly a plausible one. The idea that pursuing geoengineering research poses a *credible* threat of disaster due to institutional momentum is also a plausible one—certainly much more plausible than any claim that research inevitably ends up in catastrophic deployment. Ultimately, of course, an assessment of the merits of the relevant precautionary arguments will depend on very careful scrutiny of these premises. However, this interpretation of SSA against geoengineering research at least does better justice to worries about slippery slopes in this domain, in virtue of interpreting the argument as resting on fairly plausible premises.

The second reason in favour of a precautionary reading of the concerns expressed by SSA against geoengineering research is that this interpretation opens the way to a productive engagement with the normative concerns raised by the slippery slope argument, especially in a policy context. Discussions about the precautionary principle are fraught and characterised by many battles including over the basic rationality of precautionary thinking as well as the details of what a defensible precautionary principle might look like. That is to say: appeal to any particular precautionary principle stands in need of defence. So, critical engagement with SSA against geoengineering research would pay special attention to the form of precautionary principle the arguments require to get going; one effective way to take the force out

of SSA against geoengineering research would be to present objections to the relevant principle. Moreover, insofar as there *is* agreement in some particular context about how to use a precautionary principle to guide policy, and what shape that precautionary principle can take, the assessment and response to fears about a slippery slope in relation to geoengineering research and a case for a moratorium on their basis needs to take place through the lens of this agreed approach. That is to say that my proposed interpretation makes clear that institutions with an existing commitment to precautionary policy should take notice of the SSA against geoengineering research, and also makes clear that they should critically assess SSA against geoengineering research in the context of that policy. Properly understood, I think, the force of SSA against geoengineering research feeds into policy making via a precautionary principle, rather than via a simple weighing of costs and benefits. So understood, the relevant SSAs are not 'poor substitutes for a careful assessment of risk'—to use LaFolette's expression—but an articulation of a considered assessment of risk.[20]

The third reason in favour of a precautionary reading of the concerns expressed by SSA against geoengineering research is that this interpretation makes clear that the 'slippery slope' concerns pick out potentially forceful moral concerns—rather than just vague rhetoric or fallacious reasoning. In some respects, it is a shame that 'slippery slope' arguments against geoengineering research have been given that name. Slippery slope arguments have a bad name and not undeservedly.[21] It is often difficult to pin down the exact nature of the argument underpinning worries about a 'slippery slope'. Sometimes slippery slope arguments involve a clear fallacy or make clearly dubious assumptions. Other times they are simply unhelpful and unnecessary. Many appeals to a slippery slope, e.g., in the political sphere seem to

[20] One related consideration: SSA against geoengineering research are frequently viewed as making the case for careful regulation or governance clear (rather than as good arguments for moratoria). The precautionary framing makes particularly clear why SSA against geoengineering research would play this role. See, e.g., Callies (2019).

[21] See discussion in Jefferson (2014) and LaFollette (2015), for instance.

largely serve a reactionary and rhetorical role which is underpinned by only the vaguest and slipperiest substantive objection. As a result of these features, appeals to a slippery slope are 'almost universally derided by philosophers' and regarded as hallmarks of a bad argument and frequently listed as fallacious in informal logic textbooks (Whitman 1994, Walton 2017). While not all slippery slope arguments are bad arguments, recognising that SSA against geoengineering research's concerns about the 'slippery slope' of institutional momentum are underlain by a substantive precautionary argument helps to make clear that such arguments deserve to be taken seriously.

The fourth is that, insofar as we buy some version of the precautionary principle, this interpretation directs our epistemic attention in productive ways. Were the case for a moratorium to rest simply on some calculation of expected value, the case should rightly be understood to rest on the kind of all-things-considered judgement that Callies mentions: a kind of judgment we are not and will likely never be in a position to make. I've suggested that the case for a moratorium be understood to rest instead on a precautionary argument and, note, the main motivation for precautionary thinking is precisely that it gives a steer in conditions of uncertainty. The details of that steer vary depending on the exact version of the principle we endorse. But the simple line is—don't do that which poses a credible threat of moral catastrophe! A precautionary reading of slippery slope arguments against geoengineering research thus guides our information gathering and research in arguably more efficient ways with lower evidential demands; the task that needs to be completed is to assess the credibility of the threat of the slippery slope to catastrophic deployment.

To just elaborate on that last point, the slippery slope from research to problematic deployment was recognised as a possible concern in the WGII component of AR6 (IPCC 2022). This is the first acknowledgement of and attempt to evaluate such worries I have found in an IPCC report. The IPCC assessment is that ''There is low agreement whether research and outdoors

experimentation will create a 'slippery slope' toward eventual deployment, leading to a lock-in to long-term SRM, or can be effectively regulated at a later stage to avoid undesirable outcomes'' (citing many of the figures I've cited here). But note that the epistemic attention behind this evaluation has been directed in the wrong place if the relevant moral concerns are correctly captured by my proposed interpretation. The assessment needed was as to whether there was a credible threat of a slippery slope.

5 Wrapping up

In this section, I summarize the main take-home points from the above and respond to a few questions in order to guard against potential misunderstandings of what I intend to have claimed and to have argued.

The main claim of the paper is that so-called 'slippery slope arguments' against geoengineering research are best understood as having a precautionary spirit, i.e., relying on some form of precautionary principle. Without understanding them in this way, it is easy to view slippery slope worries about geoengineering research as weak or defective arguments, e.g., on the basis that they have very dubious premises. The potential normative force of slippery slope worries against geoengineering research becomes clear once we recognise that the force comes from a precautionary principle and in acknowledgement that there is a considerable degree of uncertainty around the key causal links that prompt the worry. This new interpretation also helps us appreciate how the concerns expressed in slippery slope arguments against geoengineering research should feed into policy decision-making—via a precautionary approach to policymaking. Moreover, the precautionary interpretation of the argument directs our attention in productive ways. This interpretation makes clear the kind of evidence needed to assess the force of slippery slope arguments against geoengineering research. It makes clear that what is needed is an assessment of whether the relevant threat of

catastrophe posed by institutional momentum is credible.[22]

Before closing, to avoid misunderstandings, I want to offer a couple of clarifications about the nature of the project of this paper and its main claims.

Am I arguing that those who make SSA against geoengineering research are deliberately appealing to precautionary considerations? No. Although I suspect many would concede the point, I can't provide evidence for that claim here. Rather, I make the case that a better way to articulate the underlying moral concern (that SSA against geoengineering research attempt to express) would be as a precautionary argument. I am open to this being a revisionary interpretation.

Is this paper a defence of SSA against geoengineering research? Not directly. The paper presents a case for understanding SSA against geoengineering research as precautionary arguments, but it doesn't make or defend the relevant arguments. First, any specific SSA against geoengineering research will depend on specific claims about institutional momentum and the effects of deployment. Those are claims that will need careful scrutiny. Second, any precautionary principle relied on will also be controversial. Indeed, it will be in just as much in need of clarification and scrutiny as appeals to 'slippery slopes.' And I make no attempt to defend precautionary thinking here. So, I don't and can't offer anything as direct as a defence of any SSA against geoengineering research here. Nonetheless, I do think that my proposed new way of looking at SSA against geoengineering research casts them in a new light which helps us see their *potential* normative force in a way that the 'slippery slope' framing does not. Whether or not that normative force is realised will depend on factors that will need to be evaluated elsewhere.

Am I arguing that it is a mistake to talk about SSA against geoengineering research in terms of 'slippery slopes'? Should we just call it a 'precau-

[22]I don't speak to whether any such threat is credible in this paper. However, the answer is clearly that the credibility of the threat will depend a lot on what kind of research is being considered.

tionary argument'? No, I haven't argued for that. And neither do I think it is obvious that this would be a sensible move. The 'slippery slope' framing does help to capture something important about the relevant concerns about geoengineering research.[23]

Let me unpack that last thought. The threat of catastrophe that the SSA against geoengineering research sees as posed by geoengineering research has two aspects. The credibility of the ultimate threat of catastrophe rests not only on there being a plausible causal path from some deployment methods to catastrophic results but also on there being a plausible causal path—from setting up a research project to properly assess and scope for minimizing the risk of catastrophe posed by certain deployment methods to a situation in which deployment is possible and the decision whether to deploy being made—in which the relevant causal mechanisms are insufficiently sensitive to strong moral reasons not to deploy. We are in a position of uncertainty about both aspects of this threat. First, we are currently in a position of uncertainty about what the results of any particular way of deploying any particular geoengineering technology would be and importantly the chances of catastrophe. Second, we are currently in a position of uncertainty about whether (or perhaps rather the extent to which) the kind of research project required to resolve the first kind of uncertainty would, once set up, take on a kind of institutional momentum towards deployment such that their chances of deployment wouldn't be appropriately responsive to good information about the chances of catastrophe (either because the good information ends up not being gathered or isn't given due weight). Talk of the 'slippery slope' when talking about worries about geoengineering research helps to capture both aspects of uncertainty and our response to uncertainty.[24] Taking a

[23] Explicit appeal to a precautionary principle would also involve a rhetorical loss as it would now be necessary to emphasise and acknowledge uncertainty about the slipperiness of the slope. But I don't know how much that loss should worry us.

[24] If either aspect of the threat was established, we wouldn't be talking about a 'slippery slope' argument against geoengineering research. If we knew deployment of a particular technology would be disastrous, no one would be seriously considering further research into it. Alternatively, if we knew research would result in

'precautionary approach to geoengineering' captures only one subset of the safeguards potentially called for by the risk of catastrophic consequences, i.e., not going ahead with deployment where there is a credible threat of catastrophe. Talking about the 'slippery slope' helps to capture the fact that a richer portfolio of safeguards is called for in light of a credible threat of the slippery slope of institutional momentum: that the precautionary response called for is one taken in light of both aspects of the uncertainty we currently have about what the result of geoengineering research will be.

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