Focus Article

'In case of emergency press here': framing geoengineering as a response to dangerous climate change†

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Geoengineering, especially its potentially fast and high-leverage versions, is often justified as a necessary response to possible future climate emergencies. In this article, we take the notion of 'necessity' in international law as a starting point in assessing how rapid, high-leverage geoengineering might be justified legally. The need to specify reliably 'grave and imminent peril' makes such a justification difficult because our scientific ability to predict abrupt climate change, for example, as tipping elements, is limited. The time it takes to establish scientific consensus as well as policy acceptance restricts the scope for effective forewarning and so pre-emptive justifications for geoengineering become more tempting. While recognizing that dangerous, large-scale impacts of climate change is becoming increasingly difficult to avoid, the pre-emptive, emergency frame is problematic. We suggest that arguments from emergency operate on a high level of uncertainty and tend toward hubristic attempts to shape the future, as well as tending to close down rather than open up space for deliberation. We conclude that the emergency frame is not likely to go away, that ignoring or repressing it is a dangerous response, and that more effort is required to defuse and disarm emergency rhetoric.

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INTRODUCTION

Geoengineering can be defined as the deliberate large-scale manipulation of the planetary environment to counteract anthropogenic climate change.[1] While geoengineering has been discussed as a response to climate change since at least the 1960s,[2] it remained marginal and has only entered into the academic and policy mainstream as a climate policy option alongside the conventional options of mitigation and adaptation in the last decade.[1] Geoengineering could potentially be done either by limiting the influx of solar energy (solar radiation management, SRM) or by removing CO_2 or other greenhouse gases from the atmosphere (carbon dioxide removal, CDR). Some technologies, such as injection of sulfate particles in the stratosphere, seem to offer the potential for relatively rapid and cheap deployment, whereas others, such as air capture, offer less controversial, longer term options.[3,4] There has also been ample critique, based not least in the fact that it is very difficult to know in advance what the impact of such interventions may be and thus a risk of serious unintended consequences, but also based on questions

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about the morality of any such intervention, and the absence of well-developed regulatory frameworks.[1,5,6]

The growing interest in geoengineering over the last decade has relied on an emergency framing in two main ways.[a] On one hand, the potential threat of abrupt, nonlinear climate events, such as rapid tundra or ice cap melt, which had been discussed in science previously, gained policy traction in the 1990s. In a context in which policy makers had historically favored forms of climate science that placed less emphasis on abrupt climate change and more on gradual, long-duration shifts, geoengineering was presented as a potential mechanism through which we might prepare some form of response to abrupt climate emergencies. On the other hand, there emerged a diffuse sense that there was an emergency within climate policy itself. The mainstreaming of geoengineering was a reaction to the failure of conventional mitigation measures, and a concern that new options were required.[7] Notably, only SRM technologies are expected to function fast enough to be useful in the kind of abrupt events typically referred to as emergencies. This article therefore focuses on rapid, high-leverage interventions used to prevent emergency, and we will use the term 'geoengineering' as short-hand for this.

Arguably, explicit emergency frames have become less dominant as the field has moved toward greater respectability and wider acceptance. Now, frames include that of a 'healing' technology, as well as talk of policy bundles, wedges, or portfolios, all marking a general attempt to integrate geoengineering into broader climate risk-benefit matrices.[8] This widening in the rhetoric and framing of geoengineering has been mapped by Scholte et al.[9] Yet, the emergency frame has not gone away. The Tyndall Centre, for example, found that 'climate emergency' was the joint most-common frame in expert appraisals of geoengineering along with insufficient mitigation,[10] and Nerlich and Jaspal found that it was an underlying narrative in scientific and popular discourse.[11] Even where the term 'emergency' is not explicitly mentioned, words such as 'urgency' or the specter of 'dangerous' or 'nonlinear' or 'abrupt' climate change all imply an emergency to come. Moreover, the impetus behind most calls for research into the possible implications of different technologies is predicated on the need to avoid geoengineering itself, prompting an emergency through unforeseen impacts.[11] However, the emergency framing of geoengineering has not gone without scrutiny. Gardiner set out a wide-ranging critique of the idea that geoengineering (specifically sulfate aerosol injection) could be a necessary—lesser evil—option in the face of an imminent catastrophe.[12] A prominent part of his critique is that the lesser evil argument is too narrowly defined and so obscures many moral and political issues. He also argues that this is especially problematic in a context where moral corruption is likely, that is where those who contributed most to the climate problem in the first hand are least likely to suffer its adverse effects, and are likely to seek excuses not to mitigate.

This article offers a critique of the emergency frame along different lines. Defining a phenomenon as an emergency implies that it has properties of danger, immediacy, and is to some extent unexpected at least in specific location or timing. This is central to the persuasive power of the emergency frame. The notion of 'climate emergency', however, remains poorly defined.[13] Accounts may refer to climate tipping points, such as sudden large methane release resulting from the thawing of permafrost, or clathrates trapped in the sediments of the continental shelves,[14] the existence and nature of which are still uncertain.[2,15] Generally, arguments tend to be vague, talking about 'rapid' or 'dangerous' climatic change, with limited specification. The rhetorical and conceptual tactic here is to make preparation for geoengineering seems *necessary* in the face of an uncertain future. The emergency frame can also be located in a context in which future threats of many kinds—from terrorism to financial crisis to zoonosis—have become part of contemporary governance regimes.[16–20] From this work, we know that once the idea of an emergency is in place, it constrains and shapes the responses that society, both at national and international scales, may be capable of undertaking. Authors have identified how emergencies, or catastrophes, work to change what is expected in normal governance, politics, and security through a pre-emptive logic: one that justifies action in the present on the basis of events at the limit of imagination and calculation.[21]

In this article, we ask: What are the implications of the emergency frame for geoengineering? In what ways can climate emergency be defined? Can climate emergency be reliably defined, and what role does uncertainty play in this process? We suggest that this line of enquiry is important given the sustained salience of the emergency frame, its vagueness, and problematic pre-emptive character. The article begins by taking the notion of 'necessity' in international law as a plausible, well-specified, and tested standard for assessing what would constitute legitimate justification for geoengineering as a preventative emergency response, and argues that such a justification fails to meet several criteria. In particular, the criterion of 'grave and imminent peril' requires that we are able to predict the occurrence of climate emergencies. The article therefore progresses to focus on the scope for reliable, scientific prediction of abrupt climate change—conceptualized as 'tipping elements' or otherwise—to underpin decisions on preventative deployment. A very limited scope for scientifically based preventative deployment is identified, and, given the time it takes to establish scientific facts as well as wider acceptance of them, the scope for effective forewarning is limited indeed. The final part of the article argues that in practice this unpredictability does not undermine the emergency logic, but rather sustains it. The emergency logic is characterized by a pre-emptive rather than precautionary orientation to the future and relies on uncertainty about the future. This is problematic, because invocation of a pre-emptive emergency logic also tends to close down debate and legitimize otherwise unpalatable options.

CAN GEOENGINEERING BE JUSTIFIED AS 'NECESSITY' UNDER INTERNATIONAL LAW?

Any deployment of geoengineering technology by a state would raise questions of what is acceptable and legitimate on the international plane. International law codifies such norms. It offers plausible precedents and arguments by which to assess the legitimacy of geoengineering as a necessary emergency response. The absence of institutional features common to national legal systems (such as centralized forms of adjudication) sometimes leads to 'realist' questioning of international law's relevance[22] but that is to assume that State-type institutions are the exclusive means to resolve collective action problems. Moreover, it remains the case that international law is very rarely not observed by those bound by it.[23]

Emergency, or the *plea of necessity*, is an established concept in international law. As codified in the International Law Commission's (ILC) draft articles, and reflecting international customary law, necessity can serve as a 'ground for precluding the wrongfulness of an act not in conformity with an international obligation of that State' [Ref 24, Article 25(1), p. 178]. At first glance, this concept applies only where a State is in breach of any of its international obligations. Whether geoengineering deployment would constitute such a breach has been the subject of considerable but inconclusive scholarly debate.[7,25,26, b] However, international law's treatment of the concept of necessity also provides a durable and shared understanding that can be applied to the concept of a climate emergency. International law's jurisprudence on necessity may help us recognize an emergency when we see it and the surrounding legal disputes and their resolution tell us something important about how the community of nations responds to claims of necessity.

As may be expected, the circumstances in which emergency responses can be justified as necessities are narrow [Ref 24, Article 25(1)(a) and (b), emphasis added]:

1. Necessity may not be invoked by a State as a ground for precluding the wrongfulness of an act not in conformity with an international obligation of that State unless the act: (a) is the only way for the State to safeguard an essential interest against a grave and imminent peril, and (b) does not seriously impair an essential interest of the State or States toward which the obligation exists, or of the international community as a whole.
2. In any case, necessity may not be invoked by a State as a ground for precluding wrongfulness if: (a) the international obligation in question excludes the possibility of invoking necessity, or (b) the State has contributed to the situation of necessity.

Let us unpack this rather dense legalese.

Consider the case of the *Torrey Canyon*, a standard example of necessity (Ref 24, 179 ff).[26] In 1967, a Liberian tanker stricken off Cornwall, UK, was discharging quantities of oil, threatening significant environmental and commercial damage to the South Coast and Bristol Channel. It was deemed permissible by the international community that the UK bomb the tanker, which burnt off the excess oil and averted disaster.[27] The UK considered various alternatives to bombing—salvage attempts were unsuccessful (and led to the death of the captain of the salvage team) and pumping off the oil was technically impossible because of the weather—and took steps to limit its effect, including operations with detergents (Ref 28, col 38–42). The absence of the UK's contribution to the situation of necessity, the gravity of the risk to the environment, and the imminence of the danger (Ref 28, col 47) all contributed to the ILC's conclusion that the UK's action was legitimate because of a state of necessity. Bombing another nation's merchant vessel would otherwise be a violation of exclusive flag state jurisdiction.

Some of the most recent examples of pleas of necessity—invariably unsuccessful—arose following measures (e.g., drastic devaluation and suspension of tariff adjustments) taken by Argentina in response to its economic crisis of 2001–2002, which caused losses to foreign investors with whom the country had bilateral investment treaties. The inability of Argentina to convince subsequent tribunals that they should be exempted from liability arising from these treaty breaches because of the existence of a state of necessity stemmed from findings that 'the measures adopted were not the only steps available' (Ref 29, paras 128–135). The central matter in the Argentina proceedings was the finding that 'government policies and their shortcomings significantly contributed to the crisis and emergency' (Ref 30, paras 95–96)—a conclusion that was fatal for the plea of necessity.

As a matter of international law therefore, Article 25 and the customary law on which it is based make very clear that necessity is intended to be available in only the most limited and exceptional circumstances. When applied to geoengineering, these limitations all point in the same direction. Could it be claimed that geoengineering is 'the *only* means for the State to safeguard an essential interest'? [Ref 24, Article 25(1)(a)]. At the very least, in the climate context States have at present options of mitigation and adaptation. Further, the climatic catastrophe faced in order to be an emergency properly so-called would need to threaten 'grave and *imminent* peril' [Ref 24, Article 25(1)(a), emphasis added]. The interpretation of these combined elements has been squarely addressed by the International Court of Justice (ICJ) in its landmark decision *Gabčíkovo–Nagymaros*.[29] This Hungarian/Slovak barrage project spanning the Danube was initially established by a bilateral treaty of 1977. When the Hungarians attempted to terminate the project owing to environmental concerns, they justified their breach of the treaty on, amongst other things, an argument of necessity. The ICJ accepted that their justification related to an essential interest (Ref 30, para 53). Moreover, the peril in question needs not be imminent in the sense of occurring proximately. As the Court noted 'a "peril" appearing in the long term might be held to be "imminent" as soon as it is established . . . the realization of that peril, however far off it might be, is not thereby any less certain and inevitable' (Ref 30, para 54). This then places considerable importance on the task of 'establishing' a climatic peril, so as to justify preventative deployment. It would appear to be considerably more demanding so to do in a climate case than in the context of dam.

As a concrete standard, the plea of necessity is considerably more refined than the more amorphous tests often deployed in the geoengineering literature and is not easily satisfied by them. Can it be said that geoengineering 'does not seriously impair an interest of the State or States toward which the obligation exists or of the international community as a whole', given the risk of un-intended regional and global side-effects? [Ref 24, Article 25(1)(b)]. And given that necessity can only be invoked by those that have not 'contributed to the situation of necessity', which is far from obviously true for the States most likely to have the capability to deploy geoengineering, it appears to have little traction in current contexts [Ref 24, Article 25(2)(b)]. As the ICJ stated in *Gabčíkovo*, an argument on the state of necessity is unconvincing unless it was 'at least proven that a real, "grave" and "imminent" "peril" existed . . . and that the measures taken . . . were the only possible response to it' (Ref 30, para 54). The question is then: can we identify grave and imminent peril, and is geoengineering the only possible response?

CAN CLIMATE EMERGENCY BE DEFINED SCIENTIFICALLY AND PREDICTED?

That the Earth is facing a climate emergency is an increasingly common opinion expressed within the climate science community. For example, the recent unprecedented and largely unforeseen (in model projections) record Arctic Sea ice-melt during the summer of 2012 was described as a 'planetary emergency' by Prof. James Hansen, and prompted Prof. Peter Wadhams to state that 'desperate measures such as considering geoengineering techniques as well as conducting a major nuclear programme' should be considered.[31]

Defining any aspect of climate change as an 'emergency' is fraught with both scientific subjectivity and uncertainty. Moreover, it is the fear of the impact (either occurring or forecast) of a changed climate on nations, societies, and economies and environments, rather than the changed climate itself that is perhaps most likely to demand political response. Here, we find it instructive to examine the recent discussion of 'tipping points' or 'tipping elements' as an example of possible emergency scenarios.

Tipping elements suggest the existence of points or conditions in major Earth systems, which could reach a moment of no-return or system-shift beyond which a qualitatively different state emerges.[32] If such 'points of no return' leading to deemed crippling climate states can be identified, and should they be expected to be imminently exceeded, geoengineering might be considered the *only* option and therefore a necessity. Lenton et al. explore possible tipping elements of the climate system, identifying nine global-scale 'policy-relevant' candidates, see

TABLE 1 | Possible Tipping Elements

Tipping Element	Timescale (years)	Primary Impacts
Arctic summer sea ice	∼10	Amplified warming and ecosystem change
Greenland ice sheet	>300	Sea-level rise
West Antarctica ice sheet	>300	Sea-level rise
Atlantic thermohaline circulation	∼100	Regional cooling sea-level rise, and ITCZ[1] shift
El Nino-Southern oscillation	∼100	Drought in SE Asia and elsewhere
Indian summer monsoon	∼1	Drought
Sahara/Sahel and West Africa monsoon	∼10	Increased precipitation
Amazon rainforest	∼50	Biodiversity loss and decreased rainfall
Boreal forest	∼50	Biome switch, e.g., replacement by temperate grassland and desert

[1]Intertropical convergence zone – more familiarly known as the 'doldrums' the regions near the equator where northern and southern hemisphere winds converge. The ITCZ is a source of tropical thunderstorm activity than can coalesce to form tropical cyclones (hurricanes).

Table 1.[15] It is important to note that the nature of these tipping elements is not well understood. While Lenton et al. consider all to be 'policy relevant',[15] only three (Arctic summer sea ice, Indian summer monsoon, and West Africa monsoon) are identified as having a decadal or lower timescale—a clearly politically relevant timescale for undertaking immediate responsive action. By contrast, sea-level rise threatens many of the world's most populous and economically significant regions, but its timescale of centuries does not easily fit with that of current political (or indeed broader societal) systems or processes: grave but not imminent peril.

While these three subdecadal-timescale tipping elements would result in huge change, only in the case of failure of the Indian monsoon is it virtually certain that the impact would be incontrovertibly negative. While Arctic summer sea ice loss is undoubtedly already impacting Arctic communities and the Artic ecosystem (and influencing mid-latitude weather patterns),[33,34] it is conversely seen by some as potentially advantageous in enabling access to previously inaccessible resources, and opening of shipping routes.[35,36] With respect to the West Africa monsoon, Lenton et al. reflect that such a change could indeed be perceived as benefiting the region by possibly enabling agricultural expansion into presently arid regions.[15]

Calculating costs and benefits is not our interest here. But following this line of argument, broad conditions might be suggested for delineating a 'climate emergency' event or events that might encourage, demand, or result in an emergency response involving consideration of geoengineering deployment, given strong scientific evidence and public awareness:

1. Phenomenon(a) occurs rapidly—impacts with a subdecadal timescale.
2. Phenomenon(a) is created or significantly exacerbated by anthropogenic forcing of the Earth's climate.
3. Phenomenon(a) has a globally significant impact—ecologically, economically, and socially.

In this context, the normal maneuver is to call for greater research to reduce uncertainty to better guide interventions now or in the future. The U.S. Government Accountability Office report, for example, asks for more data, better understanding of 'the climate and a way to determine when a "climate emergency" is reached … information on climate system thresholds, reversibility, and abrupt changes to inform societal debate and decision-making over what would constitute a "climate emergency" and whether deployment of a geoengineering approach would be merited' (Ref 37, p. 16). Similarly, the UK's Parliamentary Office of Science and Technology concludes that the science of geoengineering was not sufficiently advanced to make the technology predictable (Ref 38, p. 24), and that greater certainty is needed.

The request for more data to reduce future uncertainties into calculable and governable space has been at the heart of risk-based governance for decades[16]; its role in geoengineering is to be expected. This desire for greater certainty is however unhelpful. As sociologists of science have been arguing for a long time, a focus on quantified, probabilistic knowledge often obscures many of the most salient aspects of risks.[39] Probabilistic predictions are possible only if aspects of the problem that is not amenable to statistical analysis are treated separately, and either placed in the background of the analysis or excluded

TABLE 2 | Levels of (Un)certainty for Climate Threats

	Epistemic Condition	Kind of Analysis and Legitimation of Action Possible
1	Scientific certainty	Scientific consensus about existence, cause, and impacts of phenomenon. Cannot happen before the event.
2	Probability	The territory of classic risk analysis.
3	Some empirical evidence	But not enough for probabilistic risk analysis. Precautionary action may be justified.
4	Potential identified	'Known unknowns'. From models and theory rather than observation. Any action would be pre-emptive.
5	Unknown unknowns	Impossible to know what to act against.

entirely. Uncertainty is thus displaced rather than eliminated. So, for the purposes of preventative action, it is far from clear that we are—or ever will be—able to reliably predict any of these conditions, including the actual occurrence of the phenomenon (1). Only for some kinds of tipping points can we hope, one day, to determine the probability in advance.[40] And given the difficulty and time it may take to establish such knowledge the scope for effective forewarning is limited indeed. We are likely to have only limited evidence in advance or just theoretical identification of the potential of catastrophe, and be forced to operate on levels 4 or 5 in Table 2.

THE PRE-EMPTIVE LOGIC OF THE EMERGENCY FRAME

In this section, we take a step back and consider how the emergency frame functions and emphasize the way in which it is not just an *empirical* question of prediction, calculation of risk and legal precedent, but has a certain *conceptual* logic. We can usefully begin by contrasting arguments for geoengineering 'in case of emergency'—which as the introduction set out continue to underlie many discussions of geoengineering both implicitly and explicitly—with those who argue for geoengineering as part of a portfolio of climate mitigation options. There are similarities between the two styles of argument. Both are oriented to managing future threat; both are circumscribed by uncertainties; and both claim to be acting on behalf of a greater 'common good', be that future generations, late industrial ways of life, or the integrity of earth processes. However, these similarities mask an important distinction: mitigation is predominantly precautionary in its orientation to the future, as opposed to geoengineering 'in case of emergency' which is pre-emptive.[41]

The point of the precautionary principle is to act in the absence of proven risk, on flimsier evidence—but not none. (Table 2 therefore identifies precaution with level 3 and pre-emption with level 4.) There may be uncertainty about the nature of the future dangers, but the costs of acting now (to whatever degree as to be determined by policy or politics) are deemed preferable to waiting. If precaution is about avoiding something for which there is some evidence, then pre-emption is about dealing with something that is thought possible, but for which there is less evidence, and less certainty (level 4 of Table 2). The logic of pre-emption is that (1) there are potential emergencies in the future (whether abrupt, or more spatially or temporally dispersed) so that (2) action is necessary now to prevent such emergencies. Action in the present is therefore generative of certain futures, in that it seeks to organize what may and may not emerge to avoid certain pathways or prevent certain predicted outcomes in favor of other, preferred outcomes.[21] Action is justified on the basis of something that has not yet happened, and which may—or may not—come to pass (levels 4 and 5 of our typology in Table 2). The specific nature of the climate emergency is less important—it is more that there is some *potential* inherent in current predicted futures that we need to act to change *now*. Hence, calls, such as Bickell's,[42] that are waiting for an emergency to happen are folly and that geoengineering should be researched and even deployed in advance. In fact, Bickell argues that the mere potential of catastrophe is enough, and that we should not wait for any firm evidence.

Table 3 maps this in deliberately exaggerated fashion (for a broader overview, see Ref 21). Geoengineering can use either a precautionary or a pre-emptive logic, or some combination of both. In precaution, action is contingent on a known risk (rising greenhouse gas emissions and their likely deleterious impacts); for pre-emption, action is necessary to avoid a contingent threat with less empirical evidence (potential climate emergencies). Arguments that use the case of emergency as a

TABLE 3 | Contrasting Logics of Precaution and Pre-Emption

Precautionary Arguments	Pre-Emptive Arguments
Identified threat—climate change impacts—abundant evidence, likely to occur unless we take precautionary action	Weakly identified/potential threat—tipping point and climate emergency—*contingent*, i.e., *may or may not* occur, depending on future events
Action—contingent on recognizing the necessity of the threat	Action—necessary now to shape the contingencies of the future

way to justify research and potential deployment of geoengineering employ a distinctly different logic to those who argue for geoengineering as a precautionary technique to deal with threats that work on level 3. The key difference is in the bottom-right box; while precaution is a more humble attempt to manage the uncertainties of climate risk, pre-emption is about intentionally shaping the future, about grasping it, and making certain things happen.

Moreover, any interventions in complex earth systems that have positive (however measured) impacts would also bring unintended (both positive and negative) consequences. Any geoengineering intervention would make new climates in ways that would tend to exceed intention,[43,44] and these would need to be managed to avoid geoengineering causing its own cascade of potential future emergencies. This runs counter to the promise of control evoked by geoengineering as a climate management technique, instead creating a self-sustaining cycle of new emergency visions and interventions. To get around the uncertainty involved in any potential geoengineering intervention commentators frequently distinguish between deployment and research. In our analysis, however, such a distinction does little to avoid an emergency framing or lessen its force. First, arguments for research are usually presented as a need to insure against and prepare for potential future emergencies, and thus invoke an emergency to come, potential surprise, and uncertainty as justification. Second, research is strongly linked to deployment: greater knowledge about technologies, earth systems, and impacts makes deployment more, not less, likely. Because pre-emptive logic thrives off the uncertainty surrounding future climate emergencies more research, rather than reducing uncertainty, will cause visions of emergency to proliferate. We are at a stage where we risk emergency being 'buried' as a frame—sometimes unspoken, more often not—at the heart of geoengineering, and distinguishing between deployment and research is not a valid tactic to address this.

Essentially, our point in previous sections was that calculating the chances of climate emergencies, legal pathways, and the impacts of any deployment are hedged with an irreducible (which is not to say unmanageable) level of uncertainty. We can broadly suggest that geoengineering would most likely involve, in some form or other, first, forming an 'idea of a possible climate to be achieved and second, actualizing that form by somehow impressing it onto the matter of climate' (Ref 45, p. 233). Whether this is done according to a precautionary or pre-emptive logic matters a great deal, we suggest, because the capacity for emergency arguments to close down space for deliberation and politics is well known.[43,46] Acting under the threatening shadow of emergency, we are unlikely to make good decisions.[12] This section has suggested that different logics underlie different ways of justifying geoengineering, and that pre-emptive arguments about emergency operate on a higher level of abstraction, uncertainty, and hubris than those which advocate precaution. Given their allure, 'arguments from emergency' will continue to underlie the debate about research and deployment, even when not explicitly articulated, and we need to do more to understand their form, force, and function.

CONCLUSION

We began this article by pointing out that arguments for geoengineering usually invoke 'emergency' in several ways: a climate emergency to come; an emergency in climate policy; and the risk of any deployment causing further unforeseen climate impacts—new emergencies. We then addressed two important correlates of the emergency frame: necessity and uncertainty. We asked if 'necessity' in international law was a plausible starting point for legally justifying the emergency deployment of geoengineering. One of several obstacles to such a justification is the need to be able to analyze 'grave and imminent peril', because our scientific ability to reliably predict climate emergencies is limited. And given the time it takes to establish scientific facts as well as wider acceptance, the scope for effective forewarning is limited indeed. In other words, the scientific production of knowledge about emergency does not—apart from in very limited circumstances—meet the demands of the legal definition of necessity.

Pre-emptive geoengineering therefore sits very uneasily with the time-worn standards of the law on necessity. Advocates of geoengineering as emergency prevention might argue that this clash should be seen as a challenge to this legal framework, proposing that it should be modified to accommodate threats of limited predictability. More should be done to analyze how legal assessments of necessity have coped with uncertain predictions. More research is also needed on the relation between necessity pleas and other governance mechanisms for geoengineering deployment. It would, for example, be interesting to investigate whether there are circumstances under which the necessity standard would be trumped or by-passed, and whether such circumstances could be constructed in ways that make the problems of pre-emption irrelevant. Ultimately, however, pre-emptive arguments would seem to be poor foundations for legal deliberations.

We also suggested that the emergency frame feeds off uncertainty about the future. This means that, as increased knowledge and research can never dispel all uncertainty about climate futures or geoengineering impacts, increased knowledge and research cannot dispel the emergency frame. Therefore, pre-emptive justifications for geoengineering will proliferate alongside different levels of uncertainty. We deem it unlikely that the emergency frame will go away. This need not determine future policy. Further research could usefully look into the limits of the power of pre-emptive logics and compare their use in geoengineering to other areas.

While recognizing that dangerous, large-scale impacts from climate change is now more likely, this article cautions against any use of an emergency logic in climate policy. We suggest that merely ignoring or repressing the question of emergency is not the correct response (not least because this will drive the emergency frame underground, to lie latent where it is not explicitly articulated within justifications for geoengineering). Instead, one useful task is to further defuse and disarm emergency rhetoric. Pleas to reduce scientific uncertainty will not help here, but rather the task requires greater deliberation, a less shrill form of politics, and more reflexive justifications for research from scientists. To that end, we also opened up a distinction within geoengineering based on precautionary against pre-emptive approaches. What a 'precautionary' approach to geoengineering might look like is a question for further consideration: it may well exclude fast, high-leverage interventions.

Our analysis suggests that the emergency frame has been a mixed blessing for geoengineering. The emergency frame has an emotive rhetoric that suggests geoengineering is necessary to pre-empt the future, and this emotive character makes it hard to challenge, hard to resist, and even harder to move beyond. The emergency frame tempts us to conclude that the correct response to climate change is to prepare for deliberate large-scale manipulation of the planetary environment. Given the scope of the challenge and the growing inertia behind geoengineering it is more important than ever to resist the pre-emptive logic of the argument that, in case of emergency, we should 'press here'.

NOTES

[a] Entman (1993) defined framing as 'to select some aspects of a perceived reality and make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described'.

[b] The UK Government's own assessment of geoengineering shares the scholarly consensus that the governance regime is currently inadequate, and engages multiple instruments including the Convention on Biological Diversity (1992) and the London Protocol (1996). See http://tinyurl.com/abxfcqy and Command Paper 7936 (2010).

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