



# Ethics and climate change: an introduction

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Climate ethics is an emerging field. This paper serves as a critical introductory overview. It focuses on five areas of discussion that are particularly relevant to substantive climate policy: the treatment of scientific uncertainty, responsibility for past emissions, the setting of mitigation targets, and the places of adaptation and geoengineering in the policy portfolio. © 2010 John Wiley & Sons, Ltd. *WIREs Clim Change* 2010 1 54–66

Significant values are incorporated into the foundations of international climate policy, and necessarily so. As the leading scientific authority on climate change, the United Nations' Intergovernmental Panel on Climate Change (IPCC), recognized at the outset of one of its recent reports, while 'natural, technical, and social sciences can provide essential information and evidence needed for decisions ... at the same time, *such decisions are value judgments ...*' [1, p. 2, emphasis added]. With this in mind, it is no surprise that ethical concepts play a leading role in the way the issue is set out in the foundational legal document, the United Nations framework convention on climate change of 1992.<sup>2</sup> This treaty states as its motivation the 'protection of current and future generations of mankind', declares as its major objective the prevention of 'dangerous anthropogenic interference' with the climate system, and announces that this objective must be achieved while also protecting ecological, subsistence, and economic values. In addition, the text goes on to list a number of principles to guide the fulfillment of these objectives, and these make heavy use of value-laden concepts. For example, appeals are made to 'equity', 'common but differentiated responsibilities' (Article 3.1), the 'special needs' of developing countries (Article 3.2), the 'right' to development (Article 3.4), and the aim of promoting a supportive, open, sustainable, and nondiscriminatory international economic system (Article 3.5). There is no doubt then that ethical concerns are central to climate policy. Still, important questions arise concerning how to interpret, reconcile, and implement the relevant values, and whether the legal account of

them should be challenged or extended. This brings us squarely into the realm of moral and political philosophy, broadly construed.

In this brief introduction to the subject, I will not attempt the large project of assessing the values of the framework convention. Instead, my aim is to indicate how ethical analysis can make a contribution to five central concerns of climate policy: the treatment of scientific uncertainty, responsibility for past emissions, the setting of mitigation targets, and the places of adaptation and geoengineering in the policy portfolio. Inevitably, the account I offer here will be too simplistic and selective. Still, I hope that it provides a useful gateway into the emerging literature (see also<sup>3</sup>).

## SKEPTICISMS

On the face of it, the claim that climate change poses a real threat that justifies serious action is supported by a broad scientific consensus.<sup>4,5</sup> Still, in the public realm this claim has been subject to three prominent challenges.

The first asserts that the science remains uncertain, so that current action is unjustified. This claim raises important epistemic and normative questions about what constitutes relevant uncertainty, and what amounts to appropriate action under it. We can make some progress on the first question if we begin with a distinction. In economics, situations involving uncertainty are distinguished from those involving risk. Suppose one can identify a possible negative outcome of some action. That outcome is a risk if one can also identify, or reliably estimate, the probability of its occurrence; it is uncertain if one cannot.<sup>6</sup> On this account, it is unclear whether the science is uncertain in the technical sense. On the one hand, the IPCC does assign probabilities to many of its projections,

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making the situation one of risk. Moreover, many of these assignments are both high, and associated with substantial negative damages; hence, they do seem sufficient to justify significant action.

On the other hand, most of the IPCC's probability assignments are based on expert judgment, rather than direct appeals to causal mechanisms. Hence, these are 'subjective', rather than objective probabilities. Appeal to subjective probabilities is common in many approaches to risk. Indeed, some claim that all probabilities are ultimately subjective (e.g.,<sup>7</sup>). But if one is suspicious of subjective probabilities in general, or has particular reasons to be skeptical in this case, one might reject the IPCC assignments and continue to regard climate change as genuinely uncertain in the technical sense.

Still, granting this concession is not enough by itself to make the skeptic's case. Suppose that we do lack robust probability information about climate change. Still, there is something troubling about the claim that one should refuse to act just because of this. We do not get to pick and choose the problems we face, and ignoring those whose shapes we do not like seems both a bizarre strategy, and also out of step with how we behave elsewhere. Many important life decisions come without good probability information attached (e.g., who to marry, what career path to follow, where to live). But this does not paralyze us there.

This brings us to the issue of precaution. The framework convention makes the claim that 'where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing (precautionary) measures (to anticipate, prevent, or minimize the causes of climate change and mitigate its adverse effects)' (Article 3.3). Hence, the treaty explicitly rules out some kinds of appeal to uncertainty as justifications for inaction.

Stated as it is in the convention, this appeal to precaution is extremely minimal and underdeveloped. However, some have tried to generate a more general precautionary principle. According to one standard statement, this asserts 'when an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationship are not fully established scientifically'.<sup>8</sup> However, such claims have frequently been dismissed as extreme, myopic, and ultimately vacuous. Could not a precautionary principle be invoked to stop *any* activity, however beneficial, on the basis of any kind of worry, however fanciful? If so, the critics charge, surely it is irrational, and ought to be neglected. This is the second challenge to action on climate change.

Understood in a completely open-ended way, the precautionary principle may be vulnerable to such objections. However, it is plausible to try to restrict its application by introducing criteria to guide when the principle ought to be applied.<sup>9</sup> In previous work, I have tried to illustrate this using John Rawls' criteria for the application of a maximin principle: that the situation is uncertain, in the sense that the parties lack reliable probability information; that they care little for potential gains above the minimum they can secure by acting in a precautionary manner; and that they face outcomes that are unacceptable [10, p. 134]. This approach not only diffuses the original objections, but suggests that many disputes about precaution ultimately do not rest on a rejection of the principle, but rather on disagreement about whether the relevant criteria are met. This significantly reframes the theoretical debate.

At a more practical level, a reasonable case can be made that the Rawlsian precautionary principle applies to climate change. First, presumably some of the projected impacts, being severe or catastrophic, are morally unacceptable. Second, we have already seen that there may be uncertainty in the technical sense. However, third, the claim that we care little for the gains that can be made beyond those secured by precautionary action is more contentious. On the one hand, Cass Sunstein has argued that this condition threatens to confine the Rawlsian version of the principle to trivial cases, and moreover undermines the application to global warming because the costs of mitigation amount to hundreds of millions of dollars [11, p. 112]. (Because of this, he tries to 'build on' the Rawlsian version to develop an alternative catastrophic harm precautionary principle [12, p. 168].) On the other hand, though Sunstein is surely right that more work needs to be done in fleshing out the precautionary principle, it is not clear that the problem is that the Rawlsian version is 'trivial'. Remember that Rawls is speaking of gains that can be made *above some minimum we can guarantee* through eliminating the worst case scenario. Hence, much depends on how one understands the alternative options. Suppose, e.g., that we could avoid the possibility of catastrophic climate change and guarantee a decent quality of life for everyone, all at the cost of slowing down our rate of accumulation of purely *luxury* goods by two years (*cf.*<sup>13</sup>). This might satisfy the 'care little for gains' condition even if the cost of those luxury goods in dollar terms were very large. For example, the importance of averting catastrophic climate change might simply make such a loss relatively unimportant. Given this point, the real issue seems to revolve around the interpretation and

elaboration of the ‘care little for gains’ condition, rather than whether it is ‘too stringent’ (pace.<sup>12</sup>, p. 156). In my view, resolving this issue is likely to involve a substantive project in normative ethics.

The issue of how to understand the costs of climate change brings us to the third challenge. Many economists maintain that only modest steps should be taken, since (they say) the costs of substantial action outweigh the benefits.<sup>14–16</sup> This result, however, is hardly robust, and other prominent economists argue for the contrary conclusion, that substantial action is strongly justified.<sup>17,18</sup> There are many reasons for this disagreement. One concerns the integrity of the relevant calculations. Some distinguished economists argue that economic costs and benefits simply cannot be projected with any precision over the relevant timeframes (of a century or more), so that fine-grained calculations amount to ‘self-deception’.<sup>19,20</sup> But it is also true that long-range economic models must implicitly make many important ethical judgments, about which there is substantial disagreement. These include issues such as the distribution of benefits and burdens across individuals, countries, and time, and the correct way to deal with noneconomic (e.g., interpersonal, aesthetic, and natural) values.

Most prominently, conventional economics adopts the practice of discounting future costs and benefits at a uniform rate of 2–10% per year. This has the effect of sharply reducing the impact of high values in the future, especially when the rates are high.<sup>21</sup> Some argue that this practice is unethical, since it discriminates against future generations. Moreover, its theoretical foundations appear to be weak. Several distinct rationales are offered for discounting, and these often seem to pull in different directions.<sup>22,23</sup> More importantly, many of the rationales are essentially ethical: they claim that future people will be better off and so should pay more, or that the current generation ought to be able to protect itself from excessive demands by the future, or that political institutions ought to respect the pure time preference of the present generation (if it has one). Given this, what might initially appear to be merely a ‘technical issue’ within economics turns on substantive (and controversial) claims in ethical theory.

## PAST EMISSIONS

If action is warranted, who should take it, and what should be done? One proposal is that responsibility should be assigned in light of past emissions. Two kinds of argument are prominent. The first invokes historical principles of responsibility, along the lines of the commonsense ideals of ‘you broke it, you fix it’

and ‘clean up your own mess’.<sup>24,25</sup> Such principles are already familiar in environmental law and regulation, appearing, e.g., in various versions of the ‘polluter pays’ principle (PPP). They imply that those who cause a problem have an obligation to rectify it, and also assume additional liabilities, such as for compensation, if the problem imposes costs or harms on others. The second kind of argument appeals to fair access. The thought is that the atmosphere’s capacity to absorb greenhouse gases without adverse effects is a limited resource that is, or ought to be, held in common. If some have used up the resource, and in doing so denied others access to it, then compensation may be owed. The latecomers have been deprived of their fair share.

Such rationales for considering past emissions seem straightforward and readily applicable to climate change. However, this application has been subject to four prominent objections.

The first objection asserts that past polluters were ignorant of the adverse effects of their emissions, and so ought not to be blamed. They neither intended nor foresaw the effects of their behavior, and so should not be held responsible. This objection initially seems compelling, but turns out to be more complicated when pressed. First, it is worth distinguishing blame as such from responsibility. Though it is true that we do not usually blame those ignorant of what they do, still we often hold them responsible. Hence, showing that blame is inappropriate is insufficient to dismiss past emissions.<sup>24</sup> Second, there are reasons for holding the ignorant responsible in this case. On the one hand, consider the ‘you broke it, you fix it’ rationale. If I accidentally break something of yours, we usually think that I have some obligation to fix it, even if I was ignorant that my behavior was dangerous, and perhaps even if I could not have known. It remains true that I broke it, and in many contexts that is sufficient. After all, if I am not to fix it, who will? Even if it is not completely fair that I bear the burden, is it not at least less unfair than leaving you to bear it alone?<sup>24,26</sup> On the other hand, consider the fair access rationale. Suppose that I unwittingly deprive you of your share of something and benefit from doing so. Is it not natural to think that I should step in to help when the problem is discovered? For example, suppose that everyone in the office chips in to order pizza for lunch. You have to dash out for a meeting, and so leave your slices in the refrigerator. I (having already eaten my slices) discover and eat yours because I assume that they must be going spare. You return to find that you now do not have any lunch. Is this simply your problem? We do not usually think so. Even though I did not realize at the time that I was

taking your pizza, this does not mean that I have no special obligations. The fact that I ate your lunch remains morally relevant.

The second objection emerges from the claim that there is a disanalogy between the pizza case and that of past emissions. In the pizza case, you have a clear right to the eaten slices, because you have already paid for them. But in the case of emissions, where the shares of the latecomers are used up by those who come earlier, it might be maintained that the latecomers have no such claim. Perhaps it is simply 'first-come, first-served', and hard luck to the tardy.

In my view, this response is too quick. We must ask what justifies a policy like 'first-come, first-served' in the first place. To see why, consider one natural explanation. If a resource initially appears to be unlimited, then those who want to consume it might simply assume at the outset that no issues of allocation arise. Everyone can take whatever they want, with no adverse consequences for others. In this case, the principle is not really 'first-come, first-served' (which implies that the resource is limited, so that some may lose out), but rather 'free for all' (which does not). Since it is assumed that there is more than enough for everyone, no principle of allocation is needed.

But what if the assumption that the resource is unlimited turns out to be mistaken, so that 'free for all' is untenable? Do those who have already consumed large shares have no special responsibility to those who have not, and now cannot? Does the original argument for 'free for all' justify ignoring the past? Arguably not. After all, if the parties had considered at the outset the possibility that the resource might turn out to be limited, which allocation principle would have seemed more reasonable and fair: 'free for all, with no special responsibility for the early users if the resource turns out to be unlimited', or 'free for all, but with early users liable to extra responsibilities if the assumption of unlimitedness turns out to be mistaken'? Offhand, it is difficult to see why ignoring the past would be favored. Indeed, there seem to be clear reasons to reject it: it makes later users vulnerable in an unnecessary way, and provides a potentially costly incentive to consume early if possible. Given this, 'first-come, first-served' looks unmotivated. Why adopt an allocation rule that so thoroughly exempts early users from responsibility? Clearly, more needs to be said.

The third objection to considering past emissions emphasizes that, since significant anthropogenic emissions have been occurring since 1750, many past polluters are now dead. Given this, it is said that 'polluter pays' principles no longer really apply to

a substantial proportion of past emissions; instead, what is really being proposed under the banner 'polluter pays' is that the descendants of the original polluters should pay for those emissions, because they have benefited from the past pollution (because of industrialization in their countries). However, the argument continues, this 'beneficiary pays principle' (BPP) is unjust because it holds current individuals responsible for emissions that they did not cause (and could not have prevented), and in ways which diminish their own opportunities.<sup>27,28</sup>

Much could be said about this objection (see also<sup>29</sup> and<sup>30</sup>), but here let me make just two comments. First, the claim that polluter pays does not apply is more complex than it first seems. For example, it does apply if it refers not to individuals as such but to some entity to which they are connected, such as a country, people or corporation. Moreover, this is the case in climate change, where polluter pays is usually invoked to suggest that countries should be held responsible for their past emissions, and these typically have persisted over the time period envisioned.

Many proponents of the objection recognize this complication. To meet it, they typically reject the moral relevance of states, and instead invoke a strong individualism that claims that only individuals should matter ultimately from the moral point of view. Still (second) it should be noted that this move makes the argument more controversial than it initially appears. On the one hand, even many individualists would argue that states often play the role of representing individuals and discharging many of their moral responsibilities. Given this, more needs to be said about why the fact of membership is irrelevant for assigning responsibility. On the other hand, the argument ignores the issue that a very strong individualism would also call into question many other practices surrounding inherited rights and responsibility. Put most baldly, if we are not responsible for at least some of the debts incurred by our ancestors, why are we entitled to inherit all of the benefits of their activities? Hence, if we disavow their emissions, must we also relinquish the territory and infrastructure they left to us? The worry here is that, if successful, the attempt to undermine the PPP and BPP is liable to prove too much, or at least to presuppose a radical rethinking of global politics.

The fourth objection to taking past emissions seriously claims that doing so would be impractical. Instead, it is said, if agreement is to be politically feasible, we should be forward-looking in our approach. The most prominent response to this objection is that it makes a rash claim about political



reality. On the contrary, it might be said, since a genuinely global agreement is needed to tackle climate change, and since many nations of the world would not accept an agreement that did not explicitly or implicitly recognize past disparities, any attempt to exclude the past from consideration is itself seriously unrealistic.

## FUTURE EMISSIONS

Whatever we say about the past, most people accept that something should be done to limit future emissions. Such a limit would transform an open access resource into one that must be distributed. This raises profound ethical questions, and especially ones of procedural and distributive justice.

Procedurally, the main issue is how to get an agreement that pays due respect to all of the parties involved. In practice, international discussion has treated emissions reductions as a matter for political horse-trading. Individual nations offer cuts in terms of their own emissions in exchange for cuts from the others, and other non-climate-related benefits. However, in an international system characterized by historical injustice and large imbalances of power, the prospect that such bargaining will be fair to all parties seems dim. Moreover, as Henry Shue argues, there is a threat of compound injustice.<sup>31</sup> Those treated unfairly in the past are likely to be more vulnerable to current injustices because of their past treatment. Finally, there are worries that the interests of those most affected by future climate change—future generations, the very poor, animals and nature—are not adequately represented. Why expect an agreement driven by representatives of the current generation of the world's most affluent people to produce justice in this context?

The question of how to arrange a climate regime that is procedurally fair is an important one. But some of the concerns might be met if we had a good idea of what a fair distributive outcome might look like. At the theoretical level, this issue is complex. But one natural way to frame it is in terms of two questions.

The first question is what the appropriate trajectory of global carbon emissions should be over the long term. To answer this question, we need technical information about what kinds of emissions scenarios produce what kinds of impacts over time, and what kinds of technological and social changes—especially away from a carbon economy—we can expect, or bring about, and on what time scale. Still, as the IPCC recognizes above, we also need to make value judgments. For example, importantly, we need to know how to reconcile the concerns of present and future generations.

Presumably, other things being equal, it would be better for the future if we reduced our emissions faster, and so diminished the risks of severe climate change; but, on the other hand, it would be better for the present if we minimized the impacts on our own social infrastructure, and so proceeded more slowly. So what balance should we strike between these concerns? Similarly, presumably there would remain something wrong if we succeeded in protecting future and current people, but allowed the natural world to be devastated. So deciding what trajectory to aim for raises issues about our responsibilities with respect to animals and nature.

Interestingly, there has been very little explicit discussion of the ethical dimension of the trajectory question. Instead, policy has been framed in terms of quantitative targets (such as avoiding a temperature rise of 2 °C, or limiting atmospheric concentration of carbon dioxide to 450 or 550 ppm) without much attention to what justifies such targets, or how we might choose between them. This approach tends to hide the relevant value judgments. For example, if limiting climate change to 2.3 rather than 2 °C makes a significant difference to specific populations or industries, how is the lower benchmark to be justified? As time goes on, such issues will no doubt become increasingly important.

The second theoretical question about distribution is how emissions allowed under the overall trajectory at a particular time should be allocated. This question has received much more attention than the first, in politics and academia. Here I shall review just three basic proposals, to get a sense of the terrain. [Of course, more complex proposals exist (*cf.*<sup>32</sup> and<sup>33</sup>). But my remarks here should provide an entry point into thinking about those too.]

The first proposal is that of equal per capita entitlements (e.g.,<sup>25,34–37</sup>). The intuitive idea is that, other things being equal, permissible carbon emissions should be distributed equally across the world population, because no individual has a presumptive right to more than an equal share. Such a position has significant initial appeal. However, it also faces a number of prominent obstacles.

First, people in different parts of the world have different energy needs. For example, those in northern Canada require fuel for heating whereas those in more temperate zones do not. Hence, there is a question about whether equal entitlements really do treat people as equals. This resonates with a deep issue in political philosophy about what the appropriate aim of equality should be: equality of resources, welfare, capabilities, or something else.<sup>38–40</sup>

Second, a shift to per capita entitlements is likely to have radically different implications for different nations. Recent figures show that in 2005, global per capita emissions were at 1.23 metric tons of carbon. But national averages show wide discrepancies. In the United States, e.g., the average in 2005 was 5.32; in the United Kingdom it was 2.47; in China 1.16; in India 0.35; and in Bangladesh 0.08.<sup>41</sup> This raises serious issues. Suppose, e.g., that we were to call for roughly a 20% cut in global emissions in the next decade, and distribute the remaining emissions on a per capita basis, at roughly 1 metric ton each. This would imply that citizens of the United States would have to cut their emissions by more than 80%, those of the UK by nearly 60%, and those of China by around 14%, while the Indians could increase their emissions by around 285% and the Bangladeshis by 1250%. In short, on the face of it, the burden of the shift to equal per capita entitlements seems very different in different countries. In particular, it is often said that it would be more dislocating for those who emit the most to make such drastic cuts, since much of their infrastructure depends on much higher rates of emission.

In practice, most proponents of the equal per capita approach suggest that this problem can be dealt with by making the right to pollute tradable once allocated. Hence, on this version of the proposal, those for whom the costs of reduction are high can buy unused allocations from others whose costs are low. Moreover, for administrative simplicity, it is usually thought that allocations will actually be made to states on the basis of their populations, rather than directly to individuals. In practice, then, the thought is that the effect of the per capita proposal is that developed nations will end up buying large amounts of currently unused capacity from the developing world in order to make their own cuts more manageable.

This more complex proposal raises many new issues. On the one hand, there are concerns about feasibility. For one thing, on the face of it, trading seems to involve a massive transfer of wealth from the rich to the poor nations. For another, the proposal of giving the allowances to states may lead far away from the initial intuition toward equality. In many countries, the thought goes, such allowances are likely to become just another resource for the elite to plunder, perhaps in collusion with, and on behalf of, outside forces. What then of individuals in poor countries to whom the right is nominally given? Does the appeal to individualism turn out merely to be a convenient illusion? On the other hand, concerns about fairness remain. Do tradable allowances simply allow the rich countries to continue their polluting

habits by 'buying off' the poor? Perhaps they are morally akin to environmental indulgences, simply a fancy way for the rich to spend their way out of the implications of their bad behavior<sup>42</sup>; and perhaps they also undermine a sense of collective moral endeavor.<sup>43,44</sup>

More generally, it may be that in practice the main appeal of the 'equal per capita plus trading' proposal lies not in equal division, but elsewhere, in the way it appears to reconcile concern for the future with recognition of the past, and with global justice more generally. After all, the trading mechanism provides a mechanism for the rich nations to provide some compensation to the developing world (and without clearly appearing to do so). If the numbers had worked out differently (if, i.e., the poor countries turned out to be the big current polluters per capita), then it may be that the modified per capita approach would have little support.

The second proposal for allocating emissions initially appears to overcome some of the worries about the modified per capita approach by putting concern for the poor and for individuals right at the heart of its approach. Henry Shue maintains that individuals have an inalienable right to the emissions necessary for their survival or some minimum level of quality of life. He proposes that such emissions should be open neither to trading, nor appropriation by governments, and that they ought to be sharply distinguished from other emissions, especially those associated with luxury goods.<sup>13</sup> At first glance, this proposal has a sharply different logic than that of tradable per capita rights. On the one hand, subsistence emissions rights are inalienable, suggesting not only that they cannot be exchanged but also that they should be guaranteed even if this would predictably lead to serious harm to others, such as future generations. On the other hand, subsistence emissions are subject to a strict threshold, suggesting that emissions above that threshold might be distributed according to principles other than equality.

Of course, the subsistence emissions proposal also raises new difficulties. Most obviously, what counts as a 'subsistence emission'? After all, former US President George H. Bush infamously stated at the Rio Earth Summit in 1992 that 'the American way of life is not up for negotiation'. Does that mean that we should regard an emissions rate of 5.32 metric tons per capita as the subsistence level for Americans? Surely not. Yet even subsistence at a minimal level of quality of life presumably does include some social and cultural factors,<sup>45</sup> and these may involve different levels of absolute emissions. So how do we decide

what is necessary and what is not? Again, some moral and political philosophy seems needed.

Less obviously, in practice it is not clear that the proposal has real advantages over the equal per capita approach. On the one hand, the two may not be easily separable. Given the fungibility of the notion of 'subsistence', it seems likely that the task of determining an adequate minimum may turn out to be very close to that of deciding on an appropriate trajectory and then assigning equal per capita rights. On the other hand, if the two approaches do diverge, it is not clear that the subsistence approach does a better job of protecting vulnerable individuals. For example, if culturally sensitive subsistence emissions overshoot the equal per capita allocation, then they justify an increase in the burdens on future generations. Alternatively, if they undershoot that allocation, then the 'excess' emissions need to be distributed in some other way. If this is equal per capita, then (again) the two approaches may amount to much the same thing. But if it is not—in particular if they are to be distributed by market forces—then the subsistence approach may end up being less favorable to the poor than equal per capita.

The third allocation proposal is that nations should share the costs of mitigation fairly among themselves by trying to equalize their marginal costs in reducing emissions. This is presumably part of the appeal of nations declaring percentage reduction targets. The thought is that if each reduces their own emissions by, say, 20% in a given period, then all take on equal burdens. Martino Traxler suggests that this approach has major political advantages. No nation has any stronger reason to defect than any other, and each experiences the maximum moral pressure to participate.<sup>45</sup>

I am not so sure. First, the proposal is entirely future-oriented. Not only does it ignore past emissions but also has it the effect of embedding recent emissions levels. For example, a cut of 20% reduces per capital levels in the United States to 4.26 and in India to 0.28. Is this fair, given that the United States is so much richer? Even more starkly, if ultimately the global cut needs to be 80%, is it fair that the equal percentage cut approach reduces the United States to 1.64 per capita, when this is still significantly higher than current Chinese and Indian levels, and when Bangladesh is pushed down to a miniscule 0.1 per capita?

Second, as the first point already suggests, the correct measure of 'equal burdens' is morally contentious. Consider just three proposals. The first aims to equalize the marginal economic cost of reduction in each country. Say that this turns out to be \$50 per metric ton. Does it matter that this

amounts to the cost of nice evening out for the average American, but more than a month's income for the average Bangladeshi? Presumably, it does. Given this, a second proposal might aim at equalizing marginal welfare instead. But what if the worst-off are in so wretched a condition that taking more from them will make little difference to their misery, but the very well-off are so accustomed to luxury that even small losses hit their subjective states very hard? Does this justify taking more from the poor? Again, presumably not. Finally, as a third proposal, suppose that we adopt a more substantive account of goods, distinguishing (for example) between luxuries and subsistence goods, and differentiating their importance to welfare. Then we could protect the poor from additional deprivation by insisting that the rich should give up all their luxuries before the poor give up anything.<sup>31,45</sup> However, even if this is morally correct, it seems highly politically controversial, and so undermines many of the (alleged) practical advantages of the 'equal burdens' approach.

## IMPACTS

Efforts to reach agreement on mitigation are complicated by the further issue of adaptation. Clearly, at this point, adaptation measures must be part of any sensible climate policy, because we are already committed to some warming due to past emissions, and because almost all of the proposed abatement strategies envisage that overall global emissions will continue at a high level for at least the next few decades, committing us to even more. However, it is also sometimes maintained that adaptation should be our predominant or even sole strategy. Some maintain that the key problems are human vulnerability to weather and the social conditions that lead to environmental degradation, and that these are strongly influenced by poverty and global population. Given this, the argument continues, these issues should be our focus rather than emissions reductions.<sup>46</sup>

In this vein, Bjorn Lomborg has argued that the climate change problem ultimately reduces to the question of whether to help poor inhabitants of the poor countries now or their richer descendants later, and that the right answer is to help the current poor now, because they are poorer than their descendants will be, because they are more easily (i.e., cheaply) helped, and since in helping them, one also helps their descendants. For example, Lomborg claims that a mitigation project like Kyoto 'will likely cost at least \$150 billion a year, and possibly much more,' whereas 'just \$70–80 billion a year could give all third world inhabitants access to the basics like health, education, water, and sanitation'.<sup>15,16</sup>

Lomborg's approach incorporates two main ideas. The first is a straightforward appeal to opportunity costs: the resources used for climate change mitigation could produce greater net benefits if employed elsewhere.<sup>15</sup> Mitigation efforts like Kyoto are, Lomborg says, a 'bad deal'.<sup>16</sup>

In some contexts, opportunity cost arguments are compelling. But we should be careful about their import for climate change. The first worry concerns Lomborg's framing of the issue. The claim that the choice is between current and future generations of the world's poor assumes that climate change poses no serious threats to (say) current or future inhabitants of richer countries, to animals, or to the rest of nature. This seems either false, or highly optimistic. In addition, the choice seems to represent a false dichotomy. Helping the poor does not foreclose the option of mitigating climate change. Perhaps we can do both. Moreover, plausibly, the two are inextricably linked. Perhaps digging new wells in Africa would not make much difference if climate change induces severe drought (perhaps it will even be simply a waste of resources), and perhaps some mitigation projects also help the poor (e.g., by reducing air pollution).

A second worry concerns the compensation rationale. It turns out that 'even hard-nosed benefit–cost analysts' agree that the claim that future people could be compensated by an alternative policy loses relevance if we know that the compensation would not actually be paid, or would not suffice [47, p. 6–7]. This may be so if catastrophic climate change undercuts our efforts to grow the global economy,<sup>17</sup> or if an otherwise richer future beset by severe climate change is not better off than a poorer one without such problems, perhaps because throwing money at the problem does not help that much.

The third worry about the opportunity cost argument is that, because it assumes that we can compensate the future for failure to act on climate change with a larger economy, the argument overlooks the possibility that future people may be entitled to both. If we owe it to our successors both that we refrain from climate disruption and that we try to improve their material conditions, then we cannot simply substitute one for the other and say that we are even. This would be a morally mischievous slight of hand. It would be like arguing that we should not save for our own retirements but invest in our kids' education instead, because then they will be able to look after us (better) in our old age. On a standard view of things, we owe our children freedom from the burdens of supporting us when we are older, and also some help in securing a good education.

The one obligation cannot simply be silenced by the other.

This brings us to Lomborg's second main idea, that future people will be better off and so should pay more. This position is also open to challenge in the case of climate change. First, the approach ignores all issues of responsibility. If our generation causes the climate problem, it is far from clear that the future victims should pay to fix it (or pay disproportionately). This is so even if they happen to have more resources. We do not *always* think that those who have a greater ability to pay should pay (or pay more). Sometimes we think that those who caused the problem should pay instead. Second, future people may not be richer. For one thing, many of the world's poorer people in 2050 or 2100 may be better off than the poor are today, but still much worse off than the current global rich. So there is no reason to make them pay more. For another, if climate change has severe effects on matters such as food, water, disease, and the regional economies, then many people in the future may be worse off than people now.

Even if adaptation ought not to be our sole concern, it is clearly a crucial component of any defensible climate policy. Unfortunately, very little philosophical work has been done on this topic to date (exceptions include<sup>48</sup> and<sup>49</sup>), although some of the discussion about past emissions and mitigation remains relevant, as does development ethics more generally (e.g.,<sup>50,51</sup>). Still, it may be worth noting two initial points.

First, much resistance to mitigation seems implicitly bound up with the idea that it will be difficult for existing economic systems to 'adapt' to emissions restrictions, but not to climate impacts. This is a surprising assumption. Other things being equal, one might think that it would be easier for economic institutions to cope with sensibly managed regulation than with specific climate impacts, since the former could be designed to be gradual, predictable, and incremental, whereas the latter are likely to be sudden, unpredictable, and potentially large-scale. But whatever we say about this, it seems clear that at least some of the existing climate debate turns on background assumptions about the relative resilience of different kinds of social and natural systems. This complicated the ethics of adaptation.

Second, the natural world interacts in complex ways with the social so that it will often be very difficult to separate climate impacts from other factors. Hence, the harms and costs of failures to adapt will often be hidden—as Dale Jamieson puts it, no one's death certificate will ever read 'climate change'.<sup>49</sup> Given this, it is difficult to address adaptation without



engaging with issues of global poverty and injustice more generally.

## DIRECT INTERVENTION

A different approach to climate policy would have us try to make the planet ‘adapt’ to us. Perhaps, the thought goes, we should try a ‘techno-fix’. Why not directly intervene in the climate system in order to prevent emissions from having negative effects? Such ‘geoengineering’ solutions to climate change have been proposed for decades, but have recently gained some prominence. Proposals include deploying space mirrors to reflect incoming sunlight, ‘fertilizing’ the ocean with iron in order to suck carbon dioxide from the atmosphere, and pumping emissions from coal-burning power plants deep underground into sedimentary rock.

Philosophically, it is not clear that all such interventions are best grouped together, in part, because they seem to raise different ethical issues. However, here I shall not try to develop a general definition of geoengineering. Instead, I shall merely gesture at the idea that geoengineering involves something ‘global, intentional, and unnatural’.<sup>52</sup> Wherever it makes a difference, the reader should assume that I am taking, as my model, the proposal that is currently the most popular—that of trying to manage the earth’s albedo through injecting sulfur into the stratosphere.<sup>53</sup> I take this to be a paradigm case of geoengineering.<sup>54</sup>

Different arguments can be (and often are) offered in favor of various interventions. For example, some advocate a given approach because they think it much more cost-effective than mitigation (*cf.*<sup>52</sup> and<sup>55</sup>), others say that it will ‘buy time’ while mitigation measures are implemented,<sup>56</sup> and still others claim that geoengineering should only be implemented as a last resort, to stave off a catastrophe.<sup>53,57</sup> Differences in rationale are important because they often have divergent implications for research, governance, and policy, affecting what kinds of geoengineering should be pursued, to what extent, and with what safeguards. Given this, it is good to be clear about *why* an intervention is proposed.

Consider a few prominent arguments.<sup>54</sup> The first claims that geoengineering is relatively cheap and administratively simple.<sup>53</sup> Thus far, this argument has not proven very persuasive. The claim that geoengineering is cheap focuses on the costs of implementation, but appears to ignore the risk of dangerous side effects, and the fact that many geoengineering options leave some aspects of the carbon dioxide problem (such as ocean acidification)

unaffected. The claim that it is administratively simple relies on the idea that it would be technically feasible for one country or corporation to undertake a serious geoengineering project. This ignores the moral and political implications of unilateral geoengineering, and the real possibility of geopolitical conflict.<sup>58</sup> More widely, some worry that this argument fails to take seriously the wider context of global environmental problems and the problematic human relationship to nature that they reflect.

A second argument for geoengineering suggests that we can adopt a ‘research-only’ approach. For example, Ralph Cicerone, the President of the National Academy of Sciences, maintains that we should do further research in order to eliminate bad geoengineering options and discover if there are good ones, because there is a presumption in favor of freedom of enquiry since it promotes the acquisition of knowledge. While this is happening, he adds, there should be a moratorium on deployment and field testing. If promising proposals emerge, scientists can then bring these to the wider community so that political and ethical considerations may be brought to bear.<sup>59</sup>

There is something attractive about this proposal, and about the model it implies of science and its role in society. However, there are concerns about how good that model really is, and in particular how it holds up in the real social and political world in which we live. One concern is that it is not obvious that any particular research project should be supported just because it enhances knowledge. After all, there are limited resources for research. If we prioritize geoengineering, other knowledge-enhancing projects will be displaced. Some rationale is needed for this displacement. In addition, some kinds of knowledge enhancement seem trivial. This is relevant because some experts claim that geoengineering research is highly unlikely to yield the kind of results needed to justify action on the timescale envisioned,<sup>60</sup> and that the rate of technological progress is so fast that it may make little sense even to try.<sup>52</sup>

A second concern about the research-only approach is that there is a crucial ambiguity in the notion of ‘supporting research’. There are major differences between, e.g., individual scientists and journals being willing to review and publish papers, major funding agencies encouraging geoengineering proposals, and governments providing massive resources for a geoengineering ‘Manhattan Project’. Importantly, giving preeminence to the cause of geoengineering research cannot be justified merely by appealing to the value of knowledge for its own sake. Instead, a much more robust argument is needed.

The final concern is that it is not clear that geoengineering activities can really be limited to research. First, there is such a thing as institutional momentum. In our culture, big projects that are started tend to get done.<sup>61</sup> Second, there are real worries about the idea of a moratorium. After all, if the results of research are to be published in mainstream journals that are freely available online or in libraries across the world, what is to stop a rogue scientist, engineer, or government deciding to use that research? Third, there are issues about who gets to make such decisions and why, and about how they are enforced. If the future of the planet is at stake, why is it that the rest of humanity should cede the floor to a ‘gentleman’s agreement’ among a specific set of scientists? Fourth, there are issues about conducting geoengineering research in isolation from public input, and in particular divorced from discussions about the ethics of deployment. The background assumption that is being made seems to be that such input and discussion has *nothing to tell us* about the goals of geoengineering research or how it should be conducted. But it is not clear why we should accept this assumption (*cf.* <sup>61</sup>).

A third argument for pursuing geoengineering argues that ‘arming the future’ with geoengineering is the lesser of two evils. The argument begins with the thought that if the current failure to act aggressively on mitigation continues, then at some point (probably 40 years or more into the future) we may end up facing a choice between allowing catastrophic impacts to occur, or engaging in geoengineering. Both, it is conceded, are bad options. But engaging in geoengineering is less bad than allowing catastrophic climate change. Therefore, if it comes to it, we should choose geoengineering. However, if we do not start doing serious research now, then we will not be in a position to choose geoengineering should the nightmare scenario arise. Therefore, we should start doing the research.<sup>53</sup>

This argument initially seems both straightforward and irresistible. However, it is subject to a number of important challenges.<sup>54</sup> First, it is not clear that the nightmare choice scenario it describes is the one we should prepare for. Perhaps other nightmares are more likely, such as having to cope with catastrophic change that is already upon us, or with a geopolitical catastrophe caused by unilateral or predatory geoengineering. Second, there may be other ways to prepare. Perhaps a Manhattan Project for alternative energy, or a massive climate assistance and refugee program, or a Strategic Solar Panel Reserve, would be better than geoengineering. Such alternatives should at least be considered. Third, if the nightmare scenario comes about because of our inaction on mitigation,

then this seems to be a moral failure on our part, for which we may owe the future compensation beyond that of geoengineering research. The ‘arm the future’ argument is thus too limited in describing our obligations. Fourth, similarly, the argument is silent on the issue of how to make geoengineering intervention politically legitimate and broadly in keeping with norms of global justice and community (e.g., not seriously unfair or parochial in its concerns). For example, a basic principle of modern political thought is that political institutions are legitimate only if they are justifiable to those governed by them. How then are geoengineering institutions to be justified, and what does this imply for global ethics and political philosophy? The final challenge concerns how we are to understand such issues in a context where the need to geoengineer is to be brought on by our failure to mitigate and adapt. Are just and effective geoengineering policies any more likely than just and effective mitigation policies? And if not, what can we say about the ethics of any likely decision to geoengineering?

In addition to the major arguments for pursuing geoengineering, there are also significant arguments against it. One prominent argument concerns how risky it is likely to be, and whether we are morally entitled to take this risk, especially in a context where ethical norms are not in place to protect the victims of side effects (for a first step toward such norms, see<sup>61</sup>). A second argument concerns what kind of people we aim to be. Many people, including a number of climate scientists, appear to believe that the attempt to geoengineer is not only risky, but also both an attempt to divert attention from the obligation to reduce emissions, and ultimately a sign of hubris. This argument sees the decision to pursue geoengineering in a wider context, raising questions that go beyond consideration of what the narrow consequences of this or that intervention are likely to be. If the decision to pursue geoengineering is made in the context of serious inertia on mitigation and adaptation for climate change, and a more general indifference to global environmental problems, the claim is that this reflects badly on the particular societies and generations who make that decision and perhaps on humanity as such. On one way of looking at things, having created a problem, we are obstinately refusing to face it in a serious way, but instead doing whatever we can to defer action, impose the burden on others, and obfuscate matters by arguing that we must hold out for a less demanding solution (however unrealistic that may be). What kind of people would do such a thing?<sup>54,62–64</sup>

## CONCLUSION

In this introduction to ethics and climate change, I have tried to illustrate how ethical analysis contributes to our understanding of five central areas of climate policy: the treatment of scientific uncertainty, responsibility for past emissions, the setting of mitigation targets, and the places of adaptation and geoengineering in the policy portfolio. Much more can (and should) be said about these topics, and many other important ethical issues that I have not discussed. Of special interest is the place of climate policy within wider approaches to global justice, environmental ethics, and the ethics of human well-being. In particular, much of the current discussion (including those aspects I have emphasized above) tends to assume that we must work more-or-less within the constraints of the current geopolitical system. But, of course, climate change might be thought to pose a practical and philosophical challenge to that system.<sup>65</sup>

If so, then much current writing is at best work on what one might call the 'ethics of the transition', helping us to bridge the gap between what is and what should be. Vitally important though that project is, presumably we also need help in working out what we should ultimately be aiming for, in terms of better institutions and ways of life. Ethics should be a central part of this 'ideal' project too.

## NOTES

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## REFERENCES

- Intergovernmental Panel on Climate Change (IPCC). *Climate Change 2001: The Synthesis Report*. Cambridge, UK: Cambridge University Press.
- United Nations Framework Convention on Climate Change. *Framework Convention on Climate Change*. 1992. Available at: <http://unfccc.int/essential-background/convention/background/items/1349.php>.
- Gardiner S, Caney S, Jamieson D, Shue H eds. *Climate Ethics: Essential Readings*. Oxford: Oxford University Press; 2010. In press.
- Intergovernmental Panel on Climate Change (IPCC). *Climate Change 2007: The Physical Science Basis*. Cambridge: Cambridge University Press; 2007.
- Oreskes N. The scientific consensus on climate change. *Science* 2004, 306:1686.
- Knight F. *Risk, Uncertainty, and Profit*. Boston, MA: Houghton Mifflin Company; 1921.
- Friedman M. *Price Theory*. Chicago, IL: Aldine; 1976.
- Wingspread Statement*. 1998. Available at <http://www.gdrc.org/u-gov/precaution-3.html>.
- Gardiner S. A core precautionary principle. *J Polit Philos* 2006, 14:33–60.
- Rawls J. *A Theory of Justice*. Revised ed. Cambridge, MA: Harvard University Press; 1999.
- Sunstein C. *The Laws of Fear*. Cambridge: Cambridge University Press; 2005.
- Sunstein C. Irreversible and catastrophic. *Cornell Law Rev* 2006, 91:841.
- Shue H. Subsistence emissions and luxury emissions. *Law and Policy* 1993, 15:39–59.
- Nordhaus WD, Boyer JG. *Warming the World: Economic Models of Global Warming*. Cambridge, MA: MIT Press; 2000.
- Lomborg B. *The Sceptical Environmentalist*. Cambridge: Cambridge University Press; 2001.
- Lomborg B. *Cool It: The Sceptical Environmentalist's Guide to Global Warming*. London: Marshall Cavendish; 2007.
- Stern N. *The Economics of Climate Change: The Stern Review*. Cambridge: Cambridge University Press; 2007.
- Stern N. The economics of climate change. *Am Econ Rev* 2008, 98:1–37.
- Broome J. *Counting the Cost of Global Warming*. Isle of Harris, UK: White Horse Press; 1992.
- Spash C. The economics of climate change impacts a la Stern: novel and nuanced or rhetorically restricted? *Ecol Econ* 2007, 63:706–713.
- Broome J. The ethics of climate change. *Sci Am* 2008, 298(6):97–102.
- Cowen T, Derek P. Against the social discount rate. In: Laslett P, Fishkin J, eds. *Justice Between Age Groups and Generations*. New Haven, CT: Yale University Press; 2001, 144–161.
- Caney S. Human rights, climate change and discounting. *Env Polit* 2008, 17:536–555.
- Shue H. Global environment and international inequality. *Int Aff* 1999, 75:531–545.

25. Singer P. *One World: The Ethics of Globalization*. New Haven, CT: Yale University Press; 2002.
26. Shue H. *Historical Responsibility. Technical Briefing for Ad Hoc Working Group on Long-term Cooperative Action under the Convention [AWG-LCA], SBSTA, UNFCCC, Bonn, 4 June 2009*. 2009. Available at: [http://unfccc.int/files/meetings/ad\\_hoc\\_working\\_groups/lca/application/pdf/1\\_shue\\_rev.pdf](http://unfccc.int/files/meetings/ad_hoc_working_groups/lca/application/pdf/1_shue_rev.pdf).
27. Caney S. Cosmopolitan justice, responsibility and global climate change. *Leiden J Int Law* 2005, 18:747–775.
28. Posner E, Sunstein C. Climate change justice. *Georgetown Law J* 2008, 96:1565–1612.
29. Gosseries A. Historical emissions and free riding. In: Meyer L, ed. *Justice in Time: Responding to Historical Injustice*. Baden-Baden, Germany: Nomos; 2003, 355–382.
30. Meyer L, Roser D. Distributive justice and climate change: the allocation of emission rights. *Analyse Kritik* 2006, 28:223–249.
31. Shue H. The unavoidability of justice. In: Hurrell A, Kingsbury B, eds. *The International Politics of the Environment*. Oxford: Oxford University Press; 1992, 373–397.
32. Baer P, Athanasiou T, Kartha S. *The Right to Development in a Climate Constrained World: The Greenhouse Development Rights Framework*. London: Christian Aid; 2007.
33. Chakravarty S, Chikkatur A, de Coninck H, Pacala, S, Socolow R, et al. Sharing global CO<sub>2</sub> emission reductions among one billion high emitters. *Proc Natl Acad Sci USA*. 106(29):11884–11888, DOI:10.1073\_pnas.0905232106.
34. Agarwal A, Narain S. *Global Warming in an Unequal World: A Case of Environmental Colonialism*. New Delhi: Centre for Science and Environment; 1991.
35. Meyer A. *Contraction and Convergence*. Dartington, UK: Green Books; 2000.
36. Jamieson D. Climate change and global environmental justice. In: Edwards P, Miller C, eds. *Changing the Atmosphere: Expert Knowledge and Global Environmental Governance*. Cambridge, MA: MIT Press; 2001, 287–307.
37. Athanasiou T, Baer P. *Dead Heat: Global Justice and Global Warming*. New York: Seven Stories Press; 2002.
38. Sen A. Equality of what? In: McMurrin S, ed. *Tanner Lectures on Human Values*. Cambridge: Cambridge University Press; 1980.
39. Dworkin R. *Sovereign Virtue: The Theory and Practice of Equality*. Cambridge, MA: Harvard University Press; 2002.
40. Page E. *Climate Change, Justice and Future Generations*. Cheltenham: Elgar; 2007.
41. Marland G, Boden T, Andreas RJ. *Global CO<sub>2</sub> Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring*. Dept of Energy, United States: Carbon Dioxide Information Center. 2008, 1751–2005. Available at: [http://cdiac.ornl.gov/trends/emiss/em\\_cont.html](http://cdiac.ornl.gov/trends/emiss/em_cont.html).
42. Goodin R. Selling environmental indulgences. *Kyklos* 1994, 47:573–596.
43. Sandel M. Should we buy the right to pollute? In: Sandel M, ed. *Public Philosophy: Essays on Morality in Politics*. Cambridge, MA: Harvard University Press; 2005.
44. Sagoff M. Controlling global climate: the debate over pollution trading. *Rep Inst Philos Publ Pol* 1999, 19:1–6.
45. Traxler M. Fair chore division for climate change. *Soc Theory Pract* 2002, 28:101–134.
46. Sarewitz D, Roger P Jr. *Breaking the global warming gridlock*. *Atl Mon* 2000, July. Available at: <http://www.theatlantic.com/doc/200007/global-warming/5>.
47. Portney PR, Weylant JP. Introduction. In: Portney, PR, Weylant JP, eds. *Discounting and Intergenerational Equity*. Washington, DC: Resources for the Future; 1999.
48. Adger N, Huq S, Mace M, Paavola J, eds. *Fairness in Adapting to Climate Change*. Cambridge, MA: MIT Press; 2005.
49. Jamieson D. Adaptation, mitigation, and justice. In: Sinnott-Armstrong W, Howarth R, eds. *Perspectives on Climate Change*: Elsevier; 2005, 221–253.
50. Nussbaum M. *Women and Human Development*. Cambridge: Cambridge University Press; 2001.
51. Crocker D. *Ethics of Global Development: Agency, Capability and Deliberative Democracy*. Cambridge: Cambridge University Press; 2008.
52. Schelling T. The economic diplomacy of geoengineering. *Clim Change* 1996, 33:303–307.
53. Crutzen P. Albedo enhancement by stratospheric sulphur injections: a contribution to resolve a policy dilemma? *Clim Change* 2006, 77:211–219.
54. Gardiner S. Is “arming the future” with geoengineering really the lesser evil? Some doubts about the ethics of intentionally manipulating the climate system. In: Gardiner S, Caney S, Jamieson D, Shue H eds. *Climate Ethics: Essential Readings*. Oxford: Oxford University Press; 2010. In press.
55. Barrett S. The incredible economics of geoengineering. *Environ Res Econ* 2008, 39:45–54.
56. Wigley TML. A combined mitigation/geoengineering approach to climate stabilization. *Science* 2006, 314:452–454.
57. Victor D, Morgan MG, Apt J, Steinbruner J, Ricke K. The geoengineering option: a last resort against global warming? *Foreign Aff* 2009, 88(2):64–72.



58. Bodansky D. May we engineer the climate? *Clim Change* 1996, 33:309–321.
59. Cicerone R. Geoengineering: encouraging research and overseeing implementation. *Clim Change* 2006, 77:221–226.
60. Bengtsson L. Geoengineering to confine climate change: is it at all feasible? *Clim Change* 2006, 77:229–234.
61. Jamieson D. Intentional climate change. *Clim Change* 2006, 33:323–336.
62. Kiehl J. Geoengineering climate change: treating the symptom over the cause? *Clim Change* 2006, 77:227–228.
63. Schneider S. Geoengineering: could we or should we make it work? *Philos Trans R Soc A* 2008, 366:3843–3862.
64. Schmidt G. Geoengineering in vogue. *Real Clim* 2006, 28 June. Available at: <http://www.realclimate.org>.
65. Gardiner S. Climate change as a global test for contemporary political institutions and theories. In: O'Brien K, Clair AL St, Kristoffersen B, eds. *Climate Change, Ethics and Human Security*. Cambridge, UK: Cambridge University Press. In press.
66. Gardiner S. Ethics and global climate change. *Ethics* 2004, 114:555–600.

## FURTHER READING

- Garvey J. *The Ethics of Climate Change: Right and Wrong in a Warming World*. London: Continuum; 2008.
- Vanderheiden, S. *Atmospheric Justice: A Political Theory of Climate Change*. Oxford: Oxford University Press; 2008.
- Gardiner S, Caney S, Jamieson D, Shue H eds. *Climate Ethics: Essential Readings*. Oxford: Oxford University Press; 2010. In press.
- Page E. *Climate Change, Justice and Future Generations*. Cheltenham: Elgar; 2007.