



Climate Change Justice

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Abstract

Anthropogenic climate change is a global process affecting the lives and well-being of millions of people now and countless number of people in the future. For humans, the consequences may include significant threats to food security globally and regionally, increased risks of from food-borne and water-borne as well as vector-borne diseases, increased displacement of people due migrations, increased risks of violent conflicts, slowed economic growth and poverty eradication, and the creation of new poverty traps. Principles of justice are statements of what persons are owed either by others or by institutions and policies. Climate change gives rise to many concern of justice. This article briefly summarizes some of the most important of these, including claims to have climate change mitigated, claims regarding the sharing of the costs of climate change mitigation, claims for investment into adaptation, and claims to be compensated.

Anthropogenic climate change is a global process affecting the lives and well-being of millions of people now and countless number of people in the future.¹ Although the effects of climate change are likely to appear as the result of natural processes and disasters – and even though it may be difficult, for the time being at least even impossible, to distinguish them from natural misfortunes – they are in fact the result of human energy use and policy. Without substantial reductions in greenhouse gas emissions, especially CO₂, the most likely rise in the mean equilibrium surface temperature of the Earth over pre-industrial times by the end of this century is in the range of 3.7 to 4.8 °C, but the possible range is much wider, 2.5 to 7.8 °C.²

That much warming at that rate is unprecedented in human history. It would produce high to very high risks of severely negative effects, including widespread loss of species and eco-systemic destruction, heat waves, extreme precipitation, and large and irreversible sea-level rise from ice sheet loss.³ For humans, these consequences would include significant threats to food security globally and regionally, increased risks of from food-borne and water-borne as well as vector-borne diseases, increased displacement of people due migrations, increased risks of violent conflicts, slowed economic growth and poverty eradication, and the creation of new poverty traps.⁴ According to some forecasts, such warming could simply overwhelm the capacity of communities in various regions to adapt, rendering certain areas uninhabitable. '[T]he limits for human adaptation are likely to be exceeded in many parts of the world, while the limits of adaptation for natural resource systems would largely be exceeded throughout the world.'⁵

Principles of justice are statements of what persons are owed either by others or by institutions and policies. Climate change gives rise to many concern of justice. This article briefly summarizes some of the most important of these, but due to the need to be brief, some important considerations relevant to justice will not be discussed. For example, although we will discuss formulations of various principles of justice, we will not consider all of the relevant questions regarding the formulation and justification of these principles. Additionally, considerations of justice directly raise questions of responsibility. Accounts of responsibility concern who is called upon to deliver that which is owed to those who are owed. Although there is a reasonably clear distinction in

principle between an account of who is owed what (justice) and an account who, and in virtue of what, must perform or provide that which is owed (responsibility), in actual cases, it is often difficult to be clear about justice without discussing responsibility. And an adequate moral account for practical purposes typically requires an account of who is owed what as well as who must perform or provide that which is owed. For example, an account of the distribution of the entitlement to emit CO₂ is complemented by an account of which parties are responsible for making emissions reductions. But due to space constraints, I will leave aside most considerations of responsibility, including responsibility for mitigation. This latter matter is an important one in its own right, but it cannot be adequately addressed here.

Future people are dependent on us to leave them a planet that is inhabitable. They are, as Henry Shue stresses, in that regard vulnerable with respect to our energy policies.⁶ It seems intuitively plausible then that a principle of justice would require us to pay appropriate regard to their vulnerability. Vulnerability consists in two factors, exposure to risk and a deficiency of resources for protecting against the risk. Mitigation policies can leave future people a climate system that is less risky in relation to the irregularity of weather, intense storms, extreme droughts, sea level rise, and flooding to name just a few effects of global warming. Adaptation policies can provide resources for protection, including sea-walls and levees, crop diversification, infrastructure reinforcement, and even relocation. Financing compensation funds would allow for the provision of resources to people who are harmed by climate change. Due to inertia in the climate system and long residence of time of CO₂ in the atmosphere, mitigation policies will most benefit the very young who are now alive and people who will exist in the future, whereas adaptation and compensation policies may benefit some people currently alive as well as future people.

Mitigation as a Demand of Justice

There is a natural carbon cycle by which atmospheric CO₂ eventually returns to the Earth's surface, by means either of oceanic absorption or plant respiration. Atmospheric concentrations of CO₂ increase when humans emit at a rate faster than the natural processes can recycle. Pre-industrial concentrations of CO₂ were around 279 ppm (parts per million). In 2013, for the first time, concentrations exceeded 400. Much of the CO₂ emitted due to human activity remains in the atmosphere hundreds or even thousands of years. 'While more than half of the CO₂ emitted is currently removed from the atmosphere within a century, some fraction (about 20%) of emitted CO₂ remains in the atmosphere for many millennia.'⁷

The long residence time of CO₂ in the atmosphere has profound consequences for the moral project of mitigation. For one thing, although people in the near future may benefit from mitigation if atmospheric concentrations of CO₂ were stabilized, most beneficiaries of mitigation will be people who will exist in the distant future and suffer the most severe effects of unmitigated climate change. Hence, mitigation is importantly a matter of intergenerational morality or justice, perhaps not exclusively but mostly. Moreover, our mitigation policies are necessarily directed at helping future generations without any differentiation amongst future people on the basis of geography, socio-economic class, or special vulnerability.

The long residence time for CO₂ in the atmosphere also has implications for the stabilization of the Earth's temperature at any particular increase, which requires stabilizing the concentrations of CO₂ in the atmosphere. Because the particles emitted by humans remain in the atmosphere for so long, stabilizing concentrations at particular level requires halting cumulative emissions at some level. Different levels of total historic emissions correspond to different concentration levels, which in turn correspond to different temperature increases. The principal advantage of setting the mitigation goal in terms of cumulative emissions is that we can track with

reasonable accuracy how close we are coming to the temperature goal. If we take seriously a temperature increase limit, then the ultimate goal of mitigation is a no-carbon economy. In the meantime, the aim of mitigation is to reduce emissions in order to extend the deadline after which they must stop completely.

From the beginning of the industrial revolution to the present, humanity has emitted approximately 579,500,000 tons of carbon. In order to have a better than 66 percent chance of limiting warming to 2 °C, total human emissions must not exceed one trillion tons of carbon.⁸ We are, then, more than halfway to that limit. Because currently total global emissions are increasing, presently, the date at which the trillionth ton will be emitted is coming ever nearer. At the time of the writing of this article it was April 13th, 2040. You may consult the webpage <http://trillionthtonne.org/> to see when the trillionth ton will be emitted at the time that you are reading this article.

The authors of the Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report (AR5) express high confidence in the claim that 'Adaptation and mitigation in the near-term will affect the risks of climate change throughout the 21st century.'⁹ Why might future generations have a claim that the harms of climate change should be prevented or reduced? Most people will find the following principle of vulnerability reduction reasonable: If a person is especially vulnerable to very bad things happening due the actions and omission of others, that person has *prima facie* claim to have the vulnerability reduced. Affirming that principle entails that the vulnerability of people to climate change related risks should be reduced. But the principle of vulnerability reduction is vague in important ways. Which vulnerabilities matter? By how much should the vulnerability be reduced? And at what costs to those who would reduce it? Which factor of vulnerability – risk exposure or insufficient resources for protection – is morally relevant? The principle can be made less vague in a variety of ways as we shall now see, although there is, of course, philosophical controversy about how to fill in the details.

One view that draws on an approach widely employed in the discipline of economics, called discounted utilitarianism, holds that justice requires pursuing policies that optimize consumption across an infinite number of future generations, subject to the appropriate discounting of future costs.¹⁰ In standard accounts, there are three discount factors – for growth, for the elasticity of marginal consumption, and according to a pure time preference. Several controversies arise here. First, this account contains the liabilities of utilitarianism generally, prominent among these is the possibility that the severe suffering of a population at a particular time may be justified as a necessary means to produce small improvements for a many other populations at other times as long as these small improvement in aggregate outweigh the severe suffering. Second, those who endorse classical utilitarianism are suspicious of the aim of optimizing growth on grounds that growth is a poor proxy for well-being or happiness. Third, discounting later consumption is deeply controversial. The pure time preference, which discounts consumption merely because it comes later, appears arbitrary and even discriminatory. Finally, attempts to arrive at a factor for the elasticity of marginal consumption, which applies a discount factor where consumption is higher, are inescapably subjective.¹¹

There are alternative approaches for the distribution of the costs of climate across generations. I have explored an approach that seeks equalization of the ratios of the costs of climate change to the global GDP at various points in time.¹² According to this view, members of future generations have a claim to a ratio of costs to benefits of energy use that is equal to the present ratio. The ratio at the present time would take mitigation as a cost and GDP as a benefit. If projected future ratios of costs to benefits exceeds the present, then greater mitigation is called for now, which would increase present costs and reduce future ones. Unlike discounted utilitarianism, this is not an optimizing approach. Hence, the first criticism directed to discounted utilitarianism, namely that it uses severe suffering as a means to permit multiple small improvements, does

not apply. And because the aim is to equalize the ratio of costs to overall consumption, there is no reason to apply a discount factor for greater consumption. The costs may simply increase in proportion to the consumption increases. The third criticism does not apply since this approach employs neither a pure time preference nor a discount factor for the elasticity of marginal consumption. Finally, since the approach compares costs to benefits, there is no need to apply the controversial factor of the elasticity of marginal consumption.

Still, there are several important challenges to the view that justice requires equalizing the ratio of costs to benefits of energy use. Those who are skeptical of the value of consumption will have doubts. But this may be partially allayed by noticing that unlike discounted utilitarianism, equalizing the ratio of costs to benefits does not enjoin maximizing consumption. It is consistent with zero economic growth advocated by many environmentalists. Second, both this approach and discounted utilitarian require making projections of costs and benefits into the future; and it is unclear whether we will ever be in an adequate epistemic position to rely on such projections to guide policy. According to the recent AR5 of the IPCC, 'Economic impact estimates completed over the past 20 years vary in their coverage of subsets of economic sectors and depend on a large number of assumptions, many of which are disputable, and many estimates do not account for catastrophic changes, tipping points, and many other factors.'¹³ Finally, some will argue that the problem with cost-benefit approaches generally is that the harms of climate change are of a kind that simply should not be balanced against benefits because these harms include human rights violations.

An alternative account that takes moral aims of climate change mitigation as human rights based. In the absence of mitigation, climate change is projected to have profound, often devastating effects on, for example, human health. Accesses to food and water will also be affected. According to a United Nations Human Development Programme (UNDP) review of climate change projections, 'Overall, climate change will lower the incomes and reduce the opportunities of vulnerable populations. By 2080, the number of people at risk of hunger could reach 600 million—twice the number of people living in poverty in sub-Saharan Africa today.'¹⁴

International human rights documents offer protections against many of the aforementioned harms. For example, Article 25, paragraph 1, of the Universal Declaration of Human Rights states that

Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control.¹⁵

Article 11 of International Covenant on Economic, Social and Cultural Rights holds that

The States Parties to the present Covenant recognize the right of everyone to an adequate standard of living for himself and his family, including adequate food, clothing and housing, and to the continuous improvement of living conditions.¹⁶

The importance of human rights as a focus of climate change mitigation policy has been developed by Simon Caney and others.¹⁷ Caney presses an argument in relation to three key rights: The right not to be arbitrarily deprived of one's life, the right not to have others cause serious threats to one's health, and the right not to have others deprive one of the means of subsistence. Importantly, Caney's formulation of these rights renders them less demanding and less controversial than the rights enumerated in the paragraphs of the human rights documents cited

above. That lends considerable credibility to the claim that climate change mitigation policy should be governed by a concern for human rights.

The human rights approach is meant in part to prevent comparing some of the benefits of energy to use to the costs of climate change produced by fossil fuel use. The idea is that the violation of rights cannot be justified by policy benefits. I have suggested that there is a problem with this view if it is the case that there is no climate change policy that does not violate human rights, either by insufficiently mitigating or by producing harms contrary to the aforementioned right due increases in energy prices. For the aim of leading policy by the prohibition of human rights violations, the lack of an alternative in which human rights are not violated would produce an impasse.¹⁸

The final principle that I discuss in this section is based on a principle that proscribes poverty prolongation. I have formulated the antipoverty principle as follows:

Policies and institutions should not impose any of costs of climate change or climate change policy (such as mitigation and adaptation) on the global poor, of the present or future generations, when those costs make the prospects for poverty eradication worse than they would be absent them, if there are alternative policies that would prevent the poor from assuming those costs.¹⁹

According to this principle, the aim of mitigation is to avoid avoidable poverty. Unlike discounted utilitarianism and equal ratios of costs to benefits, the antipoverty principle is not based upon a cost-benefit calculation. And unlike the human rights approach, it is flexible enough to guide in cases in which imposing poverty cannot be avoided since it directs us towards action that as much as possible prevents the poor from assuming costs. The defense of the antipoverty principle claims that all persons seeking agreement on a principle on the basis of respect for human dignity could accept the imperative of avoiding the imposition of involuntary poverty. A utilitarian committed to optimization would, however, reject the principle, and so would anyone who thought that the prevention of human rights violations should feature foremost among the climate change related claims that future persons will have.

The Justice of the Distribution of Emissions Entitlements

Assuming that mitigation is a requirement of justice, an additional consideration of justice concerns the distribution of the burden of mitigating intra-generationally, and in particular whether some states have a claim to be less burdened by intergenerational responsibilities than others.

One possibility is that a principle distributing the entitlements of a state to emit under a mitigation plan should be a percent reduction against a baseline of current or recent emissions. In the debates about emissions reductions, this is an idea referred to as ‘grandfathering.’ Grandfathering is controversial because it seems to entrench an entitlement to high emissions to historically high emitters simply because they are historically high emitters. One argument for grandfathering is that states have a property right in their emissions. If the capacity of the atmosphere to recycle carbon is a good owned in common by all humanity, then according to one argument, past appropriation of that good by means of emitting establishes an entitlement for continued use on the basis of something like the property doctrine of adverse possession.²⁰ Adverse possession typically requires that the appropriation be known and not disputed. In the case of past emissions that is doubtful. Before the relationship between greenhouse gasses and climate change was widely understood, the emission of CO₂ into the atmosphere would not have been thought of as an appropriation. After the relationship was well understood, the emissions of high-emitting states were internationally recognized as a source of special responsibility, not as a source of an entitlement.

Rather than establishing emissions entitlements against a baseline of recent emissions, an alternative principle would require across the board equalization of the burden of mitigation.²¹ The burden that a state bears for an equal unit of cost may vary inversely with how wealthy the state is. Equalizing the burden of reducing emissions then would not result in equal amounts reduced per state. Rather, equalizing burdens would equalize the marginal disutility of reductions. The principal problem with this view is that it fails to allow that over the medium term, reductions in emissions of any amount at all might be inconsistent with economic development in states with very large populations of very poor people. Recalling the antipoverty principle from the previous section, any degree of additional suffering in these states could be morally objectionable.

Alternatively then consider the principle that the entitlement to emit CO₂ should be distributed to states on an equal per capita basis.²² Assuming the science is correct that halting planetary warming at any degree will eventually require halting emissions altogether, then over the long run per capita emissions will tend to converge as they approach zero. But that feature of the goal of mitigation does not necessarily entail that the entitlement to emit before such convergence should be on an equal per capita basis. A principle requiring equal per capita emissions is controversial. Simon Caney makes three criticisms of it.²³ First, it fetishizes emissions. Egalitarian concern should be about persons or their well-being, but not about emissions. Second, it is insensitive different human needs, the satisfaction of which might require differential emissions.²⁴ And third, it is implausibly indifferent to past emissions. Those who have either had a greater share in creating the problem or enjoyed more benefits from past emissions may not be entitled to emit as much as those who have not.

Another problem with equalizing per capita emissions is that it could require emissions reductions in developing countries that would slow poverty eradication and therefore not sufficiently improve on the problems of equalizing burdens. If there is a justified concern that climate change mitigation should not prolong poverty, and should be consistent with human development in poor countries, then equalizing per capita emissions appears to be an oblique way to safeguard it.²⁵

I have argued that a more direct way to address the need to permit human development is simply to affirm a principle recognizing the right to sustainable development.²⁶ The Preamble to the United Nations Framework Convention on Climate Change affirms the importance of the right to sustainable development.²⁷ Reconciling increased energy consumption needed for poverty eradicating development and climate change mitigation would require developed states either to make emissions reductions sufficient to offset emissions growth in states that are developing or to subsidize the use of renewable energy in these states so that increased energy costs do not slow economic growth. This moral idea is expressed by Henry Shue: '[T]hose living in desperate poverty ought not to be required to restrain their emissions, thereby remaining in poverty, in order that those living in luxury should not have to restrain their emissions.'²⁸ The right to sustainable development provides some protection to the emissions of impoverished people in poor states by giving the state a claim to develop, which could require greenhouse gas emissions. This would lay a responsibility on developed states to respect the rights of poor states. This state-centric approach is criticized by some as sheltering the emissions of rich people in poor states.²⁹ The force of the objections depends in part on whether one thinks it more important for emissions policies to track the comparative wealth of individuals or to permit state development plans.

The right to sustainable development has been criticized by Eric Posner and David A. Weisbach, who advocate International Paretianism. This latter view is a conceptual descendent of the efficiency criterion of Pareto Optimality, which holds that a distribution is more efficient than another if at least one person in the former is better off than in the latter and no one is worse

off. International Paretianism holds that, 'all states must believe themselves better off by their lights as a result of the climate treaty.'³⁰ This is in one way more demanding than Pareto Optimality and in another way less. It is more demanding insofar as the improvement must be for all states. It is less demanding because it is belief-sensitive rather than fact-sensitive. States need not in fact be better off as a result of the treaty, but they must believe themselves to be. The justification for this principle is solely on grounds of feasibility. States usually don't act against their self-interests, so a successful treaty will have to serve the interests of all states.

Posner and Weisbach claim that the main advantage of International Paretianism over the right of sustainable development is that the latter is redistributivist and by implication counter the interest of wealthy states. Because an agreement on climate change mitigation is an urgent matter of justice, this is a claim that merits serious consideration.³¹ They assume either that International Paretianism is incompatible with the right to sustainable development or that even if they sometimes are consistent in cases where they are not International Paretianism trumps.

It is by no means clear why satisfying the right to sustainable development would not be perceived to be in the interest of all states. According to the IPCC, unmitigated climate change is likely to produce warming in the range of 3.7 to 4.8 °C.³² Adapting to such warming will be extremely costly. Indeed by some accounts, it might be impossible for people in some regions of the world to adapt.³³ Measured against a scenario of widespread movements of people, conflicts over water and crops, and suffering due to drought, sea-level rise, and glacial flooding, wealthy states might stand to gain significantly by reducing their emissions very drastically and either permitting continued use of fossil fuels in poor countries or subsidizing access to more expensive renewable energy. In which case there would be no need to choose between recognizing the right to sustainable development and advantaging all states in comparison to a baseline of not mitigating climate change.

If, however, we suppose that International Paretianism is incompatible with recognizing the right to sustainable development, the claimed feasibility advantage of International Paretianism is doubtful. If International Paretianism is in fact incompatible with the right to sustainable development, then developing world countries may lack sufficient reason to agree to a proposal that satisfied International Paretianism but did not satisfy the right to sustainable development, in which case International Paretianism would seem to lack its primary attractive feature.³⁴

The appropriate account of the justice of emissions entitlements should be complimented by an account of responsibility for emissions reductions to provide a more complete moral picture. Space restrictions permit nothing more than a cursory sketch of responsibility for mitigation. Generally, there are two classes of such principles. One class includes accounts of responsibility for mitigation that track historical emissions. These include either fault or strict liability versions of the polluter pay principle, as well as versions of the beneficiary pays principle. Another class of principles of responsibility for mitigation comprises versions of the ability to pay principle.³⁵ A unified account would provide a common (or at least consistent) moral basis for the justification of both the principle allotting entitlements to emit and the principle requiring emissions reductions.

Justice in Adaptation and Compensation Policies

The mean surface temperature of the planet is already 0.78 °C higher than the middle of the 19th century, and the average annual sea-level rise in the last decade of the 20th century and the first of the 21st century 3.2 mm – this is greater than previous decades.³⁶ These observations of temperature increase and sea level rise provide incontrovertible evidence of the effects of climate change. Adaptation and compensation policies may help people in the present as well as the future cope with climate change. Recall the principle of vulnerability reduction stated

above: If a person is especially vulnerable to very bad things happening due the actions and omission of others, that person has *prima facie* claim to have the vulnerability reduced. Mitigation reduces risk by lessening the threat. Adaptation provides resources to protect against risk. Compensation would seek to repair the harms caused by climate change. The principle of vulnerability reduction provides the basis for a claim for present and future persons for protection against risks and for repair of the harms of climate change.

Although both mitigation and adaptation are vulnerability reducing policies, there are significant differences between them that are relevant to justice. There are at least two reasons that we should not be morally indifferent between simply reducing risk by means of mitigation and protecting against it by means of adaptation. First, given that, at least within a degree or two or two of warming, those who are most vulnerable to climate change live in poor countries, such as Bangladesh or the region of sub-Saharan Africa, it might be cheaper for wealthy states to pursue adaptation at the expense of a comprehensive mitigation plan. But that could be disastrous to the global poor. As Stephen H. Schneider and Janica Lane put it, ‘Simply comparing mitigation adaptation costs and aggregating the values across all nations is a “one dollar, one vote” aggregate prescription.’³⁷ Second, in the absence of comprehensive mitigation there is the grave danger there will be climate perturbations to which we simply cannot fully adapt, regions of the planet becoming uninhabitable due to drought or the massive release of methane from warming arctic waters to mention just two examples.³⁸

Adaptation policies differ from mitigation policies in part due to their specificity. They are not directed toward reducing the vulnerability of undifferentiated future generations but rather for specific groups of people who are especially vulnerable to climate change. Adaptation policies require no evidence of climate change harm, merely evidence of vulnerability, in order to be *prima facie* justified by the risk reduction principle. Other than relocating communities, there is nothing that policy can do to affect the geographical location that exposes people to climate change related risks. So, the object of adaptation policy should typically be to address the source vulnerabilities due to poverty. The poor will often have a greater claim than to adaptation protection than the non-poor. Indeed, adaptation might be carried out as part of a comprehensive development program. Nicholas Stern takes this view. ‘Development itself is the way to strengthen a society’s ability to adapt.’³⁹ In that case, poor people vulnerable to climate change have a claim to development resources as a matter of vulnerability reduction.

Adaptation spending globally should track vulnerability. Since, unlike mitigation, adaptation policies target specific people, the distribution of the burden to fund adaptation could be assigned to states in whose territory those who are vulnerable live. But this would place much heavier adaptation burdens on poor states with especially vulnerable populations. Assigning the burden to finance adaptation primarily to these states, however, would be unjust. Both the relative poverty of such states and their relatively small share of total historic emissions of greenhouse gases suggest that they have a claim not to be especially burdened by adaptation financing. In light of the above discussion of the right to sustainable development, the more plausible position is that developing states should not be left in a worse position with respect to their development agenda because of the need to adapt to climate change. Developing states then have a claim to be relieved of a heavy adaptation burden.⁴⁰

Compensation claims arise because of failures to mitigate and adapt.⁴¹ If a person’s home is destroyed due to flooding or their livelihood ruined as a result of drought, and the cause these events is global warming, then that person was not protected by vulnerability reducing policies, assuming they exist. Compensation claims, however, require evidence of climate change caused harm. Due to of the extreme limitations of scientific knowledge, we are usually unable to determine whether a particular extreme weather event was caused by climate change. The scope of *prima facie* justified claims, then, is likely to continue to be much narrower for compensation

than for adaptation. One area where the science is unequivocal is the flooding of island states due to sea-level rise. The best explanation for the sea-level rise is the warming of the planet. Hence, residents of these islands have a *prima facie* claim to compensation. Meeting this claim presumably will require relocating, re-settling, and supporting residents of these islands.

Uncertainty, Precaution, and Justice

The discussion of vulnerability above has spoken the language of risk. But much of what is worrisome about climate change is uncertain in the technical sense, in the sense that there is no basis upon which to attach a probability of the event's occurrence based upon a priori reasoning or from statistical studies of past experience. This is the sense of uncertainty developed in the pioneering work of Frank H. Knight.⁴² Uncertainty enters climate change forecasting very early on – at the estimate of equilibrium warming for a specific increase of CO₂ in the atmosphere. Climate sensitivity is the measure of warming for a doubling of pre-industrial atmospheric CO₂ concentrations. The AR5 states a range of uncertainty for climate sensitivity of 1.5–4.5 °C.⁴³ The uncertainty there effects projections of sea-level rise from warming. But the greatest contributor of sea level rise could be from the dynamic land based ice sheet collapse in Antarctica and Greenland. The processes of dynamic ice sheet collapse are not all well understood and the IPCC attaches no probability to occurrence of such collapse because of scientific uncertainty. Perhaps most worrying, scientist are uncertain of the rate and magnitude of methane release from the warming tundra and Arctic Ocean, even though many plumes of methane are now observed.⁴⁴ A methane release from the oceans 635 million years ago may have caused an abrupt warming of the planet, which warming ended one of the most severe ice ages the Earth has known.⁴⁵

Many people are vulnerable to the occurrence of these events, but not vulnerable in the sense that has been the primary focus of this paper, not in the sense that the measure of vulnerability can be ascertained by estimation of the risk to which the people are exposed and consideration of their capacity to protect themselves should the risk manifest. Vulnerability to uncertainty does not allow for such estimates. And this raises the question of what justice requires with respect to threats that are uncertain. There is no general answer to that question because uncertain threats differ considerably in kind. But I shall close this paper by sketching an argument that persons have a claim of justice to vulnerability reduction for a certain class of uncertain threats, and that several of the threats of climate change are in this class. In other words, justice requires precautionary action to reduce some uncertain climate change threats.

If there were no reason whatsoever to believe that a possible process or a possible outcome would come to pass, which if it came to pass would be harmful to a person, then there would be no reason to believe that the person had a claim that her vulnerability to the process or the outcome should be reduced. In contrast, suppose the following conditions⁴⁶:

1. The harmful outcome could possibly come about by means that are in general terms understood.
2. Several of the understood causal antecedents are in place.
3. The harm is sufficiently grave that a person has greater reason to avoid it than to pursue the opportunities that avoiding it excludes.
4. The costs of precaution are comparatively minor.

If under the above four conditions an individual were unwilling to assume the comparatively minor costs of precaution and instead leave herself exposed to what she considers a grave outcome, she would seem imprudent. If she were unwilling to assume comparatively minor costs to herself, and instead exposed another to a grave harm, her attitude would be inconsistent

with the principle of vulnerability reduction. She need not know exactly what the risks are to know that she can reduce them and therefore reduce vulnerability.

These four conditions seem to apply to several of the uncertainties of climate change, including the following: mass hunger due to crop pattern disruption and drought in the context of a rising global population, rapid sea level rise this century due to dynamic ice sheet collapse, dramatic European cooling due to shutdown of the Atlantic Meridional Overturning Circulation, and the massive release of methane from warming arctic waters and thawing tundra. None of these events would seem miraculous; several of the causal antecedents seem identifiable and at hand; they all pose grave threats, which we have very good reason to avoid; and climate change mitigation to prevent them would be much less costly than the costs of their occurrence. Hence, the principle of vulnerability reduction seems to require a precautionary approach to climate change mitigation in light of these threats.

Summary

I have contended that a plausible basic principle of justice appropriate to the damages of anthropogenic climate change can be stated as the following principle of vulnerability reduction: If a person is especially vulnerable to very bad things happening due to the actions and omission of others, that person has a *prima facie* claim to have the vulnerability reduced. I have also contended that vulnerability in the case of climate change consists in two main factors, exposure to risk and a deficiency of resources for protecting against the risk. Mitigation policies can reduce exposure to risk. Adaptation policies provide resources for protection. Compensation policies could make up for the costs a person has suffered due to insufficient mitigation or compensation; but the justification of these policies is difficult given the state of the science since it would require credible evidence that the losses are due to climate change. I have also sought to explicate several more specific principles of justice that might be thought to be appropriate applications of the principle of vulnerability reduction and to clarify some of the reasons in favor and against them.

Short Biography

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² Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment Report (AR5), Working Group III, Physical Science Basis, *Synthesis for Policy Makers*, p. 8. Available online at http://www.climatechange2013.org/images/report/WG1AR5_SPM_FINAL.pdf. (Accessed 12 June 2014.)

³ IPCC, AR5, Working Group II, Impacts, Adaptation, and Vulnerability, *Synthesis for Policy Makers*, pp. 13–14. Available online at http://ipcc-wg2.gov/AR5/images/uploads/WG2AR5_SPM_FINAL.pdf. (Accessed 12 June 2014.)

⁴ *Ibid.*, pp. 17–21.

- ⁵ Rachel Warren, 'The Role of Interactions in a World Implementing Adaptation and Mitigation Solutions to Climate Change,' *Philosophical Transactions of the Royal Society A* 369 (2001): 234.
- ⁶ Henry Shue, 'Deadly Delays, Saving Opportunities: Creating a More Dangerous World?' in Stephen M. Gardiner et al. eds. *Climate Ethics: Essential Readings* (Oxford: Oxford University Press, 2010), pp. 146–162. See also John Nolt, 'Greenhouse Gas Emissions and the Domination of Posterity,' in Denis G. Arnold ed. *The Ethics of Global Climate Change* (Cambridge: Cambridge University Press, 2011). Nolt argues that the vulnerability threatens the possibility of the domination of posterity by the present generation.
- ⁷ IPCC, AR4, Working Group I, The Physical Science Basis. *Global climate Projections*, p. 824. Available online at <http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter10.pdf>. (Accessed 12 June 2014.)
- ⁸ IPCC, AR5, The Physical Science Basis, *Synthesis for Policy Makers*, p. 27.
- ⁹ IPCC, AR5, Impacts, Adaptation, and Vulnerability, *Synthesis for Policy Makers*, p. 10.
- ¹⁰ This approach is used for example in both William Nordhaus, *A Question of Balance: Weighing the Options on Global Warming Policies* (New Haven and London: Yale University Press, 2008) and Nicolas Stern, *the Economics of Climate Change: The Stern Review* (Cambridge: Cambridge University Press, 2007).
- ¹¹ See also my *The Moral Challenge of Dangerous Climate Change: Values, Policy, and Poverty* (Cambridge: Cambridge University Press, 2014), chp. 4.
- ¹² See my 'Justice and the Assignment of the Intergenerational Costs of Climate Change,' *Journal of Social Philosophy*, 40 (2009a): 204–224; and Axel Schaffer and Darrel Moellendorf, 'Beyond Discounted Utilitarianism—Just Distribution of Climate Costs,' *Karlsruher Beiträge zur Wirtschaftspolitischen Forschung* 34 (2014).
- ¹³ IPCC, AR5, Impacts, Adaptation, and Vulnerability, *Synthesis for Policy Makers*, p. 19.
- ¹⁴ United Nation Human Development Programme, Human Development Report 2007–08.
- ¹⁵ Universal Declaration of Human Rights, Art. 25, para. 1. Available online at <http://www.un.org/en/documents/udhr/index.shtml>. (Accessed 14 June 2014.)
- ¹⁶ International Covenant on Economic, Social and Cultural Rights, Article 11, para. 1. Available online at <http://www.ohchr.org/EN/ProfessionalInterest/Pages/CESCR.aspx>. (Accessed 14 June 2014.)
- ¹⁷ See Simon Caney, 'Climate Change, Human rights, and Moral Thresholds,' in Stephen Humphreys, ed., *Human Rights and Climate Change* (Cambridge: Cambridge University Press, 2010). See also Derek Bell, 'Does Anthropogenic Climate Change Violate Human Rights?' *Critical Review of International Social and Political Philosophy* 14 (2011): 99–124; Tim Hayward 'Human Rights versus Emissions Rights: Climate Justice and the Equitable Distribution of Ecological Space,' *Ethics and International Affairs* (2007) 21: 431–450; David Miller 'Global Justice and Climate Change: How Should Responsibilities Be Distributed?' *The Tanner Lectures on Human Values*, Tsinghua University, Beijing, March 24–25, 2008, available online at http://tannerlectures.utah.edu/_documents/a-to-z/m/Miller_08.pdf. (Accessed 14 June 2014.); Henry Shue, 'Bequeathing Hazards: Security Rights and Property Rights of Future Humans' in Dore, M, Mount, T, eds. *Global Environmental Economics: Equity and the Limits to Markets* (Oxford: Blackwell, 1999), pp. 38–53; and Henry Shue, 'Human Rights, Climate Change, and the Trillionth Ton,' in Denis Arnold, ed. *The Ethics of Global Climate Change* (Cambridge: Cambridge University Press, 2011), pp. 292–314.
- ¹⁸ This argument is developed in my *The Moral Challenge of Dangerous Climate Change*, pp. 24–26 and 230–235.
- ¹⁹ *Ibid.*
- ²⁰ For a property rights defense of grandfathering, see Luc Bovens, 'A Lockean Defense of Grandfathering Emission Rights,' in Denis Arnold, ed. *The Ethics of Global Climate Change* (Cambridge: Cambridge University Press, 2011), pp. 124–144.
- ²¹ Martino Traxler, 'Fair Chore Division for Climate Change,' *Social Theory and Practice* 28 (2002): 101–134.
- ²² See Tom Athanasiou and Paul Baer, *Dead Heat* (New York: Severn Stories Press, 2002); Dale Jamieson, 'Adaptation, Mitigation, and Justice,' in Walter Sinnott–Armstrong and Ricard B. Howarth eds. *Perspectives on Climate Change: Science, Economics, Politics, Ethics* (Amsterdam: Elsevier, 2005), pp. 229–233; Peter Singer, *One World* (New Haven: Yale University Press, 2002), pp. 35–49; Edward A. Page, *Climate Change Justice and Future Generations* (Cheltenham: Edward Elgar Publishing, 2006); and Steve Vanderheiden, *Atmospheric Justice: A Political Theory of Climate Change* (Oxford: Oxford University Press, 2008).
- ²³ Simon Caney, 'Climate Change, Energy Rights, and Equality,' in Denis Arnold, ed. *The Ethics of Global Climate Change* (Cambridge: Cambridge University Press, 2011), pp. 77–103.
- ²⁴ This criticism is also made by Stepehn M. Gardiner 'Ethics and Global Climate Change,' *Ethics* 114 (2004): 555–600.
- ²⁵ Equal per capita shares may not safeguard human development sufficiently. See my 'Treaty Norms and Climate Change Mitigation,' *Ethics and International Affairs* 23 (2009): 204–224; and my 'Common Atmospheric Ownership and Equal Emissions Entitlements,' in Denis Arnold, ed. *The Ethics of Global Climate Change* (Cambridge: Cambridge University Press, 2011), pp. 104–123.

- ²⁶ See my 'A Right to Sustainable Development,' *The Monist* (2011) 94: 433–452. See also chapter five of *The Moral Challenge of Dangerous Climate Change*.
- ²⁷ United Nations Framework Convention on Climate Change, Article 3, para. 4. Available online at http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf. (Accessed 14 June 2014.)
- ²⁸ Henry Shue, 'Subsistence Emissions and Luxury Emissions,' *Law & Policy* 15 (1993): 39–59.
- ²⁹ See Paul G. Harris, *World Ethics and Climate Change: From International Justice to Global Justice* (Edinburgh: University of Edinburgh Press, 2010).
- ³⁰ Eric A. Posner and David Weisbach, *Climate Change Justice* (Princeton: Princeton University Press, 2010), p. 6.
- ³¹ *Ibid.*, pp. 73–75.
- ³² IPCC, AR5, Working Group III, Mitigation and Climate Change, *Summary for Policymakers*, p. 8. Available online at http://report.mitigation2014.org/spm/ipcc_wg3_ar5_summary-for-policymakers_approved.pdf. (Accessed 14 June 2014.)
- ³³ Warren, 'The Role of Interactions in a World Implementing Adaptation and Mitigation Solutions to Climate Change,' 234.
- ³⁴ See also J. Timmons Roberts and Bradley C. Parks, *A Climate of Injustice: Global Inequality, North–south Politics, and Climate Policy* (Cambridge, MA: The MIT Press, 2007), esp. chp. 2.
- ³⁵ I have a discussion of these principles in *The Moral Challenge of Dangerous Climate Change* chp. 6.
- ³⁶ IPCC, AR5, The Physical Science Basis, *Summary for Policymakers*, pp. 8 and 11.
- ³⁷ Stephen H. Schneider and Janica Lane, 'Dangers and Thresholds in Climate Change and the Implications for Justice' (Cambridge, MA: the MIT Press, 2006), p. 47.
- ³⁸ See also Jamieson, 'Adaptation, Mitigation, and Justice,' p. 223.
- ³⁹ Nicholas Stern, *The Global Deal* (New York: Public Affairs, 2009), p. 62.
- ⁴⁰ See also Henry Shue, 'Subsistence Emissions and Luxury Emissions.'
- ⁴¹ I am stipulating that compensation applies in cases of failure to mitigate and adapt. The term compensation is used differently by Daniel A. Farber in 'The Case for Climate Compensation,' *Utah Law Review* 2008 (2008): 377–413. Farber proposes an international commission 'that would receive claims from countries that have incurred adaptation expenses' (p. 497). Simon Caney discusses the importance of compensation in the same sense that I am using it in his 'Climate Change, Human rights, and Moral Thresholds,' in Stephen Humphreys, ed., *Human Rights and Climate Change* (Cambridge: Cambridge University Press, 2010).
- ⁴² Frank H. Knight, *Risk, Uncertainty, and Profit* (New York: Hart, Schaffner and Marx; Houghton Mifflin Co., 1921). See especially chapter 8.
- ⁴³ IPCC, The Physical Science Basis, *Summary for Policymakers*, p. 16.
- ⁴⁴ See National Oceanography Centre, Southampton, 'Warming Ocean Contributes to Global Warming,' August 14, 2009 http://www.noc.soton.ac.uk/nocs/news.php?action=display_news&idx=628 (accessed August 31, 2012); and National Snow and Ice Data Center, *Icelights: Your Burning Questions about Ice & Climate*, 'What Does Seeping Methane Mean for the Thawing Arctic?' July 3, 2012. <http://nsidc.org/icelights/2012/07/03/what-does-seeping-methane-mean-for-the-thawing-arctic/> (access August 31, 2012).
- ⁴⁵ Martin Kennedy, et al., 'Snowball Earth Termination by Destabilization of Equatorial Permafrost Methane Clathrate,' *Nature* 453 (2008): 642–645.
- ⁴⁶ See also chp. 3 of Moellendorf, *The Moral Challenge of Dangerous Climate Change*; Stephen M. Gardiner, 'A Core Precautionary Principle,' *Journal of Political Philosophy* 14 (2006): 33–60; and Henry Shue, 'Deadly Delays.'

Works Cited

- Athanasios, Tom and Paul Baer. *Dead Heat*. New York: Severn Stories Press, 2002.
- Bell, Derek. 'Does Anthropogenic Climate Change Violate Human Rights?' *Critical Review of International Social and Political Philosophy* 14 (2011): 99–124.
- Bovens, Luc. 'A Lockean Defense of Grandfathering Emission Rights.' *The Ethics of Global Climate Change*. Ed. Denis Arnold. Cambridge: Cambridge University Press, 2011: 124–144.
- Caney, Simon. 'Climate Change, Human rights, and Moral Thresholds.' *Human Rights and Climate Change*. Ed. Stephen Humphreys. Cambridge: Cambridge University Press, 2010: 69–90.
- . 'Energy Rights, and Equality.' *The Ethics of Global Climate Change*. Ed. Denis Arnold. Cambridge: Cambridge University Press, 2011: 77–103.

- Farber, Daniel A. 'The Case for Climate Compensation.' *Utah Law Review* (2008): 377–413.
- Gardiner, Stephen M. 'Ethics and Global Climate Change.' *Ethics* 114 (2004): 555–600.
- . 'A Core Precautionary Principle.' *Journal of Political Philosophy* 14 (2006): 33–60.
- Harris, Paul. *World Ethics and Climate Change: From International Justice to Global Justice*. Edinburgh: University of Edinburgh Press, 2010.
- Hayward, Tim. 'Human Rights versus Emissions Rights: Climate Justice and the Equitable Distribution of Ecological Space.' *Ethics and International Affairs* 21 (2007): 431–450.
- Intergovernmental Panel on Climate Change. Fifth Assessment Report, Working Group III, Physical Science Basis. *Synthesis for Policy Makers*, 2014a. <http://www.climatechange2013.org/images/report/WG1AR5_SPM_FINAL.pdf>.
- Intergovernmental Panel on Climate Change. Fifth Assessment Report, Working Group II, Impacts, Adaptation, and Vulnerability. *Synthesis for Policy Makers*, 2014b. <http://ipccwg2.gov/AR5/images/uploads/WG2AR5_SPM_FINAL.pdf>.
- International Covenant on Economic, Social and Cultural Rights. 1976. <<http://www.ohchr.org/EN/ProfessionalInterest/Pages/CESCR.aspx>>.
- Jamieson, Dale. 'Adaptation, Mitigation, and Justice.' *Perspectives on Climate Change: Science, Economics, Politics, Ethics*. Eds. Walter Sinnott-Armstrong and Ricard B. Howarth. Amsterdam: Elsevier, 2005: 217–248.
- Kennedy, Martin, et al. 'Snowball Earth Termination by Destabilization of Equatorial Permafrost Methane Clathrate.' *Nature* 453 (2008): 642–645.
- Knight, Frank H. *Risk, Uncertainty, and Profit*. New York: Hart, Schaffner and Marx; Houghton Mifflin Co., 1921.
- Miller, David. Global Justice and Climate Change: How Should Responsibilities Be Distributed? *The Tanner Lectures on Human Values*, Tsinghua University, Beijing, March 24–25, 2008. <http://tannerlectures.utah.edu/_documents/ato-z/m/Miller_08.pdf>.
- Moellendorf, Darrel. 'Justice and the Assignment of the Intergenerational Costs of Climate Change.' *Journal of Social Philosophy* 40 (2009a): 204–224.
- . 'Treaty Norms and Climate Change Mitigation.' *Ethics and International Affairs* 23 (2009b): 247–265.
- . 'Common Atmospheric Ownership and Equal Emissions Entitlements.' *The Ethics of Global Climate Change*. Ed. Denis Arnold. Cambridge: Cambridge University Press, 2011a: 104–123.
- . 'A Right to Sustainable Development.' *The Monist* 94 (2011b): 433–452.
- . *The Moral Challenge of Dangerous Climate Change: Values, Policy, and Poverty*. Cambridge: Cambridge University Press, 2014.
- National Oceanography Centre. Warming Ocean Contributes to Global Warming. 2009. <http://www.noc.soton.ac.uk/nocs/news.php?action=display_news&idx=628>.
- National Snow and Ice Data Center. What Does Seeping Methane Mean for the Thawing Arctic? *Icelights: Your Burning Questions about Ice & Climate*. 2012. <<http://nsidc.org/icelights/2012/07/03/what-does-seeping-methane-mean-for-thethawing-arctic/>>.
- Nolt, John. 'Greenhouse Gas Emission and the Domination of Posterity.' *The Ethics of Global Climate Change*. Ed. Denis Arnold. Cambridge: Cambridge University Press, 2011: 60–76.
- Nordhaus, William. *A Question of Balance: Weighing the Options on Global Warming Policies*. New Haven and London: Yale University Press, 2008.
- Page, Edward A. *Climate Change Justice and Future Generations*. Cheltenham: Edward Elgar Publishing, 2006.
- Posner, Eric A. and David Weisbach. *Climate Change Justice*. Princeton: Princeton University Press, 2010.
- Roberts, J. Timmons and Bradley C. Parks. *A Climate of Injustice: Global Inequality, North-south Politics, and Climate Policy*. Cambridge, MA: The MIT Press, 2007.
- Schaffer, Axel and Darrel Moellendorf. 'Beyond Discounted Utilitarianism — Just Distribution of Climate Costs.' *Karlsruher Beiträge zur Wirtschaftspolitischen Forschung* 34: (2014).
- Schneider, Stephen H. and Janica Lane. *Dangers and Thresholds in Climate Change and the Implications for Justice*. Cambridge, MA: The MIT Press, 2006.
- Shue, Henry. 'Subsistence Emissions and Luxury Emissions.' *Law & Policy* 15 (1993): 39–59.
- . 'Bequeathing Hazards: Security Rights and Property Rights of Future Humans.' *Global Environmental Economics: Equity and the Limits to Markets*. Eds. M. Dore, T. Mount. Oxford: Blackwell, 1999: 38–53.
- . 'Deadly Delays, Saving Opportunities: Creating a More Dangerous World?' *Climate Ethics: Essential Readings*. Eds. Stephen M. Gardiner, et al. Oxford: Oxford University Press, 2010: 146–162.
- . 'Human Rights, Climate Change, and the Trillionth Ton.' *The Ethics of Global Climate Change*. Ed. Denis Arnold. Cambridge: Cambridge University Press, 2011: 292–314.
- Singer, Peter. *One World*. New Haven: Yale University Press, 2005.
- Stern, Nicholas. *The Economics of Climate Change: The Stern Review*. Cambridge: Cambridge University Press, 2007.
- . *The Global Deal*. New York: Public Affairs, 2009.
- Traxler, Martino. 'Fair Chore Division for Climate Change.' *Social Theory and Practice* 28 (2002): 101–134.
- United Nation Human Development Programme. *Human Development Report*. 2007–2008.

- United Nations Framework Convention on Climate Change. 1992. <http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf>.
- Universal Declaration of Human Rights. 1948. <<http://www.un.org/en/documents/udhr/index.shtml>>.
- Vanderheiden, Steve. *Atmospheric Justice: A Political Theory of Climate Change*. Oxford: Oxford University Press, 2008.
- Warren, Rachel. 'The Role of Interactions in a World Implementing Adaptation and Mitigation Solutions to Climate Change.' *Philosophical Transactions of the Royal Society A* 369 (2001): 217–241.