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Conceptualizations of justice in climate policy

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Distributive justice in climate change has been of interest both to the ethics and to the climate policy communities, but the two have remained relatively isolated. By combining an applied ethics approach with a focus on the details of a wide range of proposed international climate policies, this article proposes two arguments. First, three categories of proposals are identified, each characterized by its assumptions about the nature of the 'problem' of climate change, the burdens that this problem imposes, and its application of distribution rules. Each category presents potential implications for distributive justice. The second, related, argument is that assumptions about technology, sovereignty, substitution and public perceptions of ethics shape the distributive justice outcomes of proposed policies even though these areas have largely been overlooked in discussions of the subject in either literature. The final lesson of this study is that the definition, measurement and distribution of burdens are all critical variables for distributive justice in climate policy.

Keywords: climate change; climate policy; distributive justice; ethics

La justice distributive liée à la politique climatique est d'intérêt pour la communauté de l'éthique ainsi que celle de la politique climatique mais celles-ci sont restées relativement isolées. En alliant une approche d'éthique appliquée ciblée sur un grand éventail de projets de politique climatique internationale ce papier avance deux arguments. D'abord, les trois catégories de projets sont identifiées, chacune caractérisée par ses propres hypothèses sur la nature du « problème » du changement climatique, le poids que ce problème impose, et la mise en œuvre des lois de distribution. Chaque catégorie a des implications en terme de justice distributive. Le second argument, lié au premier, avance que les hypothèses en matière de technologie, de souveraineté, de substitution et de perception publique de l'éthique façonnent les conséquences en justice distributive des politiques proposées bien que ces questions aient été largement omises dans les discussions sur le sujet dans l'un et l'autre domaine. L'ultime leçon de cette étude est que la définition, la mesure et la distribution des poids sont toutes des variables clés pour la justice distributive de la politique climatique.

Mots clés: changement climatique; éthique; justice distributive; politique climatique

1. Introduction

John Stuart Mill wrote that justice is 'the chief part, and incomparably the most sacred and binding part, of all morality' (Mill, 2000, p.74) and it has not been ignored in climate change debates. Within the ethics community, a group of authors including Gardiner (2004a, 2004b, 2006), Shue (1992, 1993, 1999), Jamieson (1992, 2001, 2005), Singer (2002, 2006), Ott (2003, 2004), Brown (2002) and Brown et al. (2006)[1] have examined distributive justice aspects of climate policy. Surprisingly isolated from this work has been the wide range of proposed policy architectures emerging from the climate policy community. Some of these explicitly aim to address ethical ideals (Rose et al., 1998; Blanchard et al., 2001; Pan, 2003; Paavola et al., 2006) while others do not. Regardless of intent, all policies are built on assumptions about the appropriate form of

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distributive justice within and mandate of climate change policy. It cannot be argued that policies that did not explicitly consider justice will not have distributive justice implications. As Shue (1992) has argued, 'justice is unavoidable'.

Three pieces of information are necessary to start an examination of the distributive justice implications of a climate policy:

1. which distribution rules are applied
2. how the problem of climate change and climate policy is understood
3. which metrics are used to measure costs and benefits.

An applied ethics approach forces us to examine the ethical implications of positions taken at each of these levels instead of focusing solely on the narrower question of how distribution rules should be applied. Each of these three elements of climate policy has potential distributive justice implications.

Section 2 summarizes the logic behind the key principles of distributive justice in this debate and, in the discussion of equal burdens, summarizes some of the implications of the choice of metric for policy design. Section 3 introduces some of the assumptions used to define the 'problem' of climate change, and Section 4 builds on these discussions to provide an overview of a range of policy proposals. The final two sections summarize the arguments and suggest areas for future work.

2. Which distribution rules should be used?

Formal ethics debates about climate change are useful for several reasons. First, since climate change policy necessarily raises ethical questions, it is logical to examine these directly. We may be better able to consider the implications of policy choices if the underlying ethical frameworks of these choices are clearly identified. Second, an applied ethics approach focuses on the reasoning behind our options and eventual choices, even if this reasoning is not explicit in policy design. It also provides us with clear language for discussing this reasoning. Third, an explicit focus on ethics reminds us that we have choices. Both policy design and ethics are considerations of what ought to happen; while wildly impractical policy proposals are unlikely to be helpful, identifying ideal frameworks based on our best reasoning of what we ought to do may help us craft practical proposals that meet these ideals. Designing climate policy needs to address the interests of a wide range of stakeholders over many centuries. These challenges cannot be met through conventional decision-making approaches (Morgan et al., 1999).

Within the climate policy literature, the terms equity, equality, justice and fairness are often used interchangeably but, because differences between these concepts are used to frame our analysis, we need to briefly establish clarity with regard to terminology.

Equality and equity are often used synonymously in climate policy literature, but differentiating between them can be useful. The defining element of equality is that parties have the same amount of the good or service in question. Equity refers to the process of allocation and captures the idea of treating all impartially in a decision context. The concepts of equity and equality can be at odds with one another. For example, if equality is a goal in a context marked by uneven resource distribution, the allocation process may need to be inequitable.

There is no consensus on the difference between fairness and justice. In this article justice is used to refer to the distributive elements of an allocation system in its entirety. However, we also differentiate two particular forms of justice: procedural justice and compensatory justice. Procedural justice stresses justice in the distribution process and in this case refers to the representation of all

who have a stake in the outcomes of climate policy. Compensatory justice stresses the importance of compensating parties whose interests have been harmed by the actions of another, even if those actions occurred in the past.

Like beauty, fairness resides in the eye of the beholder, and the etymological root of fair, *faeger*, refers to something beautiful or pleasing. Fairness is the subjective experience of division that respects individuals' specific situations (Finkel, 2001). Under some frameworks (e.g. Rawls, 2001), justice and fairness are inseparably linked, as the justice of the overall system depends on what a single individual, or class of individuals, would find subjectively fair during a forward-looking process of allocation, even if this occurs across background differentials in well-being. These terms will be returned to throughout this article.

One of the characteristic features of the philosophical literature on climate change is the remarkable convergence in the range of divisions of costs and benefits considered acceptable (Shue, 1999; Singer, 2002; Ott, K. et al., 2004). Within this literature, five key principles emerge: causal responsibility, preferential treatment based on need,[2] equal entitlements, equal burdens, and procedural justice.

In its focus on these five principles of distributive justice, this article does not delve deeply into debates about the responsibilities to non-human species or ecosystems (Buckmaster, 1993; Brown, 2002) or the ethical implications of particular tools, such as cost–benefit analysis, for making climate decisions (Jamieson, 1992; Howarth and Monahan, 1996; Ott, 2003). These are important debates but are beyond the scope of this article.

Intergenerational justice is clearly part of distributional ethics, and is often embodied in setting greenhouse gas stabilization targets and timetables, but is not the focus of this article. These debates are covered in a substantial literature on discounting (e.g. Weitzman, 1999; Nordhaus and Boyer, 2000; Howarth, 2003; Ott, 2003; Page, 2007). In addition to disciplinarian differences in the comparative importance of abstract logic and human preferences, assumptions about technological capabilities and substitutability of goods inform these debates and will be returned to later in the article.

2.1. Causal responsibility

Approximately 90% of the cumulative carbon dioxide emissions have been emitted by 25 emitter nations (Baumert et al., 2005). Causal responsibility has featured heavily in both the ethics and policy discussions and stems from two streams of thought. First, making polluters pay for the impacts of their actions internalizes what would otherwise be an externality and creates a disincentive for future emissions (Singer, 2002). Second, the mismatch between beneficiaries of fossil energy and victims of climate impacts gives the beneficiaries special obligations. It cannot be justifiable to make those who have benefited and those who have not benefited, but who may be victims of climate change, bear equal obligations (Shue, 1999). Both carbon taxes and cap-and-trade systems under emission stabilization targets are mechanisms for causal responsibility – and the general concept is ubiquitous in the policy and ethics literature.

It has been argued that causal responsibility should include compensation for climate impacts and unequal past emissions. This understanding of compensatory justice stems from Nozick's idea that 'the holdings of a person are just if he is entitled to them by the principles of justice in acquisition and transfer' (Nozick, 1974, p.153), and if acquisition was not just, compensation is required (Nozick, 1974, p.178). It has been argued that if we accept Locke's idea that claiming resources can only be considered just acquisition as long as this does not make the situation of others worse,[3] then industrialized countries have been using the atmosphere for the disposal of

past emissions without just claim (Dow et al., 2006). From this perspective, compensation is due, not only for the externalities of climate impacts but also for the appropriation of property which 'denied other countries the opportunity to use their shares' (Gardiner, 2004a, p.580).

Arguments for the incorporation of historical emissions have been disputed on four grounds. First, can obligations stem from one's ancestor's actions? One cannot be held morally accountable for an action one did not do (Caney, 2005). Second, do actions carry special obligations if their negative consequences were unforeseen (Beckerman and Pasek, 1995)? The opposing arguments to these first two points are that the current generation has benefited, and will continue to benefit, from their ancestors' actions, so causal obligations remain (Shue, 1999). Similarly, even if the negative consequences were unforeseen, those who did not benefit should not bear the costs (Shue, 1999).

A third critique is that, while non-industrialized countries may not have directly caused the emissions, they received some of the benefits of industrialization in other ways (see Grubb, 1995, p.491). The counter-argument to this is that non-industrialized countries have already paid for whatever benefits accrued to them (Shue, 1999), but this leads to the fourth difficulty – measuring historical costs and benefits. How do we account for variations between the diffuse and direct impacts (both costs and benefits) of industrialization? There is no objective approach to calculating the connections between historical emissions, accrued costs and benefits, and appropriate compensation (Grubb, 1995). As den Elzen et al. (2005) suggest, policy-related variables such as the year at which emissions should start to count, or the types of emissions that count, can significantly impact on the calculation of historical emissions (den Elzen et al., 2005). An added difficulty is that using past emissions to determine future allowable emissions treats all emissions through time as though they were equal, while we know that radiative forcing is a non-linear function of greenhouse gas concentrations, climate change is a complicated function of radiative forcing, and climate impacts are a complicated function of climate change. The link between emissions and impacts is complicated and indirect. For some, the scientific and political difficulties in accounting for historical emissions have led them to reject the concept altogether, even though its moral force remains recognized (Traxler, 2002). Some policies combine historical causal responsibility into forward-looking instruments by tying future emission limits to past emission levels (La Rovere et al., 2002; Claussen and McNeilly, 1998; Ott, H. et al., 2004; Michaelowa et al., 2005).

2.2. Preferential treatment by need

Preferential treatment by need has been accepted across the ethics community (e.g. Jamieson, 1992; Shue, 1992; Gardiner, 2004a; Ott, K. et al., 2004; among others). It has been argued, following Rawls, that the best solution to distribution is the scenario in which the least well-off are not harmed more, which leads to a focus on the most vulnerable (Moellendorf, 2002). It has also been argued that the comparative marginal utility of resources is an important variable in distribution, and that focusing on those who have the least will increase aggregate utility (Smart and Williams, 1973; Singer, 2002). A final argument has been made that we always have a duty to help others if we are in a position to do so (O'Neill, 1989).

This principle has several manifestations in policy proposals. Policies have included mechanisms to transfer resources to developing countries (e.g. Gupta and Bhandari, 1999; Baumert and Goldberg, 2006; Höhne et al., 2006; to name a few). Another approach has imposed thresholds for emission targets which allow developing countries headroom for growth (Claussen and McNeilly, 1998; Blanchard et al., 2001; Michaelowa et al., 2005).

Part of protecting the most vulnerable may involve setting a 'safe' stabilization level. As Tol has suggested, 'the higher our aversion to inequity, the higher the optimal greenhouse gas emission

reduction' (2001, p.71). Lower stabilization levels may protect those who are dependent on non-substitutable resources or who lack resources to adapt to climate change. Stabilization and the related debates about discounting and substitution are especially relevant for future generations and non-human species and are dealt with briefly in our later discussion about understandings of the 'problem' of climate change.

2.3. Equal rights, entitlements and burdens

Three concepts central to distributive justice are equal rights to protection from climate impacts, equal entitlements to property rights over atmosphere space, and equal division of climate policy costs. These share the basic argument that if all have equal worth the default position may be equality in rights, entitlements and burdens. As is seen throughout this article, however, the definition of the medium to be divided matters. The differences between these concepts of equality are discussed below.

2.3.1. Equal rights

Defining rights is always the challenge of using them, and a full analysis of this debate in the climate context is beyond the scope of this article. However, attempts to address rights in climate policy have been seen in provisions for adaptation funding and human development, and in debates about the definition of a 'safe' stabilization level. Perceptions about what is required to protect 'rights' to climate security are dependent on assumptions about the nature of climate change, the limits of substitution, and the potential of technology. These issues will be addressed in the next section focused on defining the burden of climate change.

2.3.2. Equal entitlement to atmosphere

Support for the concept of equal per capita emission allotment emerges from several arguments. First, if fossil fuel use is essential for basic needs, then some greenhouse gas emissions can be considered a human right reminiscent of arguments for equal rights to security (Shue, 1993; Pan, 2003; Groenenberg et al., 2004). Second, because per capita emission allotment would favour developing countries, it can be justified by the argument that utility maximization is best served when resources flow to the least well-off (Traxler, 2002).[4] Third, if no other distribution rule is self-evident, equal division may be preferable, because the cost of coming to another agreement can be too high (Singer, 2002, p.41). Fourth, equal division may be the default position; if all are equal morally there is no reason why some should receive more or less than others (Jamieson, 2001).

Equal per capita emission entitlements have received support in both the ethics and policy communities (Agarwal and Narain, 1991; Claussen and McNeilly, 1998; Gupta and Bhandari, 1999; Meyer, 2000; Singer, 2002; Höhne et al., 2006). However, even those who see merit in the concept have expressed concerns (Aslam, 2002). One concern has been its potential to create incentives for population growth. This has been addressed by assigning emission rights within a global limit and/or pegging calculation of national populations to particular years (Ott and Sachs, 2002; Singer, 2002). Another concern is that allotting emission rights to nations on behalf of their citizens does not ensure that all will benefit equally within countries (Beckerman and Pasek, 1995). A third basis of concern is that per capita allocation may be undesirable, considering the global context of variation in population density, technological lock-in, resource endowments, climate and other circumstances (Blanchard et al., 2001; Groenenberg et al., 2004). This argument leads directly to a discussion of equal burdens.

2.3.3. Equal burdens

The fundamental argument for equal burden-sharing is that if there is a communal burden and all people have equal moral weight there is no reason why some should have a heavier burden than others. The real challenge with this principle lies in the ambiguous meaning of 'burden'. The third question posed at the beginning of this article asked how metrics matter to distributive justice; this is most clearly seen in the debate about equal burdens.

If emissions reductions are the metric used to measure the burden of climate policy, an 'equal burdens rule' leads to equal emissions reductions. No-one is proposing that all nations reduce emissions equally, but it has been suggested that nations reduce their emission levels by an equal proportion of their current emission level. This has been applied, at least partially, in a range of policy proposals (Aldy et al., 2001; McKibben and Wilcoxen, 2002; Baumert and Goldberg, 2006).

This principle looks different if a burden is defined as the *effort* required for emission reductions. If effort is measured in financial costs, equal division has to consider the factors influencing this across nations. This has been proposed through the inclusion of geographical features (Rose et al., 1998), technological lock-in to existing emission-intensive infrastructure (Groenenberg et al., 2004), and comparative opportunities for emission reductions (Claussen and McNeilly, 1998; Groenenberg et al., 2004). These frameworks can be criticized for assuming that cross-border prices are truly comparable (Helliwell, 1998).

Although tonnes of GHG reductions and financial cost have been the dominant burden metrics, there are alternatives. Two alternatives that have appeared in the literature are opportunity costs defined broadly (Traxler, 2002), and differentiation of subsistence and luxury emissions (Shue, 1992, 1993; Pan, 2003; Ott, H. et al., 2004). Subsistence emissions would be immune from negotiation but luxury emissions could be targeted for reduction and traded, which would recognize the higher human costs of subsistence reductions. While conceptually feasible, political resolution of category constituents would be challenging (Gardiner, 2004b). Additional metrics that could be used, but haven't been, include equivalent labour hours or life expectancy (Morgan and Dowlatabadi, 1996). Like opportunity costs and the subsistence/luxury emission division, these metrics redefine burdens and would dramatically change the division of costs under an equal burden rule from that achieved through the conventional metrics of emission reductions or financial costs.

One of the critical features of an equal burdens argument is that the definition of burdens, regardless of metrics, is highly dependent on technology, which makes comparing burdens across space or time difficult and subject to frequent shifts. This will be returned to later in the article.

2.4. Procedural justice

Procedural justice stresses the importance of representation of all stakeholders in a decision. This has been applied in two ways in the climate context. The first is the idea that global climate impacts require representation of all countries in climate negotiations. Because developing countries may face the worst impacts, 'the successful integration of such issues into the mainstream debates and the emerging climate regime is contingent on the ability of vulnerable nations and marginalized people to gain a voice' (Sagar and Banuri, 1999, p.513). Although this point is widely acknowledged (Agarwal and Narain, 2001; Ikeme, 2003; Najam et al., 2003; Mace, 2006; Adger et al., 2006), few policy proposals contain mechanisms to improve negotiation abilities other than ensuring that developing countries are at the table, often through the inclusion of the Clean Development Mechanism (CDM) or other transfer mechanisms.

Procedural justice has also entered the conversation through emphasis on sub-national adaptation. It has been argued that, because impacts and adaptation occur locally, procedural justice should include

mechanisms to ensure that those impacted at the sub-national level have their interests considered (Thomas and Twyman, 2005; Huq and Khan, 2006). However, with few exceptions (Pan, 2003; Ott, H. et al., 2004; Paavola et al., 2006) proposals for an international climate policy have ignored sub-national level representation. The opposing argument would ask what role international policy can claim in sovereign affairs. Questions about the scope of sovereignty will be briefly returned to at the end of the article. Policies can be partially judged on their inclusion of sub-national considerations, but because policy extent has other implications, this indicator is included elsewhere, as will be discussed shortly.

3. Defining the problem

Most policies do not state their assumptions about the problem of climate change, but this does not mean that these assumptions are not there, or that they do not impact distributive justice. Three indicators highlighting these assumptions are briefly discussed here – the extent of climate policy, the treatment of substitutability, and the incorporation of technology.

3.1. Extent of policy

Some climate policies include all nations while others include only high emitters. Despite similar emission reductions, these choices may have distributive implications. Selective climate policy means that industrialized countries shoulder the entire burden and that developing countries will not have to reduce emissions, but it may also limit resource transfer mechanisms (Benedick, 2001; Stewart and Wiener, 2003; Wellington et al., 2007). This type of policy is focused on emissions reductions, not human development. Comprehensive policy designs either impose a standard equation of reductions on nations (usually moderated by ability to pay measures such as GDP) or have graduated threshold designs. Many of these may involve reductions in developing countries but also have resource transfer mechanisms to defray impacts on development. In these policies, climate change and human development are both critical goals. Assumptions about the extent to which the climate problem is defined by emissions reductions or human development can have considerable implications for the costs and benefits included in policy negotiation.

3.2. Substitution

Assumptions about substitution are critical for distributive justice in climate policy. Policies grounded in assumptions of high substitutability are likely to tolerate higher stabilization levels and focus on economic harms. Alternately, if human and non-human goods are seen as less substitutable, 'dangerous climate change' is a more proximate concern and lower stabilization levels are likely goals. The debate about substitution and the nature of the harms expected with climate change has largely driven the substantial debate about discounting across generations (Howarth, 1998; Nordhaus, 2001) and contributed to the related debate about setting a 'safe' stabilization level (O'Neill and Oppenheimer, 2002; Dessai et al., 2004; Schneider and Mastrandrea, 2005; Harvey, 2007).

It has been strongly argued (Howarth, 1998; Ott, 2003) that discounting outcomes contravenes the rights of future generations. Unlike economics, which incorporates behaviour and preferences in policy recommendations, the central tenet of utilitarianism is equal consideration for all involved in a decision. From this perspective, discounting where there are no substitutes should be zero and, where everything is substitutable, it can be the social discount rate. This part of the debate centres on the comparative weight given to preferences and logic for guiding policy, and is not discussed further in this article.

It has also been argued that the rights of future generations of humans are not compromised by not spending to prevent climate change but that, in fact, investing in costly emission reductions could harm their interests, as they would have otherwise gained significant financial benefits (Schelling, 1995; Weitzman, 1999). The key to this argument is substitution. Investing in financial investments that accrue interest only works as an argument against zero discounting and reduced mitigation efforts in the present under assumptions of high substitutability.

Assumptions about substitutability are pivotal in understandings of the 'problem' and can have distributive justice implications across and within generations. In reality, some goods are substitutable and impacts can be cushioned through financial or technological transfers, while other impacts on endangered species, cultural systems,[5] ecosystems and landscapes are not. Stabilization levels will have significant distributive justice impacts, as those dependent on non-substitutable resources will bear a greater share of costs under higher stabilization.

Within climate policy, assumptions about substitutability are partially reflected in the mechanisms used to limit emissions. As first discussed in Weitzman (1974), price mechanisms cap economic impacts while reducing emissions. Quantity controls limit emissions but do not limit economic impacts, and reflect an assumption of lower substitutability. Which instrument to prefer depends on the rate (and uncertainty) at which economic and environmental impacts change with emission controls and how these impacts are distributed (Pizer, 1999).

3.3. Technology

The role that policies assign to technology is also revealing of their understandings of 'the problem'. Technology is highly relevant for distributive justice in its capacity to alter substitution and change the costs and opportunities inherent in emission reductions mechanisms. Although dealt with only briefly here, the influence of technology permeates all aspects of distributive justice because it has the capacity to continually shift the entire cost–benefit landscape.

The centrality of technology in mitigation mechanisms is well known. Technology drives the economy and the demand for resources. The size of the economy and technological efficiency are the key drivers of emissions projections. Low greenhouse gas (GHG) futures depend on the emergence of new technologies. Radical GHG reductions through carbon capture and sequestration (CCS) can even be used to reduce GHG concentrations in the atmosphere, and technology can be used to alter the climate itself.

Technology transfer is also often proposed 'as compensation for abatement efforts' in developing countries (Stewart and Wiener, 2003, p.15). This use of technology, and this view of climate policy, has distributive justice implications. Depending on the development of technologies such as CCS, developing countries could see a dramatic reduction in resource transfers (technology or human development aid) in return for emission credits. The 'problem' in this framework is achieving cost-effective emission reductions, and climate mitigation goals are independent from human development goals.

Finally, technology is relevant to distributive justice in its power to boost substitutability between human and non-human goods. This means that technology plays a role in the distributive justice aspects of stabilization levels, as discussed earlier, and that policies focusing on technology may share some of the same understandings of the climate problem as those that are counting on high substitutability. In addition, goods that can be protected or substituted through technology are less likely to be impacted through climate change; and therefore access to these technologies will only grow in importance with respect to distributive justice in climate policy. Predicting the impacts of technologically oriented policy necessitates paying close attention not only to the application of distribution rules but also to the definitions of climate change embedded in policies.

4. Principles in proposals

We reviewed the available policy proposals and selected 32 for a more detailed analysis. We selected these proposals both to span the widest range of designs and based on their frequent citation within the climate policy literature, including works that have collected policy architectures (Ringius and Torvanger, 2002; Aldy et al., 2003; Bodansky et al., 2004). Emerging from the discussions in the previous two sections, Table 1 presents an overview of the indicators used to understand the distribution rules implicit in policies and each policy's definition of the problem of climate change. Table 2 provides a summary of the proposals examined according to these indicators.

Two important principles are not directly observed in these tables. The first is causal responsibility. Because every policy includes this either through carbon taxes, cap-and-trade mechanisms or technological development investment,[6] it cannot be used to detect variation across policies, and so has been omitted. The second key principle identified in the ethics literature but missing from these tables is procedural justice. This is because formal mechanisms to facilitate procedural justice have been missing from most concrete policy proposals. Partial exceptions to this are concerns about the need for sub-national consideration and representation in decision making, and arguments about the ideal extent of climate policy, as discussed earlier. The lack of explicit focus may be due to assumptions that the overarching UNFCCC structure sufficiently accommodates procedural justice. Only seven policies propose significantly different overarching structures or new institutions, which suggests that – for the majority – more minor alterations within these policies is acceptable. It is, however, difficult to differentiate, based only on formal proposals, the extent of assumptions about procedural justice.

TABLE 1 Indicators of distribution rules and definitions of the climate 'problem'

	Principles	Indicators
Distribution rules	Equal entitlement	Equal per capita emission allotment
	Compensatory justice	Cumulative GHGs
	Need	Resource transfer to developing countries
		Developing country headroom for growth
	Equal burdens	Subsistence / luxury emissions
		Ability to pay gradient
		Structural impacts on financial costs of reduction
		Proportional reduction
Defining the 'problem'	Technology	Technology as central mechanism
	Policy extent	Standard restriction equation, all nations
		Graduated obligations, all nations
		Some nations
	Substitution	Quantity target
		Price mechanism
		Hybrid

TABLE 2 Summary of key characteristics of climate policy proposals

Reference	Distribution rules								Definition of the 'problem'						
	Equal allotment	Compensatory justice	Treatment by need		Equal burdens				Technology	Extent of policy			Substitution		
	Per capita emissions	Cumulative GHGs	Transfers to DC	Headroom for DC growth	Ability to pay	Subsistence/luxury emissions	Limits to reductions and cost to reduce ($)	Proportional reduction	Technology central	Stand restrictions, all nations	Graduated thresholds, all nations	Graduated thresholds, some nations	Quantity mechanisms	Hybrid mechanisms	Price mechanisms
Pan, 2003			H	X	X	X					X			X	
Paavola et al., 2006			H			X				X				X	
Groenenberg et al., 2004	X			X		X	X		X	X				X	
Ott, H. et al., 2004	X	X	H	X	X	X	X				X		X		
Traxler, 2002					X	X	X			X			X		
Baumert and Goldberg, 2006			C	X				X	X		X			X	
Schelling, 2002			U	X			X				X			X	
Aldy et al., 2001			T					X	X	X				X	
McKibben and Wilcoxen, 2002				X				X		X				X	
Pizer, 1999														X	
Samaniego and Figueres, 2002			C	X	X				X		X		X		

Höhne et al., 2006	X			C	X		X						X			X	
Michaelowa et al., 2005			X	C	X		X		X			X				X	
La Rovere et al., 2002)	X		X	T	X							X				X	
Byrne et al., 1998	X			U	X		X					X				X	
Claussen and McNeilly, 1998	X		X	U	X		X		X			X				X	
Jacoby et al., 1999							X					X				X	
Blanchard et al., 2001	X		X		X		X		X			X				X	
Müller, 2001												X				X	
Gupta and Bhandari, 1999	X			C			X		X							X	
Tonn, 2003	X			C								X				X	
Meyer, 2000	X			U	X							X				X	
Manne and Richels, 1997	X											X				X	
Stewart and Wiener, 2003				T	X									X		X	
Nordhaus, 2001							X					X					X
Barrett, 2002				T			X			X		X					X
Bradford, 2004				U	X		X		X	X	X						X
Cooper, 1998												X					X
Stiglitz, 2006												X					X
Benedick, 2001				T						X				X			X
Wellington et al., 2007										X				X			X

X: Presence of a mechanism in proposed policy.
C: These policies are dependent on the Clean Development Mechanism (or similar mechanism) to transfer resources among countries.
U: These policies stipulate the transfer of resources to developing countries but do not specify what form this should take.
T: Funds specifically for technological improvements aimed at mitigation is the primary means of assistance to developing countries.
H: These policies stipulate that funds transferred to developing countries must in some way contribute to general human development or broad adaptation work (i.e. emphasis is not placed on promoting mitigative activities).

5. Discussion

From this examination, several trends become clear. First, the definition of the burden to be shared is as important to distributive justice as the application of distribution rules. By considering both characteristics, the apparent diversity of policies can be grouped into three rough categories, each of which potentially has distributive justice implications. Second, this examination identifies critical gaps in both the ethics and policy literatures, and suggests areas in which each community could consider investing further attention.

Each policy has a unique combination of mechanisms used to express distribution rules and assumptions about the nature of the problem, but they share some aspects. First, all include causal responsibility, typically expressed through either carbon taxes or cap-and-trade mechanisms. Variation in their inclusion of historical causality, or compensatory justice, will be discussed later. Another aspect that almost all policies share is the use of multiple distribution rules. With only three exceptions, all the policies include two or more distribution rules; nine include three or more of the core principles. This suggests that policy designers may try to incorporate multiple perspectives of distributive justice to increase the likelihood of acceptance. Justice clearly matters strategically when designing climate policy.

This article has differentiated policies according to their application of distribution rules, their assumptions about the nature of the problem of climate change, and the corresponding mandate of climate policy. What is important is not only variation in proposals across these dimensions independently but also interaction between them in particular policies. Interactions between these dimensions were used to generate three categories of climate policy. Informed by the conceptual differences between equity, fairness and justice discussed earlier, these categories are *equitable* division of climate policy costs, *fair* distribution of the burden of economic costs and climate change impacts, and compensatory *justice* for policy costs and liability for climate change damages.

The first category stresses *equitable* division of the *burden of climate policy*. Policies in this category are more likely to apply assumptions of high substitutability and use price mechanisms or safety-valve hybrids which aim to minimize economic costs but incur the risk of ecological costs. These policies also emphasize the 'equal burden' distribution rule in a context in which the metric is either financial or actual emission reductions. This is the only category which includes policies focused on proportional reductions based on existing emission levels as a strategy for calculating costs.

This category also includes those policies aimed exclusively at high emitters. Within these proposals the assistance for developing countries would be limited to technological transfer in exchange for mitigation. These policies define the burden of climate policy in terms of emission reductions and mitigation costs, and may not include human development or the impacts of climate change.

Technological development and transfer is central in this category. Policies with only weak mechanisms for resource transfer but with heavy emphasis on technological development for 'clean' energy have been placed into this category, as are all those for which technology is the central driving force of policy. Policies in this category are generally concerned about equitable burden-sharing. The goal is to minimize and distribute the economic costs of climate policy equally among nations. Policies in this category include those discussed by Aldy et al. (2001), Barrett (2002), Baumert and Goldberg (2006), Benedick (2001), Bradford (2004), Cooper (1998), McKibben and Wilcoxen (2002), Nordhaus (2001), Stewart and Wiener (2003) and Wellington et al. (2007).

The second category focuses on *fair distribution of economic costs and climate change impacts*. To some extent this category resonates with a Rawlsian approach, as many of the policies in this category are interested in protecting the most vulnerable from further harms and take the subjective

experiences of nations into account when evaluating the concepts of need and ability. This category includes the five policies that differentiate between subsistence and luxury emissions as an element of equal burdens (Traxler, 2002; Pan, 2003; Groenenberg et al., 2004; Ott, H. et al., 2004; Paavola et al., 2006). Equal burdens in this context are calculated as a form of human development.

In general, policies in this category reflect less comfort with the idea of substitution. None rely solely on price mechanisms, although several use hybrids, and this category would include all of the policies that share the concept of simultaneous contraction of total emissions to a 'safe' stabilization rate to limit harms, and convergence of per capita entitlements towards a less extreme distribution (Byrne et al., 1998; Claussen and McNeilly, 1998; Gupta and Bhandari, 1999; Meyer, 2000; Blanchard et al., 2001; Manne and Richels, 1997; Tonn, 2003; Groenenberg et al., 2004; Ott, H. et al., 2004; Höhne et al., 2006).

Many of these policies also feature resource transfer to developing countries, often beyond the technological transfer seen in those focused more on equity in cost division (Schelling, 2002; Pan, 2003; Paavola et al., 2006). In total, 19 policies support resource transfer to developing countries. These use three mechanisms – technological transfer (these fall into the previous policy category), CDM (Clean Development Mechanism) or generic resource transfer, and targeted resources for adaptation and human development needs. Proposals that include CDM transfers and resource transfers targeted for human development are included in this category.

This is the largest and most diverse category. Within this variation these policies aim at fairness by taking the subjective experiences of the agents into consideration and being less focused on the idea of equality in dividing the burden of climate policy. From this perspective, the burden of climate change includes the costs of policy itself and climate impacts, and human development is included in the mandate of climate policy. These policies do not, however, include considerations of compensatory justice.

The third understanding of climate policy focuses on the burden of *costs and liability for climate change* and includes a *compensatory justice* framework. Stepping beyond the broadly accepted concept of causal responsibility, these policies feature mechanisms for including cumulative emissions in the calculation of responsibility, and compensation for damages created through time. In this model, the burden to be shared includes mitigation costs, human development costs, and compensation and liability for previous (and ongoing) use of atmosphere space.

In addition to the inclusion of historical causal responsibility, policies in this category typically include per capita emission allocations and significant resource transfer mechanisms, both of which would result in broad resource redistribution. The goal of these policies is compensatory justice – they demand changes in the basic structure of the system of allocations and include compensation. Very few proposals fit this category, although elements of it garner substantial support within the ethics community (Shue, 1992, 1999; Singer, 2002; Gardiner, 2004a; Baer, 2006). From a policy perspective, the focus on justice is typically less adamant, and Sagar and Banuri (1999) note that 'somewhat disturbingly, the analyst community (which is situated almost exclusively in the North) seems to have chosen to more or less avoid a discussion of the transnational liability of climate impacts' (Sagar and Banuri, 1999, p.511). In addition to the Brazilian proposal (La Rovere et al., 2002), the only other policies that contain significant elements of a liability-inclusive justice approach are those of Ott, H. et al. (2004), Claussen and McNeilly (1998) and Blanchard et al. (2001).

5.1. Two literatures and a few gaps

This article combined an applied ethics approach with detailed policy proposals, which has led to two results. The first is the categorization of climate policies, as discussed above; the second is the identification of four gaps in the relevant literatures: evaluative modelling, public ethics, sovereignty, and technology.

This article has looked only at policy proposal architecture and has not attempted to model their potential implications. Evaluative work that includes distributive justice is beginning (Höhne et al., 2002; den Elzen et al., 2005; Rive et al., 2006) but it has focused almost exclusively on emission reductions and GDP. In part, this limitation is probably due to the difficulties in modelling the relationships between policies, impacts and regional vulnerability. The exception to this trend is in the grounded fieldwork of researchers exploring adaptation policy in context (Thomas and Twyman, 2005; Huq and Khan, 2006; Paavola et al., 2006). Work to improve our ability to index vulnerability could facilitate modelling of fair climate policies in which the burden includes impacts. This is an area where both the ethics and the policy communities could contribute.

Public ethics is a second area calling out for analysis. Allusions to public perceptions of ethics run throughout both literatures, but it is not discussed in depth in either. For example, Stewart and Wiener (2003) ground their policy in the perceived unwillingness of the American public to support anything potentially limiting sovereignty or damaging the national economy. Grubb writes that effective climate policy 'will require widespread and ongoing acceptance either that it is a 'just cause' or that the benefits, in the broadest sense, outweigh the costs' (Grubb, 2006, p.506). Jamieson argues that 'if there is to be a meaningful change that makes a difference over the long term it must be both collective and thoroughgoing. Developing a deeper understanding of who we are, as well as how our best conceptions of ourselves can guide change, is the fundamental issue that we face' (Jamieson, 1992, 151). All three statements argue that public perceptions of justice have the capacity to shape international policy but there has been no analysis of these processes. Further work is required to understand the connections between policy, public acceptability and distributive justice.

Sovereignty is a third area which could use further work in two ways. First, it is unclear who the relevant moral agents are in climate change. Second, in the multi-scaled nature of climate policy, sovereignty is not a simple concept.

Some policy literature has argued for consideration of sovereignty in determining burden-sharing because burdens are distributed among *nations* (Rose et al., 1998; McKibben and Wilcoxen, 2002; Vaillancourt and Waaub, 2006). This seems obvious, as most policies focus on nations, but in these cases it is assumed that the nation, rather than individuals in the nation, is the moral agent.

Identifying the appropriate moral agent in the area of climate policy is difficult. Are individuals, corporations or nations the relevant moral agents in the climate debate? Cumulative responsibility is calculated by nation because per capita assignment would blame individuals for the actions of their ancestors. And yet, per capita emission rights have received enormous support in both the ethics and policy communities. The tension between these positions has scarcely been considered within the climate change context (Caneypl, 2005, and Sinnott-Armstrong, 2005, are exceptions). Just as the metrics used to measure burdens matter, the metrics of agency are likely to impact the distribution of costs and benefits. Policies focused on individuals are likely to differ from those in which the relevant agent is assumed to be the nation.

The multi-scaled nature of climate policy also poses challenges to sovereignty. Several policies propose either an international institution capable of administering funds (Byrne et al., 1998; Bradford, 2004; Paavola et al., 2006) or harmonized, global taxes (Cooper, 1998; Nordhaus, 2001; Stiglitz, 2006). An argument against such mechanisms has been that they contravene the sovereignty of nation states, so cannot be acceptable to a community composed of states (Stewart and Wiener, 2003). Nonetheless, international corporations have achieved this end for centuries, and to some extent any international agreement imposes limits on sovereignty.

Investigating the implications of sovereignty in this multi-scale dilemma has been neglected. There have been calls to improve representation of sub-domestic adaptation (Mace, 2006; Paavola et al., 2006),

but what role can or should international agreements play in domestic affairs? In situations in which there are conflicts between the needs of citizens domestically and non-citizens abroad, how do we deal with the moral responsibilities of governments accountable for domestic well-being? These types of questions have emerged in debates about global ethics and the boundaries of international justice (O'Neill, 2000; Moellendorf, 2002; Tan, 2004) but there has been very little work focused on the connection of climate change to any of these considerations (Caney, 2005, is an exception; Jamieson, 2005, and Moellendorf, 2002, mention it briefly), even though tensions about the meaning, bounds and outcomes of sovereignty are already an issue in policy discussions.

The fourth, and possibly the most critical, area for further investigation is technology. Throughout this article, technology's maverick ability to transform the climate policy landscape has been stressed. Assumptions about the potential power of technology and actual technological innovations both have the capacity to shape distributive justice in climate policy.

Assumptions about technology can shape policy in two ways. First, if assumptions of high substitutability – buttressed by faith in technology – are correct, and costly policy is pursued regardless, both the current and future generations may be worse off. Instead, if such assumptions are incorrect, those dependent on non-substitutable goods may pay a very high price. Assumptions about the power of technology may shape which direction appears more desirable.

Second, assumptions about the extent to which technology is central to climate change can have distributive impacts. If technology is assumed to be at the centre of the problem, dramatically double-cast both as causal factor and as potential saviour, climate becomes a technical problem. This differs from a view of climate change in which human development is the central problem. The perceived power of technology can change how we see the problem, and what we understand as feasible, effective or desirable policies. Policies' positions on the continuum of assumptions about the power of technology will structure their suites of costs and benefits.

In addition to the importance of assumptions about technology, an example of the sensitivity of distributive justice outcomes to actual technology involves the importance of technological transfer in CDM and other transfer mechanisms. Technological development (primarily aimed at mitigation) and transfer is a central mechanism for efficiency and fairness – and separating these is difficult. One of the concerns with the centrality of technological development in the CDM is that it may substitute emissions reductions capacity for adaptive capacity. Tight ties between technology and emission reductions may result in funding flowing to countries with high emission reduction potentials rather than to those facing the greatest climate impacts or human development needs (Banuri and Spanger-Siegfried, 2002). Similarly, Sutter and Parreño (2005) suggest that only a minuscule portion of current CDM projects have met development needs.

In addition, there may be larger distributive justice implications of locking into climate policy centred on technological transfer. These transfers work because developing countries buy technology with promises of emission mitigation. If locked into policies built on this exchange model, what grounds would developing countries have for access to adaptation technologies as they are developed? Adaptation technologies could both create and protect wealth, and differential access could increase inequities in vulnerability. Similarly, as CCS and other technologies are adopted in industrialized countries, what will happen to the market for emission credits that underpins many resource transfer mechanisms included in policy proposals? Geoengineering is increasingly being debated as an option for mitigation (Dowlatabadi and Morgan, 1993; Keith, 2002; Keith et al., 2006; Wigley, 2006; Brewer, 2007), but the broader ethical and distributive questions remain almost entirely unexamined (but see Jamieson, 1996, as an exception).

6. Conclusions

By combining an applied ethics framework with the details of proposed policies, we discussed the justice implications of explicit distribution rules and the potential results of their interactions with assumptions about the nature of the problem and metrics of measurement. Policies were divided into three general categories – each of which suggests potential outcomes for distributive justice.

The first, *equitable* division of the *burden of climate policy*, focuses on the technical and financial aspects of the climate problem. It builds on the notion of economically optimal global solutions, but presents risks to those already vulnerable and to those dependent on non-substitutable resources. These policies aim to create cost-effective mitigation rather than reducing disparity in resource distribution or human well-being. In fact, depending on technological development and diffusion, these policies could exacerbate global inequalities (Dowlatabadi and Lave, 1993).

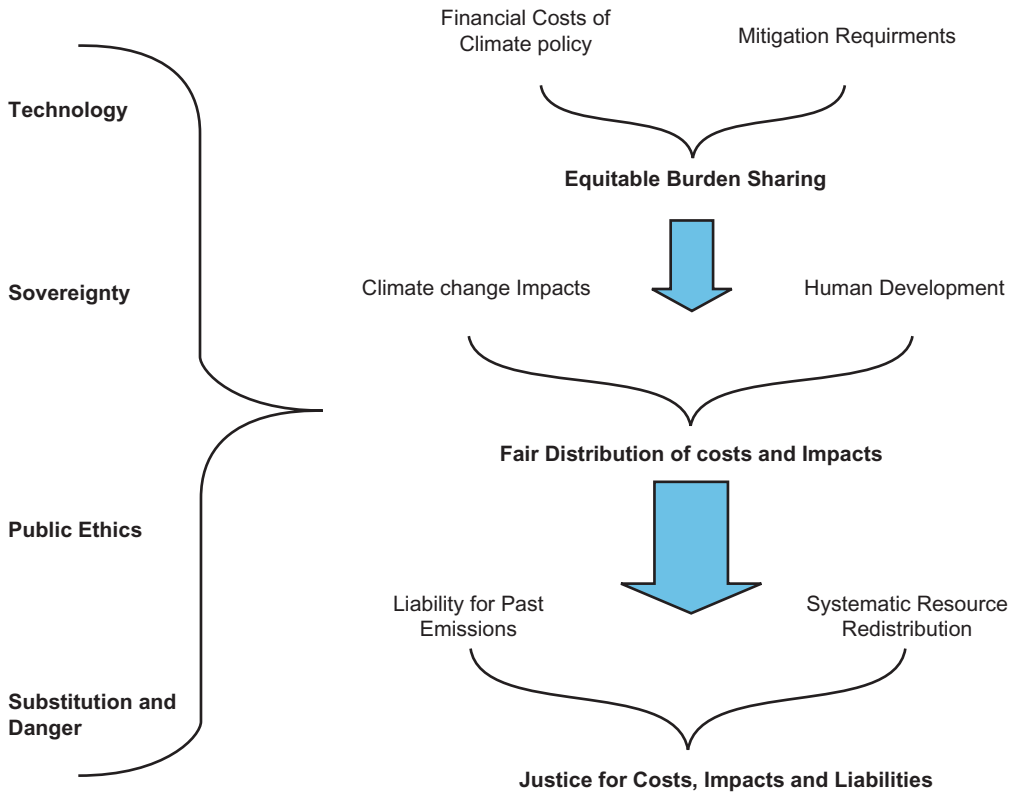

FIGURE 1 Schematic of the issues included and excluded from frameworks of distributive justice in climate policy. The left side of the diagram is dominated by assumptions about four elements underlying policies that impact distributive justice. Significantly, aspects of these elements have been debated in other discussions but their connection to distributive justice is routinely overlooked in the climate context. These elements could impact the results of policies within each of the three categories and all are dynamic. Exploration of these elements from a distributive justice perspective may be an important area for future work. The right side of the diagram represents the three categories of policy discussion. Equitable burden-sharing is the narrowest category, as it is built primarily on cost and mitigation requirements; as the categories broaden into fair distribution and justice for liabilities, the scope of climate policy increases.

Due to variation within the second category, *fair distribution* of both costs of policy and impacts of climate change, potential results are more difficult to predict. In general these policies range from those focused on human development to those that echo the policies in the previous category but have added means of incorporating human development into cost calculations. Policies with a strong human development aspect may be more likely to include mechanisms to protect the most vulnerable and resource redistribution less closely tied to technological exchange for mitigation. They also could result in more expensive policies and risk protecting future generations at the cost of the current one. The extent of this category suggests considerable interest in finding a middle ground between human development and technical cost-effective mitigation. There is a natural tendency to leverage existing development programmes to support human development needs in this category of policy. This would also have significant distributive justice impacts, necessitating further analyses of policies in this category.

The final and smallest category, *compensatory justice for the costs of climate policy and liability for climate impacts*, envisions the most extreme resource redistribution and is the only category that takes compensation seriously for distributive justice. Under this framework, it is likely that developing countries would receive substantial resources beyond the transfer of technology. At this time, however, these policies could be the most costly financially and politically, as debate about measuring historical causation, costs and benefits is likely. Such debate carries costs of time and energy, which should not be ignored.

These conclusions suggest that our vision of distributive justice in climate policy is unjustifiably narrow. Figure 1 illustrates how the underlying discussions about the climate problem have been isolated from, and yet are essential to, the incorporation of distributive justice in policy proposals. At the same time, policy proposals vary in their interpretation of the appropriate mandate for climate policy.

The argument for identifying the tendencies of each of these approaches is that it will allow us to more carefully analyse which options present the best fit with the challenge of climate change and the potential implications of these choices and assumptions. We may never reach consensus on the elusive dimensions of distributive justice in the climate context, but recognizing its multiple interpretations and the varied perceptions of the burden to be shared may be an important first step.

Notes

1. There are several other philosophers who have also discussed this, although they have not remained as involved in the discussions as this core group. These additional contributions include work from Traxler (2002), Sinnott-Armstrong (2005), Page (2007), Caney (2005) and Moellendorf (2002). Coward and Hurka (1993) also published an edited volume of work on the topic by a range of philosophers.
2. Defined to include the ability to pay for emission reductions and/or recover from climate change impacts.
3. To be more specific, Locke's original premise was that mixing one's own labour with resources gave you the right to them as long as there was 'enough and as good left in common for others'. Nozick argues that the proper interpretation of this proviso is that none should be made worse off by your assertion of property rights over something (see Nozick, 1974, pp.174–182).
4. It should also be noted that a similar argument regarding the maximization of utility was made by Schelling (1995) when he argued that the highest utility solution to the climate problem is to transfer resources to the poor today, as the future poor should be expected to be better off than the current generation. Intergenerational ethics is returned to briefly in this article in the discussion of stabilization targets.
5. It is important to note that major changes in human activity are needed in order to achieve climate stabilization. Cultures and social institutions have grown around the current patterns of activity and these will be lost. Even though humanity prides itself on adaptability, there is ample evidence that individuals and communities rarely recover from such disruptions (e.g. Inuit, Aswan, Bikini Islands, Palestine).

6. Several policies are almost entirely dependent on technological development. In these models, high emitters are the countries targeted for funding this development (Benedick, 2001; Wellington et al., 2007).

References

Adger, W.N., Paavola, J., Huq, S., 2006, 'Toward justice in adaptation to climate change', in: W.N. Adger, J. Paavola, S. Huq, M.J. Mace (eds), *Fairness in Adaptation to Climate Change*, MIT Press, Cambridge, MA, 1–19.

Agarwal, A., Narain, S., 1991, *Global Warming in an Unequal World*, Centre for Science and Environment, New Delhi.

Aldy, J.E., Orszag, P.R., Stiglitz, J.E., 2001, *Climate Change: An Agenda for Global Collective Action*, prepared for the conference on 'The Timing of Climate Change Policies', Pew Center on Global Climate Change, Arlington, VA [available at www.sbgo.com/Papers/Aldy-Orszag-Stiglitz_5.pdf].

Aldy, J.E., Barrett, S., Stavins, R.N., 2003, 'Thirteen plus one: a comparison of global climate policy architectures', *Climate Policy* 3(4), 373–397.

Aslam, M.A., 2002, 'Equal per capita entitlements: a key to global participation on climate change', in: K.A. Baumert, O. Blanchard, S. Llosa, J. Perkaus (eds), *Building on the Kyoto Protocol: Options for Protecting the Climate*, World Resources Institute, Washington, DC, 175–201.

Baer, P., 2006, 'Adaptation: who pays whom?', in: W.N. Adger, J. Paavola, S. Huq, M.J. Mace (eds), *Fairness in Adaptation to Climate Change*, MIT Press, Cambridge, MA, 131–153.

Banuri, T., Spanger-Siegfried, E., 2002, 'Equity and the Clean Development Mechanism', in: L. Pinguelli-Rosa, M. Munasinghe (eds), *Ethics, Equity and International Negotiations on Climate Change*, Edward Elgar, Cheltenham, UK.

Barrett, S., 2002, *Towards a Better Climate Treaty*, FEEM Working Paper 54.2002, Climate Change Modelling and Policy, Fondazione Eni Enrico Mattei (FEEM), Milan.

Baumert, K.A., Goldberg, D.M., 2006, 'Action targets: a new approach to international greenhouse gas controls', *Climate Policy* 5(6), 567–581.

Baumert, K.A., Herzog, T., Pershing, J., 2005, *Navigating the Numbers: Greenhouse Gas Data and International Climate Policy*, World Resources Institute, Washington, DC.

Beckerman, W., Pasek, J., 1995, 'The equitable international allocation of tradable carbon emission permits', *Global Environmental Change* 5(5), 405–413.

Benedick, R.E., 2001, 'Striking a new deal on climate change', *Issues in Science and Technology* Fall 2001 [available at http://findarticles.com/p/articles/mi_qa3622/is_200110/ai_n8981575/pg_1?tag=artBody;col1].

Blanchard, O., Criqui, P., Trommetter, M., Viguier, L., 2001, *Equity and Efficiency in Climate Change Negotiations: A Scenario for World Emission Entitlements by 2030*, Cahier de Recherche 26, Institute d'Economie et de Politique de l'Energie (IEPE), Grenoble, France.

Bodansky, D., Chou, S., Jorge-Tresolini, C., 2004, *International Climate Efforts Beyond 2012: A Survey of Approaches*, Pew Center on Global Climate Change, Arlington, VA.

Bradford, D.F., 2004, *Improving on Kyoto: Greenhouse Gas Control as the Purchase of a Global Good*, Working Papers, Center for Economic Policy Studies, Princeton University, Princeton, NJ.

Brewer, P.G., 2007, 'Evaluating a technological fix for climate', *Proceedings of the National Academy of Sciences of the USA* 104(24), 9915–9916.

Brown, D., 2002, *American Heat: Ethical Problems with the United States' Response to Global Warming*, Rowman and Littlefield Publishers, Lanham, MD.

Brown, D., Lemons, J., Tuana, N., 2006, 'The importance of expressly integrating ethical analysis into climate change policy formation', *Climate Policy* 5, 549–552.

Buckmaster, H., 1993, 'The Arctic: A Canadian case study', in: H. Coward, T. Hurka (eds), *Ethics and Climate Change: The Greenhouse Effect*, Wilfred Laurier University Press, Waterloo, ON, Canada, 61–79.

Byrne, J., Wang, Y.-D., Lee, H.-S., Kim, J.-D., 1998, 'An equity- and sustainability-based policy response to global climate change', *Energy Policy* 26(4), 335–343.

Caney, S., 2005, 'Cosmopolitan justice, responsibility and climate change', *Leiden Journal of International Law* 18, 747–775.

Claussen, E., McNeilly, L., 1998, *Equity and Global Climate Change: The Complex Elements of Global Fairness*, Pew Center on Global Climate Change, Arlington, VA.

Cooper, R.N., 1998, 'Toward a real global warming treaty', *Foreign Affairs* 77(2), 66–79.

Coward, H., Hurka, T. (eds), *Ethics and Climate Change: The Greenhouse Effect*, Wilfred Laurier University Press, Waterloo, ON, Canada.

den Elzen, M.G.J., Fuglestvedt, J., Höhne, N., Trudinger, C., Lowe, J., Matthews, B., Romstad, B., Pires de Campos, C., Andronova, N., 2005, 'Analysing countries' contribution to climate change: scientific and policy-related choices', *Environmental Science and Policy* 8(6), 614–636.

Dessai, S., Adger, W.N., Hulme, M., Turnpenny, J., Köhler, J., Warren, R., 2004, 'Defining and experiencing dangerous climate change: an editorial essay', *Climatic Change* 64(1–2), 11–25.

Dow, K., Kasperson, R.E., Bohn, M., 2006, 'Exploring the social justice implications of adaptation and vulnerability', in: W.N. Adger, J. Paavola, S. Huq, M.J. Mace (eds), *Fairness in Adaptation to Climate Change*, MIT Press, Cambridge, MA, 79–96.

Dowlatabadi, H., Lave, L.B., 1993, 'Pondering greenhouse policy', *Science* 259, 381.

Dowlatabadi, H., Morgan, M.G., 1993, 'Integrated assessment of climate change', *Science* 259(5103), 1813–1932.

Finkel, N.J., 2001, *Not Fair! The Typology of commonsense Unfairness*, American Psychological Association, Washington, DC.

Gardiner, S., 2004a, 'Ethics and global climate change', *Ethics* 114, 555–600.

Gardiner, S., 2004b, 'The global warming tragedy and the dangerous illusion of the Kyoto Protocol', *Ethics and International Affairs* 18(1), 23–39.

Gardiner, S., 2006, 'A perfect moral storm', *Environmental Values* 15(3), 397–413.

Groenenberg, H., Blok, K., van der Sluijs, J., 2004, 'Global Triptych: a bottom-up approach for the differentiation of commitments under the Climate Convention', *Climate Policy* 4(2), 153–175.

Grubb, M., 1995, 'Seeking fair weather: ethics and the international debate on climate change', *International Affairs* 71(3), 463–496.

Grubb, M., 2006, 'The economics of climate damages and stabilization after the Stern Review', *Climate Policy* 6(5), 505–508.

Gupta, S., Bhandari, P.M., 1999, 'An effective allocation criterion for CO_2 emissions', *Energy Policy* 27(12), 727–736.

Harvey, D., 2007, 'Dangerous anthropogenic interference, dangerous climate change, and harmful climatic change: non-trivial distinctions with significant policy implications', *Climatic Change* 82, 1–25.

Helliwell, J.F., 1998, *How Much Do National Borders Matter?* Brookings Institution Press, Washington, DC.

Höhne, N., Galleguillos, C., Blok, K., Harnisch, J., Phylipsen, D., 2002, *Evolution of Commitments under the UNFCCC: Involving Newly Industrialized Economies and Developing Countries*, Research Report 201 41 255 UBA-FB 000412, Environmental Research of the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (Umweltbundesamt), Berlin.

Höhne, N., den Elzen, M., Weiss, M., 2006, 'Common but differentiated convergence (CDC): a new conceptual approach to long-term climate policy', *Climate Policy* 6(2), 181–199.

Howarth, R.B., 1998, 'An overlapping generations model of climate–economy interactions', *Scandinavian Journal of Econonics* 100(3), 575–591.

Howarth, R.B., 2003, 'Discounting and uncertainty in climate change policy analysis', *Land Economics* 79(3), 369–381.

Howarth, R.B., Monahan, P.A., 1996, 'Economics, ethics, and climate policy: framing the debate', *Global and Planetary Change* 11(4), 187–199.

Huq, S., Khan, M., 2006, 'Equity in national adaptation programs of actions (NAPAs): the case of Bangladesh', in: W.N. Adger, J. Paavola, S. Huq, M.J. Mace (eds), *Fairness in Adaptation to Climate Change*, MIT Press, Cambridge, MA, 181–200.

Ikeme, K., 2003, 'Equity, environmental justice and sustainability: incomplete approaches in climate change politics', *Global Environmental Change* 13, 195–206.

Jacoby, H.D., Schmalensee, R., Sue Wing, I., 1999, *Toward a Useful Architecture for Climate Change Negotiations*, MIT Joint Program on the Science and Policy of Global Change, Cambridge, MA.

Jamieson, D., 1992, 'Ethics, public policy and global warming', *Science, Technology and Human Values* 17(2), 139–153.

Jamieson, D., 1996, 'Ethics and intentional climate change', *Climatic Change* 33(3), 323–336.

Jamieson, D., 2001, 'Climate change and global environmental justice', in: C. Miller, P. Edwards (eds), *Changing the Atmosphere: Expert Knowledge and Environmental Governance*, MIT Press, Cambridge, MA, 287–307.

Jamieson, D., 2005, 'Adaptation, mitigation and justice', in: W. Sinnott-Armstrong, R.B. Howarth, (eds), *Perspectives on Climate Change: Science, Economics, Politics, Ethics*, Volume 5, Elsevier, Amsterdam, 217–248.

Keith, D.W., 2002, 'Engineering the planet', forthcoming in: S. Schneider, M. Mastrandrea (eds) *Climate Change Science and Policy*, Island Press, Washington, DC.

Keith, D.W., Ha-Duong, M., Stolaroff, J.K., 2006, 'Climate strategy with CO_2 capture from the air', *Climatic Change* 74(1–3), 17–45.

La Rovere, E.L., Valente de Macedo, L., Baumert, K.A., 2002, 'The Brazilian proposal on relative responsibility for global warming', in: K.A. Baumert, O. Blanchard, S. Llosa, J. Perkaus (eds), *Building on the Kyoto Protocol: Options for Protecting the Climate*, World Resources Institute, Washington, DC, 157–173.

Mace, M.J., 2006, 'Adaptation under the UN Framework Convention on Climate Change: the international legal framework', in: W.N. Adger, J. Paavola, S. Huq, M.J. Mace (eds), *Fairness in Adaptation to Climate Change*, MIT Press, Cambridge, MA, 53–76.

Manne, A., Richels, R., 1997, 'On stabilizing CO_2 concentrations: cost-effective emission reduction strategies', *Environmental Modeling and Assessment* 2, 251–265.

McKibben, W., Wilcoxen, P., 2002, 'Climate change after Kyoto: a blueprint for a realistic approach', *Brookings Review* 20(2), 7–10.

Meyer, A., 2000, *Contraction & Convergence: The Global Solution to Climate Change*, Green Books for the Schumacher Society, Totnes, UK.

Michaelowa, A., Butzengeiger, S., Jung, M., 2005, 'Graduation and deepening: an ambitious post-2012 climate policy scenario', *International Environmental Agreements: Politics, Law and Economics* 5(1), 25–46.

Mill, J.S., 2000, *Utilitarianism*, Broadview Press, Peterborough, ON, Canada.

Moellendorf, D., 2002, *Cosmopolitan Justice*, Westview Press, Boulder, CO.

Morgan, M.G., Dowlatabadi, H., 1996, 'Learning from integrated assessment of climate change', *Climatic Change* 34(3–4), 337–368.

Morgan, M.G., Kandlikar, M., Risbey, J., Dowlatabadi, H., 1999, 'Why conventional tools for policy analysis are often inadequate for problems of global change: an editorial essay', *Climatic Change* 41(3–4), 271–281.

Müller, B., 2001, *Fair Compromise in a Morally Complex World: The Allocation of Greenhouse Gas Emission Permits between Industrialized and Developing Countries*, Oxford Institute for Energy Studies, Oxford.

Najam, A., Huq, S., Sokona, Y., 2003, 'Climate negotiations beyond Kyoto: developing countries concerns and interests', *Climate Policy* 3(3), 221–231.

Nordhaus, W.D., 2001, *After Kyoto: Alternative Mechanisms to Control Global Warming*, Joint Session of American Economic Association and the Association of Environmental and Resource Economists, Atlanta, GA.

Nordhaus, W.D., Boyer, J., 2000, *Warming the World: Economic Models of Global Warming*, MIT Press, Cambridge, MA.

Nozick, R., 1974, *Anarchy, State, and Utopia*, Basic Books, New York.

O'Neill, B.C., Oppenheimer, M., 2002, 'Climate change: dangerous climate impacts and the Kyoto protocol', *Science* 296(5575), 1971–1972.

O'Neill, O., 1989, *Constructions of Reason: Explorations of Kant's Practical Philosophy*, Cambridge University Press, Cambridge, UK, and New York.

O'Neill, O., 2000, *Bounds of Justice*, Cambridge University Press, Cambridge, UK, and New York.

Ott, H., Sachs, W., 2002, 'The ethics of international emissions trading', in: L. Pingvelli-Rosa and M. Munasinghe (eds), *Ethics, Equity and International Negotiations on Climate Change*, Edward Elgar, Cheltenham.

Ott, H.E., Winkler, H., Brouns, B., Kartha, S., Mace, M.J., Huq, S., Kameyama, Y., Sari, A.P., Pan, J., Sokona, Y., Bhandari, P.M., Kassenberg, A., La Rovere, E.L., Rahman, A.A., 2004, *South–North Dialogue on Equity in the Greenhouse: A Proposal for an Adequate and Equitable Global Climate Agreement*, Climate Protection Programme, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Eschborn, Germany.

Ott, K., 2003, 'Reflections on discounting: some philosophical remarks', *International Journal of Sustainable Development* 6(1), 7–24.

Ott, K., 2004, *Ethical Claims about the Basic Foundations on Climate Change Policies*, Workshop on Climate Policies, Greifswald, Germany.

Ott, K., Klepper, G., Lingner, S., Schäfer, A., Scheffran, J., Sprinz, D., Schröder, M., 2004, *Reasoning Goals of Climate Protection: Specification of Article 2 UNFCCC*, Research Report 202 41 252 UBA-FB 000653, Environmental Research of the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (Umweltbundesamt), Berlin.

Paavola, J., Adger, W.N., Huq, S., 2006, 'Multifaceted justice in adaptation to climate change', in: W.N. Adger, J. Paavola, S. Huq, M.J. Mace (eds), *Fairness in Adaptation to Climate Change*, MIT Press, Cambridge, MA, 263–277.

Page, E.A., 2007, 'Fairness on the day after tomorrow: justice, reciprocity and global climate change', *Political Studies* 55(1), 225–242.

Pan, J., 2003, *Commitment to Human Development Goals with Low Emissions: An Alternative to Emissions Caps for Post-Kyoto from a Developing Country Perspective*, UNFCCC COP9, Milan, Italy, Research Centre for Sustainable Development, The Chinese Academy of Social Sciences, Beijing.

Pizer, W., 1999, *Choosing Price or Quantity Controls for Greenhouse Gases: Climate Issues Brief*, Resources for the Future, Washington, DC.
Rawls, J., 2001, *Justice as Fairness: A Restatement*, Harvard University Press, Cambridge, MA.
Ringius, L., Torvanger, A., Underdal, A., 2002, 'Burden sharing and fairness principles in international climate policy', *International Environmental Agreements: Politics, Law and Economics* 2, 1–22.
Rive, N., Torvanger, A., Fuglestvedt, J.S., 2006, 'Climate agreements based on responsibility for global warming: periodic updating, policy choices, and regional costs', *Global Environmental Change* 16(2), 182–194.
Rose, A., Stevens, B., Edmonds, J., Wise, M., 1998, 'International equity and differentiation in global warming policy: an application to tradeable emission permits', *Environmental and Resource Economics* 12(1), 25–51.
Sagar, A., Banuri, T., 1999, 'In fairness to current generations: lost voices in the climate debate', *Energy Policy* 27, 509–514.
Samaniego, J., Figueres, C., 2002, 'Evolving to a sector-based Clean Development Mechanism', in: K.A. Baumert, O. Blanchard, S. Llosa, J. Perkaus (eds), *Building on the Kyoto Protocol: Options for Protecting the Climate*, World Resources Institute, Washington, DC, 89–108.
Schelling, T.C., 1995, 'Intergenerational discounting', *Energy Policy* 23(4–5), 395–401.
Schelling, T.C., 2002, 'What makes greenhouse sense? Time to rethink the Kyoto Protocol', *Foreign Affairs* 81(3), 2–9.
Schneider, S.H., Mastrandrea, M.D., 2005, 'Probabilistic assessment of "dangerous" climate change and emissions pathways', *Proceedings of the National Academy of Sciences of the USA* 102(44), 15728–15735.
Shue, H., 1992, 'The unavoidability of justice', in: A. Hurrell, B. Kingsbury (eds), *The International Politics of the Environment: Actors, Interests and Institutions*, Clarendon Press, Oxford, 373–397.
Shue, H., 1993, 'Subsistence emissions and luxury emissions', *Law and Policy* 15(1), 39–59.
Shue, H., 1999, 'Global environment and international inequality', *International Affairs* 75(3), 531–545.
Singer, P., 2002, *One World: The Ethics of Globalization*, Yale University Press, New Haven, CT.
Singer, P., 2006, 'Ethics and climate change', *Environmental Values* 15(3), 415–422.
Sinnott-Armstrong, W., 2005, 'It's not *my* fault: global warming and individual moral obligations', in: W. Sinnott-Armstrong, R.B. Howarth (eds), *Perspectives on Climate Change: Science, Economics, Politics, Ethics*, Elsevier, Amsterdam, 285–307.
Smart, J.J.C., Williams, B.A.O., 1973, *Utilitarianism; For and Against*, Cambridge University Press, Cambridge, UK.
Stewart, R.B., Wiener, J.B., 2003, *Reconstructing Climate Policy: Beyond Kyoto*, AEI Press, Washington, DC.
Stiglitz, J., 2006, 'A new agenda for global warming', *Economists' Voice* 3(7) [available at www.bepress.com/ev/vol3/iss7/art3/].
Sutter, C., Parreño, J.C., 2005, 'Does the current Clean Development Mechanism deliver its sustainable development claim?' International Conference 'Climate or Development?' Hamburg Institute of International Economics, Hamburg, Germany.
Tan, K.-C., 2004, *Justice Without Borders: Cosmopolitanism, Nationalism, and Patriotism*, Cambridge University Press, Cambridge, UK, and New York.
Thomas, D.S.G., Twyman, C., 2005, 'Equity and justice in climate change adaptation amongst natural-resource-dependent societies', *Global Environmental Change* 15, 115–124.
Tol, R., 2001, 'Equitable cost–benefit analysis of climate change policies', *Ecological Economics* 36(1), 71–85.
Tonn, B., 2003, 'An equity first, risk-based framework for managing global climate change', *Global Environmental Change* 13, 295–306.
Traxler, M., 2002, 'Fair chore division for climate change', *Social Theory and Practice* 28(1), 101–135.
Vaillancourt, K., Waaub, J.-P., 2006, 'A decision aid tool for equity issues analysis in emission permit allocations', *Climate Policy* 5(5), 487–501.
Weitzman, M.L., 1974, 'Prices vs quantities', *Review of Economic Studies* 41(128), 477–491.
Weitzman, M., 1999, 'Just keep discounting, but', in: P. Portney and J. Weyant (eds), *Discounting and Intergenerational Equity*, Resources for the Future, Washington, DC.
Wellington, F., Bradley, R., Childs, B., Rigdon, C., Pershing, J., 2007, *Scaling Up: Global Technology Deployment to Stabilize Emissions*, World Resources Institute, New York.
Wigley, T.M.L., 2006, 'A combined mitigation/geoengineering approach to climate stabilization', *Science* 314(5798), 452–454.