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ANALYSIS

Fair adaptation to climate change

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Abstract

This article identifies social justice dilemmas associated with the necessity to adapt to climate change, examines how they are currently addressed by the climate change regime, and proposes solutions to overcome prevailing gaps and ambiguities. We argue that the key justice dilemmas of adaptation include responsibility for climate change impacts, the level and burden sharing of assistance to vulnerable countries for adaptation, distribution of assistance between recipient countries and adaptation measures, and fair participation in planning and making decisions on adaptation. We demonstrate how the climate change regime largely omits responsibility but makes a general commitment to assistance. However, the regime has so far failed to operationalise assistance and has made only minor progress towards eliminating obstacles for fair participation. We propose the adoption of four principles for fair adaptation in the climate change regime. These include avoiding dangerous climate change, forward-looking responsibility, putting the most vulnerable first and equal participation of all. We argue that a safe maximum standard of 400–500 ppm of CO_2 concentrations in the atmosphere and a carbon tax of $20–50 per carbon equivalent ton could provide the initial instruments for operationalising the principles.

Keywords: Climate change; Adaptation; Environmental governance social justice; United Nations Framework Convention on Climate Change

JEL classification: Q54; K33; H23; D63

1. Introduction

Adaptation to climate change presents formidable dilemmas of justice to the international community, ones which are more complex and no less important than those presented by mitigation. Anthropogenic climate change is caused mainly by greenhouse gases emitted by developed countries but climate change impacts will disproportionately burden developing countries. While climate change impacts are often presented and projected at the global, continental or national levels, they are ultimately felt at the local level. This makes distributive considerations difficult because communities that are burdened by climate

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change impacts have different vulnerabilities within each country (O'Brien et al., 2004). Moreover, national governments do not protect the interests of all of their citizens equally—the most vulnerable people often have the least voice. This underlines the importance of fair processes which recognise and enable the participation of affected communities in planning and decisions regarding collective adaptation measures.

In the past decade, debates on climate justice have focused on mitigation of greenhouse gas emissions because of the urgency of promoting international action to reduce the causes of human induced climate change. Another reason is that mitigation presents a well-delineated dilemma to the global community: that of how to allocate rights to emit greenhouse gases to the global atmospheric sinks between countries. Several proposals have been made for fair sharing of the burden of mitigation (Arler, 2001; Azar, 2000; Helm and Simonis, 2001; Jamieson, 2001; Müller, 2001; Paterson, 2001; Ringius et al., 2002; Rose et al., 1998). One possibility is to acknowledge current levels of greenhouse gas emissions (or a proportion of them) as rights as implied by the Kyoto Protocol. Secondly, the contraction and convergence argument proposes a transition from the current income-based distribution of emissions to an equal per capita distribution. Thirdly, it is possible to allocate emission rights according to the countries' historical responsibility for greenhouse gas emissions (see Neumayer, 2000).

All of these proposals have their own problems. For example, the moral force of "the first come, first served" principle which underlies acknowledgement of present levels of emissions as rights is dubious. Equal per capita emission rights may initially appear just but they ignore: 1) responsibility for past emissions; 2) geographical and historical coincidences that influence the size of emissions and sinks, and; 3) present levels of development. Acknowledgement of present levels of emissions as rights and equal per capita emissions are also solutions which treat burden sharing in mitigation a problem of only distributive justice and omit whether a solution can be negotiated fairly under the pertinent international treaties. That is, they ignore what processes for making decisions on burden sharing would be fair.

But even more importantly, most discussions on climate justice ignore the incidence of climate change impacts and adaptation to them. The long-standing unease in the policy community with regard to adaptation originates from fears that the acknowledgement of a possibility of adaptation could distract international efforts to mitigate climate change. These fears do injustice to those who have no other option but to adapt to climate changes to which they have not contributed (see Parry et al., 1998; Adger, 2004; King, 2004). Even an optimistic climate change scenario predicts a minimum increase of 2 °C in the global mean temperature and altered patterns of rainfall and extreme weather events throughout the world during the 21st century. Moreover, climate would continue to change for decades and to precipitate adverse climate change impacts across the globe even if all anthropogenic CO_2 emissions ceased immediately.

Adaptation to climate change thus presents several justice dilemmas to the global community which include: 1) What is the responsibility of developed countries for climate change impacts? 2) How much should developed countries give assistance to developing countries for adapting to climate change and how should the burden be distributed among developed countries? 3) How should assistance be distributed between recipient countries and adaptation measures? 4) What procedures are fair in planning and making decisions on adaptation? We review how and to what extent international environmental law governing adaptation resolves these dilemmas, arguing that its guidance is insufficient. We explore theories of justice in order to identify concepts, principles and rules that would help to resolve the dilemmas of justice, arguing that "avoiding dangerous climate change", "forward-looking responsibility", "putting the most vulnerable first" and "equal participation of all" are the four most important principles that can help the international community make headway in fair adaptation.

The following section discusses adaptation to climate change in some detail to pinpoint the justice dilemmas. The third section discusses how international environmental law governs adaptation and analyses the ambiguities and gaps in the ways in which it seeks to resolve the justice dilemmas. The fourth section reviews theories of justice and outlines

our proposal for dealing with justice dilemmas involved in adapting to climate change.

2. Climate change impacts and adaptation

Climate change impacts will burden especially those populations who are already vulnerable and struggle with current climate variability and extreme weather events (O'Brien et al., 2004; Adger et al., 2003). Differential impacts of present-day extreme weather events illustrate this point. Older Black males who were living alone and who were not well made up a disproportionate share of excess deaths caused by the 1996 heat wave in Chicago (Klinenberg, 2002). The 2003 heat wave in Europe caused 22,000–35,000 premature deaths, most of them among the elderly (Dhainaut et al., 2004; Michelozzi et al., 2004, Schär and Jendritzky, 2004). In developing countries, economic effects of weather-related disasters reflecting current climate variability can reach up to a quarter of GDP (Guranko, 2003) and in thousands of premature deaths. Hurricane Mitch in Honduras in 1998, the hurricanes of 2004 in Haiti and the Caribbean, and extensive flooding in Mozambique in 2000 and Bangladesh in 2004 are only some of the more-publicized events of this kind. In developing countries, uninsured economic losses fall on vulnerable households who are dependent on risky agriculture and other natural resource-based livelihoods. Over the next century, increasingly frequent and intensive extreme weather events will subject the old, the young, the poor, and all of the world's farmers and fishers to the greatest risk but they will also expose previously insulated populations to new environmental dangers.

Research on adaptation to climate change has mostly focused on adaptive responses and their costs (Fankhauser et al., 1999; Pielke, 1998; Smit et al., 2000; Smith, 1997; Tol et al., 1998). Often discussed adaptive responses include policy changes such as subsidies to new lines of agricultural production that adapt food production to changing climate. Adaptive measures also include investments in transport systems, water storage capacity, flood protection, and improved buildings. Burdens of climate change impacts and adaptation can also be redistributed. However, most often adaptation involves changes in the behaviour of affected households such as switching of crops, livelihood diversification and migration.

To understand the justice implications of adaptation, it is important to identify how decisions on adaptive responses are made, how adaptive responses are timed with respect to climate change impacts (Burton et al., 2002) and what is the incidence of consequences of adaptation decisions such as welfare changes and disease burden (Leary, 1999). Adaptation will largely consist of uncoordinated actions of households, firms and organisations but it also involves collective action at the local, national and international levels and cross-scale interactions between these levels (see Table 1). This has several important ramifications. First, adaptation does not take place exclusively at international political arenas or in the local context of autonomous individuals: it also concerns national and local governments and

Table 1
A typology of adaptive responses

Response	Proactive	Reactive	Inaction
International	Guidelines for national adaptation strategies, development of new crops	Food aid measures	No responses are taken to instigate context-specific behavioural responses
National	Grain storage; agricultural policies to change crops and practices	Changes in tariffs and spending to augment food imports and disaster relief	No small infrastructure investments that would confer local benefits
Local	Investment in rainwater harvesting, irrigation and flood protection; local seed banks; local coordination	Mutual help	Migration ignored as an adaptive response
Individual	Livelihood diversification, investment in human and physical capital; alteration of agricultural practices	Migration	Adjustment to increased vulnerability and/or reduced welfare

Examples from food production and security.

non-governmental organisations. Second, individual adaptation is not autonomous: choice sets of individuals are determined by antecedent collective action and collective action is taken to alter individuals' choice sets (Adger et al., 2003). Third, there is no one, right level of decision-making for undertaking adaptive actions. While climate change impacts do influence what are technically feasible adaptive responses, justice concerns may suggest a change in the level of response. Responses at multiple levels are also frequently required.

There are three ways to time-adaptive responses (see Table 1). *Proactive responses* involve anticipation and planning so as to best deal with climate change impacts. *Reactive responses,* such as the rebuilding of infrastructure after flood damage, are taken after climate change impacts are realised but they are not necessarily ad-hoc. Uncertainty and cost considerations may sometimes justify postponing adaptive responses. Finally, inaction may also be chosen as a response to climate change impacts, implicitly or explicitly. Proactive and reactive responses frequently complement each other. For example, the building of additional water storage capacity complements and facilitates rationing of water. Yet proactive and reactive measures will not result in perfect adaptation: some residual impacts are inevitable.

Simultaneous consideration of types, levels and timings of adaptive responses in for example agriculture reveals the complexity of adaptation (see Table 1 and Kandlikar and Risbey, 2000; Risbey et al., 1999). The global community can foster proactive national adaptation strategies, help develop new crop varieties and provide food aid and disaster relief. National governments can increase grain storage, adopt agricultural policies to promote crop switching, invest in infrastructure and provide seasonal weather forecasts. National governments can also decide to deal with some climate change impacts as they are realised or not at all. Local communities can make infrastructure investments for rainwater harvesting, irrigation and flood protection as well as establish local seed banks. Households can make proactive investments and behavioural changes related to intensification, extensification and diversification or react by migrating. Despite all actions, the most vulnerable households are likely to have to absorb some residual and unforeseen impacts.

The adopted set of adaptive responses has important justice implications. Adopted responses generate a particular incidence of benefits and costs and they determine the magnitude and distribution of residual climate change impacts. Moreover, adaptive responses are chosen by using particular decision-making procedures, which have implications for procedural justice (which we will discuss in greater detail below in Section 4). That is, all adaptation decisions (including omissions to act) have justice implications, both distributive and procedural. These can, we argue, be condensed to four main dilemmas of justice which include:

1. What is the responsibility of developed countries for climate change impacts caused by their greenhouse gas emissions?
2. How much assistance developed countries should make available for developing countries and how should developed countries share the burden of assistance? This question is independent of the first one. Developed countries can be considered responsible for assisting developing countries irrespective of being responsible for climate change impacts. Duty to assist is based on the capacity to assist while responsibility arises from the harm caused to others.
3. How should assistance be distributed between countries and adaptive measures?
4. How should planning and decisions regarding adaptation be made at different levels?

In what follows, we examine international environmental law on adaptation and the ways in which it seeks to resolve these central dilemmas of justice in adaptation.

3. Multi-level governance of adaptation

Adaptation to climate change is governed by international environmental law, including the pertinent provisions of the UN Framework Convention for Climate Change (UNFCCC), the Kyoto Protocol (KP), the decisions of the Conferences of the Parties (COPs) (Melkas, 2002; Verheyen, 2002) as well as by

the Vienna Convention on the Law of Treaties, international custom and national legislation. We focus on the "climate change regime" as the collection of "principles, norms, rules, and decision-making procedures around which actor expectations converge in a given issue-area" such as climate change (see Krasner, 1982, 186; see also O.R. Young, 1994). Our emphasis will be especially on how and to what extent the climate change regime resolves the justice dilemmas we identified in the previous section.

The climate change regime does not take an explicit stance towards responsibility for climate change impacts and it remains vague regarding the extent to which developed countries should assist developing countries to adapt. Both of these issues would involve financial transfers from developed countries to developing countries but they are nevertheless independent. Responsibility would require developed countries to compensate developing countries for the harmful effects of anthropogenic climate change. It has been argued that responsibility cannot be established because climate change impacts cannot be traced to actions that caused them. However, the problems of assigning responsibility are not insurmountable (Allen, 2003; Allen and Lord, 2004; Stott et al., 2004): arguments against it have to be seen as attempts to avoid its economic consequences. Assistance is based on the principle of common but differentiated responsibilities and respective capabilities articulated in the Convention's Article 3, Paragraph 1—the duty to assist comes with the capability to assist and the right to assistance is based on limited capability to deal with climate change. Acknowledging responsibility would thus not make assistance unnecessary and providing assistance is not a substitute for responsibility.

The Convention does not ignore responsibility completely, however. Article 2 requires the stabilisation of greenhouse gas concentrations in the atmosphere so that dangerous anthropogenic interference with the climate system can be avoided. The article implies that dangerous interference is avoided if stabilisation of greenhouse gas concentrations enables natural adaptation of ecosystems, ensures food production and enables sustainable (economic) development. This means that the Parties to the Convention are responsible for ensuring that climate change and its impacts do not surpass the adaptive capacities of ecosystems, food production systems and economic systems. It is noteworthy that Article 2 gives highest priority to the responsibility to ensure natural adaptation of ecosystems. The responsibility to ensure food production and, as its corollary, to preserve human life also comes before the responsibility to ensure sustainable (economic) development.

The climate change regime also creates other responsibilities regarding adaptation. Kyoto Protocol Article 3, Paragraph 14 commits Annex I countries to meet their emission reduction targets so as to minimise adverse social, environmental and economic consequences for developing countries. The Convention's Article 4, Paragraph 1(e)–(f) commits the Parties to cooperate in adaptation planning and to incorporate climate change considerations into their economic, social and environmental policies so as to minimise adverse effects on public health, environmental quality and on mitigation and adaptation measures. Kyoto Protocol Article 10, Paragraph 1(b) directs the non-Annex I parties to the Protocol to formulate, publish and regularly update national programmes for adaptation to climate change. The Article also provides that the parties should include information on these programmes into their national communications and into their other reports.

The climate change regime makes more detailed provisions on assistance. Convention Article 3, Paragraph 2 directs developed countries to consider the specific needs and special circumstances of particularly vulnerable developing countries and formulates a duty for all parties to "take precautionary measures that anticipate, prevent or minimise the causes of climate change and mitigate its adverse effects". Paragraph 3 provides that these responses should be cost-effective to ensure global benefits at the lowest possible cost. This principle is applicable to mitigation actions, which reduce greenhouse gas emissions and provide a global public good but is less applicable to adaptive actions that generate local benefits.

The most important provisions regarding assistance are in Convention Article 4. Its Paragraph 3 commits developed countries to cover the costs of developing countries in meeting their obligations under the Convention, which include preparing national inventories of sources and sinks of greenhouse gases. Paragraph 4 commits developed countries to assist particularly vulnerable developing

countries in adaptation. Paragraph 7 underlines that the degree to which developed countries fulfil these financial commitments will determine how developing countries can fulfil their obligations, recognising that the eradication of poverty and social and economic development are their primary concerns. Paragraph 8 demands attention to the specific needs and concerns of developing countries, listing small island states, countries with low-lying coasts, arid countries and countries dependent on fossil fuels as requiring special attention in matters of financial assistance, insurance and the transfer of technology. Paragraph 9 presents a similar requirement for acknowledging the special needs and circumstances of the least developed countries.

The duty to provide assistance is expressed clearly in general terms but so far the climate change regime has failed to fully operationalise assistance despite having taken some steps to the direction. Kyoto Protocol Article 12, Paragraph 8 provides that a share of the proceeds of CDM projects should be used to assist particularly vulnerable developing countries to meet the costs of adaptation. Sixth Conference of the Parties (COP6) created an Adaptation Fund for assisting adaptation projects in developing countries and provided that it is to receive 2% of the proceeds of CDM projects, in addition to funds made available by the Annex I countries (Decisions 5/CP.7., 6/CP.7., 7/CP.7., 10/CP.7., 17/CP.7., and 27/CP.7.). COP6 and COP7 also established the Special Climate Change Fund and the Least Developed Countries Fund. The former is to support adaptation activities and capacity building and the latter the work programme of the least developed countries under the Convention, including the preparation of NAPAs (Decision 5/CP.7.). The two funds will be based on funding made available by the Annex I countries and they will be managed by the Global Environmental Facility (GEF) (see Huq, 2002; Verheyen, 2002; Dessai and Schipper, 2003).

The climate change regime firmly establishes the duty of developed countries to assist developing countries by financing, technology transfer and insurance. The regime has also created part of the institutional infrastructure for channeling assistance to developing countries. However, crucial gaps remain. The regime fails to determine how much assistance ought to be made available by developed countries and how they should share the burden of assistance. Currently contributions are entirely voluntary and, as a result, funds for assistance are negligible. The regime also leaves it unclear how assistance ought to be distributed between countries and adaptation measures. The principle of "global benefits with lowest possible costs" is clearly not applicable to adaptation activities and, if it were applied to them, would deny the legitimacy of sound adaptation projects.

However, the allocation of assistance between adaptation measures is not completely omitted: the climate change regime addresses it in one of its few provisions that relate to procedural justice. Kyoto Protocol Article 10, Paragraph 1(b) provides that developing countries should formulate, publish and regularly update national programmes for adaptation to climate change. The process to be used for generating these plans was specified by COP7 in the guidelines for the preparation of National Adaptation Programmes of Action (NAPAs). The guidelines require multidisciplinarity and public consultation in the preparation of the NAPAs (Decision 29/CP.7.). The guidelines are informed by concerns that non-transparent and unaccountable governments should not be able to dictate the content of NAPAs: vulnerable groups exposed to climate change impacts should be heard and their interests made to count. NAPAs thus constitute a process for generating national priorities for adaptation. However, it remains to be seen to what extent aims of the guidelines will be achieved and there still is not a solution for generating assistance priorities across countries.

The climate change regime has recently acknowledged also other issues of procedural justice. The establishment of Least Developed Countries Expert Group (Decision 29/CP.7.) increases the voice of LDCs in international adaptation planning and decisions. Provisions to increase the participation of women in the Convention bodies are also related to procedural justice (Decision 36/CP.7.). However, the climate change regime is still characterised by several procedural injustices. The Vienna Convention of the Law of Treaties (1969) and international custom construct parties to international agreements as formally equal sovereign nations. However, it is unequal to treat

unequals equally. Developing countries do not have same possibilities for effective participation as developed countries. Developing countries have less capacity to back up their negotiation teams and their small delegations make participation in simultaneous meetings impossible. The use of English in many meetings as primary working language is also an impediment for many negotiators (Gupta, 2002; Mwandosya, 1999). Assistance to developing countries for participating in the Convention activities goes only some way to addressing these inequalities in participation.

To conclude, the climate change regime makes attempts to resolve some of the key justice dilemmas of adapting to climate change. The regime does not address the responsibility for greenhouse gas emissions directly but it provides that emissions should be stabilised to a level that makes it possible for natural systems, food production and economies to adapt. This "capping" principle is clearly expressed but apart from the Kyoto Protocol's emission reduction targets it is not operationalised. Assistance also remains to be operationalised. The climate change regime makes a clear general commitment to assisting adaptation of vulnerable developing countries and it has made some inroads towards implementing this commitment. Three funds have been established and the NAPA process will generate national adaptation priorities for least developed countries. However, the climate change regime fails to specify the level of assistance, who should contribute what proportion of funds for assistance, and how assistance should be distributed between countries and measures. The emergence of procedural justice concerns is indicative of the increasing importance of adaptation. Many adaptation measures will be undertaken locally and all of them will have local impacts. Institutions governing adaptation thus need to reflect local interests and circumstances and to enable meaningful participation. Existing provisions create a basis for recognising and hearing developing country and local voices but it remains to be seen how consequential they prove to be. Despite commitments to assist developing countries, the Convention process remains an unequal arena for international cooperation. Participation and representation thus remain contested issues in the climate change regime.

4. Approaches to climate justice

As outlined above, adaptation to climate change consists of individual and collective choices taken at different levels of decision-making in the context of present and predicted climate change impacts, other social concerns and priorities, and the existing institutional framework that engenders a particular distribution of resources, wealth and power. All of these choices are moral in the sense that they are informed by some values that guide the comparison of alternatives and choice between them. As different parties have different interests and are informed by different values, collective adaptive decisions need to strike a legitimate balance between them (Paavola, 2005). As Müller (2001) has argued:

"In the context of moral decisions, things are not simple and the key to resolving inconsistent conclusions is not to reject moral theories, but to try and find a morally acceptable compromise between them" (Müller, 2001, p.275).

Cosmopolitan theories consider justice as being universal, unchanged by time and place. These theories have generated important concepts such as those of universal human rights as manifestations of justice. Communitarian theories consider that justice emerges from the relationships between members of a community and is thus specific to a particular space and time (Bell, 1993). While the communitarian approach helps to make sense of the variety of ways in which justice dilemmas have been addressed in different communities and contexts, it is often criticised for its alleged failure to avoid moral relativism. Obviously, much depends on how "community" is defined. For example, the pertinent community for climate justice can be considered to include all humans living now and in the future (Norton, 2002), as their fates are bound together by their actions and omissions regarding the use of global atmospheric sinks. Cosmopolitans have also argued for the consideration of all humans (and non-humans alike) as members of a global community (Attfield, 2005). But the communitarian viewpoint makes it clear that humans may be affiliated with many communities and that they may thus have different notions of justice. For this reason, justice is negotiated and generated in the context of conflicting

views and interests (see Bromley, 2004; Paavola, 2005).

For the purposes of this article, it is also important to distinguish between distributive and procedural justice. Distributive justice relates to the incidence of benefits and costs, broadly conceived so as to encompass non-pecuniary advantages and burdens (Kolm, 1996; H.P. Young, 1994) as well as the consideration of non-humans (Attfield, 2005: 43–44). Procedural justice relates to the way in which parties are positioned vis-à-vis processes of planning and decision-making, encompassing issues such as recognition, participation and distribution of power (see Fraser, 2001; Tyler et al., 1997; Young, 2000). Distributive and procedural justice considerations are relevant both within a generation and between generations but we will focus below exclusively on intra-generational justice.

The justice dilemmas involved in adaptation to climate change can be resolved in many ways. In the area of distributive justice, Aristotle's contributory principle, Bentham's rule of greatest happiness for greatest numbers, priority of those in need, Rawls' maximin rule and equality of opportunity, resources and welfare are examples of some of the rules for making fair decisions (Sen, 1992: 12–30; H.P. Young, 1994: 9–13). The contributory principle can be fair in collective undertakings for mutual gain because it provides incentives for the participation of those who can contribute and stand to benefit. However, there are many difficult choices where not everybody can win (see O'Brien and Leichenko, 2003). Utilitarian cost–benefit logic may shed light on some such choices. When difficult choices pertain to areas of life where people find the use of cost–benefit logic unacceptable, rules of equality or priority may be used.

These principles are often applied so that justice appears a matter of distributing one overarching good such as money or utility fairly between the involved parties. This requires commensuration of goods and bads and allows compensating one bad with another kind of good. For example, adequate compensation could be considered to fully resolve justice dilemmas related to the incidence of climate change impacts. However, it is not at all obvious that this line of reasoning should be accepted (see Bromley, 2004; Gowdy, 2004; Paavola, 2002a). For example, Walzer (1983) has argued that complex equality requires the absence of domination of one group across "spheres of justice". For example, questions of income inequality and environmental justice would need to be resolved separately (but not necessarily independently). Groups disadvantaged in income terms should not be disadvantaged in other spheres of justice. Thus international transfers should not be considered to resolve justice in the incidence of climate change impacts. Vital interests in health and safety ought to be considered as distinct from those related to levels of income (see Paavola, 2002b) and to occupy their own sphere. Justice demands the protection of these interests to avoid repeating the injustice of income and wealth distribution. This could be done by capping climate change impacts in conjunction with income and wealth transfers.

Distributive justice is unlikely to be sufficient for climate justice—procedural justice is needed to underpin the legitimacy of climate change regime. Procedural justice is sometimes associated with the arguments of libertarian philosophers such as Robert Nozick (1974) and economists such as Friedrich A. Hayek (1976), according to whom we should accept outcomes of processes such as markets and voluntary action as just even if they would be unequal. These theories are problematic because they deny the significance of unequal starting points, postulate the legitimacy of their favourite procedures and end up affirming the fairness of status quo. The more empirical approaches of social psychology, organisational studies and socio-legal studies to procedural justice have indicated that procedures influence the legitimacy of decisions irrespective of outcomes (Lind and Tyler, 1988). Procedural justice has been both an important demand and a part of political practice for grassroots environmental justice movements (see Schlosberg, 1999; Shrader-Frechette, 2002). Scholarship on the politics of identity and difference has also generated important insights into procedural justice (see Fraser, 200; Lash and Featherstone, 2002), indicating that it encompasses issues such as recognition, hearing, participation, and fair distribution of power. Procedural justice fosters legitimacy because it assures those whose interests are not endorsed by a particular decision that their interests have been considered and that they have a chance to count in other decisions. Procedural justice also enables

affected parties to express their dissent or consent and to maintain their dignity (Schlosberg, 1999: 12–13, 90; Soyinka, 2004).

As we have already noted, distributive and procedural justice are not independent of each other. If a group is not recognised and cannot participate in planning and decision-making regarding adaptation, its interests are unlikely to inform plans and decisions. This is why adaptation plans and decisions can aggravate inequality rather than reduce it. Similarly, the interests of future generations and non-human species are not reflected in the outcomes of plans and decisions because they are not represented effectively (O'Neill, 2001). Yet the concerns for the future generations and non-humans should be recognised.

We suggest that the principles of "avoiding dangerous climate change", "forward-looking responsibility", "putting the most vulnerable first" and "equal participation of all" would help the global community to make progress towards just adaptation to climate change. The principles of avoiding dangerous climate change and forward-looking responsibility address responsibility for climate change impacts (see also Baer et al., 2000). The principle of putting the most vulnerable first addresses the question of how assistance ought to be distributed. Finally, the principle of equal participation of all addresses the questions of procedural justice. In what follows, we will discuss and substantiate each of these principles in greater detail and suggest ways of operationalising them.

4.1. Avoiding dangerous climate change

The principle of avoiding dangerous climate change is already contained in Convention Article 2, but its applicability requires further elaboration. The principle should be considered to create a duty to limit global emissions of greenhouse gases to a level that does not surpass the capacity of natural systems, food production systems and economic systems to adapt. In essence, it is a principle that seeks to safeguard non-humans and humans alike. The principle does not resolve responsibility for past greenhouse gas emissions and it also omits responsibility for damages caused by emissions of greenhouse gases up to the safety level. Therefore, it should be considered a minimum solution for responsibility—the least we should do without excluding a more comprehensive solution.

The principle of avoiding dangerous climate change can be operationalised by setting "a safe maximum standard" (Ciriacy-Wantrup, 1952; Farmer and Randall, 1998) for greenhouse gas concentrations in the atmosphere. Estimates of safe stabilisation levels for CO_2 concentrations are 400–500 ppm (Mastrandrea and Schneider, 2004; O'Neill and Oppenheimer, 2002). We advocate setting a safe maximum standard as an attractive climate justice solution. Climate change affects natural systems, food production and economies in varied ways, depending on the spatial distribution of climatic changes and the local features of natural, food production and economic systems. Different kinds of impacts such as those on economic assets, public health and biodiversity are difficult to compare and rank. Using the conventional tort law conception of liability for damages would be problematic in this situation: the vital interests of poor inhabitants of developing countries would not attract a high price tag (see Spash, 2002; see also Baer, in press). A safe maximum standard can protect a wide range of parties affected by climate change from disastrous outcomes of abrupt or dangerous climate change. A safe maximum standard reflecting the low capacity of vulnerable systems to adapt would also provide protection, which is more crucial to them than to less vulnerable systems.

The setting and successful implementation of an absolute CO_2 concentration limit would obviously not prevent adverse climate change impacts. After all, the doubling of CO_2 concentrations from the pre-industrial levels would precipitate significant climate change impacts across the globe even if it were not dangerous to all humans (see e.g. Thomas et al., 2004). The safe maximum standard would be the first, most urgent step in resolving responsibility for climate change and in avoiding dangerous and abrupt climate change. The problems of historical responsibility and responsibility for "allowed" future climate change impacts would still need to be addressed. Reasons such as lack of knowledge of the consequences of emitting greenhouse gases can be presented against responsibility for emissions that predate the Climate Change Convention. However, ratification and coming into force of the Convention signifies that the

consequences of greenhouse gas emissions are now fully acknowledged and should thus be accompanied with responsibility for them.

4.2. Forward-looking responsibility

The easiest way to implement forward-looking responsibility for greenhouse gas emissions that maintain atmospheric concentrations below the safe maximum standard would be to agree a uniform carbon tax under the Convention process and to implement it through national legislation. Trading systems with caps could generate a permit price equivalent to the tax but taxes create stronger incentives than trading systems (see Driesen, 2003). A progressive tax would be achieved by allowing an equal per capita deduction for all countries so that the tax would only be paid on the amount of carbon surpassing the per capita quota. The tax revenue should then be used for replenishing a fund for compensating adverse impacts of climate change and assisting adaptation to them. We outline below such a system in greater detail and explain how it could address issues of responsibility and assistance.

The choice of tax level has to be informed by the costs of abating a carbon equivalent ton and the monetary value of damages a carbon equivalent ton causes. The costs of abating a carbon equivalent ton has been estimated to be around $20 per carbon equivalent ton (Fankhauser and Tol, 1996). Estimates for global annual damages from climate change are $300–350 billion (Fankhauser and Tol, 1996; Tol et al., 2004), which translate to about 1% of the gross global income (GGI) or $50–55 per carbon equivalent ton. Damage estimates are often reported as a proportion of GDP lost due to climate change. Some northern countries such as Russia are predicted to benefit from climate change while many developing countries are predicted to suffer greater relative losses (see Tol et al., 2004; Fankhauser and Tol, 1996).

Straightforward global damage estimates weigh climate impacts by income levels. For example, if climate change impacts would amount to about 1% of GGI and developing countries receive about 25% of the GGI, their damages (without accounting for differential impact rates) would be in the range of $80 billion. Yet 75% of the global population lives in developing countries and they experience at least the same proportion of climate change impacts on human populations: pecuniary measures give less weight to interests of poor inhabitants of developing countries (see Spash, 2002). Many studies such as Tol et al. (2004) seek to correct damage estimates to reflect the global distribution of income and equity concerns. Thus 25% represents the lower bound and 75% the upper bound for an estimate of the developing countries' share of global climate change damages. We propose to attribute a half of the global climate change damages to developing countries as a solution which gives equal weights to income- and population-based approaches (for a similar attribution, see Baer, in press).

The next task is to set the level of carbon equivalent deduction. Here the obvious starting point is the level of carbon dioxide emissions per capita globally—about 1 carbon equivalent ton (United States Energy Information Agency, 2004). As there is a significant need to cut greenhouse gas emissions from their present level in order to stabilise greenhouse gas concentrations in the atmosphere to a safe level, we suggest that the carbon tax deduction should be set to 0.5 tons per capita. This would mean that all North American and European countries and most countries in Eastern Europe and Russia, Latin America and Middle East would become taxpayers. There would also be some taxpayers in Asia but few in Africa.

If the purpose of carbon taxation was simply to correct the involved externalities and to bring about economically efficient CO_2 concentrations, the tax level should be set between $20 and $50 per carbon equivalent ton. This is the range of taxes used in analyses of progressive hedging strategies (see Yohe et al., 2004) as well as roughly compatible with estimates of near-future optimal carbon tax levels (Roughgarden and Schneider, 1999). Half of the tax revenue should be earmarked for compensation and assistance to developing countries (because we argued above that developing countries should be considered to suffer half of the damages from climate change impacts) and the rest could be used for similar purposes domestically and within the developed world. This means that $45–110 billion would be generated annually for compensating and assisting developed countries, depending on the choice of tax level. Of course, the carbon tax would result in

significant abatement of greenhouse gases and less funds would actually be available. Yet potentially available funds should not be underestimated—they could surpass the $58 billion currently spent on overseas development assistance in the world.

What would be the economic consequences of such a tax in countries where it would be used? A tax of $20 would increase the per capita tax burden by about $100 in the United States and by $40–70 in Europe. Oil-producing countries would pay more while countries in developing continents would pay clearly less or not at all. These are hardly back-breaking additional costs for households in the developed world. Actual per capital costs would be lower as the introduction of tax would result in the adoption of energy efficiency measures and other technological solutions for abatement, which would entail lower costs than the tax.

Carbon tax revenue should replenish a fund for compensating the impacts of climate change and assisting adaptation to climate change. This tax–fund system would, besides address justice issues in adaptation to climate change, also provide incentives for economically efficient choices in both mitigation and adaptation. The tax would result in the adoption of all abatement solutions that are efficient at the set level of tax, thereby decreasing greenhouse gas emissions, climate change impacts as well as tax burden. A combined fund for compensation and assistance would also give incentives for efficient adaptation. By making funds available for proactive adaptation, the solution would reduce the need to compensate for residual impacts yet maintain funds available for relief. We now turn to how assistance should be allocated between types of measures and countries.

4.3. Putting the most vulnerable first

Several references to the principle of "putting the most vulnerable first" can be found from the Climate Change Convention. The Convention also gives some indication of what countries should be considered vulnerable. According to the preamble of the Convention, vulnerable countries include small island countries, countries with low-lying coast, arid or semi-arid areas or areas liable to floods, drought and desertification, as well as developing countries with fragile mountainous ecosystems. However, the Convention does not define vulnerability in a way that would facilitate its use as a guideline for allocating assistance for adaptation between countries and measures. We propose to clarify the principle below in greater detail to facilitate its use in adaptation decisions.

Research on adaptation to climate change defines vulnerability as a function of exposure, sensitivity and adaptive capacity (Adger, 2003; Smit and Pilifosova, 2003; Yohe and Tol, 2002). The Convention's understanding of vulnerability best matches with the first part—exposure—of the triad of factors that determines vulnerability. The Convention pays less attention to the sensitivity of vulnerable groups to climate change impacts and their capacity to adapt. Natural disaster literature's definition of vulnerability emphasizes these two aspects of vulnerability. For example, Wisner et al. (2004: 11) define vulnerability as "the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard". This definition draws attention to factors such as assets, sources of livelihood, class, race, ethnicity, gender and poverty which demarcate vulnerable groups (see also Bohle et al., 1994).

The concept of vulnerability is central for climate justice because it helps to tie the primary concerns of adaptation scholarship to those of moral philosophy (see Kasperson and Kasperson, 2001). The practice of the proponents of equality to consider equality as a reasonable starting point for analysis offers one way to highlight the significance of the concept of vulnerability to moral reasoning (Barry, 1999; Shrader-Frechette, 2002). Equality can be considered just if there are no compelling reasons which would indicate otherwise. Need and lack of capacity are often considered to be such compelling reasons that would justify a deviation from the norm of equality. Vulnerability encompasses characteristics which are indifferent from those covered by need or lack of capacity. Therefore, vulnerability provides a justification for putting the most vulnerable first in matters of distributive justice.

How should the principle of "putting the most vulnerable first" be then operationalised? Attempts to characterise and measure vulnerability (see Adger,

1999, 2003; O'Brien and Leichenko, 2000; O'Brien et al., 2004; Tol et al., 2004; Brooks et al., 2005) provide several useful lessons. First, vulnerability cannot be reduced to exposure to climate change impacts as implied by the Convention. For example, it is not meaningful to compare the vulnerability of Florida and the Caribbean Islands to Atlantic hurricanes by examining the probabilities of landfall hurricanes. Second, vulnerability cannot be reduced to income measures. Vulnerability to climate change is neither synonymous with poverty, nor vulnerability reduction with successful augmentation of income levels. Availability of means and resources to invest in adaptation is only one of the factors in vulnerability to adaptation to climate change. For example, vulnerability is partly determined by the extent of people's dependence on risky activities and sources of income such as agriculture or fishing. The capacity of households and communities to adapt also depends on their physical assets such as health, education and man-made and natural capital, as well as on institutional arrangements, which either facilitate or constrain their attempts to reduce their vulnerability.

The Convention problematically identifies the attainment of global benefits with the least possible costs as a guideline to international actions. Yet this principle is not applicable to adaptive actions because decisions on them are and should be guided with only local benefits in mind. It is also questionable whether even a cost-effectiveness criterion could be justified as a guideline in adaptation decisions—allocating assistance where a dollar makes most good would not necessarily help those who are most vulnerable. The most suitable principle for guiding the allocation of assistance at the national level would be a vulnerability-based leximin rule (see Kolm, 1996). This rule would call for assisting the most vulnerable group first and moving then up in the vulnerability ladder. The use of this principle would not require the establishment of separate priorities between types of adaptive measures—the content of vulnerability reduction would change when the attention shifts to new groups along the vulnerability ladder. Allocation of assistance between countries could make use of relative levels of vulnerability without lexicographic ordering.

4.4. Equal participation for all

The climate change regime interprets equal participation of all narrowly, focusing on the interactions between states in the Conference of the Parties and the subsidiary bodies of the Convention. The Conference of the Parties can make decisions when two-thirds of the parties are present and the Convention enshrines the "one party, one vote" principle. The climate change regime acknowledges that there are background inequalities, which influence the ability of sovereign states to participate in international negotiations and actions. The regime seeks to correct these background inequalities by providing assistance for the participation of developing country parties. The regime also has capacity building elements to reduce barriers for participation. Furthermore, the Convention opens up the Conferences of the Parties to observers, thereby extending limited participation sideways towards non-governmental organisations and other stakeholder groups.

However, governance of adaptation to climate change rests on a multi-level solution which means that only some decisions and actions are taken at the international level while others are taken at the national, sub-national and local levels. As a result, the obstacles of equal participation vary between and across levels. Levels of economic development, state capacity and many other factors influence to what degree *states* can participate in planning and decisions on adaptation at the international level. The participation of non-state actors at the international level is primarily limited by institutional rules but it is also affected by political–economic factors. At the national and sub-national levels, the participation of political, regional, ethnic and other groupings is influenced by political cultures, institutional rules and political–economic factors. While there are formal obstacles for participation at all of these levels of governance, political–economic factors such as inequality and lack of capacity form more formidable obstacle for equal participation. Political–economic factors also constrain effective participation across levels but the lack of formal solutions for facilitating participation in climate change planning are even more glaring.

The best way to shed light on equal participation is to discuss it in two central choice situations: determination of what constitutes dangerous climate

change for the purpose of setting the safe maximum standard and determination of who is vulnerable for the purpose of allocating assistance. The former issue is pertinent to the international level of decision-making and the latter one involves interactions between local, national and international actors. Decisions on the safe maximum standard need to be made acknowledging that danger is experiential and varies to different Parties to the Convention (Dessai et al., 2004). Collective decisions on the level of safety to be provided are learning processes where participants with widely varying starting points, interests and goals have to reach a consensus (Bromley, 2004). This underlines the importance of a fair process where scientific information, values and subjective experiences can be brought together to bear on the collective choice (Adger, 2004). Formally equal participation of states is not enough for this process: it requires the involvement of non-state actors which represent local views as well. Moreover, it demands measures to rectify inequalities between the states that originate from unequal levels of economic development, state capacity and access to human and other resources.

Determination of vulnerability shares many features with the determination of what constitutes dangerous climate change. But while the Convention process may decide to hear a broader range of interests and to rectify inequalities that prevent some states from participating fully, it has less power over the decisions of sovereign states regarding who is vulnerable and who should receive assistance and for what. The fairness of national adaptation planning under the Convention depends largely on national systems of governance, political and institutional cultures and democratic traditions. For example, a review of NAPA process in Bangladesh indicates that effective participatory planning for climate change requires functioning democratic structures (see Huq and Khan, in press). Where these are absent, planning for climate change is little more than rhetoric within a landscape of unsustainable development.

One possibility for extending the effective participation of local actors in the climate change regime in matters that affect them is to create a quasi-judicial subsidiary body which would adjudicate complaints and grievances related to the determination of vulnerability and allocation of assistance. While judgements made by this kind of international body do not have the same force of law as decisions issued by the courts of sovereign states, they could establish the international standard of practice. Adjudication could also help to detail international institutional solutions so as to respect the specificities of their application contexts. Findings according to which states are not in compliance with international agreements they have signed could also be considered a reason to suspend their benefits. This would give the judgements some teeth. But more than anything, adjudication would recognise the interests and grievances of local groups and generate systematic and reasoned resolutions which would serve as precedents to national actions in the future.

5. Conclusions

In this article we identify the social justice issues involved in adapting to climate change and examine to what extent the climate change regime resolves the dilemmas surrounding them. We also propose solutions for overcoming the gaps and ambiguities that prevail in the climate change regime with regard to justice in adaptation. The reason for us taking up this task is a shared view that social justice is an integral part of environmental governance which is best addressed explicitly and directly. Fears that doing so may escalate environmental conflicts are common but largely unwarranted. Quite the contrary, keeping social justice off the negotiating table denies the relevance and legitimacy of vulnerable actors' concerns and interests.

We argue that justice dilemmas involved in adaptation to climate change include responsibility for climate change impacts, the level and burden sharing of assistance to developing countries for adaptation, distribution of assistance between the recipient countries and adaptation measures, and equal participation in planning and making decisions on adaptation. The climate change regime largely omits the issue of responsibility but it makes a clear albeit very general commitment to assistance. The climate change regime has so far failed to operationalise assistance despite taking some steps to this direction. Moreover, the regime has made only minor progress in eliminating obstacles of fair participation at the international level and across levels of governance.

We propose that adopting the principles of avoiding dangerous climate change, forward-looking responsibility, putting the most vulnerable first and equal participation of all would be a step towards fairer adaptation. The first three principles address the dilemmas of distributive justice involved in adaptation in a way that respects the diversity of affected parties and their situations. The principle of avoiding dangerous climate change can provide a degree of absolute protection to all vital interests, the principle of forward-looking responsibility gives effect to efficiency concerns and the principle of putting the most vulnerable first justifies progressive redistribution to those who are most in need. The last principle provides a guideline for resolving dilemmas of procedural justice, suggesting that all affected parties have rights, which have to be respected by recognition and participation.

We also argue that a safe maximum standard of 400–500 ppm for atmospheric CO_2 concentrations and a tax of $20–50 per carbon equivalent ton could be used to implement the principles of distributive justice. The safe maximum standard is needed to provide the absolute safety net and to constrain the sphere of economic optimisation. The carbon tax provides powerful incentives for mitigation and thus the reduction of climate change impacts as well as an instrument to accumulate revenue for compensation and assistance. Making these funds available for proactive and reactive adaptation in developing countries would in turn diminish the residual impacts that need to be compensated. At the same time, burden of assistance would be shared in proportion to contribution to climate change.

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References

Adger, W.N., 1999. Social vulnerability to climate change and extremes in coastal Vietnam. World Development 27, 249–269.

Adger, W.N., 2003. Social capital, collective action and adaptation to climate change. Economic Geography 79, 387–404.

Adger, W.N., 2004. The right to keep cold. Environment and Planning A 36, 1711–1715.

Adger, W.N., Huq, S., Brown, K., Conway, D., Hulme, M., 2003. Adapting to climate change: in the developing world. Progress in Development Studies 3, 179–195.

Allen, M.R., 2003. Liability for climate change: will it ever be possible to sue anyone for damaging the climate? Nature 421, 891–892.

Allen, M.R., Lord, R., 2004. The blame game: who will pay for the damaging consequences of climate change? Nature 432, 551–552.

Arler, F., 2001. Global partnership, climate change and complex equality. Environmental Values 10, 301–329.

Attfield, R., 2005. Environmental values, nationalism, global citizenship and the common heritage of humanity. In: Paavola, J., Lowe, I. (Eds.), Environmental Values in a Globalising World: Nature, Justice and Governance. Routledge, London, pp. 38–50.

Azar, C., 2000. Economics and distribution in the greenhouse. Climatic Change 47, 233–238.

Baer, P., in press. Adaptation: who pays whom? In: Adger, W.N., Paavola, J., Huq, S., Mace, M.J. (Eds.), Fairness in Adaptation to Climate Change. The MIT Press, Cambridge, MA.

Baer, P., Harte, J., Haya, B., Herzog, A.V., Holdren, J., Hultman, N.E., Kammen, D.M., Norgaard, R.B., Raymond, L., 2000. Climate change: equity and greenhouse gas responsibility. Science 289, 2287.

Barry, B., 1999. Sustainability and intergenerational justice. In: Dobson, A. (Ed.), Fairness and Futurity: Essays in Environmental Sustainability and Social Justice. Oxford University Press, Oxford, pp. 93–117.

Bell, D.A., 1993. Communitarianism and its Critics. Clarendon Press, Oxford.

Bohle, H.G., Downing, T.E., Watts, M.J., 1994. Climate change and social vulnerability: toward a sociology and geography of food insecurity. Global Environmental Change 4, 37–48.

Bromley, D.W., 2004. Reconsidering environmental policy: prescriptive consequentialism and volitional pragmatism. Environmental and Resource Economics 28, 73–99.

Brooks, N., Adger, W.N., Kelly, P.M., 2005. The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. Global Environmental Change 15, 151–163.

Burton, I., Huq, S., Lim, B., Pilifosova, O., Schipper, E.L., 2002. From impacts assessment to adaptation priorities: the shaping of adaptation policy. Climate Policy 2, 145–159.

Ciriacy-Wantrup, S.V., 1952. Resource Conservation: Economics and Policies. University of California Press, Berkeley, CA.

Dessai, S., Schipper, E.L., 2003. The Marrakech accords to the Kyoto Protocol: analysis and future prospects. Global Environmental Change 13, 149–153.

Dessai, S., Adger, W.N., Hulme, M., Turnpenny, J., Köhler, J., Warren, R., 2004. Defining and experiencing dangerous climate change. Climatic Change 64, 11–25.

Dhainaut, J.-F., Claessens, Y.-E., Ginsburg, C., Riou, B., 2004. Unprecedented heat-related deaths during the 2003 heat wave in Paris: consequences on emergency departments. Critical Care 8, 1–2.

Driesen, D.M., 2003. The Economic Dynamics of Environmental Law. The MIT Press, Cambridge, MA.

Fankhauser, S., Tol, R.S.J., 1996. Climate change costs—recent advancements in the economic assessment. Energy Policy 24, 665–673.

Fankhauser, S., Smith, J.B., Tol, R.S.J., 1999. Weathering climate change: some simple rules to guide adaptation decisions. Ecological Economics 30, 67–68.

Farmer, M.C., Randall, A., 1998. The rationality of a safe minimum standard. Land Economics 74, 287–302.

Fraser, N., 2001. Recognition without ethics? Theory, Culture & Society 18 (2–3), 21–42.

Gowdy, J., 2004. The revolution in welfare economics and its implications for environmental valuation and policy. Land Economics 80, 239–257.

Gupta, J., 2002. The climate change regime: can a divided world unite? In: Briden, J.C., Downing, T.E. (Eds.), Managing the Earth: The Linacre Lectures. Oxford University Press, Oxford, pp. 129–155.

Guranko, E.N., 2003. Introduction to the World Bank insurance practice: key lessons learned and the road ahead. A Presentation at Financing the Risks of Natural Disasters Conference Washington DC, 2–3 June, 2003. Available online at http://www.worldbank.org/wbi/banking/insurance/natdisaster/pdf/Gurenko.ppt. Accessed November 9, 2004.

Hayek, F.A., 1976. Law, Legislation and Liberty: the Mirage of Social Justice. Routledge and Kegan Paul, London.

Helm, C., Simonis, U.E., 2001. Distributive justice in international environmental policy: axiomatic foundation and exemplary formulation. Environmental Values 10, 5–18.

Huq, S., 2002. The Bonn–Marrakech agreements on funding. Climate Policy 2, 243–246.

Huq, S., Khan, M.R., in press. Equity in National Adaptation Plans of Action (NAPAs): the case of Bangladesh. In: Adger, W.N., Paavola, J., Huq, S., Mace, M.J. (Eds.), Fairness in Adaptation to Climate Change. The MIT Press, Cambridge, MA.

Jamieson, D., 2001. Climate change and global environmental justice. In: Miller, C.A., Edwards, P.N. (Eds.), Changing the Atmosphere: Expert Knowledge and Environmental Governance. The MIT Press, Cambridge, MA, pp. 287–307.

Kandlikar, M., Risbey, J., 2000. Agricultural impacts of climate change: if adaptation is the answer, what is the question? Climatic Change 45, 529–539.

Kasperson, R.E., Kasperson, J.X., 2001. Climate Change, Vulnerability and Social Justice. Stockholm Environment Institute, Stockholm.

King, D.A., 2004. Climate change science: adapt, mitigate, or ignore? Science 303, 176–177.

Klinenberg, E., 2002. Heat Wave: A Social Autopsy of Disaster in Chicago. University of Chicago Press, Chicago.

Kolm, S.-C., 1996. Modern Theories of Justice. The MIT Press, Cambridge, MA.

Krasner, S.D., 1982. Structural causes and regime consequences: regimes as intervening variable. International Organization 36, 185–205.

Lash, S., Featherstone, M., 2002. Recognition and Difference: Politics, Identity, Multiculture. Sage Publications, London.

Leary, N.A., 1999. A framework for benefit cost analysis of adaptation to climate change and climate variability. Mitigation and Adaptation Strategies for Global Change 4, 307–318.

Lind, E.A., Tyler, T.R., 1988. The Social Psychology of Procedural Justice. Plenum Press, New York.

Mastrandrea, M.D., Schneider, S.H., 2004. Probabilistic integrated assessment of "dangerous" climate change. Science 304, 571–575.

Melkas, E., 2002. Sovereignty and equity within the framework of the climate regime. Review of European Community and International Environmental Law 11, 115–128.

Michelozzi, P., de' Donato, F., Accetta, G., Forastiere, F., D'Ovidio, M., Perucci, C., Kalkstein, L., 2004. Impact of heat waves on mortality—Rome, Italy, June–August 2003. Morbidity and Mortality Weekly Report 53 (17), 369–371.

Müller, B., 2001. Varieties of distributive justice in climate change: an editorial comment. Climatic Change 48, 273–288.

Mwandosya, M.J., 1999. Survival Emissions: A Perspective from the South on Global Climate Change Negotiations. Dar Es Salaam University Press, Dar Es Salaam.

Neumayer, E., 2000. In defense of historical accountability for greenhouse gas emissions. Ecological Economics 33, 185–192.

Norton, B., 2002. The ignorance argument: what must we know to be fair to the future? In: Bromley, D.W., Paavola, J. (Eds.), Economics, Ethics and Environmental Policy: Contested Choices. Blackwell, Malden, MA, pp. 35–52.

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

O'Brien, K.L., Leichenko, R.M., 2000. Double exposure: assessing the impacts of climate change within the context of economic globalization. Global Environmental Change 10, 221–232.

O'Brien, K.L., Leichenko, R.M., 2003. Winners and losers in the context of global change. Annals of the Association of American Geographers 93, 89–103.

O'Brien, K., Leichenko, R., Kelkar, U., Venema, H., Aandahl, G., Tompkins, H., Javed, A., Bhadwal, S., Barg, A., Nygaard, L.P., West, J., 2004. Mapping vulnerability to multiple stressors: climate change and globalization in India. Global Environmental Change 14, 303–313.

O'Neill, B.C., Oppenheimer, M., 2002. Climate change—dangerous climate impacts and the Kyoto Protocol. Science 296, 1971–1972.

O'Neill, J., 2001. Representing people, representing nature, representing the world. Environment and Planning C: Government and Policy 19, 483–500.

Paavola, J., 2002a. Rethinking the choice and performance of environmental policies. In: Bromley, D., Paavola, J. (Eds.), Economics, Ethics, and Environmental Policy: Contested Choices. Blackwell, Malden, MA, pp. 87–102.

Paavola, J., 2002b. Environment and development: dissecting the connections. Forum for Development Studies 29 (1), 5–32.

Paavola, J., 2005. Interdependence, pluralism and globalisation: implications for environmental governance. In: Paavola, J., Lowe, I. (Eds.), Environmental Values in a Globalising World: Nature, Justice and Governance. Routledge, London, pp. 143–158.

Parry, M., Arnell, N., Hulme, M., Nicholls, R., Livermore, M., 1998. Adapting to the inevitable. Nature 395, 741.

Paterson, M., 2001. Principles of justice in the context of global climate change. In: Luterbacher, U., Sprinz, D.F. (Eds.), International Relations and Global Climate Change. The MIT Press, Cambridge, MA, pp. 119–126.

Pielke Jr., R.A., 1998. Rethinking the role of adaptation in climate change. Global Environmental Change 8, 159–170.

Ringius, L., Asbjørn, T., Underdal, A., 2002. Burden sharing and fairness principles in international climate policy. International Environmental Agreements: Politics, Law and Economics 2, 1–22.

Risbey, J., Kandlikar, M., Dowlatabadi, H., Graetz, D., 1999. Scale, context and decision-making in agricultural adaptation to climate variability and change. Mitigation and Adaptation Strategies for Global Change 4, 137–165.

Rose, A.Z., Stevens, B., Edmonds, J., Wise, M., 1998. International equity and differentiation in global warming policy. Environmental and Resource Economics 12, 25–51.

Roughgarden, T., Schneider, S.H., 1999. Climate change policy: quantifying uncertainties for damages and optimal carbon taxes. Energy Policy 27, 415–429.

Schär, C., Jendritzky, G., 2004. Climate change: hot news from summer 2003. Nature 432, 559–560.

Schlosberg, D., 1999. Environmental Justice and the New Pluralism: the Challenge of Difference for Environmentalism. Oxford University Press, Oxford.

Sen, A., 1992. Inequality Reexamined. Russell Sage Foundation, New York, and Clarendon Press, Oxford.

Shrader-Frechette, K., 2002. Environmental Justice: Creating Equality, Reclaiming Democracy. Oxford University Press, Oxford.

Smit, B., Burton, I., Klein, R.J.T., Wandel, J., 2000. An anatomy of adaptation to climate change and variability. Climatic Change 45, 223–251.

Smit, B., Pilifosova, O., 2003. From adaptation to adaptive capacity and vulnerability reduction. In: Smith, J.B., Klein, R.J.T., Huq, S. (Eds.), Climate Change, Adaptive Capacity and Development. Imperial College Press, London, pp. 9–28.

Smith, J., 1997. Setting priorities for adapting to climate change. Global Environmental Change 7, 251–264.

Soyinka, W., 2004. A Quest for Dignity. Fourth Reith Lecture on Climate of Fear, University of Leeds, broadcast on BBC4 24 April, 2004, 8 pm. Available online at http://www.bbc.co.uk/radio4/reith2004/schedule.shtml (Accessed 29 April 2004).

Spash, C., 2002. Greenhouse Economics: Value and Ethics. Routledge, London.

Stott, P.A., Stone, D.A., Allen, M.R., 2004. Human contribution to the European heatwave of 2003. Nature 432, 610–614.

Thomas, C.D., Cameron, A., Green, R.E., Bakkenes, M., Beaumont, L.J., Collingham, Y.C., Erasmus, B.F.N., de Siqueira, M.F., Grainger, A., Hannah, L., Hughes, L., Huntley, B., van Jaarsveld, A.S., Midgley, G.F., Miles, L., Ortega-Huerta, M.A., Peterson, A.T., Phillips, O.L., William, S.E., 2004. Extinction risk from climate change. Nature 427, 145–148.

Tol, R.S.J., Fankhauser, S., Smith, J.B., 1998. The scope for adaptation to climate change: what can we learn from the impact literature? Global Environmental Change 8, 109–123.

Tol, R.S.J, Downing, T.E., Kuik, O.J., Smith, J.B., 2004. Distributional aspects of climate change impacts. Global Environmental Change 14, 259–272.

Tyler, T.R, Boeckmann, R.J., Smith, H.J., Huo, Y.J., 1997. Social Justice in a Diverse Society. Westview Press, Boulder, CO.

United States Energy Information Agency, 2004. International carbon dioxide emissions from the consumption and flaring of fossil fuels information. Available online http://www.eia.doe.gov/emeu/international/environm.html#Data. Accessed 10 November, 2004.

Verheyen, R., 2002. Adaptation to the impacts of anthropogenic climate change: the international legal framework. Review of European Community and International Environmental Law 11, 129–143.

Walzer, M., 1983. Spheres of Justice: A Defence of Pluralism and Equality. Blackwell, Oxford.

Wisner, B., Blaikie, P., Cannon, T., Davis, I., 2004. At Risk: Natural Hazards, People's Vulnerability and Disasters, 2nd edition. Routledge, London.

Yohe, G., Tol, R.S.J., 2002. Indicators for social and economic coping capacity—moving toward a working definition of adaptive capacity. Global Environmental Change 12, 25–40.

Yohe, G., Andronova, N., Schlesinger, M., 2004. To hedge or not against an uncertain climate future? Science 306, 416–417.

Young, H.P., 1994. Equity: In Theory and Practice. Princeton University Press, Princeton.

Young, O.R., 1994. International Governance: Protecting the Environment in a Stateless Society. Cornell University Press, Ithaca.

Young, I.M., 2000. Inclusion and Democracy. Oxford University Press, Oxford.