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CLIMATE DANGERS AND ATOLL COUNTRIES

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Abstract. Climate change-induced sea-level rise, sea-surface warming, and increased frequency and intensity of extreme weather events puts the long-term ability of humans to inhabit atolls at risk. We argue that this risk constitutes a dangerous level of climatic change to atoll countries by potentially undermining their national sovereignty. We outline the novel challenges this presents to both climate change research and policy. For research, the challenge is to identify the critical thresholds of change beyond which atoll social-ecological systems may collapse. We explain how thresholds may be behaviorally driven as well as ecologically driven through the role of expectations in resource management. The challenge for the international policy process, centred on the UN Framework Convention on Climate Change (UNFCCC), is to recognize the particular vulnerability of atoll countries by operationalising international norms of justice, sovereignty, and human and national security in the regime.

1. Introduction

The Small Island States chapter of the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) implicitly concludes that climate change-induced sea-level rise, sea-surface warming, and increased frequency and intensity of extreme weather events puts at risk the long-term ability of humans to inhabit low-lying atolls (Nurse and Sem, 2001). In this paper we explore the research challenges and policy implications of this risk from an interdisciplinary social-science perspective. For climate change research the challenge is to identify the critical thresholds of change beyond which atoll social-ecological systems in particular may be seriously compromised, and we focus here on some important social thresholds. For the international policy process, centred on the UN Framework Convention on Climate Change (UNFCCC), a possible future in which atoll countries become effectively uninhabited radically challenges international norms of justice, sovereignty, and human and national security. We argue that if it occurs, the point at which sovereign atoll countries become effectively uninhabitable clearly constitutes a dangerous level of climatic change.

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2. Climate Impacts on Atoll Countries

Atolls are rings of coral reefs that enclose a lagoon. Around the rim of the reef there are islets called *motu* with a mean height above sea-level of approximately two meters (Nunn, 1994). Worldwide there are five countries comprised entirely of low-lying atolls: Kiribati (population 78,000), the Maldives (population 269,000), the Marshall Islands (population 58,000), Tokelau (population 2000), and Tuvalu (population 9000) (Secretariat of the Pacific Community, 2000; UNCTAD, 1999). With the exception of Tokelau (a dependent territory of New Zealand), these are all sovereign states. Kiribati, the Maldives and Tuvalu are official 'Least Developed Countries' (LDC) in the United Nations system.

Atolls have common environmental problems that render them particularly vulnerable to climate change. They generally have very high population densities, meaning that large numbers of people are potentially exposed to single events (909 people/km^2 in the Maldives) (UNCTAD, 2002). Water reserves on atolls are restricted to a narrow subterranean freshwater lens easily contaminated by salt water and human and industrial wastes (UNEP, 1999). These freshwater lenses become depleted in times of low rainfall. Atoll islands typically face coastal erosion as a result of exploitation of beaches for building materials, while construction of sea walls and infrastructure and waste dumping on reefs and mangroves undermines the ecological functions on which these island systems depend (Moberg and Folke, 1999). Coastal developments and pollution have also lead to depletion of artisanal fisheries (UNEP, 1999).

Overall, their small size, isolation, generally low levels of income, and relatively low levels of physical infrastructure make atoll countries apparently vulnerable to global economic forces as well as to climatic changes (Brautigam and Woolcock, 2001; Commonwealth Secretariat, 1999). The atoll countries are relatively more vulnerable in terms of economic structure and, on average, more food insecure than other small island developing states, as demonstrated in Figure 1. These parameters of underlying economic vulnerability can, however, be questioned for subsistence economies which are often more resilient, at least to weather extremes and climatic change, than suggested by their economic structure (Smith and Wishnie, 2000). Nevertheless, when combined with sensitivity to climatic changes, this underlying economic vulnerability creates the necessity for large-scale adaptation for the atoll countries.

The 'commitment' to climate change caused by greenhouses gases already present in the atmosphere means that the small island states in the Pacific, Indian Ocean and Caribbean regions are projected to experience a certain degree of environmental change. A mean annual warming of 2 °C or higher by the 2050s and 3 °C for the 2080s is projected, and modest declines in annual precipitation in the Pacific Ocean region are also expected along with heavier rainfall intensity (Lal et al., 2002). Given emissions of greenhouse gases up to 1995, a 5–12 cm rise in sea-level is inevitable (Jones, 1999). However, even if all countries met their

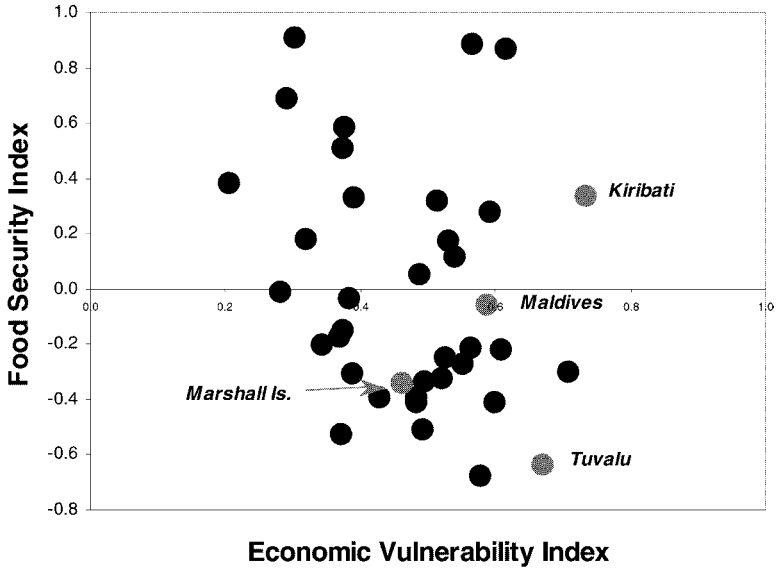

Figure 1. Economic vulnerability and food insecurity of small-island states and atoll nations. Food security is a normalised weighted index comprising national food shortage (food availability per capita); household food poverty (GNP per capita); individual food deprivation (based on FAO data) following Downing (1992). The data are from FAO sources and include national food production and imports per capita, GNP per capita, and calorific intake per capita. Economic vulnerability is an index constructed to comprise economic openness, the costs of remoteness and level of diversity in the economy. It is estimated in a normalised weighted index procedure of nine variables representing openness, remoteness and diversity, including export concentration and intensity, freight and insurance costs as a percentage of imports, proportion of net energy imports and dependence on overseas development assistance. Data are from UNCTAD and World Bank sources and the index follows the economic vulnerability index for small islands developed by the Caribbean Development Bank (Crowards, 1999). Data not available for Tokelau.

Kyoto Protocol commitments, and if all emissions of greenhouse gases ceased after 2020, a sea-level rise of 14–32 cm is very likely (Jones, 1999). Taking into account emissions beyond 2020, sea-level is projected to rise by between 9 and 88 cm by 2100 (Houghton et al., 2001). Atoll countries are the most physically vulnerable to sea-level rise of all small island states because of their high ratio of coastline to land area, relatively high population densities, and low level of available resources for adaptive measures (as measured by national income per capita) (Figure 2).

It is not sea-level rise *per se*, but rather projected increases in sea-surface temperature (SST) that poses the greatest long-term risk to atoll morphology. Coral reefs are crucial to the formation and maintenance of atoll motu, and they are highly sensitive to sudden changes in SST. The impact of climate change on SST is arguably already evident, with episodes of mass coral reef mortality through coral bleaching experienced around the world (Reaser et al., 2002). Some evidence suggests that tropical SSTs have been rising over a 50-year period, and in 1998 SSTs reached the highest on record during the change from a major El Niño to a major

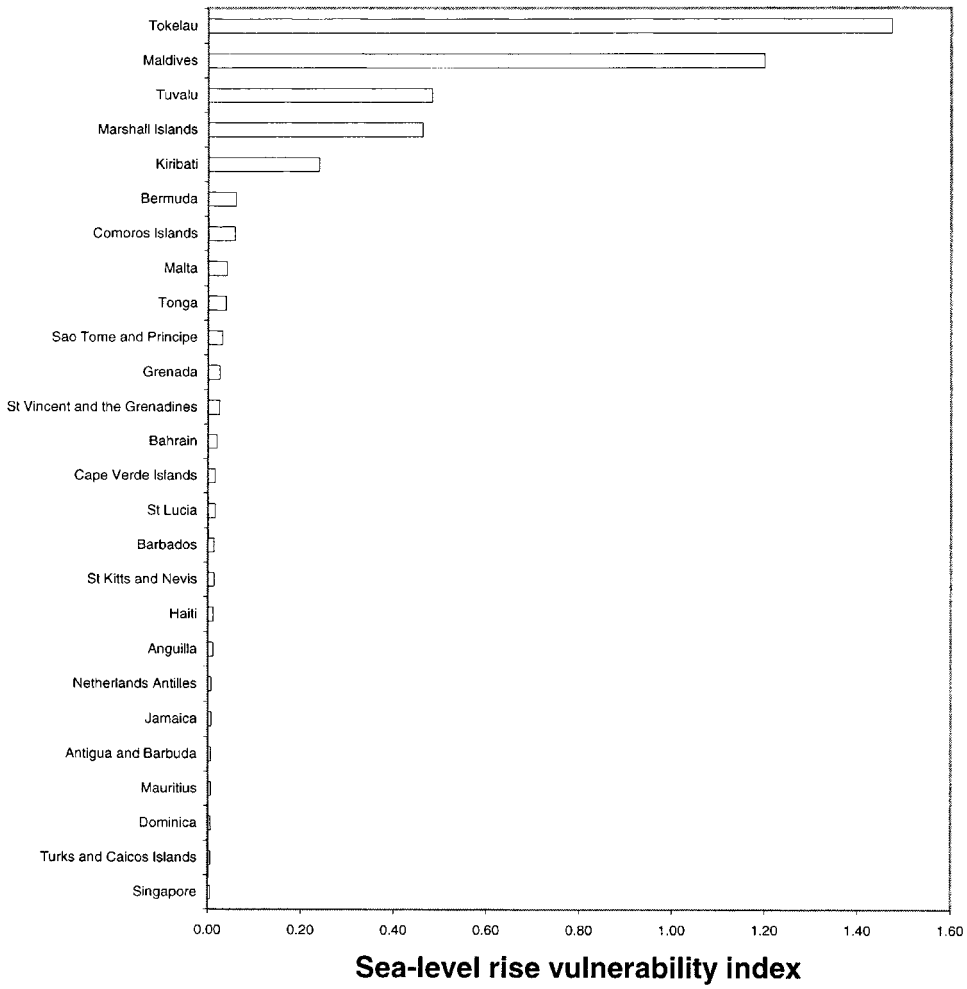

Figure 2. Vulnerability to sea-level rise of selected small-island states including atoll nations. The index is comprised of coastline length divided by land area multiplied by population density to deliver a coastal vulnerability index (adapted from Gommes et al., 1998), GDP per capita is taken as an indicator of adaptive capacity and divided by the coastal vulnerability index to deliver the overall sea-level rise vulnerability index. This figure is used to indicate the relative vulnerability of atoll countries to other small island states. It does not take account of the many different elements of adaptive capacity not captured in the GDP per capita proxy, nor does it take account of the different geomorphological properties of coasts.

La Niña event (Reaser et al., 2002). In the same year coral reefs around the world suffered the most severe bleaching on record. Large scale bleaching episodes, such as the 1998 El Niño event, are usually attributable to high sea-surface temperatures and low light conditions. Periodic natural disturbance is increasingly believed to be an important element promoting the diversity and resilience of coral reef ecosystems (Nyström et al., 2000). However, when severe and frequent distur-

Potential loss of land area due to rising sea-levels
Shifts in species competition and composition
Coral reefs, mangroves and seagrass adversely affected, with negative affect on reef fish populations
Increased salinisation of soils in coastal margins
Increasingly variable rainfall, with more intense drought events
Increase in cyclone intensity with larger storm waves and more intense flooding events
Adverse effects on staple crops due to changes in soil moisture, salinity and rainfall
Decline in food security due to adverse effects on crops on declining reef fish populations
Coastal erosion and changing climatic conditions may adversely affect tourism
Adverse economic impacts through infrastructure damage from increased intensity of extreme events, coastal protection measures, and decline in tourism income
Decline in human health through vector-borne diseases and enhanced food insecurity

Figure 3. Summary of potential impacts of climate change on atoll countries (after Nurse and Sem, 2001).

bances above the periodic natural rate occur, coral reef resilience is reduced and the ability of reefs to grow in step with sea-level rise is severely impeded. Rising concentrations of CO_2 in the oceans may also retard the ability of reefs to grow in step with sea-level rise (Kleypas et al., 1999).

So, without coral bleaching, reefs would possibly be able to grow apace with rising sea-levels (Brown et al., 2000). But they are not expected to be able to sustain themselves with the combined impact of projected sea level rise, with projected increases in bleaching episodes, and with the additional stressors such as increased land-based sources of pollution and increased atmospheric concentration of CO_2 (Westmacott et al., 2000). Due to coastal erosion and a reduction in resilience of corals, the net impact on atoll societies are likely to be increases in flooding events, freshwater aquifers becoming increasingly contaminated with saline water from storm surges and seepage, and decreasing productivity from agriculture and artisanal fishing.

Sea-level rise is a mid- to long-term problem for atoll countries. But the more immediate problems are likely to arise from enhanced climatic variability and extreme weather events (McCarthy et al., 2001) (Figure 3). As with coral reef health, the negative impacts from these changes will be exacerbated due to existing stresses caused by unsustainable development. The impacts of enhanced climatic variability and extreme weather events may in themselves constitute a 'dangerous' level of climate change to atoll social-ecological systems before, and regardless of, sea-level rise.

Water resources are likely to be increasingly stressed in the future through a shift to more intense rainfall events and possibly more intense droughts. In 2080 flood risk is expected to be in the order of 200 times greater than at present for

Pacific atoll countries (Nicholls et al., 1999). Whilst it is still highly uncertain, some modeling studies suggest that cyclones may be more intense if not more frequent (Cubasch and Meehl, 2001). Climatic variability is linked to El Niño Southern Oscillation (ENSO) events, and whilst also very uncertain, some models suggest that these too may be becoming more frequent and intense as a function of climate change (Cubasch and Meehl, 2001).

Climate variability and the impacts of extreme weather events means that artisanal fisheries are likely to decline as episodes of coral bleaching increase, and the location of deep water fish may become increasingly unpredictable as there is reasonable confidence that changed migration patterns are linked to ENSO events (McLean and Tsyban, 2001). Agricultural output is also susceptible to damage through increased heat stress on plants, changes in precipitation and soil moisture, salt water incursion from rising sea-levels, and increased damage from extreme weather events. In conjunction with the likely increased spread of vector borne diseases and more frequent and severe extreme events, this greater food insecurity is likely to degrade human health in the Pacific region. Climate change will have substantial impacts on the economies of atoll countries. The World Bank estimates that by 2050 Tarawa atoll in Kiribati could face an annual damages bill equivalent to 13–27% of current Kiribati GDP (World Bank, 2000).

So, if they occur, the adverse effects of climate change on atolls are most likely to take the form of multiple and sequential stresses to social-ecological systems arising from extreme events such as cyclones and storm surges, and droughts (Barnett and Busse, 2002). These may have more serious impacts on local and collective well-being when superimposed on climate-induced declines in food security (through a combination of decreased local production of fish and land-based crops, and decreasing ability to pay for food imports through economic contraction), deteriorating human health, reduced availability of fresh water, and coastal erosion (see also O'Shea, 2001).

This combination of changes in mean conditions and extreme events may mean that ultimately, atoll environments may be unable to sustain human habitation, a possibility with even a moderate amount of climate change over the next century. Should low-probability yet high-impact changes occur (such as melting of the Antarctic ice sheet), then this would almost certainly result in atolls becoming uninhabitable (IPCC, 2001). Thus, former IPCC Chair Robert Watson has said that low-lying small island states face 'the possible loss of whole cultures' through the impacts of climate change (Watson, 2000). This summary of impacts of climate change on atolls raises questions about the capacity of atoll-societies to adapt to potentially dangerous climate change, and the justice issues attend these disproportionate risks. These are now examined in turn.

3. Dangerous Climate Change and Sustainable Adaptive Capacity

The potential impacts of climate change outlined above suggest that the physical basis of national sovereignty of the atoll countries (broadly defined as the right to self determination) is at risk.* The human rights of people living in atoll countries are also clearly at risk. In the case of atoll countries and climate change there is little distinction between national sovereignty and human rights, a distinction which has traditionally concerned international law. Small atoll countries have a high degree of ethnic homogeneity and high population density, meaning there is little political distance between the people and the nation-state. So, the impact of climate change on people is immediately an impact on the nation-state, and we argue that climate change puts national sovereignty is at risk precisely because of the way it may impact on human welfare and human rights.

This risk that climate change poses to national sovereignty is a particular, political form of the 'dangerous' level of change referred to in the UNFCCC's ultimate objective, which is 'to stabilise greenhouse gas concentrations at a level that would prevent dangerous anthropogenic interference with the climate system' (Article 2). It is also a very clear case of human and national environmental insecurity (Barnett, 2001a).

There is as yet no agreed definition of 'danger' for the purposes of Article 2 of the UNFCCC. Ultimately 'danger' is defined in terms of perceptions of insecurity and through climate change putting that which is deemed important at risk. All perceptions of danger are therefore constructed by context and cognitive processes of risk formulation. Any *a priori* definition of 'danger' will always therefore be arbitrary in some sense (Dessai et al., 2003). This is not a call for inaction. Clearly the UNFCCC needs to tackle the issue of danger by defining it in place and time – what is being put in danger and with what consequences? Within an international legal process between Parties (States), one obvious delimitations of danger is the serious risk climate change poses to the sovereignty of some of these Parties.

* An interesting issue here is whether small island states will retain sovereign jurisdiction over their Exclusive Economic Zones should changes sea-level mean a change in the status of islands or archipelagos used to determine the EEZ boundary. This principally relates to UN Convention on the Law of the Sea (UNCLOS). This is an important point which has yet to be seriously addressed. We believe it unlikely that an island or archipelago which is currently defined as such under UNCLOS would automatically lose this status due to sea-level rise. Any change would require a decision by Parties to UNCLOS, of whom small island states represent some 20%, and therefore have considerable voting power. It is therefore less a matter of law and more a matter of politics. However we note that in the longer term of a century or more, potentially increased demand for access to fishing stocks and sea-bed minerals, coupled with significantly higher sea-levels and potentially abandoned islands, may mean significant political pressure to redefine EEZs. Pacific Island Countries are aware of this issue, as expressed in the 1999 Vava'u workshop on the implementation of UNCLOS, where the formal recommendations acknowledged the problem of sea-level rise, and called for efforts 'to ensure that rights to maritime zones and air spaces as established, should be retained under international law as a useful asset for displaced people' (http://www.vanuatu.usp.ac.fj/pactreaties/Treaties_etc/treaties_Vava'u_Recommendation.html).

The risk to atoll countries challenges the ability of science to predict and prevent dangerous thresholds of climate change (Jones, 2000). The threshold of ultimate concern is that point at which atolls will no longer be able to sustain human habitation. Thus there is a need to engage in impact assessments that consider the full range of biophysical, social, and biophysical-social interactions at all relevant scales to understand the nature of thresholds, and to link these thresholds to greenhouse gas stabilisation levels (e.g., 450, 550 ppm) (Jones, 2000). Methods designed for global and regional assessments, such as general circulation models and integrated assessment models, fail to capture the most important elements of impact and adaptation strategies on atolls. There is a need to explore empirically the effects of climate change at the local level, as well as to incorporate the culturally-specific adaptive capacity of diverse and potentially resilient atoll societies (Kaluwin and Smith, 1997; on resilience and environmental change see Adger, 2000; Barnett, 2001b; Folke et al., 2002).

The thresholds of dangerous climate change are, we argue, manifest in behaviour and risk as well as in physical parameters. So, for example, rates of international migration from atoll countries threatened with climate change may pass a critical threshold that constitutes danger for a society. This may arise through increasing dependency on remittances rather than domestic production for income, or social and cultural impacts of migration. Historically, migration patterns from atoll countries in the Pacific and from other small island nations have been shown to contribute to the resilience of these societies when faced with stresses such as hurricane impacts (Paulson and Rogers, 1997). On even longer timescales, major climatic and other resource changes have been borne by societies through major shifts in location, where whole populations have moved islands, or through alterations in resource management practices (Bayliss-Smith et al., 1988; Haberle and Lusty, 2000). So, migration in the small island context has contributed to maintaining a sustainable resource base and social structure (Connell and Conway, 2000). But ultimately a threshold may be reached which pushes the social system from previously sustainable international migration into complete abandonment. This is in effect a breakdown in social and ecological resilience caused by a major perturbation in the physical system compounded by the breakdown of institutions that could facilitate adaptation (see Carpenter et al., 2001; Folke et al., 2002). These thresholds will be breached by absolute resource scarcity on the islands, by self-perpetuating socially and culturally erosive fragmentation, or by decreased resilience to adverse effects from droughts or storm surges due to cultural change and capital shortages and dependencies.

Many small island societies have proved resilient in the past to social and environmental upheaval (Bayliss-Smith et al., 1988). The key parameters of this resilience include: traditional knowledge, institutions and technologies; opportunities for migration and subsequent remittances; land tenure regimes; the subsistence economy; and linkages between formal state and customary decision-making processes (Barnett, 2001b). However, this resilience may well be being undermined

as small island states increasingly become integrated into the world economy, primarily through commercial exploitation of their Exclusive Economic Zones and through international tourism (Pelling and Uitto, 2001). Forces of globalisation, regional integration, and national policy changes can interact with and effect adaptive capacity in important ways (O'Brien and Lichenko, 2000). Colding and colleagues, for example, argue that the observed decline in polyculture or multiple cropping in agriculture and moves towards cash crops in many Pacific island nations stems from interaction with the global market economy combined with decreases in security of tenure (Colding et al., 2003; Clarke and Thaman, 1993). This decline is an important element in undermining resilience to weather extremes since advanced polyculture systems, with annual crops mixed with shrub and tree multiple-cropping provide numerous ecosystem services, as well as food and income, but crucially are much less prone to devastation from the frequent cyclone impacts (Elmqvist, 2000).

The confidence of foreign investors, aid agencies and atoll people themselves in the ability of atolls to sustain future human occupation represents an important critical threshold. The threat of future serious climate impacts can undermine present sustainable resource use in two major ways. First, given the prospect of ultimate abandonment due to climate change, the theoretical optimal exploitation rate for renewable and non-renewable resources may be something less than the sustainable rate since future resource availability is no longer a consideration. A key question is whether this theoretical optimal strategy is actually occurring and whether the institutions of resource management can cope with negative expectations. This unsustainable resource use may create a feedback that undermines ecological and social capacity to adapt to climate change. The institutions for collective action in resource management will tend to change their practices when there are expectations of future resource degradation (Adger, 2003; Arnold, 1998). Often previously sustainable coastal management practices based on collective action can be undermined by such expectations. This has been evident in tourism development in the Maldives where the tourism sector adopts a frontier resource use strategy, opening new atolls to tourism as the tourism life cycle seeks pristine beaches and waters. Such development is in effect the open access use of scarce resources and has been shown to lead to the deterioration of water quality as well as substantial alterations in cultural practices (Brown et al., 1997).

Second, should foreign investors and aid agencies believe that atolls will cease to be able to sustain human populations in the future, then investment and aid may cease to flow into atoll countries. The government of Tuvalu, for example, may well have undermined investor confidence by negotiating migration rights to New Zealand for nearly all of that country's population in the event of serious climate change impacts. A decline in foreign investment (and aid) is likely to undermine sustainable development and capacity to adapt to climate change. A precursor of this possibility is the increasing withdrawal of insurance coverage for climatic extremes (Edwards, 1999; Stripple, 1999).

Through these processes, the result of lost confidence in atoll-futures may be the end of the habitability of atolls. But this could, we argue, be brought about less by the physical impacts of climate change *per se*, and more by a common expectation of serious climate impacts leading to changes in domestic resource use and decreased assistance from abroad.

There are two implications for climate change research of this issue of confidence thresholds. First, the prevailing emphasis of research on vulnerability is conducive to a loss of confidence as it focuses on weaknesses and shortcomings rather than inherent strengths and opportunities (Campbell, 1997). This can be avoided by framing research in terms of risk and resilience rather than vulnerability. Second, the highest standards of uncertainty management are necessary. Estimates of severe change need to be subjected to a higher level of certainty given their potential effects on confidence, and extant uncertainties need to be clearly and forcefully stated. Shifting the emphasis of impact assessment to risk assessment with explicit quantification of uncertainties is therefore desirable (Jones, 2001).

Such a risk and uncertainty-based approach does not mean that the impacts of climate change are so uncertain as to prevent inaction on either mitigation of emissions or adaptation. The precautionary principle enshrined in Article 3.3 of the UNFCCC still applies, efforts to reduce greenhouse gas emissions should continue, as should policies to facilitate adaptation.

The 1987 Montreal Protocol on Substances that Deplete the Ozone Layer is germane to the problem of uncertainty and action in the UNFCCC. Its relevance arises in the simple sense that ozone depletion is a global scale atmospheric problem arising from emissions of damaging substances, and because ozone depletion was addressed through a multilateral treaty. In a more complex sense, what is relevant is that the Montreal Protocol was negotiated, and implemented, despite there being scientific uncertainty about the magnitude and implications of the problem at the time (although like climate change the theoretical basis of the problem was not really in despite). Informed by the precautionary principle, Parties to the Montreal Protocol nevertheless committed themselves to begin reducing emissions of ozone depleting substances, and they instigated further research to determine the extant uncertainties (Hurlbut, 1993). It was not until later that the uncertainties were reduced, revealing the problem to be more significant than first realized and vindicating the precautionary approach. So, States can and do act in precautionary ways in the face of scientific uncertainty, and while reducing greenhouse gas emissions is a far more complex policy problem than reducing ozone depleting substances, this does not obviate the dangers of climate change and the need to act in a precautionary manner.

4. Justice in Global Climate Policy

In climate policy research, debates over fairness predominantly concern the equitable distribution of costs of emissions reduction measures rather than consideration of equity in the burden of impacts (Azar, 2000; Hamaide and Boland, 2000; Ringius et al., 2002).* Analyses of burdens of impacts and emission reduction measures are defined largely in outcome terms often based on the assumption that there can be an optimisation of competing values. However, the risk of the loss of atoll countries is incommensurable with economic optimisation in that there is no common measure by which to compare the value of atoll sovereignty and cultures with the monetary costs of climate change (Barnett, 2001c). To compare values to a common standard for the purposes of seeking an optimal solution implies all items of value are ultimately substitutable and losses can be compensated (O'Neill, 1993). We argue that atoll countries and cultures can never be satisfactorily compensated for the loss of their physical bases. Thus a conception of fairness in this case is in effect based on a deontological rule rather than a consequence or outcome. The difficulties of sufficient compensation for loss of land and the cultural and economic impacts that ensue is evident in ongoing tensions over land rights and self-determination in post-colonial countries such as Australia and New Zealand, countries which are themselves likely hosts for migrants from the Pacific atoll countries given their already large populations of people of Pacific Island origin.** It is also evident in the case of Nauru (an uplifted atoll-country), which after ninety years of phosphate mining has been left with 80% of its land area severely degraded and unusable. While partially compensated for these losses, the compensation in no way constitutes an adequate recompense for the environmental and cultural implications of such widespread destruction: indeed it is unlikely that there is some level of 'adequate' compensation (McDaniel and Gowdy, 2000).

This incommensurability of loss of rights with monetary values renders decision-making about the costs and benefits of mitigation strategies problematic. Cost-benefit analysis applies more for micro-level decisions and requires standard metrics of value which are unavailable as the comparability between values cannot be sustained in this instance. So, to reduce the problem of lost atoll countries into any such decision-making framework would be to fit philosophically incomparable values into inappropriately technical procedures (O'Neill, 1993). In economic terms, the lack of appropriate compensation means that any decision taken on the basis of winners and losers implies that 'some individuals have the right to cause

* While justice and equity are thus far synonymous in international law (Kokott, 1999), they are nevertheless distinct if interpreted as 'absolute fairness' and 'relative fairness', respectively.

** It is increasingly understood that migration is only one element of demographic change in response to environmental change. The term 'environmental refugee' and the associated simplistic assumptions of displacement migration as a primary response to environmental change are widely discredited in demographic and other analyses (see Locke et al., 2000; O'Neill et al., 2001; Lutz et al., 2002).

[uncompensated] damage to others' (Azar, 2000).* If this is not an acceptable position and the loss of national territory cannot be compensated for, then some new path to the future and some new decision-making rules must be found.

This is not to say the decision-analysis of the problem must be non-rational, or that choice is impossible. It is the latent recognition by some countries of the potential severity of impacts on atoll countries that has given the small island states considerable leverage in negotiations over the UNFCCC (Shibuya, 1997). However, decisions on global climate policy must be made according to a formal conception of justice rather than merely equitable distribution of costs.

'Justice' has no universally shared meaning; its operationalization proceeds only with consensus among parties in specific contexts. At the global scale, difficulties concerning the meaning and practice of justice are at their most complex. The constituencies includes at least all states, if not all people, and it requires some standardization across diverse issues. The meaning, let alone practice, of international justice therefore remains elusive (Brown, 1997). The international system, built on the sovereign rights of states, frequently struggles to reconcile sovereign rights with human rights, and at present the rights of states are largely upheld, but at the frequent expense of the rights of people (Linklater, 1999). The case of climate risks to atoll countries is rare in that the rights of atoll countries are largely synonymous with the rights of their constituents. Norms of national justice and social justice are therefore both applicable and mutually reinforcing.

We can look to various international treaties to find more formal benchmarks of justice. For example, the Universal Declaration of Human Rights states simply that 'everyone has the right to a nationality' (Article 15.1), and that 'no one shall be arbitrarily deprived of his [sic] property' (Article 17.2). The United Nations Covenant on Civil and Political Rights states that 'in no case may a people be deprived of its own means of subsistence' (Article 1.2). In the case of climate change's effects on atoll countries, these basic rights are at risk, reinforcing the 'danger' that climate change poses to atoll countries and cultures. For international decision-making on climate change, consideration of just actions should seek to incorporate these existing laws and norms.

Theories of justice are implicit in such international laws and norms. Although we recognize that conceptions of fairness such as those proposed by Rawls and implied by Kantian philosophy were formulated to apply to individuals, the principle can be applied to the behavior of states as well (this is not unusual in so far as Hobbesian realism is equally a generalisation of individual behavior to explain state behavior) (see Beitz, 1979). In this case, the explicit international rule would be that global decision-making on climate change by nation states would adhere to the maximin principle. Fair actions under this formulation of distributive justice should minimize the impacts of climate change to the most vulnerable state (Adger,

* See Azar (2000) on the Hicks–Kaldor compensation rule in cost-benefit decision-making on climate change.

2001; Rawls, 1971). For sovereign states the possibility of extinction would constitute the greatest threat, and this is possible for perhaps five of the 181 states which are Parties to the UNFCCC. Even without this maximin principle, a radically different and just outcome would be arrived at if states negotiated under a 'veil of ignorance' whereby the 181 states in the UNFCCC decided on 'dangerous climate change' without knowing *a priori* which of the five out of 181 states would cease to exist as a result of continuing anthropogenic interference with the climate system. This would result in greater action than exhibited at present in the Kyoto Protocol negotiations. These philosophical underpinnings for climate justice are implicit in the negotiating position of the Association of Small Island States and carry some moral weight, though clearly not outweighing national self-interest which, as the 'veil of ignorance' exercise shows, obscures other dimensions of justice such as egalitarianism (see Müller, 2001).

The constitutive principle of international relations – sovereignty – is itself problematised by the possibility of climate change extinguishing atoll countries. Sovereignty is the right of political entities to be free from outside interference. It is an intersubjective construction, meaningful only because it is mutually recognised that states should not act in ways that interfere with other states. It is a founding principle of the Charter of the United Nations (Article 2.1), and is the core value underlying national security practices. For all states to do less than everything possible to prevent the loss of a sovereign entity is to undermine this most essential and powerful norm of international law and politics.

5. Conclusions

Climate change puts the long-term sustainability of societies in atoll nations at risk. The potential abandonment of sovereign atoll countries can be used as the benchmark of the 'dangerous' change that the UNFCCC seeks to avoid. This danger is as much associated with the narrowing of adaptation options and the role of expectations of impacts of climate change as it is with uncertain potential climate-driven physical impacts. The challenges for research are to identify the thresholds of change beyond which atoll social-ecological systems collapse and to assess how likely these thresholds are to be breached. These thresholds may originate from social as well as environmental processes. Further, the challenge is to understand the adaptation strategies that have been adopted in the past and which may be relevant for the future in these societies. Existing techniques for assessing optimum climate policy responses are incapable of dealing with the risks posed to atoll countries and cultures. This is, in effect, a call for both new precautionary science (Kates et al., 2001) and new institutions for decision-making at the global scale that seek to promote social learning for just solutions to the consequences of climate change on diverse cultures and societies. The possible risks to atoll countries, and the mechanisms for insurance or funding for adaptation, have yet

to be sufficiently incorporated into UNFCCC negotiations. These risks call for an explicit conception of justice such as embodied in other international treaties and in some norms of international law, rather than simply a focus on the economic optimisation of the costs and benefits of reducing greenhouse gas emissions.

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