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Adaptation now

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Introduction

Look out the window and assess the weather. If it is hot, change into a lighter shirt. If it is raining, take an umbrella. This is adaptation to changing weather.

Adaptation to changing climate is a different matter. The climate may change either slowly or rapidly, and the changes may be irreversible and impossible to predict with any accuracy. The simple principles of adapting to changing weather begin to break down when the climate changes. In the context of climate change the options for adaptation may involve relocating homes, moving cities, changing the foods we grow and consume, seeking compensation for economic damages, and mourning the loss of our favourite place or iconic species. The difference between adapting to changing weather and adapting to a changing climate lies both in the time-frame and in the significance of the changes required. Moreover, the consequences of *not* adapting to climate change may be far more serious than not adapting to changing weather.

There are two aspects of climate change that have profound significance for adaptation. First is the growing recognition that the weather is no longer 'natural'. While the weather varies and changes seasonally as part of the natural rhythm of our lives, climate change, as it is presently observed, is now beyond all reasonable doubt driven by human activities. This induces a feeling, for some, that the world is sullied, and nature itself is at an end (McKibben, 1999). Adapting to changes that are caused by humans thus involves changing our understanding of our relationship to the climate system. The second aspect of climate change that has implications for adaptation is that it involves harm to some (now and in the future) on the basis of gain to others (in the past, present and future). Hence climate change raises

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questions of justice, responsibility and obligations. If human activities are driving climate change, then adaptation involves issues such as compensation and liability. 'Blaming the weather' is no longer a benign and apolitical excuse for uncontrollable natural phenomena. Instead, adaptation to climate change is both a social and a political process.

These social and political dimensions form the backdrop for the analyses presented in this book. Here and in the following chapters we analyse how adaptation occurs, how it may be limited by unknown and sometimes non-linear responses in physical and biological systems, and how societies act both in terms of the values that they hold and the collective action that they undertake.

We already know that adaptation is necessary – the impacts of climate change are already apparent or in some cases predictable with some certainty, as discussed in numerous reports of the Intergovernmental Panel on Climate Change (IPCC) (Parry et al., 2007). While there are many uncertainties concerning present and future adaptation to a changing climate, the book presents emerging findings that have major implications for current discussions and debates about climate change.

First, the chapters in this book suggest that adaptation to climate change is, in general, a desirable outcome: adaptation will often, for example, promote other benefits that can lead to equitable and sustainable development. Building resilience and the capacity to adapt to climate change promotes flexibility, learning and protection of ecosystems from shifting into ultimately undesirable states and provides common good resources to cope with change in general as well as direct social and environmental benefits.

However, even with such ancillary benefits, this book also shows that building resilience in the face of a changing climate is not going to be costless. In fact, adaptation may involve significant transformations rather than incremental changes, some of which will be painful to those in societies reluctant to, or not able to, embrace change. International action and funding may be required to assist in promoting resilience, not only to finance adaptation projects, but also to facilitate the exchange of knowledge and practices that embrace a resilience approach to adaptation.

But if adaptation is indeed such a universally 'good thing', then why does it not occur spontaneously, for the benefit of all? Herein lies the second major contribution of this book: adaptation is limited as a response to the climate crisis. We argue that global-scale analyses of adaptation cannot capture the complexity and diversity of changes that are already taking place in response to climate change, nor can they capture the significance of the losses that are already being experienced. The limits to adaptation, as a response to climate change, depend on ecological thresholds, individual and cultural values, and institutions and governance. As these social, physical and ecological factors together will determine whether adaptation is

successful, analyses that overlook one aspect may present a dangerously misleading understanding of the consequences of climate change.

Third, the analysis in this book suggests strongly that the science of adaptation to climate change cannot determine an optimal path between abating the cause of climate change (mitigating greenhouse gas emissions) and adapting to the risks of climate change, at least at the global scale. Framing the global problem of climate change as a trade-off between 'mitigation' and 'adaptation' in effect involves accepting climate change that may breach too many potential thresholds and lead to a loss of resilience, causing harm to people and places that cannot readily be compensated. Accepting, and working towards achieving, a safe level of global climate change involves judgements in the present which may easily be seen in the future (Page, 2006; Caney, 2008). Furthermore, in popular discourse, mitigation and adaptation involve actions and processes that are invariably intertwined and feed into each other; blurring, therefore, a more localised level, the distinction between the two.

Adaptation and its limits

The calculus between adaptation to climate risks and mitigative action to reduce emissions is fundamentally difficult, given the uncertainty created in the global experiment of climate change. Yet, as Gardiner (2004) portrays the distinction, the future can be characterised as a choice between either simply adapting to the consequences of unabated climate change or reducing the risks through abatement (mitigation) of climate change. In the first case the world will be adapting to 'sudden unpredictable large scale impacts which descend at random on particular individuals, communities, regions and industries and visit them with pure irrecoverable costs' (p. 574). This can be compared to mitigation-led strategies where adaptation would be 'addressing gradual, predictable, incremental impacts, phased in so as to make adaptation easier' (p. 574). Stern (2007), Dietz et al. (2008) and others argue that economics has (some of) the tools to make judgements on the trade-offs between mitigation and adaptation, or at least to make them explicit. Parry et al. (2008) and many others argue that there is indeed a globally optimal strategy between mitigation and adaptation. Other approaches suggest that multiple metrics, coupled with knowledge and judgement of unacceptable thresholds in Earth systems, can provide the necessary global scale analysis of the trade-offs between coping with the consequences of climate change or reducing them through decarbonising the economy to mitigate the risk in the first place (Schneider and Lane, 2006; Schneider et al., 2007; Lenton et al., 2008). All of these approaches rely on being able to identify a safe level or rate of change, or at least a socially acceptable level of risk to be avoided.

All of the chapters of this book analyse adaptation in the explicit recognition that adaptation is not a simple and straightforward substitute for action to prevent climate change in the first place. In focusing on what can and should be done in the face of unavoidable climate change, we are acutely aware of the dangers of 'making the case for adaptation a self-fulfilling prophecy' (Gardiner, 2004, p. 574). Much of the severe and potentially catastrophic climate change is eminently avoidable through early and sustained action to reduce emissions of greenhouse gases. Such reductions can occur through many channels – individual behaviour, the development of new technologies, government regulations and new architectures for international co-ordinated action (Barrett, 2007; Stern, 2007, 2008). Although the mechanisms and means for such mitigation measures are well known, whether the necessary mitigation actions are taken is nonetheless dependent on the ability and willingness of societies and ecosystems to cope with and adapt to climate change.

How to respond to climate change at the global scale is not, however, a simple trade-off between the economic damages of climate change impacts and the economic costs of reducing fossil-fuel dependency. The trade-offs are more complex for a number of reasons. First, as the chapters of this book point out, individual species and natural communities are directly limited in their adaptation capacity. While it is possible to envisage how ecosystem services that are of value to humans will be affected by climatic changes, many of the ecological impacts are fundamentally unknowable in terms of ecological processes and surprises.

Second, from many philosophical positions and belief systems, ecosystems have intrinsic value over and above the services they provide to humans. From these perspectives, there is a moral imperative to avoid climate change that threatens global and local extinctions of species, even if non-humans do not have explicit rights within many national and international legal frameworks. Such moral imperatives may appear to be vague and outside the domain of the politics of climate change, but they are not. The imperative to protect non-human species are embodied in law and culture throughout the world: from UN World Heritage Sites to the US Endangered Species Act, through to stewardship ethics in all major world religions. In addition, a material rationale for conservation can be justified by the emerging realisation that ecosystems provide supporting, regulating and cultural services that underpin human life and well-being (as described in the Millennium Ecosystem Assessment, 2005).

Finally, new observations of climate and the impacts of climate change and new models based on improved understanding of physical processes of climate change continually emerge, raising new and penetrating insights and potentially dire scenarios of future climate change. For example, since the IPCC Fourth Assessment Report was published in 2007, new projections from global assessments suggest that observed and projected sea level rises may in fact exceed those reported in

IPCC (Hansen, 2007; Rahmstorf, 2007) but that there are high levels of uncertainty around projections of sea level change that could rise by up to 7 metres with loss of land-based ice sheets in Greenland and Antarctica.

Similarly, new reviews suggest that aerosols from traditional pollutants continue to mask regional warming trends and that these pollutants are likely to be reduced in many countries due to their health impacts. The combined effect will be to unmask the real warming trend raising global mean temperatures above those previously estimated in stabilisation scenarios (Ramanathan and Feng, 2008). The world is, therefore, potentially already committed to 2.4 °C warming due to emissions even up to 2005. Research on ocean acidification has also introduced new questions about the future of marine ecosystems under climate change (Orr et al., 2005; Hoegh-Guldberg et al., 2007). These new findings suggest that the probability of global society being required to adapt to climate and resource states hugely different from today's is indeed high and that radical changes in where and how we live are likely to be necessary.

The challenge of adaptation

The critical and overarching challenge of climate change is how and when to act in the face of scientific evidence. As we demonstrate in this book, this is more multifaceted than simple models suggest. First, ecosystems and social–ecological systems can absorb significant perturbations if they are resilient. But when thresholds are breached, they often undergo significant regime shifts into alternate states that may be equally resilient, yet are often undesirable from human perspectives.

Second, the impacts and consequences of climate change can be valued according to different metrics, which include but are certainly not limited to economic measures. For example, Schneider et al. (2000) identify five numeraires for judging the significance of climate change impacts, including monetary loss, loss of life, biodiversity loss, distribution and equity, and quality of life. Adaptations measures taken by individuals, communities, groups and generations may reflect one metric over another, and be closely tied to prioritised values. When it comes to decisions on whether or not to act in the face of scientific evidence about climate change, the question inevitably arises of whose values count. The values that are pursued and those that are ignored can easily become enmeshed in the politics of climate change adaptation.

Third, the implementation of adaptation is essentially a governance issue. Adaptation involves deliberate action, or inaction, taken by individuals and through collective action. Governance involves processes through which we engage with our environment and the rest of society: governance involves those activities which make a 'purposeful effort to guide, steer, control or manage sectors or facets of

societies' (Kooiman, 1993, p. 2). The dilemmas of governance concern the location of power and influence within society, relating again to whose values count, and to the presumption of collective wisdom over myopic individual choices taken on the basis of self interest (Adger and Jordan, 2009). The scale of adaptation action required is enormous, yet at the same time the geopolitical systems that are in the thrall of the carbon economy creates massive inertia. Under these circumstances it is not enough to simply state that resources should be shared, adaptation should be funded through international transfers, or people and settlements should move in the face of risk. These actions will not take place. Economists label these inertias as market failure or government failure. This book shows the governance challenges of promoting necessary adaptation are significant even if they are largely assumed away in simple models of adaptation action. In reality, the governance of adaptation is likely to be complex and somewhat messy – a legacy of past modes of operating combined with the persistence of outdated paradigms that make it difficult to enact effective adaptations to an issue as complex and multifaceted as climate change.

The implications of thresholds for adaptive action

A threshold is defined as 'a level or point at which something starts or ceases to happen or come into effect' (Soanes and Stevenson, 2008, p. 1502). There are many thresholds for adaptive action, and they generally fall into two categories. First, there are thresholds at which adaptive actions first appear. These are the levels or points when responses come into effect and reduce vulnerability to the negative effects of climate change. Second, there are thresholds beyond which adaptive actions cease to be effective in reducing vulnerability. These can, in effect, be considered limits to adaptation, in that adaptation no longer represents a successful response to climate change. While the first type of threshold is important for initiating positive actions in response to climate change, the second type is of greater concern, as it defines the changes that cannot be adapted to, as well as the losses that will be incurred as a result of climate change.

Current scientific discourses on limits to adaptation focus on immutable thresholds in biological and technological parameters, or even in unaffordable economic costs. Thus 2 °C of global mean warming is regarded as a threshold of dangerous anthropogenic interference for its impacts on sensitive ecosystems such as coral reefs (Schellnuber et al., 2006). But framed another way, adaptation by humans is endogenous to the way in which society operates and hence any limits are contingent on parameters such as ethics, knowledge, attitudes to risk and cultural constraints on action (Adger et al., 2009). Meze-Hausken (2008) similarly argues that although some thresholds can be quantified (most often by experimental design where other

variables are held constant, or by statistical analysis), others 'can only be defined through subjective assessments of levels of acceptable risk and impact, as well as on expectations and experience' (Meze-Hausken, 2008, p. 318). For Meze-Hausken (2008) adaptation is considered the adjustment *to* a response or impact, with the possible consequence of either increasing or reducing the threshold level. In other words, thresholds may change over time, depending on adaptive actions. This represents a third type of threshold – a dynamic threshold that is itself influenced by adaptation measures. This draws attention to the importance of assessing the implications of adaptation measures for thresholds, not only from physical or ecological perspectives, but also from social, cultural and experiential perspectives.

Reducing the vulnerability of households and communities to climate change has been identified as a key response by both the climate change and disaster risk reduction communities (Schipper and Pelling, 2006; UNISDR, 2008). Vulnerability approaches can directly address the physical risks of climate change through technological interventions, such as adjustments to infrastructure or new varieties of seeds. They may also address the underlying and systemic factors that contribute to vulnerability in the first place, such as land tenure laws, unequal access to markets or credit, or a lack of social safety nets. Finally, vulnerability approaches often focus on enhancing adaptive capacity, by improving access to education, financial resources, information such as seasonal climate forecasts or diversifying livelihoods. Together, all of these strategies can help to increase the thresholds at which climate change creates negative outcomes. Vulnerability reduction itself can be considered an adaptive response to climate change.

Yet what about the thresholds that define conditions beyond which society can successfully adapt? Schneider and Lane (2006) discuss 'imaginable surprises', such as deglaciation of Greenland or changes in the North Atlantic Thermohaline Circulation, which would present numerous and, arguably for many people and species, insurmountable barriers to adaptation. They also discuss the possibility of 'true surprises' that have yet to be imagined or taken into consideration when discussing climate change impacts, vulnerability and adaptation. These critical thresholds are sometimes referred to as 'tipping points', in that at a particular moment in time a small change can have large and long-term consequences for a system (Lenton et al., 2008).

The possibility of surpassing critical climate change thresholds has important implications for adaptive actions. First, adapting to a world beyond 'tipping points' requires foresight and investment, ideally sustained over long periods of time. Large-scale infrastructure projects, massive population resettlement schemes and changes to global food production systems will have to be planned, financed and implemented amidst tremendous uncertainty about the future. Second, surpassing climate change thresholds will lead to innumerable losses, regardless of adaptation

measures. Although the potential changes will undoubtedly create unequal outcomes, the changes will be so dramatic that the real equity issues are intergenerational. Demanding future generations to adapt to changes set in motion by past and present human activities raises ethical and philosophical questions that are only beginning to be addressed (Gardiner, 2004; Adger et al., 2006; Caney, 2008; Jagers and Duus-Otterström, 2008). Third, the consequences of the tipping points described by Lenton et al. (2008), such as the collapse of the West Antarctic Ice Sheet or dieback of the Amazon rainforest, will create changes in physical systems and ecosystem services, as well as geopolitical changes and transformation of economic and social systems. The notion of 'adaptation to climate change' is unlikely to be the main concern under such scenarios, but rather the focus is likely to shift towards adaptation to complex emergencies and disasters. Finally, although much can be done to adapt to climate change thresholds, the question of what type of a world we want to live in and whose values count in deciding this must be addressed. These aspects of climate change adaptation are discussed below in relation to the chapters of the book.

Values in adaptation: whose and how they count

Adaptation, like most other changes in society and economies, involves a multitude of decisions taken by individuals acting in their own perceived interest, but with impacts and ramifications well beyond those actions both in space and time. As with all such situations, people act collectively as well as individually, and hence governments have a role in steering society towards longer-term outcomes. Adaptation actions are likely to be undertaken by individuals or businesses if they perceive early rewards or benefits from their actions, such as reduced damages from extreme weather events or cheaper insurance. In order for these actions to be economically efficient the individuals and businesses concerned must bear all the costs and receive all the benefits from their actions. There are cases however, where private actions create externalities that must be borne by others. In addition, in many cases, the incentives to act to adapt to climate change are not sufficiently strong, or there are property rights and public good aspects which hinder private action. These situations where adaptation is not efficient or optimal in any meaningful sense are not the minority of cases. Negative externalities and spillovers are, in effect, pervasive. As Hanemann (2000) suggests, economically optimal adaptations are built into economics models of adaptation, almost in the hope and expectation that they will occur rather than on evidence that they do occur.

What then are the key roles of public policy in adaptation? Some economists writing in this area suggest that much adaptation will occur spontaneously through adjustments to markets and individual behaviour (as discussed by Hanemann,

2000). But markets are, in effect, constructs of the laws, regulations and collective will of the agents and regulators involved. Governments, as an expression of collective will, influence everything. The major objectives of public policy to adapt to climate change therefore would seem to be (1) to protect vulnerable populations by reducing their vulnerability and exposure to risk; (2) to provide information for planning and stimulating adaptation, and (3) to protect important public goods (such as nature conservation) as well as to provide public goods such as human security and protection (such as coastal defence and early warnings of extreme events). In addition, a strong signal from the public sector that it is taking adaptation seriously can induce increased action in the private sector.

These principles are similar to many arenas of public policy, from social welfare to environment to health. In all of these areas, the implementation of policy is hugely contested as the values, goals and belief in policy prescriptions and instruments varies widely (Adger et al., 2009). One of the greatest problems in implementing adaptation lies in identifying who and what is vulnerable, and even in specifying who has the right and responsibility for identifying who and what is vulnerable. Understanding the wider implications of adaptation measures requires that many important normative and ethical issues be discussed and debated.

Aside from providing adaptation actions directly for nature conservation or other reasons, government can aid private actors by providing information about the likely environmental changes and impacts, and the options for adaptation. Importantly, government may become involved in private adaptations to shift the burden of the costs from the victim to the polluter. It is important to be clear who is responsible for compensation. If the polluter is to pay for adaptation, then we need to be able to pinpoint the links between who emitted greenhouse gases in the past and the impacts that we are now suffering. Under widely established principles of law, polluters should compensate victims by at least the value of the harm inflicted. A natural analogy to the climate change case is the set of those compensations claims under tort law for harm caused by toxic substances (so-called toxic torts) (Farber, 2007). Clearly legal processes are not in such a position to directly point the finger of blame for climate change at present. But there is a strong possibility that advances in environmental sciences to attribute proportions of individual extreme weather events to human-induced climate change will bring the issue of liability to the fore in the next decade (Allen and Lord, 2004; Allen et al., 2007).

Such discussions of public policy in adaptation largely assume, of course, that governments act in a far-sighted manner to promote their citizens towards equitable and sustainable outcomes. Importantly it also assumes that governments, as the agents of collective action, have the necessary means and knowledge to implement that vision. The chapters of this book point to the limits of such assumptions. Most often governments act in the interest of the most vociferous and influential actors

in society, to the detriment of others who are less powerful and influential. So while some adaptations to climate change may be efficient, they may leave behind the most vulnerable. There are, as discussed in Chapter 13 by Hallie Eakin and colleagues, therefore inherent trade-offs between public policy interventions based on the dominant policy paradigms of efficiency and those based on minimising vulnerability, or even building resilience. Vulnerability approaches suggest that some risks are unacceptable and should be avoided at all costs, an approach consistent with Rawlsian accounts of equity and justice (Dow et al., 2006; Paavola and Adger, 2006). Resilience approaches suggest that system resilience and learning can come at the expense of loss to individuals. Hence the objectives of adaptation, and how governments act on underlying values, makes a huge difference in terms of outcome.

Making adaptation happen for the common good

Adaptation has always taken place, and is likely to continue doing so. Human beings have been able to adapt to changing environments and societies, surviving and flourishing overall. However, if we hold a lens to the adaptation process and analyse it further in detail, it becomes clear that environmental and social change does not affect everyone equally. Less resilient communities – and more vulnerable individuals – can be severely affected by change, thus limiting their opportunities for adaptation.

The prospect of climatic changes of greater magnitude and frequency than those experienced throughout most of human history beg the question of whether adaptation is possible and how adaptation to present and future changes may be facilitated. In very simple terms, adaptation entails an adjustment to changing conditions. On a social level, this can be interpreted as some form of cognitive or behavioural response at individual and collective levels, both being invariably entwined. Understanding adaptation in the context of climate change requires careful consideration of two dimensions: scale (Who is responding where, to what?) and purpose (Why are we responding? What are the aims of adaptation?).

Let us consider these in turn. Adaptation occurs at different but related levels. Policies shaped by national and international circumstances set objectives to be achieved at local and regional levels. Individuals and organisations however do not operate in isolation. Interpretation of information and its translation into decisions and behaviours are affected by social context, individual characteristics and direct experiences. In other words, adaptation is a multi-scalar process of multi-level governance, concerned with the interaction of individual and collective behaviours acting from the bottom–up and the top–down in response to changing circumstances (see Pelling et al., 2008; Urwin and Jordan, 2008). Given, however, that