Tyndall°Centre
for Climate Change Research

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Executive Summary

The world's climate is changing and will continue to change at rates projected to be unprecedented in recent human history into the incoming century. The risks associated with these changes are real but highly uncertain. For societies vulnerability to these risks may exacerbate ongoing social and economic trends, particularly for those parts of societies dependent on resources that are sensitive to changes in climate. Risks are apparent in agriculture, fisheries and many other components that constitute the livelihood of rural populations in developing countries. In the light of these observations the Tyndall Centre for Climate Change Research, the School of Development Studies at University of East Anglia, as a Tyndall partner, and the International Institute for Environment and Development hosted a workshop at the Royal Society in London in October 2001 to explore policy and research questions with academics, development and humanitarian NGOs, and government agencies.

The objectives of this one day workshop were to:

- to bring together practitioners and agencies from the development community to explore the implications of the latest assessments of climate change impacts and potential for adaptation;
- to facilitate engagement of the UK development community with the climate change social and natural science community for agenda and priority setting in the area of adaptation.

The meeting explored the implications of the full range of present knowledge on the challenges of adapting to climate change from the IPCC Third Assessment Report and be a timely input into discussions leading to the World Summit on Sustainable Development in 2002. The challenges of climate change for development are in the present – observed climate change, present day climate variability and future expectations of change are changing the course of development strategies – development agencies and governments are now planning for this adaptation challenge.

This document is based on reflections by the conference organisers on the agenda and discussions raised on the day. We review the evidence on present-day adaptation in these developing countries and on co-ordinated international action on future adaptation. We argue that all societies are fundamentally adaptive and there are many situations in the past where societies have adapted to changes in climate and to similar risks. But some sectors are more sensitive and some groups in society are more vulnerable to the risks posed by climate change than others. Thus some major issues raised from the presentations and discussions on the day focussed on the role of policy, perception of risk, and the wider context of climate change adaptation. In summary:

- Climate change risks to natural resource-dependent societies mean that adaptation will inevitably be characterised both by processes of negotiated adjustments involving individuals, civil society and state, and involving renegotiation of risk-bearing and sharing between them;

- Such renegotiation is often problematic in an era where autonomy of national governments and of individuals is restricted by access to technologies, and by the nature of the global economic system. Renegotiation of risk often pushes such risk downward to individuals who have fewer resources to deploy to adaptation outside their experienced coping ranges.

- It needs to be recognised that much adaptation in the developing world will rely on past experience of dealing with climate-related risks. But past practice is likely to be limited when unknown risks emerge.

- Finally, there was much discussion and agreement that international institutions need to learn from adaptation from past and present adaptation the developing world and ultimately to act to maintain the inherent resilience of people coping with an uncertain future.

Thus the challenges from this meeting, posed at both the scale of local natural resource management and at the scale of international agreements and actions, is to promote adaptive capacity in the context of competing sustainable development objectives while recognising that the processes of adaptation are not independent from the wider political economy of uneven development. We thank all participants, speakers and sponsors of this important meeting and hope bridges between the communities will continue to be well crossed in future.

1 Introduction

Negotiators from the world's countries meet each year in an ongoing evolution of one of the most contentious and critical international environmental agreements, the UN Framework Convention on Climate Change. This convention encapsulates the major dilemmas of development, equity, marginalisation and globalisation within its remit and is likely to have far-reaching consequences across the world in everything from energy use to settlement patterns. Climate change is arguably the most persistent threat to global stability in the coming century. The convention itself has learned the lessons from existing international environmental agreements in building legitimacy through a large-scale significant international scientific effort funded by governments through the UN, known as Intergovernmental Panel on Climate Change (IPCC) (see Jäger et al., 2001). In Marrakech in Morocco in November 2001 at the Seventh Conference of the Parties, delegates focussed their minds on both adaptation to climate change and mitigation measures. The meeting resulted in all the signatory countries to the Convention, with the significant exception of the United States of America, agreeing to ratify the Kyoto Protocol so that it may go into force by the time of the World Summit on Sustainable Development (WSSD) in 2002.

The IPCC proclaims that there is now little doubt that human-induced climate change is happening. All societies need to learn to cope with the changes being predicted — warmer temperatures, drier soils, changes in weather extremes and rising sea level. Although it is difficult to unambiguously distinguish human-induced change from natural variation in climate on local scales, evidence of long-term changes is now apparent in many parts of the world, such as the retreat of mountain glaciers and the earlier arrival of spring (McCarthy et al., 2001). But research in this area necessarily encompasses insights from social as well as natural sciences and from policy analysts even outside the IPCC process that, by its nature, cannot be all-encompassing. At the meeting in London in October 2001 the participants, (climate scientists, humanitarian relief and international development agencies – see Appendix 2) argued that new priorities for research and policy in this are were required, reflecting the lived experience of resource-dependent societies in the developing world in coping with climate variability, and even with observed climate change in the recent past. And these lessons, they argued, should feed upwards into the actions of international development agencies and to the whole notion of adaptation within the processes and mechanisms of the UN Framework Convention on Climate Change.

The IPCC in its Third Assessment published in 2001 (IPCC, 2001) has assessed the capacity of the world to cope with and adapt to the inevitable impacts that climate change will bring. Whilst this assessment was far from comprehensive, it finds, not surprisingly, that the impacts of climate change are not evenly distributed — the people who will be exposed to the worst of the impacts are the ones least able to cope with the associated risks (e.g. Smit et al., 2001). But the meeting in London highlighted that people of developing nations are not passive victims. Indeed, in the past they have had the greatest resilience to droughts, floods and other catastrophes. Pastoralists in the West African Sahel have adapted to cope with rainfall decreases of 25-33% in the 20th century, while resilience in the face of changing climate has been documented for smallholder farmers in Bangladesh and Vietnam, and indigenous hunting communities in the Canadian Arctic (e.g. Cross and Barker, 1992; Mortimore, 1998; Huq et al., 1998; Huq, 2001; Adger et al. 2001; Roncoli et al., 2001; Berkes and Jolly, 2001).

Given this apparent paradox - the discrepancy between the conclusions of a global assessment and the past experience of societies living with environmental change - a new and agreed research agenda is clearly required. What are the parameters of risk and vulnerability in developing countries? How can we enhance the capacity of people in developing countries to adapt to a new scale and a greater persistence of climate change?

2 Are developing countries vulnerable to the impacts of future climate change?

2.1 Vulnerability to what risks?

Nearly all human societies and activities are sensitive to climate in some way or other. This is because in large measure where people live and how they generate a livelihood and wealth is influenced by the ambient climate. Since climate is inherently variable for quite natural reasons, human societies have always and everywhere had to develop coping strategies in the face of unwelcome variations in climate or weather extremes – for example migration in semi-arid pastoralist societies or financial insurance mechanisms in the case of industrial societies. Some of these coping strategies are more technologically-dependent, better resourced or more robust or resilient than others – compare coastal communities in Netherlands with those in Bangladesh - and therefore populations today are differentially vulnerable to existing variations in climate and weather based on structural factors.

The vulnerability or security of individuals and of societies is determined, not only by the likely responses of the resources on which individuals depend, but by the availability of resources and, crucially, by the entitlement of individuals and groups to call on these resources. Vulnerability can be seen as a socially-constructed phenomenon influenced by institutional and economic dynamics. The vulnerability of a system to climate change is determined by its exposure, the physical setting and sensitivity, and the ability and opportunity to adapt to change To illustrate these categories, sensitivity will be high where the system in question includes, for example, settlements built on flood plains, hill slopes or low-lying coastal areas. In terms of action, adaptation may take the form of reducing dependence on vulnerable systems such as diversifying food production away from a limited number of drought-prone crops, of decreasing sensitivity by avoiding building settlements and infrastructure in high-risk locations, or by strengthening existing systems so that they are less likely to be damaged by unusual events.

These emerging conceptualisations of vulnerability and adaptation clearly draw on insights from risk and natural hazards, vulnerability to hunger and famine, and ideas of entitlement and autarchy in development (e.g. Hewitt, 1983, 1997; Bohle and Watts, 1993; Sen, 1981, 1999; Ribot et al., 1996; Adger 1999). But vulnerability to climate change, as with vulnerability to hazards, is not strictly synonymous with poverty. Although poverty and marginalisation are key driving forces of vulnerability and constrain individuals in their coping and long term adaptation (see Cannon, 1994), vulnerability to future climate change is likely to have distinct characteristics and create new vulnerabilities. This is not to say that those most marginalized are not most at risk. Indeed both vulnerability and adaptation processes to climate change, it has been argued, are likely to reinforce unequal economic structures (Kates, 2000).

How will the underlying vulnerability change in the future as climate changes? Or does the vulnerability "map" of today's world simply project forward in time? Just as there is differential vulnerability to today's climate, is there differential vulnerability to future climate change? Answering these questions requires some understanding of the broad characteristics of future climate change as well as an understanding of the sensitivity and exposure of different communities and activities to climate.

Global climate is already warming at a rate unprecedented in the last 1,000 years (IPCC, 2001) and is therefore inevitably altering the character of local and regional weather around the world. A different global climate must by definition induce different experiences of local weather. Although we cannot lay out a simple cause-and-effect chain from a severe weather episode back to human-induced climate change, we can begin to identify those parts of the world where we are already measuring rather different weather characteristics from those that have been experienced in earlier decades. Thus the frequency of intense precipitation events is increasing over many northern mid-latitude regions (Easterling et al., 2000); instances of extreme summer heat, often combined with high humidity, have increased in most world regions; ENSO episodes over the last two decades have been both unprecedently large (e.g., 1997/98) and prolonged (e.g., 1991/94; Trenberth and Hoar, 1997); and severe hurricanes (e.g. Mitch) and extensive riverine (e.g. Mozambique) and coastal flooding (e.g. Orissa) have led to many tens of thousands of premature deaths.

That the global climate is changing is undisputed. The trend in climate over the past century - a globally-averaged change of nearly 1 °C has occurred concurrently with changes in some extreme event regimes as shown in Table 1, based on the summaries of the IPCC (2001). This further suggests that future climate change will bring about further extension of many of these trends. Of course, some of the projections, and some of the observed historical trends, are known with more confidence than others. So although data from around the world show very evident patterns in reduced diurnal temperature ranges and higher minimum temperatures and frost free days, there is little or no consensus on whether tropical cyclones have been becoming more damaging in the past, let alone whether the regimes will alter significantly in the future (e.g. Diaz and Pulwarty, 1997; Henderson-Sellers et al., 1998).

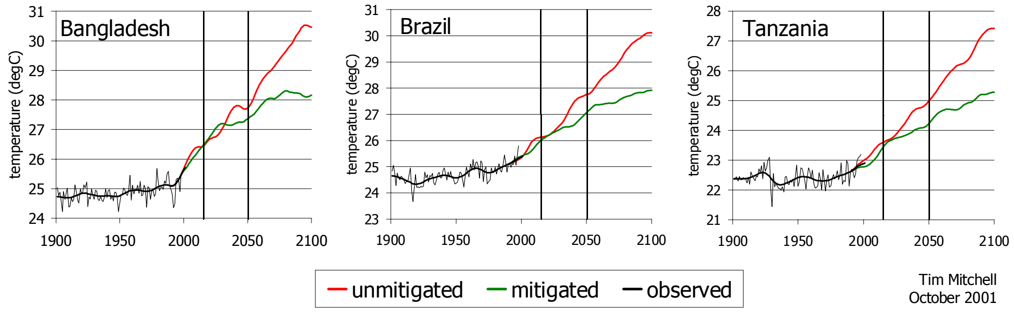
None of the historically observed extreme weather events, such as the ENSO events mentioned above represent particularly convincing evidence that humans are altering global climate. Taken collectively, however, and placed on the context that at a global-scale there is strong evidence of a human fingerprint on climate (Mitchell et al., 2001), a wise inference from these data is that historical statistics and experiences of local weather are *unlikely* to provide a sound basis for planning and management for the future. We can illustrate this past and future change in climate using annual average temperature at a country level as an indicator. We do this for Brazil, Tanzania and Bangladesh in Figure 1. All three countries have experienced a warming of their climate over the last 100 years – between 0.4 and 0.8 °C – and this warming is likely to continue, if not accelerate, in the decades ahead. For this particular model calculation these countries warm by a further 1-2 °C over the next 50 years, the rate of warming partly depending on the future growth rate in global greenhouse gas emissions. In either assumed world, however, further warming is substantial and easily exceeds natural variability within the next two decades (after 2015 vertical line in each figure).

Table 1 Estimates of confidence in observed and projected change in extreme weather and climate events

Changes in climate phenomenon	Confidence in observed changes (latter half of 20th century)	Confidence in projected changes (during 21st century)
Higher maximum temperatures and more hot days over nearly all land areas	Likely	Very likely
Higher minimum temperatures, fewer cold days and frost days over nearly all land areas	Very likely	Very likely
Reduced diurnal temperature range over most land areas	Very likely	Very likely
Increase of heat index over land areas	Likely over many areas	Very likely over most areas
More intense precipitation events	Likely (northern hemisphere mid - high lat. areas)	Very likely over many areas
Increased summer continental drying and associated risk of drought	Likely in a few areas	Likely over most mid-latitude continental interiors
Increase in tropical cyclone peak wind intensities	Not observed in few analyses available	Likely over some areas
Increase in tropical cyclone mean and peak precipitation intensities	Insufficient data for assessment	Likely over some areas

Source: IPCC (2001).

Figure 1: Past and future changes in annual average temperature for Brazil, Tanzania and Bangladesh



Notes: Figures from 1900-2000 are observed. 2000-2100 estimates are calculated using the Hadley Centre model (HadCM2) assuming two different global greenhouse gas emissions scenarios. Vertical lines mark 2015 and 2050.

2.2 Uncertainty and its characteristics

These estimates of temperature for three developing countries in Figure 1 show widening ranges the further into the future we look. Although the projections of climate change into the future are fundamentally uncertain, and are even less clear for any specific location within each country, the consensus remains that climate change will be a significant challenge for developing countries. Climate change is likely to feed through to societal impacts through changes in water, natural resources, food systems, marine ecosystems and through coping with a changing regime of weather extremes.

Quantifying this uncertainty has been the subject of the greatest efforts among the climate change research community, teasing out how much of the diverging 'cones' of projected temperature shown in Figure 1 is due to model uncertainty and how much is due to the human system. In other words, part of the reason why there are diverging estimates of temperature and other variables into the future is associated with not knowing how the climate system reacts to unprecedented rates of greenhouse gas emissions or in knowing how clouds, forest, grasslands or particularly the world's oceans react to climate perturbations and how they feed back into the system. This uncertainty through projections is often manifest in ranges of estimates for particular parameters. Table 2 highlights inter-model disparities in rainfall change in Africa (from IPCC, 2001) for the key rainfall seasons in West Africa (JJA) and Southern Africa (DJF). In Southern Africa the rainfall signal in DJF is inconsistent between models and in West Africa the coherence of the signal in JJA is affected by the level of the emissions scenario, with low emissions producing an inconsistent signal and high emissions suggesting no change in rainfall. Similar levels of uncertainty in future rainfall apply elsewhere in Africa and the developing world, although inter-climate model differences in future temperatures are much smaller, particularly in the Northern Hemisphere (IPCC, 2001). For the agricultural and water sectors, however, inter-climate model differences in rainfall change often remain a barrier to the effective use of climate change information by managers and stakeholders.

Table 2 A summary of inter-climate model consistency regarding future rainfall change for Africa caused by greenhouse gas emissions

Region	December to January		June to August	
	High emissions scenario	Low emissions scenario	High emissions scenario	Low emissions scenario
West Africa	Small increase	Small increase	No change	Inconsistent
Southern Africa	Inconsistent	Inconsistent	Small decrease	Small decrease

Source: Adapted from IPCC (2001).

Uncertainties to do with the evolution of societies are of a different nature. The rate of growth of the world's population into the coming century, the rate of development of decarbonising technologies, and their global uptake are fundamentally unknown. Yet these properties of our future world will increasingly determine the future emissions of greenhouse gases into the global atmosphere. For these parameters, the uncertainty stems less from the various methods for their estimation than from the contested and political nature of the changes implied (O'Neill et al., 2001; Carter and La Rovere, 2001). Some recent efforts have been made to reconcile these two sets of uncertainties, or at least to characterise and distinguish between them (Schneider, 2001; Wigley and Raper, 2001). Nevertheless, future change in climate, and the need to adapt to this change, remains an inescapable conclusion. Following from these observations, we argue that there are two further key research areas – understanding adaptation processes and understanding the international political economy of response to the threat.

3 Adaptation in developing countries: past, present and future?

Given the risks and the scale of potential impacts, a serious effort on characterising and understanding adaptation is therefore now underway. Analogues of adaptation in the past are complemented with policy and social science research on the present adaptive capacity of governments, civil society and markets to deal with climate perturbations. The economic costs of future adaptations are being derived by examining the differences between the economic losses associated with scenarios of technology uptake and diffusion. Among these approaches, a key issue is the identification of successful adaptations in the developing world where the greatest risk and physical vulnerability persists. But within examples of success, from indigenous strategies for resource management, to large-scale infrastructure and irrigation, their will still be winners and losers.

First of all it is necessary to distinguish adaptation by who is undertaking it and the interests of the diverse stakeholders involved. It is clear that individuals and societies will adapt and have been adapting to climate change over the course of human history – climate is part of the wider environmental landscapes of human habitation. Thus individual and societies are vulnerable to climate risks and other factors and this vulnerability can act as a driver for adaptive resource management. There are various scales and actors involved in adaptation. Some adaptation by individuals is undertaken in response to climate threats, often triggered by individual extreme events (Ribot et al., 1996). Other adaptation is undertaken by governments on behalf of society, sometimes in anticipation of change but again, often in response to individual events.

But these levels of decision-making are not independent – they are embedded social processes that reflect the relationship between individuals, their networks, capabilities and social capital, and the state (Adger, 2001). Sometimes a distinction is drawn between planned adaptation, assumed to be undertaken by governments on behalf of society and autonomous adaptation by individuals (summarised in Smit et al., 2001). But this distinction obfuscates the role of the state in providing security, or in using security as a weapon of coercion when faced with an environmental risk. The nature of the relationship between individuals and agents of government in handling risk is a fraught but under-researched area (Adger, 2001). Political ecology approaches demonstrate that, for example, when faced with a flood risk, residents of marginalized but risky areas of Georgetown, have only a limited set of adaptation options – and the state allows such risks to exist as part of the politicised nature of urban planning and control (Pelling, 1999).

Realising that action is required to enhance the adaptive capacity of the most vulnerable societies and groups, the emerging research agenda is focussed on identifying generic determinants of resilience. This is being undertaken in part through learning the lessons from present and past adaptations. These determinants include the social capital of societies, the flexibility and innovation in the institutions of government and the private sector to grasp opportunities associated with climate change, and the underlying health status and well-being of individuals and groups faced with the impacts of climate change (Adger 2001). Agricultural communities in northern Nigeria have demonstrated resilience in continued increases in per capita agricultural production and stability in the last three decades of the 20th century at a time of increasing aridity and population growth. In Bangladesh, new local government investments in shelters have helped to reduce mortality from cyclones. The key is to pick out the characteristics of the institutional and technological conditions that promoted broad-based and equitable adaptation.

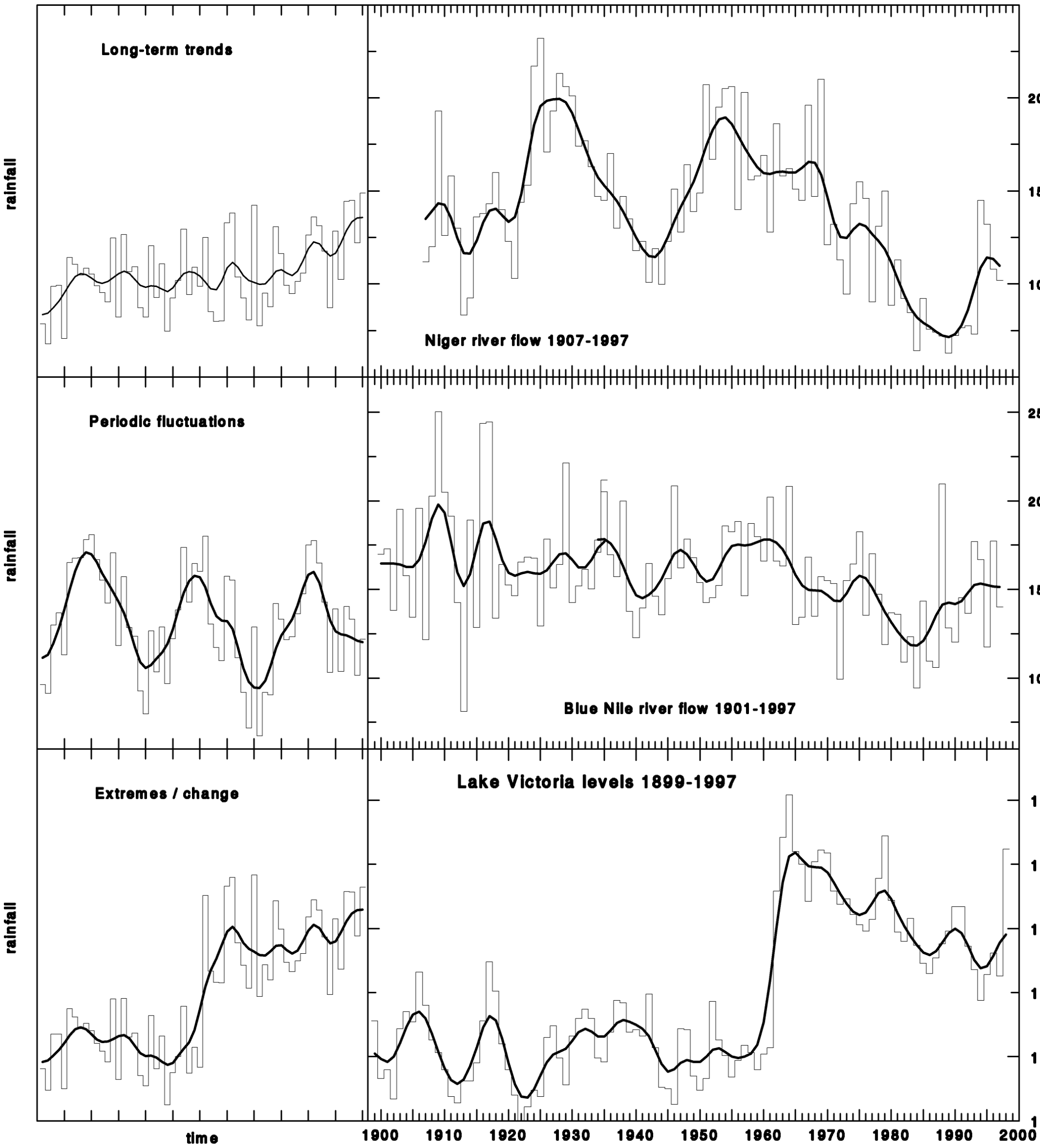
So the role of collective action in facilitating adaptation is a key issue where lessons can be learned from political ecology, and other theoretical insights, for present day adaptation processes. From research on collective action (Agrawal, 2001) it is clear that the size of the group undertaking the collective action, the boundaries of the resource at risk, the homogeneity of the decision-making group, the distribution of benefits of management and other factors are all important in determining the ultimate success of collective management. Research is required on how collective action is central to adaptive capacity at various scales. At present in the climate change area insights on climate change as collective action are primarily used to examine national level co-operative action to reduce greenhouse gas emissions under the UN Framework Convention on Climate Change (Müller, 2002) rather than on how the process of adaptation evolves.

Analogues of past climate change contrast with scenarios derived from climate model experiments in the search for adaptation insights. The analogue approach involves taking detailed case studies of past responses to climate variability and extremes (temporal analogues) or present-day behaviour in regions with climate conditions similar to those that might possibly develop in the region of interest (spatial analogues). The aim is to establish how individuals and institutions anticipate or respond to reduce the risks of different types of climate variability and how policy has influenced these actions. Understanding the present-day effects and response to climate variability at all levels of social organisation is a prerequisite for studying the effects and responses to future climate change and for identifying the key determinants of successful adaptation in the future.

High levels of interannual rainfall variability and their effects on water resources in Africa can provide illustrative examples of climate-environment-society interactions. A commonly cited drawback to the analogue approach to climate change assessment is that the characteristics of future climate change are likely to be very different to past climate variability, particularly in terms of the rate and magnitude of change. Examples exist for Africa, however, where the observed rainfall variability is *greater* than changes suggested by climate models for the next 50-100 years (Hulme, 1998).

Figure 2 shows three hypothetical patterns of rainfall variability together with examples of the high level of variability in African water resource systems primarily in response to rainfall conditions during the 20th century. In the left panels are three idealised hypothetical series generated from what is an almost infinite distribution of future climate change conditions in which *trend, periodic fluctuations, change and extremes* may feature in varying proportions across space and through time. The right panels show three river systems exhibiting similar temporal characteristics, long term *trend* Niger river, Sahel), *periodic fluctuations* (Blue Nile, Ethiopia), and long term *change* and short term *extremes* (Lake Victoria, East Africa).

Figure 2 Left panels; three hypothetical examples of trend, periodic fluctuations, change and extremes in rainfall. Right panels; three observed examples of river systems in Africa exhibiting high levels of temporal variability(the Niger, Sahel; the Blue Nile, Ethiopia; and water levels in Lake Victoria, East Africa).



Source: Adapted from Conway (2002).

The most pronounced example of variability has been the multi-decade decline in rainfall over the Sahel where the 1961-90 average is about 25% drier than earlier decades (Hulme et al., 2001) with dramatic consequences for river flows in the region (e.g. the Niger, Figure 2). Local long term studies of agricultural practices and the social and economic conditions during this dry period highlight the dynamic nature of individuals capacity to successfully adapt to change (see for example Mortimore and Adams, 1999) and the complex interplay of other, non-climate factors. Benson and Clay (1998) illustrate the complexity of relating drought shocks to macroeconomic indicators in some African countries highlighting highly differentiated, economy wide impacts and the importance of national economic structure, resource endowments and other short term economic factors.

The first example in Figure 2 shows periodic fluctuations in Blue Nile river flows that have led to significant water resource management problems in Egypt. During the past two decades conditions have moved from a prolonged period of low flows with the very real threat of water shortage in Egypt (only alleviated by a timely high flood in 1988) to a series of relatively high flows which have brought the High Aswan Dam reservoir to record levels and enabled the Egyptian Government to pursue a major expansion programme of irrigated agriculture into the Western Desert and Sinai. The resultant increase in demand for water may, from a climatic perspective, be maladaptive in that ii is likely to increase Egypt's vulnerability to climatically induced future changes in water supply.

The third example in Figure 3 shows long term change and rapid fluctuations in Lake Victoria levels due to the combined effects of rainfall variability and a large hydrological system with complex and delayed response to climate events (Conway, 2002). The immediate hydrological impacts of such events include disruption and damage due to temporary inundation of lakeside and wetland areas and river flooding. Longer term management implications revolve around the dynamic nature of water resources over time and the need for flexible management systems that consider the inherent uncertainty in the resource base. This undermines traditional assumptions of reliable yields for planning water supply projects. Fluctuating lake levels and wetland extent also present challenges and opportunities for agriculture, fishing and other lakeside activities (e.g. Sarch and Allison, 2000).

In all these cases isolating the effects of climate from other factors of change during the analogue period is an extremely complex undertaking. Nevertheless, detailed study of their impacts and responses including the influence of non-climatic factors is a prerequisite for understanding the importance of future climate change and for identifying effective adaptation strategies. Indeed, an interesting test of our ability to do this for future climate change would be to step back into the 1960s and ask: what would be the impacts of a 25 percent reduction in rainfall sustained over the Sahel during the next 30 years? Whether this would produce answers similar to what actually happened is a moot point, but it certainly underscores the enormity of the challenge to predict the impacts of what remains highly uncertain change in future climate.

This review suggests that there are crucial limits as to how far analogues of past and present adaptation experiences are relevant for adaptation to future climate change as a result of two inter-related phenomena. First, there may well be non-linearities, or critical thresholds, in the climate change impact or response function of natural and social systems. And, second, the scale and rate of the change in climate in many parts of the world may turn out to be unprecedented in human history. Taking these factors together, human societies may experience what is already hypothesised in emerging ecosystem science - that smooth change and adaptation can be interrupted by sudden and drastic switches to another state, resulting in the inability to cope with new circumstances. These sudden shifts can be seen in forest, coral reef, grassland and other ecosystems as a result of apparently gradual climate change (e.g. Scheffer et al., 2001). There is also the reverse situation where climate change is not gradual – i.e., a sudden discontinuity in climate or more than one extreme weather event coming in close sequence which may also undermine the inability to cope. Indeed, this characteristic of the sequencing and recovery time from weather-relate hazards is well understood within the hazards research area. Blaikie et al. (1994) suggest that the timing of hazardous discrete events in nature constitutes a building of pressure on the vulnerability of marginalized populations. The vulnerability of populations is both event-based and a product of political and economic structural factors (Mustafa, 1998; Pelling, 1999; Adger, 1999). As with ecosystems, interventions to facilitate societal adaptation in the developing world, and the developed world, requires new priorities in maintaining individual and social resilience.

4 Policy responses on adaptation to climate change

A second key area for research on adaptation is more normative. It involves identifying feasible and desirable adaptation options such as agricultural technologies and governance structures, and further identifying the necessary conditions in which these options can be implemented. And it involves the international political context of decisions at appropriate scales. But the limits to many adaptation options are already apparent in areas such as population movement and migration, in the ability to bring new agricultural land under irrigation when rainfall is threatened, or to bring about large-scale infrastructural changes to minimise the impacts of sea level rise on coastal areas. Migration, for example, is a coping mechanism used throughout history by societies as part of their resource utilisation strategies and as a means of coping with climate variability. Indeed migration, including to urban centres, continues to play an important role in livelihood resilience to the present day in many parts of the developing world. There is a substantial degree of certainty that areas of the present day developing world will face greater incidence of extreme weather events in the future. If desirable migration is not available to those affected, it may ultimately increase the necessity of displacement migration, typically undertaken as a last resort when other coping strategies are exhausted.

There is emerging evidence from Brazil, Vietnam and the small island developing nations that new migrants to frontier areas build up knowledge of the local environments to promote sustainable utilisation of resources (Muchagata and Brown, 2000; Adger et al., 2002; Connell and Conway, 2000). Migration would appear to be a feasible climate adaptation strategy in particular circumstances. But the right to migration, particularly international migration at a time when there are increasing inequities in international labour flow practice, is likely to be increasingly contested (O'Neill et al., 2001).

The COP7 meeting of the Climate Change Convention in Marrakech in 2001 agreed the setting up of a number of funds including a Climate Change Fund to support the developing countries on adaptation, technology transfer and capacity building with respect to climate change as well as a separate LDC (Least Developed Countries) Fund to help the LDCs to develop National Adaptation Plans of Action (NAPAs). Contributions to funds were to be voluntary and a number of developed countries pledged to make contributions at the level of over $400 million a year that would be channelled to the developing countries through the Global Environment Facility (GEF). This figure is expected to rise to $1 billion by the time of the World Summit on Sustainable Development. The GEF has been supporting work in developing countries on adaptation to climate change through a staged process. Stage I was to support studies and planning, Stage II to support detailed planning and capacity building and Stage III to support actual adaptations. Most developing countries have already carried out the initial assessment (or Stage I) studies on adaptation (many of which are reported in their National Communications to the UNFCCC). A few Stage II studies (for example in the Caribbean, Pacific and Bangladesh) have also been initiated. However there is a need for the developing countries to prepare more detailed assessments of adaptation to climate change including policies and ensuring their compatibility with action plans under other multilateral;

environmental agreements (such as biodiversity and desertification) as well as with other national sustainable development plans or strategies (Huq, 2002).

Within this set of international negotiations there are divergent views as to what constitutes adaptation and the role of development, particularly sustainable development in the process. Adaptation to climate change is not a costless exercise. We have already highlighted in this article that it is inextricably intertwined with the political economy of natural resource use. Hence investments in adaptation will inevitably have winners and losers (Kates, 2000). Equally the nature of uncertainty concerning the scope and magnitude of climate changes as discussed above, suggests that some adaptation strategies may turn out to be redundant. In the worst scenarios, investments in adaptation may be offset by maladaptive policies in other sectors (Burton, 1997). So within the international negotiations the view is often expressed that sustainable development is required both in terms of managing future climate change risks, as well as weather-related hazards in the present day, and indeed in seeking to promote low-emission based industrialisation. But others argue that the climate threat and the need for adaptation is a not a continuation of what has gone before and that climate change brings new and urgent dimensions to sustainable development. Further, the Kyoto Protocol, and related mechanisms around the international agreements on climate change, has authority only to focus on environmental impacts and adaptation provoked by a narrowly defined human-induced climate change. Hence there is a fundamental dilemma at the heart of international action on this issue – the need for reductionist identification of the 'climate'-related part of global social and economic trends, versus the desire to see climate change as another important dimension of global environmental threats to development.

These same issues are played out throughout the mechanisms of the international agreements. Projects implemented as part of the Clean Development Mechanism (CDM) of the Kyoto Protocol, one of the so-called flexible mechanisms, have the dual mandate of reducing greenhouse gas emissions and contributing to sustainable development. Ambitious claims have been made about the likely benefits of CDM projects in developing countries without basis in research or observation. Developing countries are unlikely to become fully engaged in implementing the UNFCCC unless they perceive development benefits. At present there are serious risks to developing countries engaging in CDM activities not least of which is that may distort development priorities, and may also lead to the situation where the only domestic mitigation measures remaining are higher cost activities (Karp and Liu, 2000, Parson and Fisher-Vanden, 1999, de Jong et al., 1999).

5 Conclusions

Climate change adaptation is the adjustment of a system to moderate the impacts of climate change, to take advantages of new opportunities or to cope with the consequences. Many participants in the meeting in London argued that due to the nature of the new challenges brought about by climate change in natural resource management and other areas of governance, adaptation will inevitably be characterised both by processes of negotiated adjustments involving individuals, civil society and state, and involving renegotiation of risk-bearing and sharing between them. This is different to the dominant discourses of adaptation in international negotiations which perceive of adaptation as a process which can be smoothed through international development transfers. Global managerialism dominates these policy and international institutions and discourses (Adger et al., 2001a). It creates a distortionary focus in these debates toward only 'planned adaptation' by the state, both at the global scale and in the role of national governments. Of course, the role of international action is critical in this area because of the interaction of planning for adaptation with an emerging scientific understanding of the risks involved.

This review of issues raised at the October 2001 meeting has shown that much adaptation in the developing world will rely on past experience of dealing with climate-related risks. Thus much adaptation by farmers, fishers, coastal dwellers, and residents of large cities will be autonomous and facilitated by their own social capital and resources. This will not easily be identifiable among a myriad of social, demographic and economic factors impinging on development trajectories and experiences (O'Brien and Leichenko, 2000). But there is a key role for planning for adaptation in these ongoing processes. International institutions need to appropriate these latest research insights on adaptation from the developing world and build a global coalition, not only to take action to reduce damaging emissions, but to facilitate the inherent resilience of people coping with an uncertain future.

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Appendix 1

Adaptation to Climate Change: Setting the Agenda for Development Policy and Research

25th October 2001, Royal Society, London

Introduction

Dr. Neil Adger and Dr. Saleemul Huq

Emerging Perspectives from the Intergovernmental Panel on Climate Change

(chair: Professor John Lawton, Natural and Environment Research Council)

Climate change and extreme weather events: what do we know?
Dr. Mike Hulme, Tyndall Centre for Climate Change Research

Emerging perspectives on adaptation to climate change in developing countries
Dr. Saleemul Huq, International Institute for Environment and Development

Implications of Adaptation to Climate Change for Development Policy and Research

(chair: Dr. Katrina Brown, Tyndall Centre and School of Development Studies, University of East Anglia, Norwich)

Health impacts and adaptation
Professor Andrew Haines, London School of Hygiene and Tropical Medicine
Dr. Koy Thompson, Action Aid

Disaster planning and disaster relief
Dr. David Satterthwaite, International Institute for Environment and Development
Dr. Patricia Feeney, Oxfam UK

Water resources and food security
Dr. Declan Conway, School of Development Studies, UEA and Tyndall Centre
Dr. Michael Mortimore, Overseas Development Institute

Research Priorities and Direction: Panel discussion

(chair Dr. Neil Adger, Tyndall Centre)

Dr. Andrew Bennett, Department for International Development
Dr. Camilla Toulmin, International Institute for Environment and Development
Mr. John Ashton, Foreign and Commonwealth Office, London, UK.
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