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Defining response capacity to enhance climate change policy

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Abstract

Climate change adaptation and mitigation decisions made by governments are usually taken in different policy domains. At the individual level however, adaptation and mitigation activities are undertaken together as part of the management of risk and resources. We propose that a useful starting point to develop a national climate policy is to understand what societal response might mean in practice. First we frame the set of responses at the national policy level as a trade off between investment in the development and diffusion of new technology, and investment in encouraging and enabling society to change its behaviour and or adopt the new technology. We argue that these are the pertinent trade-offs, rather than those usually posited between climate change mitigation and adaptation. The preference for a policy response that focuses more on technological innovation rather than one that focuses on changing social behaviour will be influenced by the capacity of different societies to change their greenhouse gas emissions; by perceived vulnerability to climate impacts; and by capacity to modify social behaviour and physical environment. Starting with this complete vision of response options should enable policy makers to re-evaluate the risk environment and the set of response options available to them. From here, policy makers should consider who is responsible for making climate response decisions and when actions should be taken. Institutional arrangements dictate social and political acceptability of different policies, they structure worldviews, and they determine the provision of resources for investment in technological innovation and social change. The importance of focussing on the timing of the response is emphasised to maximise the potential for adjustments through social learning and institutional change at different policy scales. We argue that the ability to respond to climate change is both enabled and constrained by social and technological conditions. The ability of society to respond to climate change and the need for technological change for both decarbonisation and for dealing with surprise in general, are central to concepts of sustainable development.

Keywords: Adaptation; Mitigation; Climate change policy; Risk; Technology; Social change; Response capacity

1. Introduction

''Dichotomies are useful, but when falsely configured they can be harmful'' (Stevenson, 2002, p. 263)

Creating national climate policy is challenging. Long time frames, scientific uncertainty about impacts and about social and economic futures all conspire to test the abilities of existing decision-making processes. Specific difficulties arise because national climate policy deals with climate change impacts generated through actions taken both within and outside most countries, as well as natural climate variability. It is clear that there are many causes of climate change and there are many solutions, which depend to a degree on how societies and individuals in the present day are willing to trade-off their consumption and lifestyles for speculative improvements in the well-being of future generations. Often the easiest decision (and one lobbied for by particular interest groups) is to postpone decision-making until more information is available, although the costs or benefits of doing so are unknown, but could potentially be significant (Mastrandrea and Schneider, 2004; Schneider, 2004).

Decision-making about climate change is difficult because of the scientific uncertainties, the long time frames for impacts to occur, and the global natural of the problem. Individual disciplines, which provide guidance on specific issues are limited in their ability to guide decision-makers. Microeconomic theory, for example, describes how individuals make decisions under uncertainty when dealing either

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with other people or with external hazards in nature (see for example, Keeney and Raiffa, 1993). Unfortunately, due to the expected long times frames associated with climate change, these techniques are proving less than useful on guiding climate policy (Scheraga and Grambsch, 1998; Tol, 2003). Probability-based decision-making frameworks are also of little use as there are no known probabilities of different climate impacts occurring at given times, places or in the form of specific hazards, and no evidence that nature will behave in a particular manner in response to a certain level of emissions or concentrations of greenhouse gases, or degrees of atmospheric warming. Without the availability of such probabilities, planning for climate change will continue to be made in ignorance of potential impacts (Dessai et al., 2005). As a result climate policy responses taken today more often depend on individual decision-makers attitudes towards risk (Schneider, 2002).

At the international level, the UNFCCC annual Conference of Parties (COP) negotiations are working towards resolving international conflicts of interests, for example through the creation of the Kyoto Protocol and the Marrakesh Accords, but these are making only limited progress on tackling the causes of climate change. The slow progress in tackling the causes of climate change is partly due to the issue of historical responsibility for creating climate change impacts. The responsibility issue is crucial, since this will ultimately have implications for the allocation of international compensation. On the basis of most definitions of justice, those nations that have generated the most emissions historically should pay compensation to those who will suffer the consequences of those emissions. Countries are therefore very cautious in their negotiations because of the possibility of the attribution of liability at some time in the future (Barnett and Dessai, 2002). Perhaps because of this impasse at the international level, perhaps because of the nature of impacts and the avoidance of apparent liability for past action, there is a division of activities within the international institutions into adaptation and mitigation. 'Mitigation' refers to actions taken to reduce greenhouse gas emissions and hence to tackle the causes of climate change, 'adaptation' refers to actions taken to deal with the consequences of climate change, both before and after impacts are felt. This dichotomy of actions to manage climate change risks separately through adaptation and mitigation in this way is mirrored at the national level, with adaptation and mitigation usually occurring in different policy domains and engaging different communities.

Dichotomies can create fractured and biased images of the world and reduce the possibility of finding holistic responses that consider sustainability, that are dynamic and learning based, that build on strengths rather than needs, and that put human well-bring at the centre of the issue. Research in various related fields, from welfare economics to natural hazards has sought to bring cause and consequence of development processes together (Dasgupta, 1993; Blaikie et al., 1994; Rayner and Malone, 1998). These insights, with some exceptions, have largely been missing from the climate change debates.

Wilbanks et al. (2003) argue that this adaptation and mitigation dichotomy has arisen because of the perception that raising adaptation options in policy circles reduces the requirement for mitigation. This may be true in those countries where there are strong vested interests in not mitigating and where the costs of adaptation are not considered insurmountable (Wilbanks et al., 2003). The US may be a case in point (Mendelsohn and Neumann, 1999; Wilbanks et al., 2003). There are various critiques of the separation of mitigation and adaptation implied in the IPCC and other assessments (see for example, Barker, 2003). There is also recognition of the danger in setting up apparent trade-offs between adaptation and mitigation as this division could lead to separate policies being developed in a vacuum from one another. Potentially this could lead to increased costs of managing climate change with little effect on climate risks (Kane and Yohe, 2000:2).

The use of a framework that depicts adaptation as an end-of-pipe solution to the climate problem by various institutions means that division of response options into adaptation and mitigation will remain the dominant paradigm for the foreseeable future. To understand and perhaps overcome the dichotomy we require insights into the structure and nature of both institutions and individual choices to explain the relationship between adaptation and mitigation. Both choice theory and institutional theories dispel the notion that adaptation and mitigation should be approached separately. We do not deny that differences exist between the two concepts, but, following Lawson (2003:200), recommend a 'less sharp, less categorical rendering of them' (Lawson, 2003). As Peters (1987) notes, as a result of institutional complexity and inertia, models may continue to be used long after they have been rendered useless because they are embedded and rooted systems. She argues that 'the power of models is such that the process of paradigmatic shift is long and painful' (Peters, 1987:177).

In the next section, we consider the components of climate change response, i.e. those of technological innovation and societal change, and review the issues that are central to effective decision-making in the face of uncertainty. The third section develops the concept of a response space and response pathways as well as the idea of response capacity. The question of what drives response capacity is considered and the issue of how to develop a more flexible and sustainable approach to climate change is investigated. The focus here is on how developing response capacity may enhance societies' ability to achieve more sustainable development. The paper concludes that the capacity of an individual, group or institution (at any scale) to learn and modify its response to climate change is important in generating sustainable outcomes. We propose that this can be best achieved by adaptive management and

social learning at all scales from international climate change policy making to individual action.

2. Defining the response set

In this paper, a response is defined as any action taken by any region, nation, community or individual to tackle or manage environmental change, in anticipation of that change or after change has occurred. This loose definition deliberately avoids tying 'response' to climate impacts as it is almost impossible to separate pressures exerted as a result of climate change from other economic, environmental or developmental pressures. Building on past research we propose that any response to climate change must be cognisant of wider development pressures as well as goals such as increasing economic, environmental and social well-being instead of focussing solely on single system management (see Tompkins and Adger, 2004).

2.1. The response space

We propose that responses to climate change require consideration, not only of other development pressures and goals, but also of the factors that enable and constrain adaptation and mitigation. We believe that the latter comprises two critical elements: the availability and penetration of new technology and the ability (including the willingness) of society to change. For example, response to hurricane risk is determined by many factors, one of which is construction technology, including the availability of hurricane wind-resistant glass for windows. However, the availability of this glass alone is not enough. People need to have the ability to find out that these windows exist, purchase them, effectively install and maintain them. If the social acceptance of such technology does not exist, or there are social barriers to uptake, possibly through an income constraint, then the response will be limited. Another example can be seen in flood protection where the set of responses are constrained by the availability of early warning systems (technology) and the willingness of those in the hazard zone to listen to this and take guidance from this in both the short term and the long term (social willingness to change). In other areas with competing environmental and developmental pressures, including: flood management, coastal zone management, nature conservation, and common property resource management, these two factors have also proved to be important factors in constraining and enabling responses.

Hence, we propose that these same two factors (the availability and penetration of new technology, and the willingness and capacity of society to change or adopt this new technology) are likely to drive responses to climate change through the creation of 'response capacity' and the implementation of response actions. We propose that 'response capacity' describes the ability to manage both the causes of environmental change and the consequences of that change. Fig. 1 depicts these two drivers as framing the range of response options available in a 'response space'. The response space bounds the set of options available to decision-makers. The space can be increased or decreased through investment in the two boundary conditions: technology and societal change.

Using the UK as an example, public policy investments have been made in education for the wider society on the potential impacts of climate change and societies role in creating and managing those impacts. These investments have been made through agencies such as the UK Climate Impacts Programme (UKCIP), the Energy Saving Trust and the Carbon Trust (see for example, Eppel and Eyre, 2002; UKCIP, 2003). Ultimately the purpose of such investment is to alter behaviour and increase society's ability to cope with future impacts. Such investment is expected to enable individuals to start to respond to climate change, to promote uptake of new technology, to enable them to internalise the costs of responding to climate impacts, and to reduce future investments in disaster management. There is a subtle demarcation between mitigation and adaptation, with UKCIPs remit extending only to impacts and adaptation, and the Carbon Trust and Energy Savings Trust focussing on mitigation.

Governments also have to deal with the issue of how much to invest in research and development for new technology to reduce carbon emissions and to adapt to a changing environment. How much to invest in these two areas (technological innovation and social change) over both the short term and the long term is a difficult question facing many governments at present. With a finite set of assets that can be allocated at all scales and in all countries this question is subsumed into, the bigger question of, how should assets be allocated to maximise the well being of society?

Referring to Fig. 1, this question can be re-phrased as 'how can we move from having a low response capacity to having a high response capacity', i.e. how can we move from the 'low' area to the 'high' area in Fig. 1 under a specific budget? The 'low' response area of Fig. 1 describes a situation of low capacity and desire to respond. Here, it is

Fig. 1. Elements of a climate change response space.

assumed that there are limited resources allocated to enable access to technology and there is little perceived risk or vulnerability associated with climate impacts. Hence there is little support by the wider society to invest in response measures. Conversely, the 'high' area within Fig. 1 suggests that there is a high degree of awareness of vulnerability/risk and that the need for adaptive actions is recognised. Clearly high and low response capacity are relative concepts that are not measured on an ordinal scale and do not correspond to single points in Fig. 1. The path taken to reach 'high response capacity' is determined by a much larger set of issues influencing attitudes to risk and uncertainty; access to capital assets (human, physical, natural, financial and social); the vulnerability context in which the society or group operates (including vulnerability to shocks or trends); and institutional context.

2.2. Attitudes to risk

Attitudes to risk and uncertainty are clearly important in explaining why regions of the world have adopted different approaches to managing the potential threats of climate change (see Tompkins and Amundsen, 2005). Regions perceiving themselves at risk from impacts are investing in adaptation. In the Caribbean, the recently completed project Caribbean Planning for Adaptation to Climate Change (CPACC) had the remit to build capacity to reduce vulnerability to climate change (World Bank, 1997). CPACC adopted an institutional strengthening approach through monitoring, communication, training and information dissemination programmes to provide guidance to country level managers (see for example, King and Clarke, 2000). In the Maghreb region, another UNDP/GEF funded initiative 'Capacity building of the Maghreb countries in climate change' is focussing on building structures to manage climate change sustainably, to prepare adaptation strategies at the local level, and to engage the private sector to see how it can reduce its contribution to greenhouse gas emissions (see Regional Coordination of the UNDP/GEF RAB/94/G31 Project, 2002).

Nations with a different perception of the risk faced appear to be adopting decision rules that encourage them to invest in both adaptation and mitigating technology to ensure benefits are maximised from future climate changes. For example, the UK has adopted an approach that focuses on drawing out the benefits that can be gained from climate change—including new business opportunities, as well as considering the risks that the businesses face (Clarke et al., 2002; UKCIP, 2003). There are many different approaches being applied, each one dependent on attitudes to risk and vulnerability to climate change impacts.

What are decision-makers trading off when they consider risks associated with climate change? Both casual observation and public choice theory suggest that national level policy making, at least within democratic systems are constrained by a number of socio-political factors and a set of economic factors. The socio-political factors include (a) the length of political voting cycles (how long-term after investments are made before politicians should be held to account for them), (b) the transmission of information from state to society on risk, (c) lay perceptions of risk, and (d) the length and nature of issue-attention cycles. The demand for action in the face of risk is mediated through voting systems, the media and other actors (see Michaelowa, 2000) for an elaboration of a political economy approach to influence and demand for different strategies). In addition, public policy decision-making on climate change involves economic decisions that include formulation of expectations on the extent and cost of impacts, the cost of adaptation, the transaction costs of information, and the expected cost of misplaced foresight.

Both socio-political and economic factors manifest themselves in different ways in individual political cultures—they can be framed as trade-offs between legitimacy, equity and efficiency, or as a judgement on 'dangerous' climate change (Dessai et al., 2004). But, ultimately, each of the elements, cost, risk and socio-political factors, are encompassed in the shape of the indifference curve between reactive and anticipatory management.

2.3. The role of institutions

The response landscape and trade-offs between anticipatory versus reactive action is made of actors in government, civil society and individual agents. Fig. 2 shows how the strategic level decisions by governments which involve trade-offs between investment in new technology or investment in social response capacity (shown in Fig. 1) are imposed through a set of institutions and policies on a society that makes individual decisions on the basis of individual assets and perceptions of vulnerability and risk. The outcome of these collective and individual decisions is the response to the climate change threat, a combination of adaptation and mitigation actions. Clearly this model of societal decision-making implies a linear progression from policy-making, to implementation, to policy outcome. Such a model is challenged in many theories developed in public administration and political science, which point to both the limits of the state in many policy areas, the breakdown or hollowing out of the state, the diverse nature of public policy formulation, and the interaction of social capital and state (O'Riordan et al., 1998; O'Riordan and Jordan, 1999; Hall and Soskice, 2001; Adger, 2003).

The availability and penetration of environmentally sound technology is also an important element defining ability to respond. We argue that the same factors that enhance willingness and ability of society to respond, i.e. attitudes to risk and uncertain scientific information; access to capital; the vulnerability context; the institutional context, all effect the uptake and introduction of new technology.

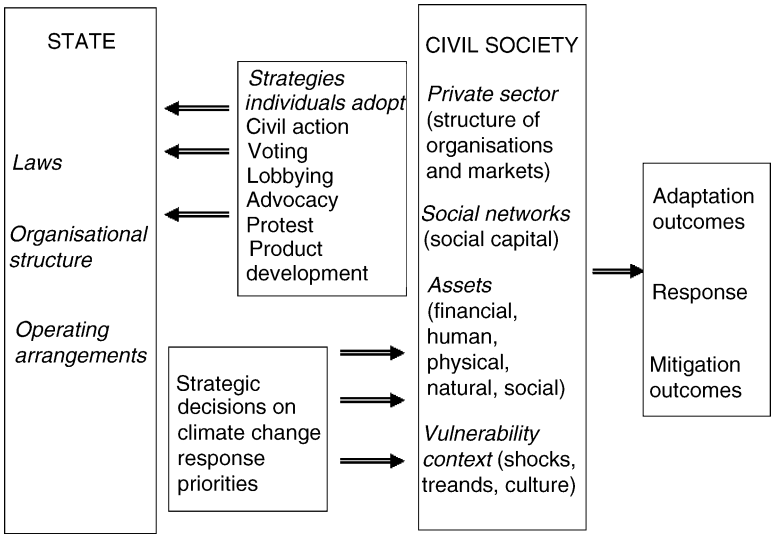

Fig. 2. Relationships between assets, institutions and society.

The factors that influence technological uptake relate to the current levels of vulnerability of the individuals or societies, their access to assets, and the institutional structures and policies that can enable the uptake. In other words the factors influencing the uptake of new technology are very similar to the factors influencing whether individuals or societies are willing to embrace change. This understanding is described clearly by decision-makers themselves. An example is given by Turnpenny et al. (2003) who interviewed a series of key agents in implementing climate strategies in the UK. One government decision-maker noted that adaptation and mitigation are often treated separately because different methods or analysis techniques are used with each. However, adaptation and mitigation both ultimately occur as a result of behavioural change (Turnpenny et al., 2003).

One of the most important features of both Figs. 1 and 2, is that no explicit trade-offs are forced between adaptation and mitigation. It is assumed that a more accurate representation of the decision environment might be to find a balance between investing in technological research and development (R&D) and building social response capacity. The timing of the investment in climate change responses is important, but this is clearly influenced by attitudes to risk, access to capital and other factors. Whenever the climate change response is timed, reactively or in anticipation of impacts, there are very different roles for the government, the private sector and individuals or wider society (see Table 1).

Deciding how to allocate resources is not apparent from the conceptualisation of the response space in Fig. 1 or the social context shown in Fig. 2. More resources may mean more action, but on what basis are decisions taken to prioritise different actions when the benefits and costs are unknown, or difficult to assess with any degree of accuracy? In the absence of a more appropriate decision-making framework we suggest that consideration should be given to two specific elements of the decision problem: the timing of the investment (in anticipation of specific climate change impacts or after impacts have started to be experienced) and who should be making the decisions and taking actions (the government or non-government agents). Table 1 depicts the continuum of timing of decision-making into two groups: anticipatory decision-making that takes place before climate change impacts occur, or reactive decision-making that takes place after impacts have started. Clearly there is no separation between the two, Table 1 is used for illustrative

Table 1
Adaptation options by timing and by responsibility

	Timing of response	
	Anticipatory (ex ante)	Reactive (ex post)
Responsibility for response		
Private	Private insurance markets	Adjustments in insurance markets
	Private R and D and investments	Identification of least-cost adaptation options
Public	Public infrastructure provision (e.g. coastal protection)	Post-disaster recovery
	Risk communication to public	Compensation for impacts
	Publicly available R and D	Insurance underwriting

Source: Adapted from (IPCC, 2001):279.

purposes only. Table 1 also explores the type of decisions made depending on who is making the decision. Again, for explanation, a division of decision-making responsibilities into those made by the private or public sector are shown, however in reality, responsibility for decision-making is also likely to lie along a continuum with both groups interacting with each other and informing the decision process.

By characterising the decision environment by timing of decision and by responsibility for decision-making, it explicitly reveals the trade offs inherent in the decision-making process. Short-term gains or long term gains might be a more appropriate dichotomy to develop. Such value-focussed thinking, as suggested by Keeney and McDaniels (2001), is recognised as an important precursor to institutional policy-making under uncertainty.

Table 1 portrays the benefits of responses as accruing in either the public or private domain. Some elements of investment in climate change response are 'public' and include conservation of nationally or internationally important habitats. Others are effectively private. If private firms in the water industry invest in knowledge of climate change risks, the costs and the benefits of this response are private. Climate change planning by governments at present tends to concentrate on providing public goods such as scenario information, risk assessments in the public domain, and public awareness campaigns, see (ERM, 2000; Hulme et al., 2002; UKCIP, 2003). Hence, many response programmes at present avoid providing subsidies to private adaptation decisions. But the public and private elements of responding to climate change are not fixed: they are shaped by institutional and regulatory features in each sector of the economy. Further, they can change from public, to private and back again over time (see Bakker, 2003 on the UK water industry, for example).

This public–private issue is important to spell out, since it represents real trade-offs in policy. Governments in Europe, for example, continue to intervene in agricultural markets to reach public policy objectives of 'food security' through the Common Agricultural Policy even though the benefits have leached from farmers income while capital values accumulate in land (Allanson and Hubbard, 1999). But there may be less willingness to invest in climate change responses if all the benefits are perceived to be 'private'—i.e. accrue to individual farmers, insurance companies and energy companies. The private and public nature of climate change response is determined by public policy and by underlying institutions and regulatory frameworks. Thus, similar responses in the water sector could accrue to the public or private sphere, and could change over time (Bakker, 2003).

3. Elements of response capacity: technology and society

As discussed above, responses to climate change are expanded or constrained by societal willingness to change and access to technology appropriate for adaptation and mitigation. Understanding what the act of responding means is important, but so to are the pre-conditions that enable responses to occur. Response capacity is time and context specific. Over time, as the information about climate science changes and understanding of the climate futures change, perceptions of what factors enhance the ability to respond are also likely to change. The factors are also likely to be culturally and regionally specific as different societies or groups will need different characteristics and tools to respond to different hazards and different types of climate change. Hence, it may be that in the future when we look back and evaluate past responses we may find that we have in fact been developing inappropriate response capacity. With this knowledge, it becomes important to recognise that any capacity that is built or developed is able to change in response to new information or learning. We now explore the elements of a response capacity and consider the issues of social learning and adaptive management.

3.1. Institutions, agents and decisions

Response capacity can exist within institutions, individuals and groups, and it can be influenced by the institutional environment as well as individual choice and behaviour. New institutional economics and choice theory offer insights into how such capacity can be built.

Current research suggests that existing institutions are unlikely to be able to cope efficiently and equitably with climate change outside their range of experience (Kane and Yohe, 2000), particularly in developing countries (Kates, 2000). This is partly because climate policy decisions are most frequently made at the national level, although the consequences of those decisions are experienced at local, national, regional and international scales. How then can we develop institutions that can cope with these unusual policy dimensions? Various areas of study suggest through the promotion of institutional and social learning and more effective management through greater inclusion and integration.

Empirical studies on barriers to adoption of new forms of technology or to social change show that there is a clear need for integration among sectors, among government departments, and across different scales of management, from the international to the local. In coastal zone management, for example, much attention is devoted to concepts of horizontal and vertical integration, inclusion, systems management and learning based approaches (see for example, Gezon, 1997; Sorensen, 1997; Tompkins et al., 2002). Other studies indicate that laws or regulations imposed without enabling a behavioural change will have little or no effect in changing either institutions or human behaviour. For example in energy policy (Sorrell, 2003) identifies institutional and behavioural barriers to energy efficient construction of non-domestic buildings in the UK. He highlights the presence of imperfect information, moral hazard in the relationships

between agents in the energy services market, split incentives within organisations, bounded rationality limitations on decision-making, and hidden costs of rational behaviour (Sorrell, 2003). Some of these impediments could be removed through better communication among those involved and a more integrated planning process.

The complexity of human relations and the social, economic and cultural context in which people operate are as important as the legal framework. Integrative approaches that recognise the institutional bounds placed on individual decisions would likely advance their effectiveness. New technology and social change have both positive and negative externalities associated with each resource allocation decision, whether undertaken by governments or individuals. For example, an adaptation to cope better with extreme heat could increase green house gas emissions. A mitigation action to reduce use of fossil fuels would impact on the economies of the OPEC countries. Since we can expect that anticipatory climate change responses will be undertaken by individual agents (adopting insurance cover, moving location from hazardous areas), government decisions need both to avoid the inefficiencies of subsidising stewardship likely to take place anyway, and to incorporate planning for adaptation in their mitigation strategies. In other words, public sector decisions on responses also require consideration of implementation issues, as discussed above.

3.2. Learning to respond

Decision support tools, to facilitate public response to climate change, are needed to guide decision-makers in their response. Keeney and McDaniels (2001) point out that due to the long time frames for decision-making, the lack of information available and the uncertainty about impacts mean that the danger of becoming locked into a limited set of response options is very high for climate change decision-making. They propose that to overcome this problem, a shorter time frame (less than 20 years) is required within which preliminary policy objectives for climate change are developed, pursued, tested and evaluated. In their study in North America, they suggest that there are six objectives which should influence the decision-makers values: learning; education; alternatives beyond the planned 20 year time frame; the severity of the threat; the consequences of the current options; accountability for decision-making. Each of these addresses the issues of social change and adoption of new technology, however, they are built around the premise that management capacity changes through learning.

In the area of natural resource management, social learning is increasingly encouraged through a range of approaches known collectively as adaptive management (Jordan and O'Riordan, 1995; Parsons and Clark, 1995; Tonn et al., 2000; Jäger et al., 2001). Adaptive management recognises that decisions will be made that may be perceived as inappropriate with hindsight (Walters, 1986, 1997; Olsen et al., 1997; Roling and Wagemakers, 1998; Lee, 1999; Olsson and Folke, 2001; Folke et al., 2002; Tompkins and Adger, 2004). The adaptive management approach requires decision-makers to accept reflexive, evaluative decision-making as part of the long-term process of testing and refining appropriate responses to climate change. This approach has been recommended in the area of coastal zone management for many years (Olsen, 1993; Hale and Lemay, 1994; White et al., 1994; Olsen et al., 1998). Adaptive management builds learning into the decision-making process. It recommends iterative decision-making: start small, test the decision made, if useful and generating the desired outcomes then build on that decision, and constantly test and revise assumptions. Dynamic institutional structures, which have the capacity to be reflexive and adapt in response to new information, are more likely to facilitate change and development in a society than inflexible rigid institutions. As a caveat to this, it is important to remember that institutional flexibility can generate high operating costs, and that institutions are heterogeneous, so flexibility is not 'uniformly useful' (Kane and Yohe, 2000).

Nordhaus (1994) applies a version of a normative decision-making framework and suggests an 'act then learn' approach to decision-making under uncertainty (Nordhaus, 1994) that links clearly with adaptive management promoted in ecological management (Walters, 1986, 1997; Lee, 1999; Folke et al., 2002). Nordhaus proposes a sequential decision-making process wherein decisions are revised as new information becomes available. As there is no useful information initially it is accepted that the first decision made may require complete transformation as learning takes place. More recent work, looking at the importance of hedging in coping with climate uncertainties supports Nordhaus's conclusion that near term mitigation is necessary, irrespective of the current levels of uncertainty (Yohe et al., 2004).

Learning by doing requires decision-makers to accept that they make mistakes and bad decisions. If this acceptance is not present, then learning cannot happen. As Keeney and McDaniels (2001) note, economists and systems analysts have recognised the significance of learning by doing for over 30 years, and this has a major influence on the attractiveness of repeated decisions. Social learning is a complex area and not well understood. Learning can be active or passive. There are costs associated with both learning and gathering information, and the mechanisms by which learning occurs, whether through markets and prices or through other means such as social capital and networks (Allen et al., 2001; Adger, 2003). The information asymmetries that exist along with the complexities of learning can mean that the potential benefits that can be gained from such approaches are reduced unless these issues are tackled (Cordes and Yezer, 1998).

Developing climate policy is riddled with difficulty as it requires large investments in technology and social change, it also has to penetrate all sectors: transport, construction,

agriculture, shipping, utilities, tourism, and so on. Each sector, while pursuing its own internal objectives, can be encouraged through regulation or social pressure to also respond to climate change. As Keeney and McDaniels (2001) point out, 'the first step is for governments to understand what they want to achieve with climate change policy choices' (p. 989). Locking into their values and their preferred states of the world at a given time is critical to developing consistent horizontally integrated climate policy.

4. Conclusions

The interdependence between mitigation and adaptation is clear in the context of sustainable development, both are driven by the availability and penetration of new technology and the ability of society to change. The existing constituencies of adaptation and mitigation in most governments are only marginally overlapping. Energy planning and the carbon intensity of economic growth, for example, are usually high in the priorities of industry sectors, government and by consumers who are interested in security of energy. Adaptation within government is primarily dealt with by spatial planners and different (non-energy) sectors of the economy. It also involves different consumption and production decisions by households from those relating to energy use.

The divergence between the parties responsible for adaptation and mitigation poses a problem for policy integration and sustainable climate change responses. We argue that this divide is supported by international and national approaches to climate change that focus specifically on adaptation and mitigation. As an alternative, we consider the two fundamental elements of both adaptation and mitigation, i.e. technological innovation and building social response capacity, and recommend that these actions become the focus of government policy. Enhancing response capacity could increase the ability to make use of the spectrum of options that are available to respond to climate change. The division of response capacities are at present only hypothesised, though we have pointed to some key issues in this paper.

Response capacity is driven by technology and societal factors in the form of individual or group behaviour, economic markets and institutions. Both drivers can expand or constrain the set of response options that exist, and both have implications for sustainable development. Building the capability to be adaptive, to be able to learn and grow through learning processes, are beneficial for other instrumental reasons. The greater the perception of ownership and agency in policy formulation, the greater the chance of widespread implementation. Societal engagement with democratic decision-making is, of course, beneficial for many other non-instrumental reasons. A joint response capacity can be elaborated in terms of resource needs; the distribution of risk; the institutions required for social learning and the ability to adjust to climate change.

Another approach to climate change policy could involve an exploration of climate change technologies, both to reduce greenhouse gas emissions and to cope with the unstoppable impacts that will be experienced in the future resulting from climate change impacts. Alternative integrative approaches to climate change policy include efforts to encourage social change, adopt new technology, and embrace the future changes associated with climate change. Without this social acceptance any climate change response is destined to failure.

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