

Managing adaptation: linking theory and practice

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Preface

Eight years have passed since UKCIP's Risk and Uncertainty in Decision-making Framework was published. In the intervening years, the risk framework has proved highly influential within the UK and international impacts and adaptation communities, forming the methodological basis of the first ever National Climate Change Risk Assessment in the UK (CCRA) and being reflected in the work of the Intergovernmental Panel on Climate Change (IPCC), Stern Review, Australian Greenhouse Office and others. In that time the adaptation agenda has also become increasingly prominent and the rate of development in adaptation thinking has increased rapidly.

Risk based approaches to climate adaptation are now widely embraced in the UK and abroad, making UKCIP's Risk Framework more relevant than ever. In order to realise its full potential as a decision support tool there is a need to reflect on, and to incorporate, UKCIP's experience in applying the framework since 2003. In particular, we recognise a need to provide organisations with better guidance on how to initiate their assessments in a way that will enable them to go beyond raising awareness, to undertaking assessments that will lead to the implementation of practical adaptation actions and decisions.

This guidance aims to address that need by discussing key issues that should be considered when making the transition from awareness to action. It is aimed specifically at those undertaking a systematic climate change risk based assessment as part of an adaptation work programme and emphasises, in particular, the importance of the scoping phase of assessment. We have found that some of the most important and difficult decisions and judgements in adaptation planning are made during the scoping phase, and that these can profoundly influence the depth and breadth of an assessment and the mechanisms and players involved in subsequent work. If this process is not actively and explicitly engaged with, tacit assumptions can be inadvertently made which strongly influence the outcomes, or create path dependency which limits the flexibility of adaptive planning.

This document can be read as a stand-alone piece, or in conjunction with Stages 1 and 2 of UKCIP's Risk Framework.

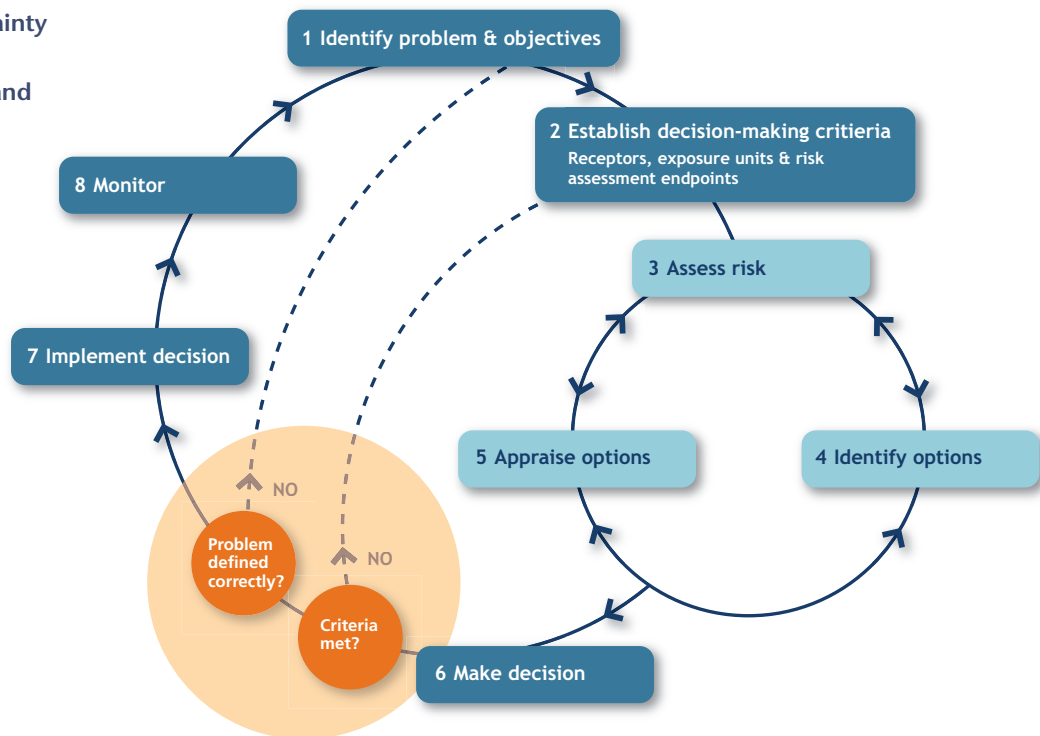
1 Introduction

Efforts to understand the nature and scope of climate change adaptation, as well as the scale of adaptation that will be required or is deemed desirable, can seem complex and hard to pin down. UKCIPs basic approach to navigating this complexity is provided by the Climate Adaptation: Risk, Uncertainty and Decision-making (RUD) framework which is a staged framework designed to help decision-makers identify and manage their climate risks in the face of uncertainty. The framework is laid out in a UKCIP Technical Report (Willows and Connell, 2003) and is based on standard decision-making and broadly applicable risk principles. Users are encouraged to consider their climate risks alongside their non-climate risks.

The key stages of the process are:

1. Identify the problem and objectives
2. Establish your risk tolerance level and decision-making criteria
3. Identify and assess your risks
4. Identify a range of adaptation options
5. Appraise your adaptation options
6. Make a decision
7. Implement the decision
8. Monitor the decision

Figure 1: Risk, uncertainty and decision-making framework (Willows and Connell, 2003).



This document supplements the Risk, Uncertainty and Decision-making framework (RUD) and is designed to provide additional support for organisations seeking to undertake some form of adaptation planning, either for the first time or in consolidating work undertaken so far. **It is aimed particularly at those undertaking a systematic climate change risk based assessment as part of an adaptation work programme.** Risk is used in a broad sense to encompass any approach, high level or detailed, which produces qualitative or quantitative assessments of the threats and opportunities posed to an organisation's operations by climate change and their associated likelihood and consequences. The term risk should not, therefore, deter those who have not undertaken a classical risk assessment from engaging with this document or the Risk, Uncertainty and Decision-making framework. The guidance provides supplementary information to Stages 1 and 2 in the Risk, Uncertainty and Decision-making framework, including:

Identifying the problem and objectives (Stage one).

- Highlight some of the key characteristics of adaptation as a decision problem
- A checklist of things to consider in identifying the scope and overarching objectives of adaptation

Establish your risk tolerance and decision-making criteria (Stage two).

- Highlight the major approaches to climate risk assessment
- Highlight the major approaches to adaptation decision-making and their advantages and disadvantages.

The Risk, Uncertainty and Decision-making framework offers a way to help structure thinking on adaptation planning and practice and is designed to support practice and should not constrain it. The framework is therefore not intended to be a rigid structure which must be followed in a strict stepwise fashion but rather offers a flexible learning approach to planning, implementing and evaluating adaptation. The framework, illustrated in Figure 1, is laid out in a UKCIP Technical Report (Willows and Connell, 2003) and is based on standard decision-making and broadly applicable risk principles. Users need not follow the risk framework strictly in order to find this guidance document helpful. Indeed, it should be useful for anyone considering adapting to a changing climate.

1.1 THE NEED FOR SUPPLEMENTARY GUIDANCE

The Risk, Uncertainty and Decision-making framework is one of the core tools within UKCIP's portfolio. The report has had a mixed reception among the adaptation community, gaining significant intellectual credibility on the one hand (Appendix, Tables A & B) and being criticised as technical and heavy going on the other. In many ways this simply reflects the diversity of stakeholders which are potential users of the tool as well as some of the inherent difficulties in providing guidance on climate change adaptation ([Section 2.6](#)). UKCIP has gone some way to addressing the needs of those who would find the framework useful but want a 'light touch' version by creating the UKCIP Adaptation Wizard (UKCIP, 2008) which is a web-based question driven tool derived from the Risk, Uncertainty and Decision-making framework but provided in a relatively non-technical, user-friendly format.

A snapshot of how some of UKCIP's stakeholders have reacted to the framework is provided by a UKCIP mid-contract review questionnaire conducted by Defra in 2007 (Unpublished Defra report, 2007). This questionnaire supported the finding that the Risk, Uncertainty and Decision-making framework has been directly used by a rather limited group of stakeholders and while it has generally been well received and found to be beneficial to that group, it had not enjoyed wider uptake among UK decision makers at that time. However, UKCIP web statistics for August and September 2010 show that uptake has markedly increased recently. In any case the direct uptake is only part of the story because the framework has been very influential within UKCIP and in the national and international (and academic) impacts and adaptation communities. It has formed the methodological basis of important regional and sectoral climate risk and adaptation assessments in the UK, including the First National Climate Change Risk Assessment (CCRA), (Appendix, Table A), which is perhaps partially responsible for the recent surge in uptake of the RUD as evidenced in UKCIP web-stats (UKCIP, 2010). The RUD framework has also been reflected in the work of the IPCC, Stern Review, Australian Greenhouse office and others (Appendix, Table B).

The RUD framework forms the backbone of much of UKCIPs approach to adaptation and provides an extremely helpful framework with which to contextualise different steps in an adaptation process and the methods, tools and resources provided to support them, not least the climate change information (currently the UKCP09 climate change projections). The core competence of the framework is in supporting planning and decision-making under uncertainty, which is the basic problem underlying all adaptation.

1.1.1 THE CHANGING CONTEXT

Adaptation can no longer be considered the ‘Cinderella’ of climate change. By way of example, the number of adaptation plans published in the USA, Canada, UK and Australia per year has increased from approximately 1 or 2 in the early 2000s to around 5–10 per year from 2005 to 2007 and over 30 in 2008 (Preston *et al.* In Prep). Similarly, while a suggestion 10 years ago that adaptation would be unavoidable was considered defeatist, it is now commonly accepted that immediate investment in adaptation will be essential to buffer the worst climate impacts (Parry *et al.* 2008). Recognition of the adaptation imperative has led to a rapid increase in the rate of development in adaptation thinking and also in the policy context. In the UK, the Climate Change Act, with its provision of an Adaptation Reporting Power (ARP), and a national Climate Change Risk Assessment (CCRA) are significant developments in the nation’s adaptation efforts. Risk based approaches to adaptation are now widely embraced and the new probabilistic climate projections (UKCP09) support this approach.

These developments in the field of adaptation make the risk framework more relevant than ever. However, in order to realise its full potential as a decision support tool, it will benefit from revision to reflect the experiences of the UK Climate Impacts Programme since the report was published in 2003.

Much of the work undertaken to date in the UK can be categorised as awareness raising or making the case for adaptation. This alone is a significant undertaking and while good headway has been made the job is far from over. At the same time there is a desire to move from generic awareness raising to assessments which can inform practical real world decisions. **The transition from generic, ‘making the case’ messages to conducting detailed, context specific, assessments that are needed to inform practical decision-making can be a bumpy one. This guidance is intended to outline some of the issues which in our experience need to be fully considered in making this transition.** In particular, this document emphasises the importance of the scoping phase of assessment which may not be critical in awareness raising activities but which is absolutely crucial in structuring an appropriate assessment and programme of work (Jones and Preston, 2010).

1.1.2 THE IMPORTANCE OF SCOPING AND OBJECTIVE SETTING

Our experience indicates that some of the most important decisions in adaptation planning are made during the scoping phase. But, our work suggests that many organisations tend to spend very little time on scoping and see adaptation as a technical issue which can be tackled on a project level as a discrete package of work, either in-house or by specially commissioned external consultants. While it may be convenient to see adaptation in this way, and while this approach is certainly appropriate for some questions which relate to a wider programme of work, it may not always be sufficient.

In particular, with risk-based adaptation assessment, it is difficult to decide on the appropriate level of analysis required and many decisions need to be made on, for example, the planning horizons and comprehensiveness of assessment, both in depth (detail) and breadth (scope). More broadly the desired outcomes of adaptation and the mechanism by

which adaptation will relate to established management mechanisms and approaches are tricky issues to tackle. Broad impacts assessment can be relatively objective but adaptation is as much about policy setting for 'desired outcomes' (what are we adapting for?) as understanding the 'objective' threats and opportunities (what are we adapting to?), particularly where tradeoffs need to be made or where synergies are possible or desirable. A lack of clarity of the desired outcomes can consequently present as much of a barrier to adaptation as uncertainty about the nature of future climate hazards. A strategic scoping phase of assessment is therefore helpful to steer adaptation work at the programme and project level. In the scoping phase a great many decisions and judgements are made which influence the depth and breadth of an assessment and the mechanisms and players involved in subsequent work. **If this process is not actively and explicitly engaged with, tacit assumptions associated with different approaches and tools can have a strong influence on outcomes, or create path dependency which limits the flexibility of planned adaptation.** This is likely to be particularly problematic where formal and especially statutory programmes of work are intended to follow.

This is not to say that all critical decisions must be made at the start of the process but **this guidance does argue from the perspective that a careful and explicit scoping and designing of the process itself relatively early on will enhance the quality of the programme of work and its outputs.** In many cases adaptation grows organically and there is not a clear-cut starting point when a strategic direction is set, at least not one with widespread buy in. This guidance acknowledges the value in this work; however at some point there may be a benefit in consolidating the incremental work which has gone before into a more structured framework, e.g. at the point at which an organisation seeks to monitor progress and assess how they are performing some form of framework is helpful. Those new to the climate change adaptation agenda, have an opportunity to start by thinking about these fundamental issues from the outset. This supplementary guidance is concerned with outlining some of the key issues which need to be addressed when undertaking these activities.

Section 2: Getting started, identifying the problem and objectives (Stage 1)

Adaptation planning is fundamentally about deciding how to deal with an uncertain climatic (and generally uncertain) future. Attempts to accurately predict and adapt to a particular future are likely to be inappropriate in many cases and it is widely acknowledged that approaches to adaptation need to be flexible so that they can evolve and respond to new conditions as they arise and/or become foreseeable. Consequently, adaptation planning is not amenable to being tackled as a one off task and a single assessment is unlikely to yield the complete set of relevant knowledge required to make the ‘best’ adaptation decisions in response to an uncertain climatic future.

This is not to imply that there are not components of adaptation which can be cost effective and/or easy to undertake – in many cases there are – but rather that a thorough understanding of, and appropriate response to, climate risk is something which will need to evolve over time as institutional familiarity with the topic increases and the different sources of relevant knowledge are accumulated and digested. **Adaptation then is not simply a technical challenge but has many aspects and is likely to require a long-term**

component which is itself flexible and adaptive to changing values, expectations and priorities as well as changing environmental conditions. This simple observation has significant ramifications for what is likely to constitute an appropriate approach to adaptation. Much of the rest of this guidance is devoted to explaining this position and detailing the major consequences it has for adaptation planning, as well as highlighting the strengths and weaknesses of existing approaches.

2.1 PRINCIPLES OF 'GOOD' ADAPTATION

The term adaptation describes a myriad of different actions throughout society, by individuals, groups and governments (Adger *et al.* 2005). This breadth fosters a huge variety of approaches, perspectives and levels of analysis. **While a unified approach is probably impossible and quite likely not even desirable, a common framework enabling different approaches to be related and contextualised would greatly aid discussion and learning, and facilitate increased understanding of cross-sectoral linkages.** The Risk, Uncertainty and Decision-making framework and this supplementary guidance provide a modest contribution to this aspiration for the UK.

Although many of the issues raised in this guidance are generic across the adaptation endeavour, this document does not attempt to deal with the entire breadth of activities which can be described as adaptation, but is primarily concerned with adaptation of organisations in the UK to climate change, including variability. It has a particular focus on those undertaking or considering undertaking some form of systematic risk-based adaptation assessment. Even in this clearly defined domain, adaptation is a complex task which encompasses many things. A helpful distinction is to divide adaptation into three functional components, planning, **process**, and **outcomes** (Tompkins *et al.* 2005; McEvoy *et al.* 2010). Approaches to adaptation need to address each of these components.

1. **Planning:** Planning for and managing the process, ('what's on paper'). Planning is important for establishing a strategy, as well as for monitoring and evaluating progress. This document is chiefly concerned with the planning aspect of the adaptation process but it is important to have due regard to the other components. Some important considerations in planning are:
 - a. Planning provides the means of establishing aims and objectives against which actions will later be judged through monitoring and evaluation initiatives. Without this anchor, assessment is much more difficult.
 - b. Plans will need to be tailored to the institutional environment in which they will be applied,
 - c. Plans themselves must also adapt so that the plans are formed and developed through an ongoing, institutionally constrained process.
2. **Organisational Process:** The real world system of people, processes and protocols which constitute the social and institutional environment and mechanism through which any plans and actions are produced and delivered. This includes existing culture, capacities and practices and the building of additional capacity and practice.
3. **Outcomes, decisions and actions:** Planning and process must in due course result in a series of decisions and actions, the outcome of which is intended to reduce the risks posed by environmental conditions resulting from climate change. These need not, and in most cases should not, be based purely on climate change adaptation considerations.

- a. What constitutes an outcome is an area of potential complexity. For example, organisational process changes, sometimes categorised as building adaptive capacity, might lead to real changes in levels of resilience or adaptability and therefore be considered outcomes. There is a tendency perhaps to consider these as just processes and categorise outcomes only as changes in physical assets and infrastructure. This simplistic division may be unhelpful and privilege hard adaptation measures over soft adaptation measures.

While each of these components of adaptation is clearly linked, it is functionally useful to consider them as categories and try to ensure that adaptation thinking and practice plays due regard to each. When discussing adaptation it can be helpful to clarify which component the conversation is concerned with, for example, planning or outcomes, as it is common to chop and change between each and/or all of them, which creates space for misunderstanding.

Despite the difficulties associated with defining a particular adaptation approach or measure as being good, acceptable, or successful, a number of principles of 'good adaptation' have been defined from practise to inform adaptation **planning** and **processes** and to some extent measure adaptation **outcomes**.

Typical principles include:

- **Work in partnership** – identify and engage your community and ensure they are well informed.
- **Understand risks and thresholds**, including associated uncertainties.
- **Frame and communicate SMART** (specific, measurable, achievable, results-oriented, and time-bound) **objectives/outcomes** before starting out.
- **Manage climate and non-climate risks using a balanced approach** – assess and implement your approach to adaptation in the context of overall sustainability and development objectives that includes managing climate and non-climate risks.
- **Focus on actions to manage priority climate risks** – identify key climate risks and opportunities and focus on actions to manage these.
- **Address risks associated with today's climate variability and extremes** as a starting point towards taking anticipatory actions to address risks and opportunities associated with longer-term climate change.
- **Use adaptive management to cope with uncertainty** – recognise the value of a phased approach to cope with uncertainty.
- **Recognise the value of no/low regrets and win-win adaptation options** in terms of cost-effectiveness and multiple benefits.
- **Avoid actions that foreclose or limit future adaptations** or restrict adaptive actions of others.
- **Review the continued effectiveness, efficiency, equity and legitimacy of adaptation decisions** by adopting a continuous improvement approach that also includes monitoring and re-evaluations of risks.

(UKCIP, 2005; Adger *et al.* 2005; HM Treasury, 2009)

2.2 THE ADAPTATION CHALLENGE

Adaptation to climate change is not an entirely new challenge; having both familiar and unfamiliar components. It is familiar in that societies are already adapted (albeit imperfectly) to the conditions they find themselves in, and naturally seek to continually adapt themselves to environmental and socio-economic changes as they perceive them. Most of the activities (e.g. disaster risk management, coastal management, spatial planning, public health, agricultural management) and methods (e.g. risk assessment, vulnerability assessment, impact modelling) applied to adaptation are not new and are drawn from existing and usually well established fields (Füssel, 2007a). The challenge of being 'adapted' to a stable climate (usually the operationally assumed status quo) requires decision-makers to account for the average climatic conditions, and the variable weather conditions associated with that climate, including extremes. In this respect managing current climate risk is no different to any other risk where it is necessary to make judgements about the nature, scope and scale of adaptation that is appropriate, e.g. whether it is better to manage every eventuality, or accept some level of damage. This judgement requires knowledge of the **hazards and opportunities** (technical knowledge) and **decision preferences** (policy choices) about whom or what should be protected and what it is acceptable not to protect given limited resources and preferences. Even in this relatively simple situation, there are elements of uncertainty in both of these aspects of the decision-making process.

In spite of these challenges, routine decision-making procedures have developed to manage these types of challenges and most successful organisations have established processes which deal with decision-making of this nature, albeit with varying levels of efficacy, efficiency, equity and legitimacy. One approach to adaptation in the context of climate change is to start by doing this better ([Section 3.1.2](#)). However, it is worth noting that **organisations sit within an established governance and legislative structure which partially directs their response**. These structures may well be enabling in relation to dealing with current conditions. However, governance and legislation can be far less enabling – or in fact inhibit – adjustment to expected changes in the future. Fundamentally, the possibility of climate (and social) change may challenge existing governance and legislative structures which are generally reliant on empirical information for their formulation, and which may therefore, by nature, be inherently rather backward looking. As a result, much adaptation planning at the organisational level will need to be developed in cooperation with developments in these overarching governance and legislative structures. Actions which are not aligned with existing mechanisms will usually be more challenging to deliver, and some adaptation planning and adaptation options can be expected to be out of alignment with and challenge existing structures. To some extent this is an inevitable 'teething trouble' which actors seeking to undertake adaptation planning and delivery will encounter. However, it is in the interests of organisations to try to influence the evolution of this governance and legislative context, which is itself learning how best to enable adaptation, in order to minimise these troubles. It is also crucial that those responsible for developing these structures ensure they remain flexible and adaptive, since they have the potential to enhance or inhibit individual actors from taking flexible action.

In addition to the familiar challenges outlined above, there are a number of novel aspects of adaptation to climate change. First, the scientific evidence indicates that we are at risk of experiencing levels of climatic change **unprecedented (in rate and magnitude)** in modern human history (IPCC, 2007b). Second, the availability of this information (**in itself unprecedented**) and the **potential for significant risks** has moved adaptation from being primarily unconscious and reactive to a **planned, proactive endeavour**. Third, **adaptation planning presents a difficult methodological challenge** which existing approaches and communities (e.g. natural hazards and water-resource management) are not fully equipped to deal with (Füssel, 2007a). These difficulties arise because of the combination of characteristics which adaptation exhibits:

- **Uncertainty**
 - » **Climate.** Although the broad view that the Earth is warming and that this it will have significant impacts on the climate, environment and society is clear and well established, the partially chaotic (non-linear, unpredictable) nature of the climate system, difficulties in estimating future emissions and the characteristics of climate models, result in deep uncertainties about the precise nature and timing of climatic changes, particularly at a regional and local scale.
 - » **Social and economic** developments are intrinsically dynamic and are in many ways more deeply uncertain than projected changes in climate.
- **Complexity**
 - » The **interconnected** (and intra-connected) nature of the climate with physical, biological and social systems makes understanding climate impacts intrinsically complex;
 - » Climate change occurs **across multiple scales** – temporal, spatial and governance – so adaptation can be seen as a nested process in that risks observed at one scale may have consequences for activities at another scale (higher or lower), and adaptive actions taken at one scale can, similarly, reverberate throughout the system, for better or worse (Preston & Stafford-Smith, 2009).
 - » On the timescales in question, **social and technological changes** are likely to significantly alter aspects of the way people live and interact with the environment which may significantly alter risk characteristics ([Technical Box 2](#)).
- **Potential for very significant consequences.** Climate and climate sensitive ecosystems perform many services which support human societies. Climatic changes have the potential to significantly alter the provision of these services with significant ramifications for society as well as these systems themselves.
- **Irreversibility.** Many climate driven changes such as sea level rise will be so long lived they are effectively irreversible on human timescales.
- **Urgency.** Many decisions taken now will influence the climate well into the future so decisions to defer action are far from risk free and should be taken in the light of an assessment of risk rather than as a simple matter of policy ([Section 3.2](#)).

Adaptation is therefore a complex and multifaceted issue. These types of issues have been characterised by policy analysts as wicked, as opposed to tame, as a way to characterise situations where important decisions need to be made with imperfect knowledge. Climate change adaptation is an exemplar wicked issue (Lonsdale, 2009, see [Technical Box 1](#)). This observation has important implications for approaches to adaptation and the way adaptation questions are framed and solutions sought (this is explored in Sections [2.4](#) and [2.7](#)).

TECHNICAL BOX 1: ADAPTATION POSES NUMEROUS CHALLENGES TO CONVENTIONAL DECISION-MAKING

The combination of characteristics which climate change exhibits, in particular the long timescales, uncertainty, complexity, and potential for significant consequence means that it is very difficult (practically impossible) to collect sufficient information with sufficient certainty to be able to make 'optimal' adaptation decisions using conventional maximum utility type decision approaches. These situations are not unique to climate change adaptation and have been described by Funtowicz and Ravetz (1991) and Gallopín (1999) as post-normal because of the challenges they present to 'normal' decision-making.

Earlier work by Rittel and Webber (1973) made a distinction between the 'tame' problems of natural science and the 'inherently wicked' problems of public policy, the 'wickedness' arising out of the difficulty inherent in 'efforts to delineate their boundaries and to identify their causes, and thus to expose their problematic nature'. Darwin *et al.* (2002) developed the idea of 'tame' and 'wicked' further suggesting that problems exist on a spectrum and that while traditional 'rationalist' approaches work well at the tame end they are increasingly less effective as you move towards the 'wild' and 'wicked' end (Darwin *et al.* 2002):

tame > tricky > wild > wicked

In essence, the argument is that conventional linear management approaches may be appropriate when the problems are 'tame' but different approaches are required when having to deal with wild and wicked problems, i.e. moving beyond a 'predict and provide' paradigm. Adaptation is an example of an 'unbounded problem' described by Chapman (2002) as a problem where:

- there is no clear agreement about what exactly the problem is;
- there is uncertainty and ambiguity as to how improvements might be made;
- the problem has no limits in terms of the time and resources it could absorb.

Unbounded or wicked problems require a different approach to planning and implementing solutions that acknowledges uncertainty and explicitly encompasses disagreement between different groups affected. This requires a process of dialogue where the actors involved can listen to, and understand, the perspectives of others. Government and policy processes have traditionally made decisions using theory based more on certainty, rationality and predictability (Eyben, 2005).

Because of the complex nature of adaptation there is not a single objectively right answer to any given adaptation problem. As a consequence the way in which information is generated and interpreted will be highly influential to the conclusions reached and the types of decisions which are made on this 'evidence'.

Conventionally there is a tendency for people to assume that information can be collected which is broadly objective and forms an evidence base for policy or decision-making. However, it is very important to acknowledge that the informa-

tion gathered is not wholly objective and there are components of the process which requires workers to make assumptions which are not evidence based (or are made on very scant evidence) but rather are simplifying assumptions, often based on some value judgement or political views. Furthermore, study results are often highly sensitive to these assumptions so the assumptions and judgements made can heavily influence results even when based on a foundation of relatively objective data. A classic example is in estimating economic costs of climate change which require judgements to be made on the discount rate which is applied (Stern, 2007; Hulme, 2009).

The construction of evidence is therefore frequently not a simple objective process based on scientific data alone, but is one in which scientific evidence is interpreted in various frameworks which requires judgements and assumptions to be made. Different studies which utilise the same or similar basic data but which hold different world views and choose different simplifying assumptions, can therefore reach markedly different conclusions. This does not necessarily reveal disagreement in the underlying data but rather differences in the assumptions used to interpret this data in a meaningful way. Much of this lies outside the realm of science due to a lack of data availability (fundamental unavailability rather than awaiting collection). A study's findings will consequently be strongly socially and politically driven rather than merely providing objective 'evidence' out of which policy choices can relatively easily fall.

This is important to understand if adaptation assessments are to be placed in their proper context within an adaptation process or programme. This observation also places a duty on those managing an adaptation process to understand and, importantly, document the assumptions they are making – both individually and institutionally – in their approach, to inform subsequent assessments and analysis of results. Potential dangers of not appreciating the partially value-laden nature of climate risk and adaptation assessment are listed below:

- An assessment which is value-laden may be assumed to be objective and treated as such, resulting in misuse of results to, for example, justify a political view on supposedly objective grounds. This could result in a violation of the principle of legitimacy of proposed adaptation actions.
- The importance of the initial stages in scoping and understanding the process of adaptation including impacts or risk assessment may be missed. As a result tacit assumptions/decisions may significantly influence the direction of adaptation decisions. This is particularly problematic for institutions which represent public interest or have statutory duties.
- A significant source of uncertainty in the investigations may be neglected and not taken into account in choosing a decision strategy/approach.
- The credibility of an assessment may be undermined because observers expect studies to report similar findings on the premise that they are based on objective methods. In reality though, only part of the study may be objective while other components are necessarily judgement-based, so different conclusions should be expected.
- The choice of approach, people and institutions to involve is a key source of path dependency which may be a barrier to learning through iteration.

- Availability of data may determine actions (tail wags the dog). For example, if an organisation is looking to allocate resources, and data availability on, say, infrastructure exposure far outweighs that of information on vulnerability, chosen interventions might be biased in favour of infrastructure-oriented solutions rather than those that are based on well-considered policy and other decision choices.
- New studies may follow the example of previous studies by taking on their methods without considering how well they fit their organisational goals and culture, and whether they are transferable in time and space.

KEY MESSAGES

1. Adaptation to climate change presents a complex methodological challenge. Difficult, value-laden decisions must be made regarding the level of risk to be accepted and the level of adaptation required.
2. Making such decisions can be difficult though, given the following traits of the 'adaptation challenge':
 - **Uncertainty** – in terms of future emissions, climate and societal impacts and responses
 - **Complexity** – the interconnected nature of climate with physical, biological and social systems
 - **The potential for very significant consequences**
 - **Irreversibility** – changes may be irreversible on human timescales
 - **Urgency** – decisions made now can shape future climate sensitivity
3. This complexity and uncertainty makes adaptation a 'wicked' problem requiring approaches which acknowledge disagreement and uncertainty.
4. Adaptation occurs within a pre-existing governance and legislative landscape which partially directs the responses employed. A balance needs to be struck between aligning actions with these existing structures and ensuring that these structures evolve to create an enabling environment in which appropriate adaptation decision-making can thrive.
5. Given the value-laden nature of adaptation decision-making, it is vital that the assumptions associated with, and framing of, adaptation are acknowledged, understood and recorded.

2.3 RISK PATHWAYS

In most cases there is a significant disparity between the information stakeholders want and need to undertake adaptation planning and the information which can be provided by the various experts charged with supplying climate or climate impacts information. This does not in most cases highlight weaknesses in the climate information provided (although there are difficulties here too, [Section 2.6](#)), but points to the fact that adaptation is a compound issue which requires multiple sources of information, some from outside the organisation in question and some from within. Not all of the information required for adaptation planning can therefore be considered to follow a consumer based supply and demand model and it is currently unreasonable/unrealistic to expect it to.

This gap between climate information provision and adaptation knowledge requirements reflects the fact that **climate information providers, as you might expect, provide information about the climate. Whereas most decision-makers are concerned with the effect of these changes on their operations and not directly interested in the climate at all.** Bridging this gap requires an understanding of the risk pathway, the way in which climate drivers are transferred through various intermediate stages into an effect, positive or negative, on a particular receptor, since we are focussing on organisations this will be an organisation or set of organisations. Even in situations where climate is the main driver of a particularly defined risk, the effects are determined by the way the climate changes are transferred to a particular organisation's operations.

The particular risks identified are strongly dependent on the assessment endpoints which are chosen. These in turn are influenced by the spatial, temporal and institutional level of an assessment. For example, an assessment of flood risk in a particular catchment is very different in character to an assessment of the risk to an organisations business continuity resulting from flooding. The difference is primarily due to the different assessment endpoints which are selected so that flood risk within a particular catchment is an intermediate impact on the pathway to an understanding of the risk to a particular organisations business continuity rather than an endpoint in itself. The risk of flooding is a valuable input into the latter assessment, but may still be a poor indicator of a business's risk of disruption. It can be helpful to define relatively direct biophysical effects such as river flooding or drought as **impacts** and their effects on a particular organisation as **consequences**. But these definitions exist in relief to a particular organisations context and so may not be uniform between studies.

As a rule, the greater the separation between the climate driver (e.g. heavy rainfall) and risk endpoint (e.g. business disruption for a particular firm), the more intermediate steps occur along a risk pathway, and the more complex and uncertain a risk assessment is likely to be. On the other hand, the closer an assessment endpoint is to the driver of that risk (e.g. heavy rainfall), more confidence may be placed in the assessment, but it is also likely to be of less direct relevance for many decision makers. (This is akin to what is described in the IPCC (2007) and elsewhere as a "cascade of uncertainty" in climate change impacts assessments, whereby uncertainties escalate as one progresses through the assessment process.).

Defining appropriate assessment endpoints and elucidating the risk pathway is thus a significant challenge in all adaptation planning, and also provides important contextual information which aids the comparison of different studies. However, the way in which assessment endpoints are defined, and the stage at which consideration of the risk pathway is necessary, depends to a large extent on the approach taken.

Two broad assessment approaches may be taken, namely top-down and bottom-up. These are described in detail in [Section 3.1](#). In top-down assessments, an adequate understanding

of the risk pathway is vital if realistic estimates of impacts are to be estimated from climate variables. Established risk pathways are thus a prerequisite for top-down assessments to be successfully applied.

Bottom-up assessments start by cataloguing past consequences which have resulted in a meaningful impact to a business or council. These represent risk assessment endpoints and can usually be related perhaps rather vaguely to a cause, e.g. heavy rainfall. The issue of risk pathways is thus partially side-stepped.

The bottom-up approach is helpful because it starts with what people already know and at least partially understand. However, it is not always straightforward to relate the consequences of a climate impact to the driving mechanisms behind it, frequently due to a lack of data, e.g. events are often catalogued but their drivers and pathways are often not explored or recorded. The events themselves are often not adequately recorded, if at all, if they are perceived to occur sufficiently infrequently for contingency planning to cover any costs that arise. If there is no evidence to suggest that the event may become more common in future, this is probably a reasonable response. However, the lack of data makes it difficult to estimate the likelihood of such events recurring in future, and to determine what the severity of the consequences would be should they recur.

Whichever approach is taken to identify and evaluate adaptation options to reduce climate risks, it is extremely helpful to understand the risk pathway involved as this will highlight potential intervention points where risks can be minimised or avoided. Without this understanding, the generation of adaptation options is likely to be limited and it will be difficult to target effective, let alone optimal, points of intervention.

KEY MESSAGES

1. A risk pathway refers to the way in which climate drivers are transferred through various intermediate stages into an effect, positive or negative, on a particular receptor (or organisation).
2. The particular risks identified are strongly dependent on the assessment endpoints which are chosen. As a rule, the greater the separation between the climate driver (e.g. heavy rainfall) and risk endpoint (e.g. business disruption for a particular firm), the more intermediate steps occur along a risk pathway, and the more complex and uncertain a risk assessment is likely to be. Thus defining appropriate assessment endpoints and elucidating the risk pathway is a significant challenge in adaptation planning.
3. Understanding the risk pathway is extremely helpful when identifying and appraising adaptation options as this will highlight potential intervention points where risks can be minimised or avoided. Without this understanding, the generation of adaptation options is likely to be limited.

2.4 FRAMING ADAPTATION TO CLIMATE CHANGE

So far the argument has been made that adaptation is not wholly amenable to a simple maximum utility (see [Section 3.2](#)) type decision approaches. To summarise, this is because these approaches rely on prediction and optimisation and are consequently susceptible to decision errors resulting from uncertainty about the future. In addition, it has been demonstrated that adaptation assessments cannot be entirely objective processes from which adaptation priorities naturally fall, because judgements and assumptions are necessary in order to interpret data in a way that can inform decisions. This section explores some of these judgements and assumptions further. In particular, it considers the different ways in which adaptation is framed and how these different framings can influence risk assessment and decision strategies.

‘Frames’ or ‘framing’ in this context refers to a **‘collection of organising principles that allow a person to predict and qualify the complexity of their environment as a basis of decision and action, these are not just personal mindsets but predominantly cultural structures which shape the way social actors interact and take shared or opposing positions regarding an issue’** (Wardekker *et al.* 2009). Climate change can be, and is, framed in a number of fundamentally different ways. This basic framing shapes the way people perceive the issue of climate change, and to a large extent accounts for the fact that people reach very different conclusions based on the same basic evidence. The importance of such frames in shaping how people approach climate change, and other complex issues, is often poorly dealt with in decision-making, with the underlying frame of reference often remaining tacit and unexamined.

The difficulty in adequately ‘framing the problem’ was highlighted as one of the key adaptation challenges in the report of the Royal Commission on Environmental Pollution (RCEP, 2010), This difficulty is linked to the ‘wickedness’ of climate change and the adaptation challenge (see [Technical Box 1](#), and Prins *et al.* 2010).

There is no single objectively correct way of framing climate change and adaptation in particular, with different framings each having strengths and weaknesses. Furthermore, assessment results are often highly sensitive to dominant framings. Consequently there is a strong argument for making explicit the dominant framing (as a minimum) and looking to add additional, contrasting framings to help open up the adaptation process (ideally). To some extent this is achieved by taking a participatory approach and including diverse stakeholders in the decision-making process, but this can be further strengthened by explicitly dealing with the differing fundamental assumptions and value judgements which separate different groups.

A very helpful approach to understanding how climate change is framed, both generally, and in terms of decision-making and decision tools, is provided by de Boer *et al.* (2010). The critical point of clarity provided by this approach is that **there is a relationship between the fundamental framing of climate change and the understanding of the decision problems it represents. This to a large extent determines the tools selected for the task of planning and the institutional structures required to deliver them.** These basic framings and underlying assumptions are therefore extremely influential, not only in governing what the goals of adaptation are, but also in determining how risks are assessed and options prioritised, which in turn determines who is involved in adaptation efforts. Firmly held and unexamined framings of the nature of the adaptation challenge are a potentially significant source of path dependency which can make flexible, adaptive management of climate risks difficult ([Section 2.1](#)). Clearly issues which so fundamentally influence the process of adaptation should be carefully considered and the process well documented

as this information is vital in understanding what is being achieved, and equally importantly what is not being achieved in any given stage of an adaptation process, and has considerable value for the post implementation monitoring and evaluation process.

The framework of de Boer *et al.* (2010) offers one approach to doing this. The framework provides two simple matrices. The first (Table 1) provides a way of distinguishing between framings based on what de Boer *et al.* (2010) term ‘perceptual distance’ and ‘goal orientation’. Perceptual distance describes a gradient with long-term broad categories at one end of the spectrum, and short-term narrow categories at the other. Goal orientation is defined as the promotion of a desirable outcome or the prevention of an undesirable one. The combination of these factors suggests a number of broad framing categories.

Common approaches to climate change can be mapped onto the categories provided in this first matrix (Table 1). A number of examples are presented in Table 2. For instance, a combination of proximal (perceptual distance) and prevention (goal orientation) can be typified by Al Gore’s cautionary film ‘An Inconvenient Truth’ which implies a morale duty to avoid crossing natural limits (see Table 2). An alternative framing based on a combination of proximal (perceptual distance) and promotion (goal orientation) adopted by many SMEs implies that adaptation is about appropriate investment to improve near-term competitiveness (see Table 2). These represent very different perspectives on climate change and tend to lead to rather different perspectives on what constitutes an appropriate response. de Boer *et al.* (2010) argue that since none of the framings is better than the others, with each having strengths and weaknesses, introducing a contrasting framing to the dominant one may be helpful in opening up the decision-making process.

Table 1: Two strategic contrasts combined. Source: de Boer *et al.*(2010).

	Goal orientation and focus	
Perceptual distance	Promotion orientation	Prevention orientation
Distal view (long-term, broad categories)	Using broad categories to represent general features and focusing on gaining positive outcomes (hits)	Using broad categories to represent general features and focusing on avoiding negative outcomes (errors)
Proximal view (short-term, narrow categories)	Using narrow categories to represent contextualized features and focusing on gaining positive outcomes (hits)	Using narrow categories to represent contextualized features and focusing on avoiding negative outcomes (errors)

Table 2: Science-related frames grouped into four strategic contrasts, with examples about climate issues. Source: de Boer *et al.* (2010)

	Goal orientation and focus	
Perceptual distance	Promotion orientation	Prevention orientation
Distal view (long-term, broad categories)	<i>Social progress frame</i> Defines the issue as improving quality of life or harmony with nature <i>Middle way frame</i> Puts the emphasis on finding a possible compromise position between polarized views Example: Plan to reconcile adaptation and mitigation	<i>Morality/ethics frame</i> Defines the issue in terms of right or wrong; respecting or crossing limits <i>Pandora's box frame</i> Defines the issue as a call for precaution in face of possible impacts or catastrophe Example: Al Gore's movie: An Inconvenient Truth
Proximal view (short-term, narrow categories)	<i>Economic development frame</i> Defines the issue as investment that improves competitiveness <i>Conflict/strategy frame</i> Defines the issue as a game among elites, a battle of personalities or groups Example: climate proof city	<i>Scientific uncertainty frame</i> Defines the issue as a matter of what is known versus unknown <i>Public accountability frame</i> Defines the issue as responsible use or abuse of science in decision-making Example: sea level discussion

A second matrix (presented in [Table 3](#)) has been developed to clarify the frames which are inherent in decision tools. Decision-makers are considered to perceive certainty or uncertainty regarding causation and certainty or uncertainty regarding outcome preference in combination providing four categories of decision type. The authors map suitable methods and tools onto these categories and classify them as **computation**, **compromise**, **judgment** and **inspiration**. As an example, where both the science and the decision preference are perceived to be well known, the actors are likely to choose relatively straightforward computational tools. Whereas where both the science and the decision preferences are perceived to be uncertain there is a tendency towards delay and inaction and very different 'inspirational' tools are required, e.g. "rich picture" drawing.

This simple but elegant framework provides a means of categorising the dominant institutional approach using the first matrix (Table 1) and should help to identify and explain the priorities of the organisation. It could also allow the questioning of these priorities at this stage, in which case the framework provides a structure for finding contrasting framings which might complement and broaden the decision base. Or if these are not questioned at this stage, it will identify the priorities against which the next phase of adaptation will be assessed. Either way, it provides a useful categorisation so that the work can be positioned in such a way that it is clear what is being attempted and what is not being attempted. Once described, this position should then be explained and justified, and future plans to reassess the work identified and if possible scheduled. Different aspects of the work programme may fall into different categories and this too would be interesting to reflect on.

Given the identification of the broad framing of adaptation aims from matrix one (Table 1), the second matrix (Table 3) enables workers to consider the state of knowledge concerning these priorities in terms of the certainty or uncertainty regarding desired outcomes and cause effect relations. The answer to these questions will indicate the sorts of decision strategies which suit the circumstances which they have defined, although this may vary across the spectrum of issues for which adaptation is being attempted, and the stage in an adaptation process.

Table 3: The two basic dimensions of decision combined to identify different decision strategies (after Thompson, 2003). Source: de Boer *et al.* (2010)

	Preferences regarding possible outcomes	
Beliefs about cause/effect relations	Certain	Uncertain
Certain	Causation and outcome preferences are certain, data are voluminous <i>Computational strategy</i>	Uncertain due to: <ul style="list-style-type: none"> • Opposing preferences • External constraints <i>Compromise strategy</i>
Uncertain	Uncertain due to: <ul style="list-style-type: none"> • Incomplete knowledge • Inherent uncertainty • Competition with rival decision-makers <i>Judgmental strategy</i>	Uncertainty due to: <ul style="list-style-type: none"> • A combination of reasons from the upper right cell and the lower left cell <i>Inspirational strategy</i>

KEY MESSAGES

1. Climate change can be viewed from a number of different perspectives or frames. These frames reflect the way in which we individually or collectively view the world, as well as our values and beliefs. There is thus no single correct way to frame climate change.
2. Critically, these framings explain why people come to different conclusions even when faced with the same evidence. Framings can also shape adaptation goals and determine how risks are assessed and options prioritised. Yet despite their importance, frames are often poorly understood and rarely considered in the context of decision-making.
3. The framework of de Boer *et al.* (2010), outlined in Section 2.4, offers one approach to exploring different framings. Using simple matrices they show how distinct frames emerge, shaped by the time period which has been considered and whether the goal is to promote a desirable outcome or to prevent an undesirable outcome. They then consider the impact of certainty or uncertainty on causation and possible outcomes and how this influences the type of adaptation strategy which might be employed.
4. An appreciation and understanding of the concept of framing and the factors and assumptions which lie behind each frame should lead to more open, considered decision-making in the context of adaptation.

2.5 THE 'ADAPTATION BOTTLENECK'

Awareness of climate change and adaptation is growing and adaptive activities are quite advanced within some sectors, but for many organisations understanding of generic climate impacts is not translated into an understanding of the climate risks relevant to a particular endeavour or how much climate changes should be incorporated into existing risk management strategies. A number of authors (Burton, 2002; Vogel *et al.* 2007; Preston and Stafford-Smith, 2009) have identified this '**adaptation bottleneck**' where decision-makers have reached a high level of awareness of climate change in the general sense, and frequently understand the case for adaptation, but have difficulty in identifying and implementing specific adaptation policies and measures in the way they would in more familiar decision areas. Symptomatic of this bottleneck there is frequently a lack of awareness, or insufficiently detailed awareness, of vulnerability to current climate (mean and variability, extremes). Preston and Stafford-Smith (2009) point out that traditional climate change research methods have done little to overcome this by undertaking assessments which are not linked to any particular decision-making event or question. They go on to suggest that in order to push past this bottle neck work needs to ensure that assessments are undertaken in the service of adaptation decision-making and are therefore able to deliver policies, programmes and measures that reduce vulnerability to climate risks.

It is argued here that this 'bottleneck' often occurs at a transition point from predominantly generic awareness raising exercises ('making the case') to adaptation assessment exercises. Unsurprisingly this is not a hard distinction and the two activities are highly interrelated. Nevertheless, there may be some utility in distinguishing between them as the success measures are slightly different. For example, the effectiveness of awareness raising should

primarily be assessed on the basis of how much institutional awareness has increased, senior management buy in secured and so on, rather than on the quality of information collected (although clearly this must not be misleading). An adaptation assessment where information must be collected and synthesised to enable decisions to be made must, on the other hand, be assessed more on the quality of information used and its relevance for practical decisions. Both of these aspects are in practical terms very important but their relative importance may be different at different stages in the development of the adaptation agenda within an organisation. Disaggregating the clarity of message required for awareness raising from the more detailed information needs of adaptation assessment may also go some way to resolving the problems in providing guidance outlined below.

KEY MESSAGES

Two key issues need to be addressed to help organisations push through the adaptation bottleneck and progress from conducting awareness raising activities to delivering policies, programmes and measures that reduce vulnerability to climate risks.

1. Climate risk assessments need to be linked to a particular decision-making event or question.
2. The information used needs to be tailored to suit the requirements of the assessment to ensure it is appropriate for the task at hand: generic high level information is suitable for awareness raising activities, but more detailed information that is specific to the problem at hand is required to support adaptation decision-making.

2.6 INHERENT DIFFICULTIES WITH INFORMATION PROVISION

One of the basic difficulties with climate change adaptation guidance provision is striking an appropriate balance between acknowledging the complexity of the 'problem' and providing the simple clear guidance which stakeholders invariably desire. The difficulties inherent in adaptation planning are often acknowledged by the recognition that stakeholders should be engaged in the process of tool and resource development. But these processes are sometimes conducted in an open and unstructured way. This can result in stakeholders expressing the relatively naive desire for the partially incompatible goals of (1) robust technical knowledge, and (2) clear simple messages provided in language they understand and which are directly relevant to the current context in which they work. These requests are helpful, but only up to a point. Balancing robustness with simplicity is clearly a desirable goal, but it is not always possible to provide fully 'translated' simple messages without glossing over important complexities which begs the questions: what is the best balance that should be achieved? what tradeoffs do stakeholders prefer? Glossing over important complexities in the interests of simplicity can leave the door open to misuse of information which can in turn lead to accusations of information providers providing inaccurate or misleading information, and ultimately to poor decision-making.

In many ways this is an insoluble problem. All those involved in adaptation must continually strive to address this challenge, while yet at the same time appreciate that it cannot ever be fully resolved. New entrants to climate adaptation in particular tend, initially, to underesti-

mate its complexity and the difficulties involved in conceptualising the problem. As a result there is a tendency to expect that guidance should be made simpler so that it meets some of these pleas. Those new to the subject area often assume that this gap is not genuinely difficult to breach, and simply stems from the inability of technical people to communicate their work effectively in plain English. No doubt there is some truth in this cliché and yet the issue is also deeper so that the gap remains – not primarily through a refusal or inability to provide the simplified messages that are requested, but because of the risk that in providing simple messages, important details will be overlooked and adaptation planning processes and decision-making will suffer. On the other hand there is no utility in providing intellectually robust information which is entirely opaque to end users.

Policy and decision-makers often level the criticism that guidance is too technical or complex. At the same time technical experts criticise that important details are being overlooked. The extent to which it is appropriate to tailor technical information and emphasise the communication, translation and guidance writing role of technical experts, trainers and communications experts and the extent to which adaptation requires increased capacity of individuals and organisations to learn how to understand and digest new types of sometimes complex information is far from resolved. Often the onus is placed on technical experts to reach out and this is clearly appropriate. But how far should they go in translating information at the cost of detail and robustness? And how far should decision-makers broaden their own capacity assuming that they do not really want, and certainly cannot effectively use, readily understandable information which is oversimplified and therefore too easily misinterpreted?

Clearly some balance must be struck and the optimal, or perhaps least damaging, position between these two extremes is a question without a simple answer which itself needs to be understood and addressed by all involved in adaptation planning and decision-making. Future stakeholder engagement exercises could start to address this issue by highlighting the sorts of tradeoffs which occur so that stakeholders can explore them and make an informed choice about what tradeoffs between simplicity and completeness they are able to accept.

KEY MESSAGES

1. Climate change adaptation requires decisions to be made on the basis of complex information. Many decision-makers, or users, require information in the form of clear, simple guidance that they easily understand and which are directly relevant to the context in which they work.
2. However, it is not always possible to provide fully translated messages without glossing over important complexities. There is a risk that in providing simple messages, important details will be overlooked that will compromise the effectiveness of any consequent adaptation decisions.
3. An appropriate balance must therefore be struck between providing information that is accessible to decision makers and yet which remains technically robust and accurate.
4. One way of reconciling the potentially conflicting requirements of information providers and users could be to initiate engagement activities by highlighting the tradeoffs that occur between completeness and simplicity so that users can make informed decisions about which tradeoffs they are prepared to accept.

2.7 ESTABLISHING BOUNDARIES

In order to push through the adaptation bottleneck and construct knowledge which will inform programmes and policies, it is useful to undertake some form of risk-based assessment. This is recognised in the literature (Preston and Stafford-Smith, 2009) and been borne out through our experience. Before undertaking any kind of risk assessment it is important to clearly set out the problem at hand and the boundaries within which any plans and decisions are to be applied (DETR, 2000). We have already discussed some of the issues in defining an organisations broad approach to adaptation and the importance of this in directing subsequent work. Here we focus on some of the specific information types required for a risk-based assessment. To meaningfully assess risk, the following factors need to be considered and decided upon:

- **Hazard/Impacts:** priority drivers of concern typically flooding, heat waves etc
- **Timescale:** how far into the future, and future point in time vs. dynamic change approach
- **Sphere:** internal (within) vs. external (outside) vs. cross scale risks (within & outside)
- **Knowledge domain:** socio-economic vs. biophysical vs. integrated
- **Exposure unit** system or activity to which risks are of interest (risk pathway)
- **Assessment endpoint, receptor:** Particular attributes of concern

Source: derived from Füssel (2007b)

However, we have already seen that climate change poses ‘wicked’ or ‘unbounded’ challenges ([Technical Box 1](#)) so that in practice setting appropriate boundaries around climate change risk assessment and deciding on these categories is not a trivial task. A tangible example of this difficulty is revealed by considering the information requirements to adequately assess climate risks. Climate change risks are frequently conceived of as existing in some absolute sense, which implies it is possible to estimate risks to society based on an understanding of how bio-physical (biological and physical) hazards will evolve. However, this is only partially correct where human systems are involved. Since risks exist in relation to some level of adaptation or preparedness to climate change and other societal developments, it is only possible to estimate risks by assuming a certain level of adaptation or preparedness. The degree of adaptation or preparedness that occurs will be determined to a large extent by contextual factors such as socio-economic environment (e.g. Jaroszweski *et al.* 2010), which are uncertain. Future climate risks will consequently be determined to a large degree by policy choices, both directly as a result of choices made to adapt or which consider adaptation, and through wider socio-economic factors as well as climatic/ bio-physical factors. A clear understanding of climate risks therefore requires **estimation of how the hazard and the things exposed to the hazard (receptors) interact and how that interaction evolves through time**. This is a challenging task in practice, as illustrated in the example in [Technical Box 2](#).

TECHNICAL BOX 2: SNOWFALL, WINTER 2009/2010

An illustrative example of the importance of preparedness and societal development is provided by the 2009/10 snowfall. Although the snowfalls were not historically extreme, the reduced frequency of snowfalls in recent years may have led to reduced preparedness for such events, as investing in large stockpiles of salt and snowplough equipment may not have been judged by many Local Authorities to be necessary, or at least good value for money. Reduced frequency of snowy conditions may also have resulted in many drivers being out of practice at driving in such conditions.

In addition, a series of societal developments such as health and safety culture, explicit liability and multiple household employments most likely enhanced societal disruption.

The net effect was that the 2009/10 snowfall was more consequential for transport disruption, school closures and economic losses than might have been the case historically when such events or similar were more commonplace. In a purely physical sense, the hazard of winter snowfall has lessened, as such events are not necessarily becoming more extreme, and are becoming less frequent. But the consequences when they do occur are likely to be greater because the level of preparedness has decreased, driven by planning choices and general societal developments.

This example is not intended to suggest that any of these choices are wrong, but simply illustrates that consequences of climate conditions can change for the better or for the worse simply through societal and planning changes.

Moving from the identification of potential impacts and risks to the development of specific adaptation plans and the selection of adaptation strategies requires policy choices to be made, informed by an evidence base. Adaptation choices are thus as much about setting policies and strategies as they are about 'objective' assessment of hazards and opportunities. Uncertainties exist in relation to both of these knowledge domains. It is important to acknowledge this complexity because it is one of the issues which makes setting the scope of an adaptation assessment difficult. **The important point here is that wherever you start from it is not possible to fully scope the adaptation challenge through one category of information.** Decisions on policy choice are contingent on information about hazards and opportunities which is in turn contingent on information on policy choices. For this reason an iterative learning approach that continually refines the process will enable all relevant categories of information to be incorporated.

All assessments need to start somewhere though, and we will see that it is possible to start by focussing on either of these knowledge domains or by looking at them both. However, while it is always easy on intellectual grounds to argue the case for comprehensiveness, in practice **resources are inevitably scarce, and tradeoffs need to be made so the question of what to do first is nearly as important as the question of what to do at all.** All assessments may ultimately aim to cover the same or very similar categories of information ([Table 4](#)) but they start in different places ([Section 2](#)) and so early in the adaptation process organisations which have taken a different approach may well have collected markedly different information and this situation may persist for some time before they begin to converge.

Table 4: 'Information' categories which all adaptation approaches will need to aim towards

Policy choice (decisions on outcome preferences): Where do you want to be?

1. **Strategic goals**; what does the organisation aim to do/deliver now and into the future, not just in terms of adaptation. This may vary considerably on different time/planning horizons
2. **Culture/attitude to risk**; is the organisation risk taking or risk averse; internal risk to organisation versus external risk to stakeholders. This will probably vary across different risks and may change with the timescales in question.
3. **A clear approach to adaptation**; what are the immediate and longer-term goals for adaptation and the boundaries around the work to be achieved? How has the work been prioritised?
4. **Criteria for selection of adaptation options**, in policy terms. Linked to 1 and 2, it should be possible to identify criteria for the generation and selection of adaptation options. This will require a vision of what successful adaptation is felt to look like.
5. An **approach to monitoring & evaluation** of adaptation policy objectives, measures and strategies.

Cause effect relationships (science, risk dimensions): How might the climate and socio-economic context change?

1. An understanding of **current exposure** to weather & current climate (weather/consequences, and pathways/causal relationships if possible).
2. **Current organisational sensitivity** to weather and climate, including the influence of key non-climate stressors/hazards & their consequences.
3. **Organisational processes** (related to 2 above); it is helpful to understand the organisational characteristics which determine how readily an organisation might be able to recognise and change in response to trends/events both now and in the future, and to develop its adaptive capacity.
4. **Current risk estimates** based on synthesising information on exposure, sensitivity and adaptive capacity to both current climatic and non-climatic drivers.
5. **Projected climate change estimates** for relevant variables and places
6. **Scenarios of key non-climatic drivers, impacts and consequences**, e.g. socio-economic scenarios looking at future changes in demographics, economic pathways and so on.

Table 4 *continued...*

Integration: How might the interaction of climate and other external drivers interact with organisational characteristics to determine future risk?

1. **Future risk estimates;** qualitative or quantitative estimates of how climate and non-climate drivers are likely to interact and the resultant likelihood and consequence for delivery of organisational aims and objectives, and those of its clients and stakeholders.
2. In the light of the organisational objectives, attitude to risk, approach to adaptation and risk estimates, it is necessary to have a **method of generating a list of adaptation options** which might be applied to mediate risk or exploit opportunities identified.
3. **Criteria for selecting adaptation options** best suited to reducing risk in relation to organisational objectives.
4. **Approach to monitoring and evaluating** adaptation plans, decisions and actions.

Since the purpose of this guidance is to inform adaptation planning, it is sensible to consider the whole process as one of adaptation planning informed by certain information sources, rather than a process of impacts or risk identification followed by identification of adaptation options as a relatively separate follow on process. In this context, it seems sensible to consider short-term as well as long-term aims and select an approach to adaptation which facilitates the most relevant information sources being collected first. If current priorities, for example, are concerned with helping vulnerable groups, then approaches which identify those groups currently sensitive to climate change and variability would aid this agenda first. But if priorities are around understanding the exposure of infrastructure, then assessments which look at what different climate change information implies for infrastructure exposure would be the most informative route in the near term.

Again, the approach taken should be explicitly considered and documented rather than adopted unquestioningly. Effective approaches in one context might not be appropriate for another, so learning from practice is helpful, but is best achieved by assessing the work of others in the context of the policy objectives with which it is associated. Precisely for this reason it is very important to clearly establish and communicate the purpose of the work. There is no single right way to document an adaptation assessment, but a clear document trail is critical to effective management of risk (HM Treasury, 2009).

KEY MESSAGES

1. Before undertaking any kind of risk assessment it is important to clearly set out the problem at hand and the boundaries within which any plans and decisions are to be applied.
2. Climate change risks cannot simply be assessed by examining their bio-physical aspects, as how they are played out is a result of the policy and social landscape which changes with time and is often much harder to quantify.
3. Both 'knowledge domains' (bio-physical and socio-economic) are needed to fully scope the adaptation challenge.
4. Different approaches are appropriate for different issues and should not be adopted unquestioningly.

2.8 MAINSTREAMING

Climate change adaptation is not a discrete activity. Climate drivers are intrinsically cross-cutting and in many cases interact with non-climate factors to determine impacts and consequences. The need to integrate climate and non-climate factors into practical adaptation management has led to the concept of mainstreaming or embedding adaptation. This is where climate change impacts are managed as far as possible by bringing them into established practices and procedures such as business continuity and asset management.

For mainstreaming to be a successful strategy it is necessary to effectively introduce new concepts into existing practices and when necessary adjust the existing practices to cope with the challenges the new concepts present. There are two broad approaches to mainstreaming climate risk and adaptation assessment.

- Climate risks can be seen as a sufficiently new or unique source of risk that it requires an initial assessment separate from existing risk procedures. Findings from this assessment can then be reconciled and integrated into existing practices.
- Climate risks can be seen simply as an extension of existing risks, perhaps requiring the use of some new data or consideration of longer timescales but risks are considered to be identifiable through existing mechanisms. Crosscutting challenges and procedural shortcomings are identified and escalated up the decision hierarchy via existing mechanism.

In practice these are not mutually exclusive approaches and some combination may yield the best results. In any case, whatever approach is taken, the assessment will need to consider climate risks at all levels of decision-making. The need to incorporate multiple levels of decision-making means that the question of who owns the assessment of climate risk and responsibility for managing them and what mechanisms are in place to facilitate climate risk escalation through the decision hierarchy is critical to the delivery of effective climate risk assessment.

Section 3: Establishing decision-making criteria

The contextual nature of adaptation means that there is not a single uniformly accepted approach for planning, assessing and implementing adaptation measures. Rather the process of adaptation involves the flexible application of different methods and approaches which are thought relevant to a particular context (Füssel, 2007b). Climate change adaptation approaches and theories draw on diverse concepts and terminology including risk, resilience, impacts, vulnerability and hazard. These terms (and many others), have evolved from different disciplines, spanning both the physical and social sciences. These disciplines have used the terms not only with different foci but also frequently with quite different technical meanings (Gallopín, 2006; Klein, 2009) and work on adaptation to climate change has not integrated this diversity into a single coherent entity.

It is important to be aware of the scope for confusion that stems from this diversity, **and it is advisable, when developing an adaptation programme, to define clearly all of the key terminology at the outset.** Understanding specific definitions is equally important when considering work from different studies: check there is consistency and that any inconsistencies are clear and do not obscure differences which might have significant implications for the results or application of the work. It can be tempting to simply adapt a standard terminology such as defined by the IPCC but even here there is scope for confusion: sometimes the definitions are formally quoted but loosely adhered to and sometimes the definitions leave plenty of room for interpretation, so supplementary definitions are worth considering. This may seem a lengthy process but developing a clear and mutually understood terminology removes a considerable source of confusion from an already complicated area of work and is therefore well worth the time investment. A shared language is also a key step in developing a shared understanding of adaptation within a programme or project team.

Approaches to adaptation can be considered in two broad steps: (1) **assessment** which focuses on data collection/generation; and (2) **decision-making** which focuses on using information to help contextualise and inform decision-making. These steps are not distinct in practice where assessment will develop and improve in parallel with a series of decisions over time. However, it is helpful to consider the steps separately when thinking about which approaches are suitable for a given context since different combinations of assessment and decision-making approaches/tools can lead to different information and resultant decisions, particularly in the near term.

3.1 ASSESSMENT APPROACHES

3.1.1 RISK APPROACH

In much climate adaptation theory, policy and practice, risk-based approaches to adaptation assessment are proving popular because they offer approaches that explicitly deal with the uncertainty inherent in adaptation and many organisations already have some familiarity and capacity in risk methods into which climate change risks might be integrated. In this document risk is used as a conceptual component of a framework designed to help understand the phenomena of climate change, impacts, vulnerability and adaptation and relate it to other areas of work. **It requires some measure of likelihood and consequence and associated uncertainties but beyond that is non prescriptive in approach.** Risk defined in this very loose sense can encompass many different methods and approaches to elucidating climate risks through qualitative and/or quantitative means. This guidance therefore advocates a risk based framing of adaptation but does not necessarily endorse a classical risk assessment approach, these may well have their place but the pros and cons of that approach should be weighed up and documented like any other.

Within this framework approaches to assessment are quite diverse but can be crudely classified into top-down and bottom-up, as discussed in [Section 2.3](#). Top-down assessments are broadly rooted in the natural hazards tradition, start at the global level and work down to the local (hence top-down). Bottom-up assessments are broadly rooted in development work and start at the local level making linkages upwards towards the global (hence bottom-up), (Dessai and Hulme, 2004). These approaches are not mutually exclusive but do have some practical and philosophical differences, and potential tradeoffs.

3.1.2 TOP-DOWN (IMPACTS) APPROACH

The top-down approach to adaptation, sometimes categorised as an ‘impacts’ approach, is historically the dominant one and probably still the most common. The focus of top-down assessment is typically to evaluate the likely impacts of climate change under a given climate scenario, or range of scenarios, and to assess the efficacy of adaptation measures to reduce negative projected impacts or exploit potential opportunities (Carter *et al.* 2007).

Top-down assessments tend to follow a relatively linear stepwise process and take global climate scenarios as the starting point. Typically, global climate scenarios are downscaled and used as the input for an impacts model or models which estimate the associated biophysical (physical and biological) impacts that could result under the assumption of no adaptation. Impact models are usually themed around certain impact types, e.g. flooding or building overheating. The potential consequences for society of those impacts identified (e.g. damage to people and property, loss of business etc.), are usually less thoroughly studied, but are sometimes estimated by reference to past and present experience of similar or analogous events, or through scenario exercises. Adaptation options (e.g. flood walls, shading) can then be proposed in order to help reduce the specific impacts and/or consequences identified, and these options can then be assessed for efficacy by re-running the impacts model with the different proposed adaptation interventions in order to investigate which shows the most potential for reducing impacts and consequences.

Partly due to its dominance as an approach within the IPCC reports top-down assessments make up much of the available literature on climate change threats and opportunities and are likely to be a valuable source of information on the broad picture of the types of impacts which may be experienced in a given region, and which might affect a particular sector. Desk-based assessments of existing literature will invariably need to draw on this rich body of information. However much top-down information is generated in what Preston and Stafford-Smith (2009) term, a decision vacuum, and while helpful in building an information base, raising awareness about the general phenomena of climate change and its broad impacts, which is useful in making the case for the need to adapt, and undertaking initial high level assessments, far fewer of these studies provide rich contextual information which can readily be used to inform adaptation planning and subsequent programmes of work.

These assessments tend to provide information on whom or what will be most **exposed** to climate change hazards, but are weaker on the social and institutional factors that define much of a systems **sensitivity** to climate hazards. Consequently purely top-down assessments usually only get half way to an assessment of whom or what is most at risk from climate change and generally provide first order impacts such as flood risk mapping but don’t estimate the consequences (sometimes referred to as 2nd, 3rd, 4th etc. order impacts), such as loss of building access, asset damage and loss of business. This information, although more uncertain, represents the information most decision-makers fundamentally need to consider ([Section 2.3](#)). This information about exposure readily informs decisions about interventions which might prevent or reduce the risk of an impact occurring (e.g. authorities looking at flood barriers to reduce the severity and/or frequency of flooding in an area). Frequently however this sort of intervention is outside the direct control (agency) of an organisation which are often necessarily more concerned with reducing the consequences of such an impact for them (e.g. damage to stock by flood water).

A substantial criticism of this approach is that the sequence of analysis seems to rest heavily on the foundations of global and regional climate models and particularly their ability to predict the extent of climate change expected for a given place and time. While climate models have made impressive leaps forward and are fundamental to our understanding of Earth system processes, very large uncertainties remain in projections particularly at the

local scale and in terms of changes in the incidents of climatic extremes (Dessai *et al.* 2008; Murphy *et al.* 2009), the very information felt to be of most relevance by decision makers, especially in the near term. The heavy reliance of top-down assessments on climate and impacts models means that decision makers need to be very cautious about how they interpret the information from these assessments. In particular the outputs can appear similar to conventional environmental risk information, e.g. on flood return intervals derived from historical data which is routinely used to inform many investment decisions today. This apparent similarity can make it tempting for decision makers familiar with utilising this information to treat model outputs based on future projections in a similar way. However, these model outputs contain considerably greater uncertainties than information that is derived from historical data. Furthermore, longer-term decisions are themselves also intrinsically highly uncertain, so decision makers need to think very carefully about how they choose to use this information to inform decision-making. The fact that top-down assessments rest on the back of climate projections is not intrinsically a weakness, but it does present different challenges for decision makers: they should not treat outputs as **predictors** of the future, but rather tools for **exploring** potential futures. As we will discuss later, [Section 3.2](#), the extent to which this fundamental uncertainty presents a problem depends to a large extent on the specific approach to decision-making applied within this broad approach to adaptation assessment.

The theoretical considerations outlined above also produce some practical limitations of top-down assessment in adaptation assessment and planning. Understanding even the major climate impacts for a specific organisation can be difficult through a purely top-down approach simply because it is unlikely that all of the significant impacts will have been incorporated in impacts models and outputs generated for the relevant locations. Where existing models exist it may be possible to run them relatively cheaply for the specific locations of interest but for variables where impacts models do not currently exist development and testing is time consuming and relatively expensive. **Consequently there is generally insufficient data for adaptation planning to be dealt with across an organisation's functions, purely through a top-down approach.**

In spite of this issue though, many adaptation investigations start with impacts modelling, perhaps because many find the approach intuitively appealing and probably because of path dependency. This is not fundamentally wrong but does present a possibility that significant risks, for which there is little quantitative data, get sidelined because they cannot be readily represented in impacts models. Contrastingly, risks with good quantitative data get pushed forward primarily because there is good evidence even if they are not truly the most likely or severe. This leads to a potential for 'data leading analysis' rather than information needs driving analysis. Workers undertaking this kind of assessment should explicitly deal with this issue.

As described earlier [Section 2.3](#) different approaches tend to favour certain tradeoffs between principles (Eakin *et al.* 2009). ([Section 2.1](#)) and are therefore loaded to favour certain types of solutions. **This 'bias' inherent in approaches and tools is unavoidable and only problematic in so far as they are not understood and acknowledged as part of the decision problem.** An example of where the chosen approach partially directs the outcome is where a top-down study is used to identify targeted adaptation interventions which have already prioritised the most expedient application of resources (efficiency) above considerations of the most vulnerable groups (equity), based on evidence of who and what is exposed to climate hazard rather than who or what is most sensitive (Eakin *et al.* 2009).

3.1.3 BOTTOM-UP (VULNERABILITY) APPROACH

Another approach to adaptation assessment is to work from the bottom-up, this is sometimes referred to (potentially confusingly) as a vulnerability approach. Bottom-up approaches are traditionally favoured in assessments undertaken in a development context. In these situations detailed climate projections are rarely available and significant vulnerabilities to current climate variability are present. However, growing awareness of the insufficiency of purely biophysical data in understanding climate risks, increasing interest in adaptive capacity and resilience approaches to adaptation ([Section 3.2](#)) and the growing need to appraise adaptation options and validate their success, mean that bottom-up approaches to adaptation assessment are gaining greater currency across the board.

Bottom-up approaches invariably involve some form of vulnerability assessment, but there are many different definitions of vulnerability and the chosen definition influences the scope of the analysis so that all vulnerability assessments are not necessarily bottom-up assessments. Nevertheless most definitions of vulnerability involve *understanding exposure, sensitivity and adaptive capacity* (Adger, 2006; IPCC, 2007a; Klein, 2009) and differences tend to be related to the degree of emphasis across these factors.

In contrast to the top-down approaches, which start with scenarios of future global change, bottom-up approaches begin with an assessment of the current system of interest (e.g. UKCIP, 2008; Kelly and Adger, 2000) and the factors which influence its vulnerability to current weather and climate. In a sense this approach starts by defining risk assessment endpoints based on recent experiences without initially worrying about the complexities of the risk drivers and pathways. This has the advantage that decision-makers are generally dealing with the sorts of information that they are familiar with and early progress can be much quicker without the barrier of complex and specialist climate and environmental information. These risk events or records are then used to trace backwards along the risk pathway, identifying current **exposure, sensitivities and adaptive capacity**. This approach tends to focus on the factors which influence, enhance or inhibit a system's (in this case an organisation's) existing capacity to cope with and respond to a stress or hazard. A particular strength is the acknowledgement and focus on current socio-economic and political characteristics, processes and trends which are key determinants of how sensitive a given system is to climate, and non-climate, hazards.

This information can readily be used to inform policies relevant to reducing the impacts and human consequences of current climatic variability. This information is informative in selecting no- or low-regrets adaptations which yield net benefits irrespective of the extent of climate change. An improved response to current climate variability can go some way towards reducing vulnerability to future changes and certainly it is likely to be hard to plan for future adaptation requirements if current practice is unable to cope well with present conditions. Given the inherent uncertainties in planning for the future, understanding the strengths and weaknesses of current socio-economic as well as biophysical structures is useful and tangible information to inform adaptation planning.

This kind of analysis can lead to an understanding of 'critical thresholds' and sensitivities either physically or socially defined, which can be used to understand how risks might change under different climate and socio-economic scenarios for the future. However, since it does not necessarily engage with the future, the bottom-up approach is most helpful in enhancing capacity to adapt to changes in existing hazards and stresses. For many this may be sufficient, since the majority of impacts predicted to arise from climate change, such as rising storm damage or declining biodiversity, already exist as a major concern (Pielke *et al.* 2007). However there is an argument that vulnerability to more significant or

unexpected changes, are probably not dealt with so well through this approach. In addition cataloguing the consequences of past climate events tends to focus efforts on climate events rather than trends.

As a goal vulnerability tends, by definition, to identify and focus adaptation efforts on what the assessment identifies as the most vulnerable aspects of a system. Arguably this is based on an underlying valuation of equity which can in many cases be at the expense of cost efficiency (Tompkins *et al.* 2008; Eakin *et al.* 2009). So once again the selection of an approach can be seen to influence the recommendations which are most likely to flow from it.

Neither of these approaches offers an objectively better solution than the other as a means of assessing and planning adaptation measures. Conceptually they aim for rather similar information but gather it from opposite directions so that differences which arise from the approach taken should be greatest in the near term and diminish over time. The best approach for a particular situation is likely to be influenced by near term objectives and the ease with which different types of information can be incorporated into the organisation in question. In practice though, the two approaches do tend to involve different schools of thought, and a different emphasis. They therefore tend to support certain approaches to adaptation, particularly in the short term. Due to resource constraints and disciplinary boundaries, the transition from one type of assessment to include the information from the other may not always be as smooth and easy as is desirable. Ultimately though, a comprehensive assessment will require the collection and synthesis of information through a combined approach.

KEY MESSAGES

1. Risk-based approaches to adaptation are proving popular as they offer approaches that explicitly deal with the inherent uncertainty within adaptation.
2. Many methods and approaches can be used within a risk based framework to elucidate climate risks. These can be broadly classified as top-down approaches (which start at the global level and work down to the local) and bottom-up, or vulnerability, approaches (which start at the local level and make linkages up to global). Each has their place and neither is necessarily better than the other, but there are some practical and philosophical differences as well as potential tradeoffs between these approaches that should be identified and acknowledged. These are explored in [Section 3.1](#) above.
3. The most appropriate approach for a given situation is likely to be influenced by the near term objectives of the organisation in question, as well as the ease with which different types of information can be incorporated into that organisation's assessment.
4. In practise, the two approaches tend to involve different schools of thought and emphasis, and ultimately support differing approaches to adaptation making it difficult to incorporate information from one type of assessment into another.
5. Ideally some combination of top-down and bottom-up assessments should be explored to ensure a comprehensive assessment is achieved.

3.2 APPROACHES TO DECISION-MAKING, OPTIONS GENERATION AND APPRAISAL

The next section will describe how assessment and decision-making are interlinked and emphasises the importance of scoping which allows the chosen method to be informed by consideration of the various factors which it might need to try to meet. It is possible to do a generic assessment followed by an adaptation assessment, but a closer match between assessment and decision methods are likely to be achieved if both steps have been considered in the scoping phase. Without this consideration there is a danger that generic assessments do not provide the information needed to support a chosen decision strategy.

Risks can be categorised and ranked purely in terms of their likelihood and severity and the timescale on which they are likely to operate. But risk decisions also need to take account of the institutional factors which dictate the timing of decisions relating to those risks, so that actions are prioritised on the basis of the **most urgent risk decisions** rather than the most urgent risks alone. For example, the commissioning of a new building or of building refurbishment will have long term ramifications and might therefore be an important and urgent adaptation decision even though the risk is not expected to be expressed until perhaps the 2030s or later. Based on our experience and emerging literature, key factors which likely to influence the priority of a risk decision – in addition to its likelihood and consequence – are:

1. **Time before a decision is necessary:** this may be irrespective of climate change (e.g. commissioning a building), but may also be linked to the time when a risk may become an issue.
2. **Time required for adaptive response** (inertia)
3. **Lifetime/duration** of action
4. **Flexibility / reversibility of action**
5. **Resource requirements**, for adaptation including accepting the risk
 - a. The opportunity to act, or influence action, (Agency)
 - b. The potential for learning
 - c. Appropriate capacity in place

This process of risk decision prioritisation will need to be intimately connected to the generation of adaptation options since some of these questions will only be answerable in relation to specific proposed adaptation options.

There are many different ways that adaptation decision-making can be approached. Perhaps the most simple categorisation is to divide them into two broad approaches: optimising and resilient.

3.2.1 OPTIMISATION

The most common approach to decision-making is optimisation. Efforts are made to weigh up the cost and benefits of the different options and the option offering the greatest benefit for the least cost (economic or otherwise) is favoured. There are lots of different ways in which the costs and benefits can be weighed up, from relatively simple qualitative approaches (such as SWOT analyses) to quantitative approaches (the best known and most widely applied of which is cost benefit analysis, or CBA). There are many different approaches and tools to help choose an 'optimal' decision. Particular methods attempt to deal with and trade off specific issues which arise in applying this procedure. For example, to undertake a quantitative assessment all of the complexity needs to be compressed into

a single metric or index which can be used to weigh up the pros and cons of a given decision. The ways in which this is done can be very influential to the outcome. However, here we are not concerned so much with the detail as the wider implications of selecting this broad optimising approach.

Pros of the optimising approach include:

- Given that it is an established means of decision-making, many institutions have significant experience and expertise in different methods of decision analysis for optimization.
- It is already imbedded in government policy and particularly with HM Treasury (HM Treasury, 2009).
- It is seen to be an efficient and effective means of allocating resources when the estimates on which the analysis are based are thought to be reliable with acceptable levels of uncertainty.

Cons of the optimising approach include:

- It is not likely to lead to effective or efficient decisions if the estimated conditions on which the analysis is based turn out to be incorrect.
- Where quantitative analysis is concerned, it can be difficult to adequately value or monetise things which lie outside of the economy.
- In the case of climate change adaptation this approach requires climate science to produce locally and temporally accurate forecasts, which it is not realistic in the foreseeable future.
- If rigidly adhered to this approach can lead decision makers to conclude that they don't have enough information to act, resulting in a 'wait for more information before deciding' approach.
- It can lead to a simplistic or unquestioning approach to the use of climate information, which could be damaging to the reputation of scientific information and adaptation planning more generally.

Where the risks (both threats and opportunities) are relatively well known (Technical Box 1) this can be a sensible strategy which optimises certain benefits for a given set of conditions. However optimization is a much less desirable approach when large and significant uncertainties exist as to the future conditions in question. An optimization strategy which seeks to undertake adaptations which optimise utility for a given climatic future are likely to be less than optimal to the conditions which actually prevail.

It is still possible to prioritise quite different adaptation measures through an optimization approach depending on what is judged to be the greatest benefit and what the most unacceptable cost, which cuts back to the most fundamental questions about what is most important and how much risk is tolerable in respect to these priorities. But whatever the judgements about what should be prioritised, the outcomes are subject to decision errors owing to different conditions actually prevailing.

3.2.2 RESILIENCE

An alternative decision option, aligned to a precautionary approach, is to make decisions which lead to resilience. Although there are upwards of 20 formal definitions of resilience (Klein, 2009), the IPCC definition is adopted here which describes resilience as:

“The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change.” (IPCC, 2007a)

Resilience thinking has its roots in ecology (Holling, 1973), and as a goal is based on the premise that complex systems (including all social and economic systems) have the capacity to change rapidly or flip from one state to another (often less desirable) one and often in unpredictable ways. Conceptually these changes in state involve the passing of thresholds which represent the transition from one relatively stable state to another quite different state. Frequently it is some form of unforeseen variability or volatility originating within but more usually from outside the system which tips the balance towards a new state.

A resilient organisation is able to tolerate variability, volatility and localised loss for the greater good of the organisation's integrity (without the system moving to a fundamentally different state). An action to increase resilience must increase the aggregated capacity of the organisation to absorb shocks. A resilience approach therefore favours the whole organisation and those components crucial to its continuity, often at the expense of some vulnerable or endangered aspects. In some cases there might therefore be a values trade off between approaches which focus on vulnerability and resilience (Gallopín, 2006; Tompkins *et al.* 2008; Eakin *et al.* 2009).

Resilience strategies generally take two forms: (1) aiming for increased resilience in the general sense; or (2) resilience to particular identified risks. Strategies towards enhancing generic resilience to all shocks, emphasising the threat of rapid and unpredictable changes such as the global credit crunch are designed to be inherently flexible, learning based, and adaptive (Tompkins and Adger, 2004). Resilient strategies therefore involve learning from mistakes and adapting, either to prevent collapse (which is close to the original ecological definition of resilience, above) and/or to reorganise and recover once a shock has caused a collapse (which is more in line with emergency and business continuity type planning).

Resilient responses to particular identified risks can be partially covered by the generic activities detailed above but certain sorts of decision such as large infrastructure investments require additional means of enhancing resilience. These decisions can be fruitfully addressed by robust decision strategies (Dessai and Hulme, 2007). At the most fundamental level robust decision strategies apply methods to test the sensitivity of adaptation options to uncertainties in climate (as well as any other specified dimension of uncertainty) and favour options which are the most robust across the range of uncertainties identified, rather than the ones which perform best for a given future. In most cases these robust decisions and resulting resilient solutions therefore appear less efficient than optimising strategies. Of course this will only be known in the fullness of time.

KEY MESSAGES

1. It is a good idea to scope out the decisions that have to be made that will be most greatly affected by climate change e.g. those that have a long lifetime, high resource requirements or which are irreversible.
2. There are two main approaches to adaptation decision-making, options generation and appraisal: optimising and resilience.
3. Optimising approaches aim to identify the approach with the greatest benefit for the least cost.
4. Resilience approaches aim to provide increased resilience either in general or in response to specific risks. They generally involve learning from experience. The options favoured in this approach tend to be ones considered to be robust against a range of uncertainties.

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