

# **Objective Setting for Climate Change Adaptation Policy**

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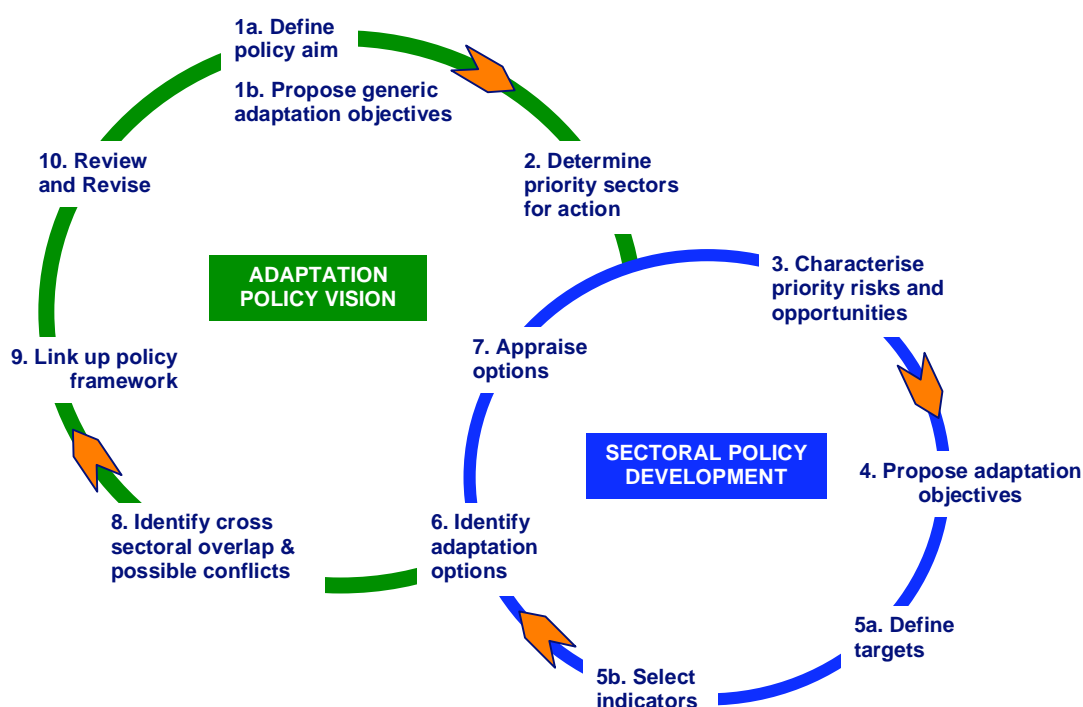
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# Executive Summary

Many countries have put forward adaptation strategies to address the impacts of future climate change. The UK Government is one of the few to go beyond this and to consider how to develop adaptation policy. This project, commissioned by Defra, sets out a method for adaptation policy setting, which is used to develop “strawman” adaptation policy objectives and example targets and possible indicators in priority sectors. The purpose of these strawman outputs is to trigger discussion and aid further development, and not to set out or pre-empt adaptation policy.

There are many methods that could potentially be used for policy-setting, some of which have been published and a lesser proportion put into practice. A review of both generic methodologies and those that have been developed specifically for adaptation, uncovered some valuable features for an approach for adaptation policy setting, including impacts assessments, strategic options appraisals, use of scientific evidence base, iterative processes and stakeholder engagement. However, none of the existing methodologies provides a suitable, clear, and pragmatic course of action for setting adaptation policies, for selecting targets and identifying suitable indicators by which to monitor progress. For this reason, a new method for adaptation policy setting has been proposed.

To accommodate the challenges posed by adaptation, the method developed is circular and iterative (see below). It allows for input from individual sectors to occur concurrently and somewhat independently, and requires engagement with a range of stakeholders at various stages in its application. Defra has already started to develop the adaptation policy vision. It is envisaged that government departments will have an active role in taking the process forward in their sectors. Without ownership of this process by the sectors themselves, the evolving policy is unlikely to have the impact required for effective, co-ordinated and comprehensive adaptation.



This study has applied the proposed method to develop adaptation objectives, targets and indicators in *six* priority sectors. The process of selecting priority sectors is important because it helps to determine which sectors may be explicitly addressed in future phases of Defra's Adaptation Policy Framework. The criteria that were used to choose priority sectors include the economic importance of the sector to the UK, and the potential significance of climate impacts and adaptation measures in the sector in economic terms, the immediacy of potential climate change impacts, and the potential significance of the social and environmental consequences of climate impacts and adaptation responses within the sector. The choice of sectors was also influenced by the extent to which stakeholders, from a variety of organisational types and geographical regions, would be willing and able to participate.

On the basis of these criteria, defined in the broadest terms, the project team in consultation with Defra, identified six sectors in which to work: water resources, flood & coastal risk management, transport, tourism, agriculture, and energy.

Strawman policy objectives were developed in each sector using a risk-based approach. Starting with the identification of risks and opportunities from climate change, a prioritisation was produced based on probability and magnitude, and considering uncertainty in the climate (and other) information available. Given the scope of the study, the risk assessment has largely been based on qualitative statements, which should ultimately (where possible) be supported by quantitative analysis.

Risk prioritisation should ideally take into account agreed levels of risks, information on financial/economic costs, and considerations of existing adaptive capacity, thus linking the characterisation of the risk and opportunities stage in the methodology with the options appraisal stage. Prioritisation should also take into account knock-on effects in other sectors. The risk assessments could, in most cases, be carried out by the departments with responsibility for the sector in question, in consultation with stakeholders.

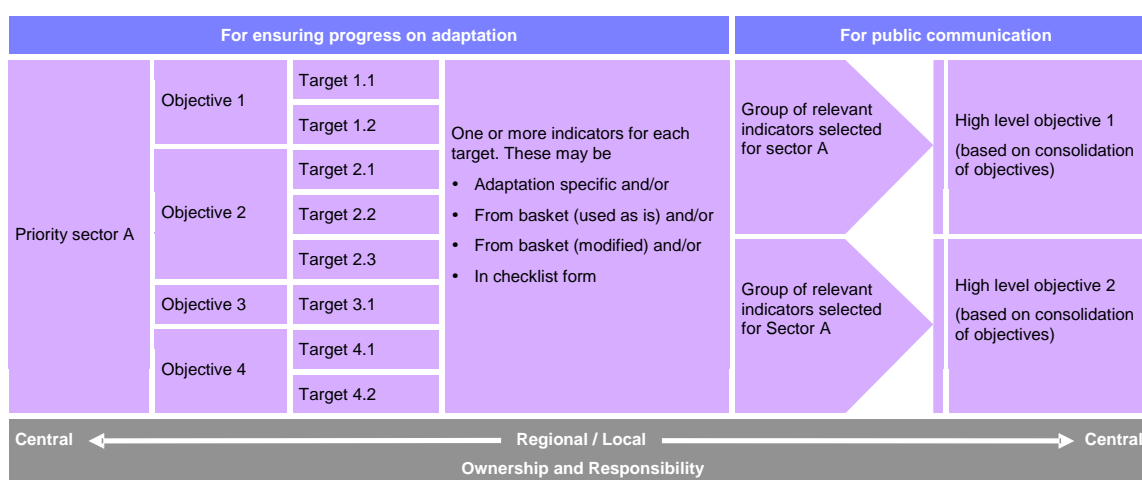
The working objectives that have been suggested as “strawmen” in this report have generally been worded very flexibly. This is because the best adaptation solutions to identified climate risks are, in most cases, likely to involve a mix of responses, some of which are “climate-proofing” (such as changes in design specifications), and some of which are “living with risk” (such as contingency planning). Solutions are also likely to take the form of an evolving process, the balance of which will change over time.

For a sample of the strawman objectives, illustrative examples of targets have been proposed. These spanned both building capacity and delivering actual adaptation. The targets are largely process-based, stating “what” is required, but not “how” it should be done, in order to retain flexibility. Ultimately, a number of targets may be associated with each objective. Each target will require ownership. Process-based targets can form the basis for the early steps towards adaptation, though for real policy progress, they need to be complemented by outcome-led policy.

A number of existing indicators that are relevant to adaptation have been identified. However, no new adaptation-specific indicators were produced. It was felt that it was premature to do this for three reasons: 1) the lack of a defined policy, and targets, makes the identification of specific indicators premature; 2) the majority of targets identified are process-based and not formulated specifically-enough to identify a relevant indicator; and 3) indicator identification and selection should be carried out by the organisation responsible for data collection and reporting, and thus based on practical considerations of resources and existing processes. Annual reportage of progress in relation to the process-

based targets suggested under each objective is likely to form a crucial element of monitoring in the early stages of an adaptation policy.

The figure overleaf shows how these different components of the adaptation policy link together in an adaptation policy framework. It is envisaged here that there are two sets of outputs under the policy framework. One set ensures that genuine progress is made on implementation of specific adaptation measures in order to reach stated objectives; the other ensures that summary information on progress can be presented to a wider audience. Note that the ownership of the different outputs varies, with local government and the regions taking a much more active role in development of indicators.



One model for allocating regional and local adaptation responsibilities is that of sustainable development, in which the UK Government’s Sustainable Development Strategy sits under an overarching UK framework (and alongside sustainable development strategies for the devolved administrations). Each English region develops its own regional sustainable development framework (with priorities and commitments), and beneath that, local authorities have responsibility for much of its delivery.

We offer the following recommendations with regard to the future application of the proposed policy-setting method:

- To facilitate the development of adaptation policy, it would be useful for Defra to progress the definition of “successful adaptation”. A definition might, for example, focus on ensuring cost-effective and proportionate adaptation, but it could also be based on categories such as ‘living with risk’ or ‘climate-proofing’. Whichever approach is taken, it will be important for the definition to be agreed among key stakeholders. It is not possible to define objectives, targets and indicators properly until this overarching vision for adaptation is set.
- Lower level objectives, targets and indicators follow from this goal for adaptation policy, once the definition is clear. We believe that the policy cycle presented in this report would be a valuable and practical process through which to draw down the more detailed policy components from this high level goal.
- Of course, an effective adaptation policy needs to draw on the evidence base from a wide range of disciplines, reflecting existing knowledge, expertise and practical experience, throughout its development and implementation. This evidence base is large, fragmented and complex. In leading the adaptation policy setting initiative, Defra would benefit from building on the established participatory and inclusive approach, interacting with organisations in a range of sectors, particularly during the process of setting objectives, targets and indicators.
- Policy-setting action in those sectors that do not take policy lead from Defra may be more effective if led by the appropriate government departments. Consistent

with the existing approach, Defra should continue to involve other government departments at an early stage and encourage adaptation to be seen by these departments as a priority issue. Without real commitment and leadership in each sector, it is unlikely that adaptation will be effectively integrated into relevant sectoral policies and the impacts of the policy will be limited. This point parallels UKCIP advice for an “adaptation champion” at the organisational level.

- The project identified six priority ‘sectors’ for adaptation (transport, energy, agriculture, tourism, water resources and flood management). However the project team strongly believes that other priority sectors need to be assessed using a similar approach to the current study. Perhaps some of the most important sectors that we omitted are health, ecosystems (biodiversity and nature conservation), spatial planning (though this could be featured as a cross-cutting theme) and the built environment.
- The limited scope of the study prevented a comprehensive analysis of cross-cutting issues. However, we suggest that a number of areas may be suitable for inclusion as cross-cutting themes in the adaptation policy framework. These include procurement, education and training, science and research (in particular connected with interpreting new climate change scenarios) and monitoring and evaluation.
- Regional variations in both climate impacts and preferred adaptation strategies can affect adaptation within each sector, and may lead to the development of different policy objectives or targets at the regional level. However there are some sectors over which the regional and local level can exert minimal influence (such as perhaps agriculture and tourism which are so strongly market-driven). Sectoral leads responsible for developing adaptation policies will need to bear such issues in mind.
- Successful adaptation activities require the co-operation of a wide range of organisations and individuals. Adaptation policy development therefore also requires extensive stakeholder involvement. This involvement needs to be structured to ensure that it is properly focused. The project team have found the use of a staged approach, i.e. the iterative method described in this report, to be extremely useful in identifying when, and which, stakeholders can best have an input at a given stage. This approach might be useful for managing stakeholder input to subsequent phases of the APF.
- One of the difficulties faced by the project team was keeping the process moving against the uncertainty inherent in climate change and gaps in the evidence base. The preferred choice of an objective or target might depend on, for example, the results of appraisal of various adaptation measures or more detailed understanding of existing sectoral policies. As this policy-setting method is applied in practice, similar challenges will be encountered. In most instances it will not be possible to delay decisions until all of the evidence is available. One solution is to use the process-based approach. Whilst this means that there may be some uncertainty over outcomes, it does at least enable progress to be made. Subsequent iterations could help clarify or refine process-based targets and indicators, or replace them with outcome-based targets and indicators if this becomes possible.
- Whilst adaptation remains at an early stage of development, it is inevitable that objectives, targets and indicators will focus on building capacity. To this end, there is a need for a balanced mix of process-based and outcome-based targets and indicators. As the area progresses, we would envisage a shift towards outcome-based indicators, that focus on measuring the delivery of actual adaptation.

We offer the following recommendations with regard to the strawman objectives, targets and indicators:

- The strawman objectives and targets in this report have been designed to provoke discussion, leading to further development and refinement during future sector-based work. Although they might be suitable, none of the objectives or high-level objectives proposed in this report is anything other than an example. They are based on the opinions of the project team and a small number of informed stakeholders, but should not be presented as agreed sectoral objectives and targets.

- Targets and indicators could be further developed with organisations that have the responsibility for meeting and monitoring them. The project team has proposed some initial ideas; the next stage in developing these could take place amongst key stakeholders in existing sectors. Without this early involvement of stakeholders, targets will not be “owned” and access to a full range of data for indicator development is not possible.
- We suggest using a basket of existing indicators to communicate progress towards adaptation. Use of these indicators will also promote ‘mainstreaming’ of adaptation issues within sectors. However, these basket indicators will not be appropriate for measuring progress towards adaptation targets. For these, new adaptation-specific indicators will be required, in conjunction with checklists to ensure that key steps towards individual targets are achieved. The project team recommends the use of only one or two adaptation-specific indicators per sector, given existing pressures on organisations responsible for data collection and indicator reporting.
- Whilst headline indicators are sometimes useful for communication and can provide adaptation with a separate ‘identity’, it may be too early to focus attention on headline indicators. A headline indicator cannot adequately summarise or represent progress across all other indicators. We recommend that the focus could be placed more appropriately on measures of progress across the board in preparing for climate change, i.e. building capacity, consistent with our overall policy recommendations above.

Finally, we offer the following recommendations for future work, the most immediate priorities being:

- To develop a definition of successful adaptation for the UK. This is linked to our first recommendation, above, and could underpin future progress on the APF.
- To initiate adaptation policy analysis in priority sectors not covered by this project (including health, biodiversity and the built environment, among others).
- To engage more thoroughly with sectoral stakeholders in order to reject or refine specific strawman objectives.
- To specify targets related to revised objectives in greater detail.
- To continue to develop baskets of indicators that will be useful for communicating progress towards adaptation (perhaps to include examining trends in existing sectoral indicators against climate impacts in recent years).

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# 1 Introduction

## 1.1 BACKGROUND TO THE PROJECT

Over the last year, the UK Government has initiated a number of major international and domestic developments to address climate change (HMG 2005a). These include:

- putting climate change as a top priority for both the UK's G8 and European Union presidencies in 2005
- discussion at an international level on further engagement of all parties to the United Nations Framework Convention on Climate Change on future action to reduce greenhouse gas emissions, and adaptation strategies
- launch of the Climate Change Communications Initiative with funding of at least £12 million over the period 2005-08, to tackle public attitudes to, and understanding of, climate change, and what we can each do to help reduce our personal contribution to climate change
- delivering against commitments in 'Energy Efficiency: The Government's Plan for Action'
- a consultation on the draft code for sustainable buildings during 2005, with national rollout planned to begin in 2006
- launch of the Government's pilot carbon offsetting scheme for air travel in 2005
- pressing for the inclusion of intra-EU air services in the EU emissions trading scheme from 2008 or as soon as possible thereafter
- publication of a climate change adaptation policy framework.

This report is a key input to the latter objective.

The issues surrounding adaptation to climate change in the UK have already been the subject of much investigation. The publication of future climate scenarios by the UK Climate Impacts Programme (UKCIP) in 2002, presenting projected climate changes for 2020, 2050 and 2080, may have been the catalyst for much of this work. In addition to a growing body of scientific research, many regional and local government initiatives have emerged, some with rapidly evolving adaptation programmes.

The Government now believes that "co-ordination of adaptation activities is now required – not only to avoid duplication or major gaps, but also to provide some strategic direction. Government has agreed to develop a framework for adaptation to define roles and responsibilities of different departments and organisations, and ensure a comprehensive and coherent approach to adaptation in priority sectors" (HMG 2004).

The Department for the Environment, Food and Rural Affairs (Defra) has therefore initiated a national Adaptation Policy Framework (APF) in order to provide a more strategic national approach to adaptation. Developed in consultation with other government departments and devolved administrations, the APF will provide objectives and measures of progress, structure and transparency for adaptation activities, long term policy direction and communication of action on climate change. The intention is to produce a dynamic policy document that will be continually evolving, reviewed and updated. The APF will be structured on a sectoral basis, setting out key objectives and measures of progress for each sector.

Defra and its forebears has long been involved in policy which aims to manage the impact of society on the environment. Climate change is one such area and considerable effort has already gone in to the development of a national and international climate change mitigation policy. However, adaptation to climate change poses a new set of problems. Here, it is the impact of the environment on society that has to be managed. The climatic

changes anticipated over the next century and beyond will necessitate major adjustments not just to individual lifestyles, but also to where we live, how business operates and how national infrastructure is developed.

The APF must create the right conditions for an effective response to climate change of uncertain magnitude over long timescales. This will involve incorporating the flexibility to react rapidly to the new information presented by climate science and impacts assessments. Adaptation policy must take into account regional variations in vulnerability as well as climate impacts. To address these issues successfully will require a new approach to policy setting.

Adaptation to climate change is fundamental component of the goal of sustainable development, to enable all people throughout the world to satisfy their basic needs and enjoy a better quality of life without compromising the quality of life of future generations. For the UK Government and the Devolved Administrations, that goal will be pursued in an integrated way through a sustainable, innovative and productive economy that delivers high levels of employment, and a just society that promotes social inclusion, sustainable communities and personal well-being (HMG 2005a). Even with an effective APF, climate impacts on the economy and society pose a major threat to sustainable development in the UK.

Within Europe, the importance of adaptation as well as mitigation is increasingly being recognised. Following their recognition in the communication “Winning the battle against global climate change” that more resources need to be allocated in the EU to adapt effectively to climate change, the European Commission launched phase 2 European Climate Change Programme (ECCP II) in October 2005. Working Group 2 for ECCP II is on Impacts and Adaptation and its work programme includes 10 thematic meetings for which status reports will be delivered by September 2006. The greater prominence of adaptation in ECCP II may result in a stronger impetus for adaptation activities not only among Member States but also at regional and local levels. The UK’s pioneering work on adaptation policy-setting is a timely contribution to the European level debate.

## **1.2 PROJECT OBJECTIVES**

The purpose of the project is to develop a set of potential objectives, targets and indicators for adaptation to climate change (see Appendix IX for a full project specification). To achieve this purpose, Defra have set out a number of objectives for the project, which are:

1. To review objective-setting methods used in a range of environmental policy areas and in the relevant literature. The review should examine different approaches such as using quantified targets, indicators, valuation, risk management methods or process based indicators, and gather experience from other countries in the area of adaptation policy-making.
2. To identify lessons that can be transferred to develop soundly-based principles and methods for setting objectives and targets for adapting to climate change, against which it will be possible to measure progress as well as developing new and innovative ways to measure progress in adaptation.
3. To identify priority sectors in which the methods will be applied. This list will be drawn up on the basis of previous scoping work on climate change impacts, and ongoing work in drafting the APF. The principles and methods identified from the review and analysis should be used to suggest potential “strawman” objectives, targets and indicators in these priority sectors.

4. To apply the principles and methods at local government level, to develop potential local authority indicators of adaptation, which might integrate with existing local sustainable development indicators.
5. To use stakeholder workshops to consider whether the principles and methods identified are appropriate for target-setting in adaptation policy, and to develop refinements to both methods and targets.

The project team did not, therefore, set out to produce a new assessment of impacts or full evaluation of adaptive capacity. Rather, the intention was to draw existing information into a consistent and manageable format to inform policy development.

## 1.3 DEFINITIONS

The definitions set out in Table 1 cover key words and terms used in this report.

*Table 1. Definitions*

<b>Policy</b>	The overall plan of action to address the issue. Policy implies a process. In the context of this study we use policy as a fairly generic term to refer to the entire structure of objectives, targets, indicators and actions that together make up the detail of the process to achieve successful adaptation to climate change.
<b>Strategy</b>	The long term plan of action designed to achieve a particular goal. If policy emphasises the “what”, strategy is more concerned with the “where” and “how” to get there. Strategies may operate at a range of levels, and in the case of adaptation, arguably the most crucial strategies are those adopted by stakeholders in implementing actions that contribute to progress towards adaptation targets and objectives. The UK’s highest level adaptation strategy, although not specifically articulated, is characterised by being “stakeholder-led” and directed in large part by the tools and guidance offered by UKCIP.
<b>Aim</b>	An anticipated <i>outcome</i> that the policy is seeking to achieve and that guides all subsequent planned actions. The overarching, potentially aspirational, direction for the policy.
<b>Objective</b>	A medium to long-term goal within the policy. It should contain specific elements that sit comfortably within, and guided by, the aim, and in some cases it may be linked to a timeframe. It should be achievable.
<b>Target</b>	A nearer-term goal than the objective, perhaps in a set of incremental targets leading towards the objective (and therefore more closely defining the specific strand of the strategy). Targets should be specific, measurable, achievable, realistic/relevant and time-bound (SMART).
<b>Indicator</b>	A metric or value (preferably quantitative) used to demonstrate progress towards a target or objective. It should provide an indication of the condition or direction over time of achievement of the target or objective.
<b>Adaptation option</b>	One of several possible courses of action to address the impacts of climate change in a particular area. Options could include “do nothing” or “delay decision”; they could indicate general categories of approach; or they could be more concrete actions to commission new research, adopt new policies, or change plans, procedures, or operations. Adaptation options may be combined with a timeframe in order to define an objective or target.

<b>Measure</b>	In general terms, a measure could be any manoeuvre made as part of progress toward the overall policy aim. In this study we should perhaps confine it to specific (perhaps particularly statutory) mechanisms that central government may choose to introduce in order to maintain, accelerate, enforce or control action to adapt by other actors (i.e. stakeholders). The study is not concerned with defining specific policy measures.
<b>Outcome-based</b>	An outcome-based approach seeks to define an explicit outcome, or end point, of the adaptation action (e.g. increased drainage capacity to cope with more intense winter precipitation events). This might also be referred to as 'downstream' in the sense that the focus is on the residual effects of risks as experienced.
<b>Process-based</b>	A process-based approach seeks to define the key stages in a process that would lead to the best choice of end point, without specifying that point at the outset. This is an 'upstream' approach in the sense that it seeks to predict outcomes, or at least provide enhanced capacity to manage a range of outcomes.

## 1.4 LAYOUT OF THE REPORT

The main body of the report has been kept as focused as possible. For this reason, much of the review material has been included in Appendices.

The overview of international, national, regional and local adaptation initiatives, which sets the scene for the project, has been placed in Appendix II. These initiatives indicate real progress in climate impact research and development of appropriate strategic responses at all levels across different sectors. However, they also indicate how fragmented the response can become without strong leadership from government. The national initiatives highlight the lack of adaptation policy setting experience globally. The UK is one of the few countries to tackle the problematic issue of adaptation policy setting head on. Other governments make reference to adaptation policy, but no attempt to define it. Of the countries reviewed, only Canada appeared to be starting to develop an adaptation policy. Finland has developed a comprehensive adaptation strategy, but has yet to integrate this strategy into national policy.

Section 2 describes the methodology for adaptation policy setting developed by the project team. First, a set of principles is identified. In Section 2.2 the method developed is described in more detail. The issues that arose in the development process are considered in Section 2.3. This section draws heavily on the review of policy setting methods (one of the project objectives), which has been placed in Appendix III. The approach to stakeholder consultation within the project is also described.

The results of the application of the methodology are described in Sections 3 to 6. Section 3 describes the policy aim and outlines some accompanying generic objectives. Section 4 explains the rationale for the selection of priority sectors used in this project. Section 5 explains the process for producing the objectives and targets in more detail, and sets out strawman objectives and targets for the priority sectors. Section 6 examines existing indicators that could be suitable for adaptation and options for using adaptation specific indicators.

The relationship between objectives, targets and indicators is summarised in Section 7 using an example adaptation framework. Other key components of the policy setting process, which have not been the subject of analysis in this project, are also discussed.

Finally, the project team's conclusions and recommendations are set out in Section 8.

## 2 A Methodology for Adaptation Policy Setting

This section describes principles and methods for setting objectives, targets and indicators in adaptation policy. The final section indicates how the methods were applied in the context of this research study.

### 2.1 PRINCIPLES FOR SETTING ADAPTATION POLICY

A wide ranging review of policy-setting methods (see Appendix III) revealed that many organisations have adopted principles to assist the policy development process, or have identified criteria for successful policy development that may be used as principles. These include the Cabinet Office on *Better Policy Making* (Bullock *et al.* 2001), the United Nations Environment Programme in its policy setting handbook for compliance with the Montreal Protocol (UNEP 2003) and the Royal Commission on Environmental Standards in its report *Setting Environmental Standards* (RCEP 1998).

The principles outlined in the *Better Policy Making* paper, referred to as ‘core competencies’, appear to be particularly relevant, partly because they are grounded in actual policy setting experience in government and partly because they provide a framework that covers the many key issues for adaptation. They also have the advantage of reflecting recent Government thinking and should, therefore, be an appropriate guide for Defra.

However, the project team felt that the principles could be refined to improve their relevance to adaptation. The bullet points in Box 1 link the broad principles identified in *Better Policy Making* more specifically to adaptation issues. The adaptation principles are based in part on the project team’s own experience in adaptation and in part on the *Principles of Good Adaptation* produced by the UK Climate Impacts Programme (UKCIP). The *Principles of Good Adaptation* are not aimed at policy setting, but at the development of organisational adaptation strategies; however, some of them are very relevant to the policy setting process.

#### Box 1. Principles for Setting Adaptation Policy

##### Vision

- Forward looking – work simultaneously on short, medium and long-term policies, with a view to minimising adverse climate change impacts in the long-term
- Outward looking – take account of the many climate change adaptation initiatives in the UK and research, strategy and policy developments in other countries
- Innovative and creative – question established policy setting approaches, accept uncertainty and adopt appropriate (e.g. risk-based) tools to keep the decision-making process moving

##### Effectiveness

- Uses evidence – use best available climate models, impact analyses and adaptation options from a wide range of sources to focus on priority climate risks, whilst balancing climate and non-climate risks
- Inclusive – take account of a wide range of stakeholders and work in partnership to ensure the development of a robust and deliverable adaptation policy that has broad support
- Joined up – ensure policy is properly integrated across all key sectors to avoid adaptation-constraining decisions, and look beyond institutional barriers and



boundaries to the Government's strategic objectives

**Continuous improvement**

- Evaluates – build systematic long-term evaluation of outcomes into the policy process, using both indicator-based and process-based targets
- Reviews – keep established adaptation policy and the policy development process under review to ensure it continues to focus on priority risks and responds promptly to changes in the evidence base
- Learns lessons – learn from experience of what works and what doesn't, both in the UK and abroad.

## 2.2 METHOD FOR ADAPTATION POLICY SETTING

This section sets out a sequence of steps and methods for developing the components of an adaptation policy. The key outputs of the policy-setting process are:

- An overall aim
- Policy objectives (both overarching and sector-specific)
- Targets and indicators
- A policy framework.

This study has developed a method for adaptation policy-setting that could be applied by Defra. Key stages of the method have been tested within the context of the study. The generic method is shown in Figure 1, with the roles of stakeholders in the process included in Figure 2. The development of the method is discussed in Section 2.3.

The main features of the method are that:

- It is circular and iterative;
- It requires simultaneous input from several sectors;
- It requires stakeholder input at various stages in its application.

Figure 1 shows two iterative circles of activity. The circle on the left identifies the stages for formulating the vision for adaptation policy. The circle on the right sets out the more involved stages for which a sectoral representative has responsibility.

Some stakeholders consulted during the project advised that the method should show clearly the role of different organisations in the policy-setting process (see Figure 2). It is envisaged that the circle on the left is the responsibility of Defra. Sectoral policy development is likely to be run by the relevant government department (and is likely to include Defra). The project team believes that active involvement of, and buy-in from, these other sectoral leads is essential if the method is to work satisfactorily. It is envisaged that each sectoral representative will separately pursue the stages in this right hand circle before feeding back into the circle managed by Defra.

Figure 2 also shows responsibilities for different parts of the process, and identifies where particular stakeholders could make greatest input. The intention is not to exclude any stakeholders from having an input at any stage, but to show which stakeholders are likely to add most value to the process.

Figure 1. Generic method for adaptation policy setting

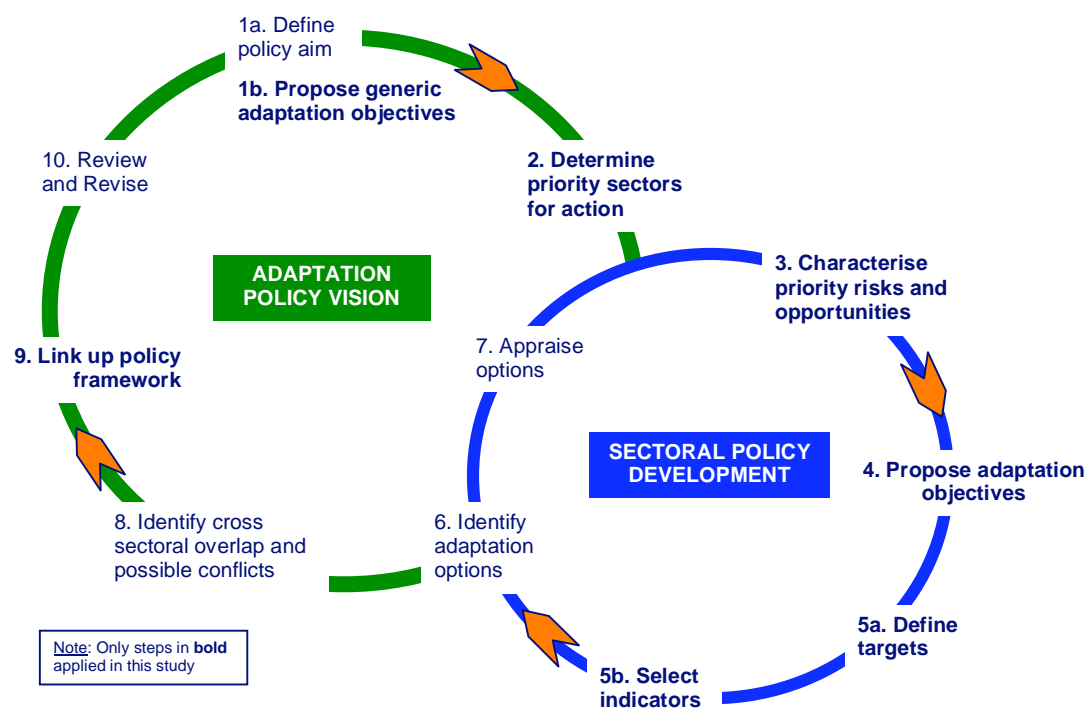
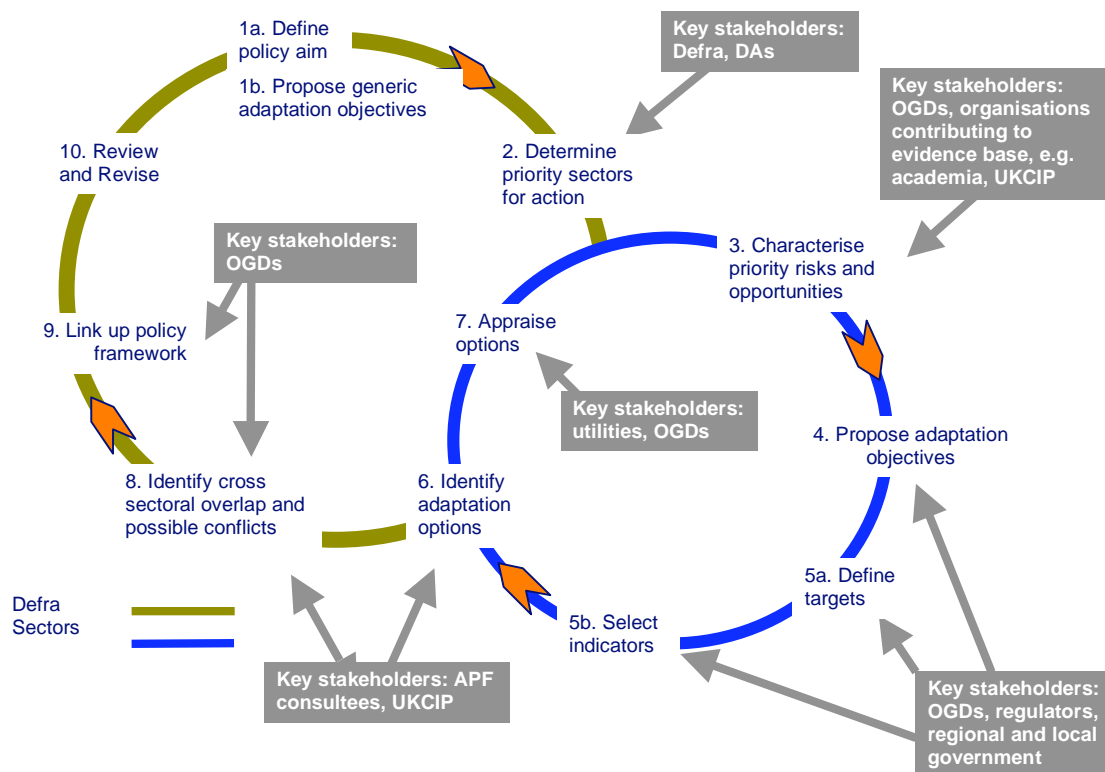


Figure 2. Possible UK stakeholders for adaptation policy setting



The sections below explain each stage in more detail.

### **Step 1 – Define policy aim**

The first step in the process is to suggest an overarching aim for the national adaptation policy: this aim can be aspirational and broad in scope. It presupposes a body of work that has identified the parameters of the policy area and the directions in which the government wishes to see progress. The greater the pre-existing body of evidence and experience in the area, the more likely is the initial definition of this aim to be both precise and practicable. All of the methods reviewed stress the importance of soundly evidence-based policy making. Subsequent steps do not require final agreement of this policy aim at the outset, since it may be clarified and refined later, on the basis of knowledge gained from the process.

### **Step 2 – Select priority sectors**

Effective adaptation requires co-operation between different organisations and across sectors, because both the impacts of climate change and potential adaptation actions may bring indirect “knock-on” effects in related areas. Development of adaptation policy requires integration of knowledge and experience across the board. However, the starting point is to consider individual sectors, since it is within sectors that concrete actions to adapt to specific impacts will be taken. This step in the policy development process therefore identifies priority sectors for adaptation action.

There are a number of considerations in choosing the sectors in which to focus initial activity. Criteria such as vulnerability of the sector, economic and social impact of the sector, potential for adaptation and temporal considerations can be used. Our approach to selecting these priority sectors is expanded in Section 4. Once the priority sectors have been selected, the analysis proceeds on a sectoral basis, though cross-sectoral dialogue is needed at later stages.

### **Step 3 – Characterise priority risks and opportunities**

This step brings into the process the evidence base on the impacts of climate change, including confidence levels, in the selected sectors. Here one can start to incorporate stakeholder definitions of acceptable risk in order to characterise the priority risks and opportunities in each sector. This step also enables any regional variations in the prioritisation of those risks and opportunities to be recognised. It promotes forward-looking policy development, consistent with the principles identified in Section 2.1.

Alongside information on climate change in the UK, it may be important in some sectors to consider the indirect effects of climate change elsewhere in the world (e.g. in changing global markets) if these are seen as constituting priority risks or opportunities. Assessments of impacts and risks at regional levels and in some sectors have been carried out through the UKCIP and other government-funded research programmes. Some UK government departments have published their own assessments of climate impacts. These sources embody previous stakeholder input, which, along with expert judgment, can be used to obtain a ranking of sectoral risks and opportunities.

Specific tasks in this step include:

- a. Identify the key impacts of climate change within the sector, based on existing studies.
- b. Identify risks and opportunities that these impacts will present.
- c. Compile an illustrative risk assessment: a simple exposure matrix will be developed indicating the magnitude of risks relative to others in the sector, their geographical extent and variation (e.g. are they confined to particular regions?), whether they will become a concern in the short, medium or long term (relative to planning horizons), and the lead stakeholders implicated.

#### **Step 4 – Propose adaptation objectives**

The aim of this step is to develop sectoral adaptation objectives that will address the priority risks (and opportunities) identified in step 3. Ideally the step would involve discussions with representative stakeholders, bringing to bear existing reviews and policy processes.

A range of possible objectives should be identified initially. As well as providing scope for discussion of cross-sectoral considerations and the wider sectoral policy context, the identification of a range also provides the means by which regional variations in level of risk and favoured policy approaches can be incorporated later.

The specific tasks include:

- a. Articulating a desired adaptation outcome in response to each of the risks / opportunities identified at Step 3.
- b. Proposing relatively extreme examples of objectives, to bracket a range of possible approaches to the outcome. This enables innovative thinking (as favoured by the principles). For example, one might propose a desired outcome of “reduced property damage from coastal flooding”, which could be met by outcome-based objectives such as:
  - Climate-proofing: To develop coastal defences robust enough to prevent coastal flooding for an extreme scenario of climate change.
  - Living with risk: To allow the coastline to adapt to changing environmental conditions without structural flood defences.
- c. Evaluate potential objectives according to existing sectoral policies and issues. The key policy frameworks and policy objectives for each sector should be screened according to whether or not they explicitly address climatic risks and adaptation, indirectly relate to climate change, or could be extended to plan for climate adaptation. The way in which lead stakeholders in the sector relate to national policy will also be considered. Objectives should build on existing sectoral policies, either to ‘mainstream’ climate change or to avoid conflicting policy goals, embracing the principle of joined-up policy making.
- d. Evaluate potential objectives with respect to cross-sectoral conflicts / synergies. Objectives / outcomes should also be weighed in terms of possible conflicts or synergies with policies in other sectors. Some objectives may be dependent on actions in other sectors. This reflects the principle of inclusive policy-making, and promotes consistency.
- e. Identify regional differences that will affect objectives. At this stage it is enough to identify those outcomes / objectives where regional variation may be important.
- f. Reduce initial suggestions to one or more possible adaptation objectives corresponding to each risk or group of risks in the sector (identifying where regional variation may need to be included). It may be possible to phrase the objective more flexibly where a range of options is still deemed important.

#### **Step 5a – Define targets**

At this stage, the sectoral adaptation objectives should be converted into a series of realistic and time-bound targets. The aim of this step is to break down the objective into tangible segments of effort. A range of techniques may be helpful in this. Ideally, stakeholder engagement is required in order to analyse acceptable levels of risk and (re)consider the definition of “successful adaptation”. Stakeholders will also need to advise on what is achievable in terms of cost, timescales and political will (in the light of international, national and regional landscapes).

One approach to developing targets is to try to identify all the problems associated with achieving an objective, and then to suggest possible solutions, which form the targets. Existing sectoral policies, issues, standards, guidance and research should be considered, as well as regional priorities and cross-sectoral issues. Indicative timeframes should be

attached to each target: NOW (by 2010), SOON (2010–2030), or LATER (2030–2050). These timescales ensure the policy is long-term and forward looking, in line with the principles.

This process of setting targets is also aligned with the UKCIP principle of using adaptive management to cope with uncertainty: this is a flexible approach which involves putting in place incremental adaptation options, rather than undertaking large-scale adaptation all at once. Later targets can be modified as new information becomes available, or as predictions of climate change become more or less certain. Flexibility was also emphasised in the UNEP guidance.

#### **Step 5b – Indicators**

This step draws largely from existing datasets used for monitoring. Criteria for choosing indicators include availability of data, consistency with national indicators, coverage of the range of exposure, and influence in promoting successful adaptation. While it may be possible to define complex indicators to measure some aspects of adaptation, it is preferable for indicators to be simple and easy to understand. Our approach starts by identifying a basket of indicators that taken together provide an indication of progress towards or away from adaptation in each sector. Another advantage of this approach is to link adaptation into monitoring that is underway at different levels and in different policy areas, thereby promoting the concept of mainstreaming. The issues associated with defining indicators for adaptation policy are explored in greater detail in Section 6.

#### **Step 6 – Identify adaptation options**

With a set of objectives and targets, it will be possible to identify a long list of the most suitable adaptation measures. Some of the measures will have already been considered and analysed in the adaptation evidence base. However, wide consultation at this point is advisable to capture novel approaches. Under its existing APF consultation process, Defra has already started to gather a large volume of information on adaptation measures from stakeholders in a number of sectors.

#### **Step 7 – Appraise options**

Consideration must now be given to the adaptation measures to produce a short-list of viable options. The relative costs of different options will play a major part in their attractiveness and considerable sectoral and economic expertise may be required to assess the costs and benefits. Responsibility for analysis may fall to government, but input from large private sector companies that will be affected by subsequent policies, particularly the utilities, will be crucial. At this point, some of the options will be ruled out because they are too costly. This is likely to affect views on risk and opportunities in step 3 and some of the objectives and/or targets in steps 4 and 5. For example, a proactive response to adaptation may be rejected on cost grounds and a decision made to live with the climate impacts. Thus it will be necessary to revisit earlier steps to make the appropriate modifications.

#### **Step 8 – Identify cross sectoral overlap and conflicts**

When a set of adaptation objectives, targets and options have been produced for all sectors, an identification of the effects of the proposed course of action of one sector on all the others will be required. This is essential to avoid adaptation-constrained outcomes or mal-adaptation, where benefits to one sector cause problems in another. Defra's APF consultation process will help to identify where overlaps and conflicts lie, but further discussion with sectors will also be required.

#### **Step 9 – Link up policy framework**

In this step, the sectoral objectives, targets and indicators should be presented clearly to show how they fit together under the overarching policy aim, indicating where regional variation is required. It will be necessary to make links to regional and local level objectives, targets and indicators as appropriate.

**Step 10 – Review and revise**

The time frame for the adaptation policy-setting process is long (potentially decades) and the results should be reviewed on a regular basis, with a new iteration instigated as appropriate. It may be necessary to revisit and restate the overarching national policy aim after the first iteration. However, subsequent iterations may not require all stages to be revisited. One of the aims of the review stage will be to identify how frequently particular stages will need to be revisited in order to develop long-term plans for future improvements.

**2.3 DEVELOPMENT AND APPLICATION IN THIS STUDY**

The principles and method presented in Sections 2.1 and 2.2 were developed and refined on the basis of a review of existing relevant material and the experience of applying the method during the course of the study. This experience is outlined here.

**2.3.1 Review of methods**

Many methods that could potentially be used for policy-setting have already been developed, of which some have been published and a lesser proportion put into practice. The review began with the most generic methodologies – those which could be applied to any policy-setting process – and ended with those methodologies that have been developed specifically for adaptation policy-setting. Whilst the latter are more relevant to climate change adaptation, the purpose of the review was to tap ideas that may not be picked up by the adaptation specific methodologies. The methodologies considered are summarised in Appendix III.

Each methodology was reviewed against a number of criteria (see Box 2). These criteria are based on key issues for adaptation that have been raised in the literature (see References) and in part on the project team's own experience. They provide a rationale for identifying the most valuable aspects of each methodology and summarising its overall value as an approach for adaptation policy setting.

**Box 2. Criteria for assessment of methodologies**

Does the methodology provide:

- Principles for effective policy setting?
- A robust framework that tackles all policy setting stages?
- A means for cross-sectoral integration of policies?
- An outward-looking approach?
- Tools for developing and utilising an effective knowledge base?
- A means for tackling institutional barriers within Government?
- A means for encouraging long-term thinking?
- Tools to handle uncertain outcomes?
- A means for developing targets and indicators?
- An inclusive approach that seeks the views of many stakeholders?

Methodologies that have been designed specifically for adaptation will naturally score higher than the more generic methodologies. However, they may be missing certain ideas or components that can be borrowed from elsewhere. The project team was open to the possibility of combining components of a number of different methodologies to produce the most effective approach.

There are key underlying differences in the analytical approach used for setting targets (or appraising options) within these general methods. There are different schools of thought, traditionally with the UK government favouring cost-benefit analysis and the EC favouring cost-effectiveness. Development literature tends to favour multi-criteria analysis, though there are strong differences in the degree of consultation. These different starting points affect the structure of the method reported. The reviews in Appendix III highlight the differences of the methodologies considered.

However, there are also a number of strong similarities. Several of the methods, particularly those proposed by RCEP (1998), UNDP (2005), EEA (1999) and UKCIP (2003) start with the identification of the problem, carry out an analysis to look at impacts and then set out strategic options in response. In general, they are circular and iterative. Some refer to a scientific evidence base and some use of decision criteria to rank and prioritise options for reducing impacts.

The methods provide approaches to policy-making, but do not outline a clear, pragmatic course of action for setting adaptation policies, for selecting targets and identifying suitable indicators by which to monitor progress. For this reason, the project team sought to develop a new method for adaptation policy setting.

### **2.3.2 Development of the method**

Informed by the various methods described, the project team identified a series of hypothetical steps for policy setting. Working through these in a linear fashion quickly revealed a number of problems. These and the project team's solutions are described below:

- It is difficult to make effective use of the diverse evidence base on adaptation. Scientific data are associated with varying degrees of uncertainty and it is easy to become bogged down in complex analyses that hinder progress. Nevertheless, the project team placed particular importance on the value of robust science to underpin adaptation policy, as emphasised in the RCEP (1998) report. Clearly, tools for utilising this evidence base are vital to ensuring that useful scientific results were taken into consideration. The project team believes that the risk-based approach advocated by UKCIP (2003) and also UNDP (2005) offers a sensible means of assessing and prioritising adaptation related information to begin the process of formulating policy objectives. A range of risk-based tools and techniques have been developed through UKCIP to facilitate this process.
- The decision-making process is highly interconnected, with some early stages in the process requiring information derived at later stages. For example, it is not realistic to appraise adaptation options without first identifying some policy objectives; yet the objectives depend substantially on the cost-effectiveness of the options. For this reason, the project team accepted that a circular, iterative process was most appropriate for resolving complex adaptation related issues. The team envisaged iterations for groups of activities, so that there may be more than one iterative circle.
- One of the challenges of responding to adaptation effectively is to keep the decision-making process moving in the face of uncertainty or lack of information. This became apparent at particular stages in the policy setting process. For example, with a wide range of potential objectives, setting targets became problematic, since the targets depended on the nature of the response to the objective and to available (or in many cases unavailable) indicators. The project

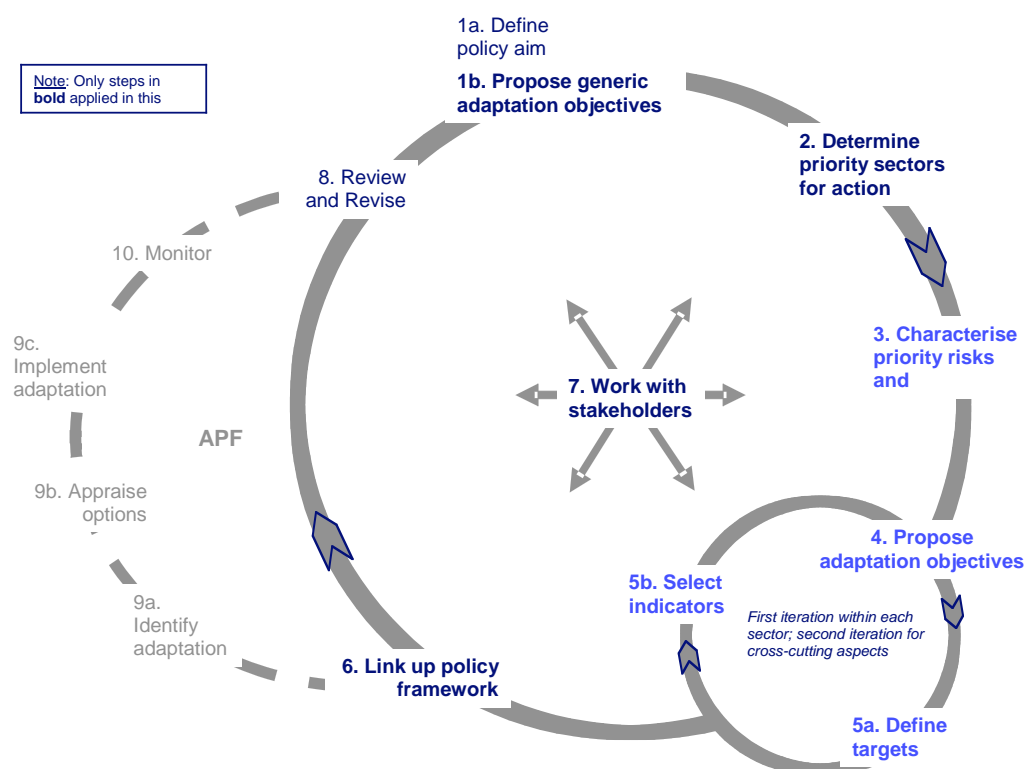
team's approach was to adopt process-based, rather than indicator-based targets. The process-based approach was essential to keep momentum, and to provide direction, whilst retaining the flexibility to improve at a later stage.

- Much of the material reviewed indicated that considerable stakeholder involvement is required for successful adaptation. However, involvement of all stakeholders at all stages is an inefficient use of resources. During the project, the project team used two different stakeholder groups: sectoral experts to inform sector-specific adaptation objectives and targets; and regional / local government experts to understand the issues surrounding practical implementation of policy and use of indicators at a local level. This separation worked well. A similar approach could be used at other stages in the process.

### 2.3.3 Application of the method

In the light of these findings, the method was refined. Further improvements were made after a team meeting with Defra ('brainstorming' note included in Appendix VIII). The method applied in the project is shown in Figure 3. It shows how key steps in the project could be tied to Defra's adaptation policy framework (APF) activities. Note that this method is orientated towards the requirements of the project.

Figure 3. Method used within the study





Sections 3 to 7 of this report describe the results of the application of this method.

At the end of the project, the method was reviewed in the light of our experiences with the six sectors. In response to requests from various stakeholders, the method was further revised to provide a framework outlining the possible roles and responsibilities of the organisations most likely to take the work forward. It is this generic method, presented in Section 2.2, that is proposed for future use.

## **2.4 STAKEHOLDERS FOR THIS STUDY**

Stakeholder consultation was a key element of the project. Two groups of stakeholders were interviewed:

- Experts in each of the six sectors, to help formulate the strawman objectives and targets; and
- Local and regional government and climate change partnership staff in two target regions (north west and south east), to help understand what indicators could be applied to these targets and the practicality of implementing adaptation policy on the ground.

The regional consultations were carried out as group discussions. The sectoral consultation was carried out in small groups where possible, although the short time frame for the project meant that in some cases individual interviews were necessary. A list of the stakeholders consulted is set out in Appendix VII.

The intention is for a workshop to be held on completion of the project to allow a much broader audience to consider the results, so that wider feedback on the proposed approach and strawman objectives may be incorporated.

### 3 Definition of the Policy Aim

The current study builds upon a wealth of climate change impacts assessments (and increasingly adaptation experience) in the UK, primarily carried out through the UK Climate Impacts Programme and other government research programmes. This evidence has led to the articulation of an overarching aim for UK adaptation policy, expressed as a strategic outcome of Defra's climate change and energy strategic priority<sup>1</sup>:

“The UK successfully adapting to unavoidable climate change”

Two key elements of this statement are the focus on “unavoidable” climate change, by which we may restrict ourselves, at least initially, to accepted scenarios of climate change over the 21st century such as UKCIP02, and the use of the descriptor “successfully”. This latter will require careful definition with reference to stakeholder frameworks of acceptable risk (see Box 3). The policy aim is taken to imply not only minimising the risks associated with climate change, but also maximising the benefits that may come from climate change.

#### Box 3. What is “successful adaptation”?

To start to address this fundamental question, the project team suggest that successful adaptation needs to make clear distinctions between different time-scales, levels of certainty, and costs. It should distinguish between *no regrets options*, justified by current climate conditions, and *low-regrets options*, made because of climate change but at minimal cost (i.e. cost-effective and proportionate<sup>2</sup>). Where greater uncertainty or longer time-frames are involved, or higher costs implied, then a more detailed analysis will be needed, using uncertainty and sensitivity analysis, to examine the costs and benefits of adaptation (such a detailed approach is beyond the remit of this study). Thus, as an initial approach to the adaptation planning process, we suggest that good adaptation could generally emerge from a three-tiered process:

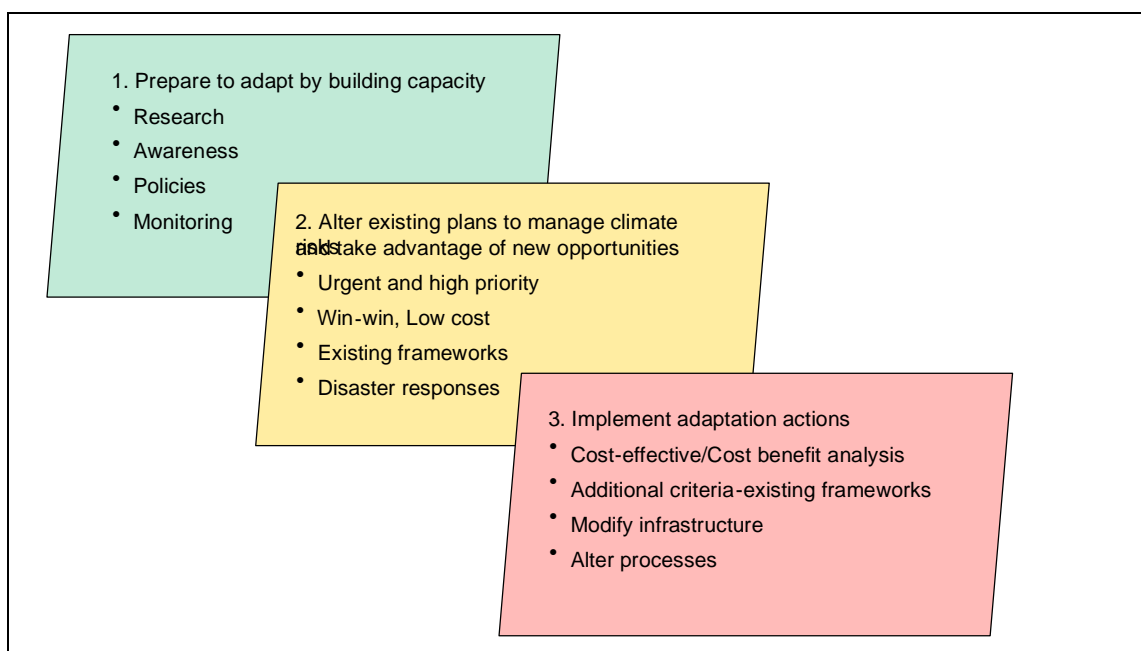
- Plans should initially focus on developing actions and building capacity (e.g. **raising awareness**), followed by
- Identification of **win-win or no regrets options** (prioritisation on low-cost or highly cost-effective actions);
- Then consider **other possible actions**, and investigate in detail looking at the costs and benefits of options, and considering how uncertainty might influence any decision.

Continuing the adaptation process involves implementing, monitoring, evaluating, improving and sustaining the initiatives launched by any adaptation project. In this context, uncertainty will be reduced as the research and evidence base is enlarged and as continued monitoring and re-evaluation occurs in the future.

(Continued overleaf)

<sup>1</sup> Defra's Strategic Priorities are set out in “Delivering the essentials of life: Defra's Five Year Strategy”, December 2004. Available on [www.defra.gov.uk](http://www.defra.gov.uk).

<sup>2</sup> Viewed from an economic perspective, the costs of adaptation responses should not be greater than the costs of the climate change impacts (that would occur in the absence of adaptation). Costs in both cases should be defined as societal costs including for example the costs associated with non-market sectors.



Definition of the policy aim is the first step in the method identified by the project team. However, the aim on its own provides little direction for subsequent objective setting. The project team therefore identified a set of generic objectives that classify the kinds of adaptations that the policy is intending to deliver. They indicate the breadth of activities that are correctly included within the concept of adaptation (see Table 2).

*Table 2. Generic adaptation objectives*

<b>Administrative</b>	To adapt policies and plans to reduce vulnerability to, and increase benefits from, the impacts of climate change
<b>Operational</b>	To introduce technical, structural or economic adjustments to reduce the negative effects of climate change on operations (including economic appraisals that consider potential impacts of climate change over the lifetime of the investment)
<b>Standards and regulation</b>	To adapt standards, regulations and guidance to include consideration of impacts from the changing climate
<b>Research and monitoring</b>	To support relevant research on the impacts of climate change and adaptation, and appropriate monitoring of effects
<b>Education and communications</b>	To raise awareness of the impacts of climate change and adaptation at all appropriate levels
<b>Stakeholder partnerships</b>	To work co-operatively across organisational, regional and sectoral boundaries to deliver robust adaptation

This step reflects both the RCEP (1998) guidance to formulate “policy aims” prior to detailed deliberation and the recommendation for generic adaptation objectives in the UNDP (2005) guide. Other areas of UK policy, such as transport, incorporate very broad objectives for national policy which are interpreted in detailed and specific ways at regional or local levels. These generic objectives provide common threads for the development of more detailed policy objectives and targets in different sectors and at different levels of government.

## 4 Selection of Priority Sectors

The aim of this section is to identify at least six priority sectors for which the project team will develop adaptation objectives, targets and indicators. This is an important task because it will effectively determine the sectors that can be explicitly addressed in future phases of the Adaptation Policy Framework. Consequently, it is desirable that this process of prioritisation has a clear and transparent basis. This section attempts to develop such a rationale.

### 4.1.1 Methodology

There are a number of potential criteria that may be used as a means of guiding the selection of priority sectors. Broadly, these may be characterised as the sectors' economic importance, and potential significance of climate impacts and adaptation measures in the sector in economic terms, the immediacy of potential climate change impacts, and the potential significance of the social and environmental consequences of climate impacts and adaptation responses within the sector. The choice of sectors, however, should also be clearly linked to stakeholders' representation.

On the basis of the potential changing patterns in future climate identified in UKCIP (2002), we first highlight a range of major sectors likely to be impacted, before applying more precise impact criteria and stakeholder selection criteria to refine the selection of priority sectors and specific organisations.

IHPC (2003) identifies the following broad sectors where there are major challenges from climate change:

- Management of water resources, including flood management
- Management of the built environment
- Management of coastal defences
- Management of agricultural production
- Management of infrastructure (including transport, communications and energy infrastructure)
- Management of forestry, fisheries and the marine environment.

Furthermore, UKCIP (2005) suggests that climate adaptation is likely to be a priority for those organisations that:

- Manage the consequences of present day variability in weather or climate
- Make decisions with long term consequences for land-use, built assets or population groups
- Are responsible for infrastructure and business areas that are sensitive to weather and climate
- Are responsible for contingency planning
- Put long term policies in place.

Primarily driven by consideration of such criteria within sectors, certain sectors' understanding of climate change impacts – and the associated need for adaptation – is reported to be more advanced (UKCIP (2005)). These sectors<sup>3</sup> include:

- built environment

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<sup>3</sup> Note that these sectors are not defined on a single basis (e.g. economic sectors) but reflect a wider range of concerns including climate change impact (buildings) and adaptation (flood & coastal defence) units

- water resources
- insurance (flood and coastal defence)
- transport
- energy
- agriculture
- biodiversity
- tourism.

Taking these findings into account, explicit criteria related to the potential significance of climate change impacts (to be mitigated by adaptation measures) can be used to further sort and prioritise sectors. These may include: economic significance; social significance (including vulnerability), environmental significance and temporality, i.e. whether adaptation is required immediately or over the longer term. These criteria are useful for policy priority determination in that they reflect the three pillars of sustainable development. We therefore accord these criteria some primacy in this prioritisation exercise. However, it should be noted that the distinctions between economic, social and environmental significance are not clear-cut; there is clear overlap between them, and, indeed, climate impacts in the sectors identified have social, environmental and economic consequences. Similarly, the temporal division is crude and indicative only.

The application of broad economic, social and environmental criteria in prioritising sectors for case studies within this project has been based purely on the judgement of project team members.

#### 4.1.2 Results: the priority sectors

Using the perceived priority sectors from UKCIP (2005) listed above, and applying these criteria we can identify a possible grouping of priority sectors (see Table 3).

Related work being undertaken for Defra on the economic significance of climate impacts in a range of sectors including those highlighted above supports this judgement (Metroeconomica, forthcoming).

For the purposes of this study, we have excluded biodiversity from subsequent analysis. This decision was based on practical considerations, including the fact that the cross-sectoral, pervasive nature of biodiversity necessarily makes discussion of adaptation extremely complex. As a result, representative stakeholder engagement of the type proposed below would be extremely difficult to bring about in a small-scale project such as this.

The built environment is also clearly an important climate impact sector. However, it is likely that the most significant potential climate impact upon buildings will be flooding. This issue is addressed to some extent in the flood and coastal management sector.

*Table 3: Sectoral prioritisation on the basis of economic, social, environmental and temporal criteria*

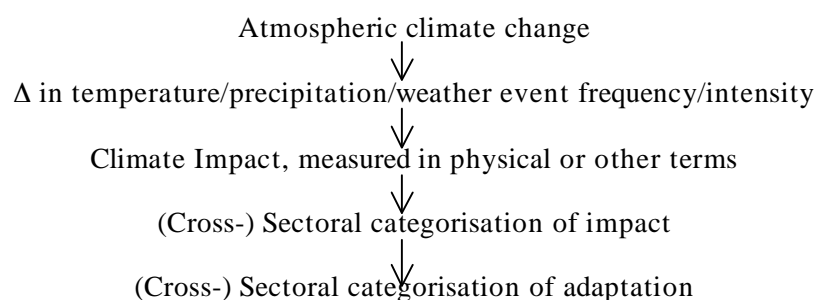
IMPACT	SECTOR
<b>High Economic Impact</b>	
Current	Transport infrastructure
Medium term	Agriculture
Long term	Tourism
<b>High Social Impact</b>	
Current	Water resources
Medium term	Energy
Long term	Flood and coastal risk management
<b>High Environmental Impact</b>	

Current	-
Medium term	Water resources
Long term	Biodiversity

Note: here we assume Medium term is to 2025 and Long term is 2025 onwards.

### 4.1.3 Possible refinements to impact-based criteria

One approach that can be taken to identify additional criteria with which to prioritise sectors is to characterise the climate impact/adaptation context as an impact pathway, as has been done previously in other environmental contexts (e.g. air pollution in the CAFE cost-benefit analysis). In this case, the impact pathway can be seen as:



Further criteria ancillary, and related, to these include:

- Those related to climate variables
  - prioritisation of those sectors that were impacted by one weather variable if, for example, the scientific certainty was thought to be greatest for that variable (mean or variability)
- Those related to impacts
  - whether the impact is cross-sectoral or not
  - geographical coverage of impacts
  - whether the sector(s) impacted have national strategic importance
- Those related to process/form of adaptation:
  - capital infrastructure-dominated sector (related to lifetime of investment where decisions are made now)

The criteria listed above may be evaluated in the first instance in the form of a matrix such as that outlined in Appendix VIII where the full activity/sector list compiled in UKCIP (2005) is provided. Whilst we suggest that those sectors identified in Table 4 are likely to be appropriate for the subsequent strawman testing within this project. The matrix presented in Appendix VIII may be used for cross-checking this preliminary conclusion. At present, it has only been completed in an indicative way for a small range of sectors. A full analysis – should it be deemed necessary – would require all rows to be filled, with supporting explanations for many entries.

### 4.1.4 Stakeholder-based criteria

Additional to the above criteria we need to consider how to ensure wide stakeholder coverage. This sub-section develops a simple matrix tool that can be applied subsequently in order to check that sectors selected according to the initial set of criteria also meet this requirement.

A key aim for Defra in adaptation policy setting is to be as inclusive as possible. Inclusiveness is desired in order to achieve two purposes; one is in order to involve as many key stakeholders as possible in order to build a platform of commitment for the framework, the other is in order to obtain a representative data sample to feed into the framework. On this basis it could be considered that there needs to be:

- Regional variation in stakeholders (north and south)
- Organisational type variation (private and public sector)
- Organisational level variation (national and local or regional)
- Attitudinal variation in stakeholders (high interest (awareness) / high influence and low interest (awareness) / high influence)

These stakeholder criteria can be mapped to the sectors identified above through the climate impact related criteria in order to see how well both sets of criteria are met (see Table 4). Since the classifications are not independent, explanatory notes would need to accompany cell entries. In the first instance, however, we have simply indicated how we feel the sectoral stakeholders are represented.

*Table 4. Matrix for identifying Stakeholder – Impact criteria compatibility*

I M P A C T			Geog. cover	Organisational level		Organisational type		Stakeholder attitude	
			Wide	Local	National	Private	Public	High influence / high interest	High influence / low interest
	<b>Economic</b>								
	Current	Transport infrastructure	√	√	√		√		√
		Energy	√		√	√		√	
	Medium term	<b>Agriculture</b>	√	√	√	√	√	√	
	Long term	Tourism	√	√	√	√	√		√
	<b>Social</b>								
	Current	Water resources	√	√	√	√		√	
	Medium term	Energy	√	√	√	√	√	√	
	Long term	Flood and coastal R.M.	√	√	√	√	√	√	

#### 4.1.5 Conclusions

In this section we have attempted to identify and apply a list of criteria that might be used to prioritise sectors in which to test the setting of indicators and objectives of adaptation policy. Using broadly defined criteria related to the possible economic, environmental and social consequences of climate change impacts, as well as their temporal incidence, combined with stakeholder-perceptions of priority sectors, we have made an initial identification of six sectors. Other impact-related criteria are also documented so that a complete range can be used to evaluate sectors. The appropriateness of the initially identified six sectors to stakeholder organisational coverage has also been tested against a further series of stakeholder-related criteria.

We therefore suggest that the case studies within this project are applied to the following sectors:

- Water resources
- Flood and coastal risk management
- Transport
- Tourism
- Agriculture
- Energy

## 5 Sectoral Strawman Objectives and Targets

This section sets out the method used to identify specific objectives and targets and the project results sector by sector. The **objectives** for adaptation are medium to long-term goals that are guided by the policy aim. The **targets** indicate how the objective might be achieved. Until specific sectoral objectives have been established, it is not possible to set targets (or indicators of their achievement).

Two issues need to be considered when translating objectives into targets:

- Targets are temporal: whereas objectives are broad goals, targets should be related to specific time frames. This temporal dimension is particularly relevant to climate change, which evolves from the present risk on the time frame of decades to centuries. The scheduling of adaptation strategies and actions should match the time frame when climate opportunities and risks become apparent, or intolerable. Not all potential adaptation actions need be put into place immediately. Conversely, we may not be able to foretell which strategies and measures will be most effective over a time frame of 20 to 50 years.
- Targets may be quantitative or categorical: a target of achieving reduced mortality due to heat waves might set a quantitative threshold (e.g., fewer than 1 person in 100,000). However, many targets are in the nature of a checklist—the existence of an early warning system and emergency preparedness plans for heat waves is a categorical target that might be essential to achieving the quantified target.

Indicators demonstrate progress towards a target. Targets and indicators are linked: targets should be chosen that can be achieved and where that achievement can be measured. If the indicators of achievement are too difficult to collate or interpret, it may be worth considering simpler targets. Indicators are discussed in more detail in Section 6.

### 5.1 THE METHOD IN PRACTICE

The method described in Section 2 explains the thinking behind the development of strawman objectives and targets can be developed. Here we describe the actual process in a number of steps:

1. A policy analysis was carried out, to set out the policy context of the sector concerned.
2. A climate risk analysis was carried out. Climate change impacts were drawn up and associated risks and opportunities identified. A risks-opportunities table was thus produced.
3. Those risks that are considered priorities are explored in more detail, with reference to their extent, magnitude and timeframe (and lead stakeholders). A risk assessment table was thus produced to help prioritise risks.
4. The priority risks are linked to a “desired outcome”, which could take several forms, depending on the emphasis of the sectoral policy. Various extreme options for objectives that achieve that outcome are then suggested. These were written down to stimulate thinking around the issue. Relevant policies and issues (sectoral, cross-sectoral and regional) are considered to see whether they support or exclude one or more of the possible objectives. In a few cases it was clear that only one option is possible, and this could then form the suggested objective in the list at the



end of the table. In other cases, the choice of objective depended upon further appraisal, and more than one objective was sometimes used in combination. In this situation, the suggested objective was phrased more flexibly, and was in some cases simply a rewording of the “desired outcome”. A table showing possible objectives was thus produced.

5. For each objective, the potential barriers to achieving it were considered. The following questions were posed to stimulate thought: What are the decisions needed? What are the obstacles envisaged? What are the dangers of proceeding? What are the constraints on strategy / options? What are the knowledge gaps? Who are the lead stakeholders?
6. The answers to these questions were used to suggest broad targets, associated with broad timeframes: NOW (by 2010), SOON (2010–2030) and LATER (beyond 2030). The targets were placed into the six different categories identified by the generic adaptation objectives suggested in Section 3 (Administrative, Operational, Standards & Regulation, Research & Monitoring, Education & Communications and Partnerships). These targets suggest “what” needs to be done to work towards the objective, but they do not define “how” each step is to be achieved: the detailed strategy at each stage is much better defined by experts with local knowledge and an appraisal of the various options available. The targets identified in this way are not specific and measurable in the traditional sense, but they represent a sensible starting point from which to refine “SMARTer” targets. They are process-based in that they map out a process leading towards an outcome, rather than quantifying the outcome itself. Targets were identified for a sample of the objectives in each sector.

This section shows the results only of steps 1, 2, 4 and 6 as described above. A large proportion of additional analysis has been completed, but is too lengthy to be included in the report. However, information on steps 2 and 3 (the climate impacts and risks tables) have been included in Appendix IV.

## **5.2 TRANSPORT**

### **5.2.1 Policy analysis**

The transport sector is largely controlled by government and public sector bodies, though responsibilities, for example for different parts of the road network, are in some cases delegated down to regional and local levels. In the context of this study, we have focused on the road and rail systems, but it is clear that water transport (particularly ports and ferries) and air transport will also face significant and unique pressures from climate change that will require adaptation of current systems and practices. For road transport, the location and type of new roads, in particular, is strongly influenced by regional planning policies and strategies, as well as transport strategies. For the rail sector, the picture is complex, with a balance of responsibility between the regulated industry (including the various train operating companies) and the centralised control and maintenance of infrastructure by Network Rail.

The Department for Transport’s Public Service Agreements set out some broad directions for transport policy that are relevant to adaptation. These include intentions such as improving punctuality and reliability of rail, improving safety and respecting the environment, making better use of existing road network, as well as cost-effectiveness. The Future of Transport White Paper sets out key policy priorities for the development of road and rail transport in the UK.

There are some important cross-sectoral links, including with biodiversity, with flood management, with water quality and with spatial planning. The need for accessible routes to be maintained at all times for emergency services is an additional constraint on the adaptation options available.

Since certain areas of road transport policy are a local level responsibility, there will be a strong need for regional priorities and local decision-making to be drawn in to the formulation of adaptation solutions. This may mean that objectives at the UK level should be worded flexibly enough to allow this to happen, or that different regions can assign different priority to some of the objectives, depending on the specifics of their situations.

### **5.2.2 Climate risk analysis**

The transport sector will face impacts from almost every aspect of climate change anticipated in the UK. Higher temperatures and more frequent extreme high temperatures have a range of effects on both road and rail infrastructure as materials are tested to their limits of durability. Reduced rainfall and drier summers is expected to mean that subsidence in areas of clay geology could become more of a problem, not only for buildings and road infrastructure but also for earthworks through desiccation. Wetter winters and more frequent episodes of intense rainfall increase risks of flooding, bringing disruption to travel on road and rail, and greater risk of accidents. Waterlogging reduces slope stability, potentially increasing risk of landslips and collapse of cuttings, embankments and other earthworks. Rising sea levels and increasing risks of storm surges increases the vulnerability of coastal roads and rail to flooding and damage. Some scenarios indicate a possible increase in storminess in the UK, and this brings risks of damage to overhead structures, for example transmission cables, signs or bridges. In the main, the most significant impacts on infrastructure will arise from extreme weather.

The scale of the risks to infrastructure very often is strongly linked to current maintenance. Network Rail have indicated that many of the problems faced by the rail network during the hot weather in August 2003 had more to do with general failures in management practices and monitoring at that time than with the weather conditions themselves. Significant changes have since been instigated, such as maintenance of the network being brought back “in house”. This means that in 2005, the risks to the rail sector from extreme hot weather were much lower, and if similar weather recurred, disruption to services is expected to be minimal, or even non-existent.

There will also be implications for maintenance of the soft estate across the road and rail networks. Longer growing seasons will affect decisions about management of verges, and there will be implications for biodiversity issues as changes in climate envelopes lead to migration of species along these “green corridors”. Alongside the physical impacts, climate change is also likely to affect demand for transport, and may lead to changes in preferred modes. A warmer drier summer climate could mean a greater diversity of modes used for daily commuting, and an increase in leisure travel. Apart from increased potential for more sustainable modes of transport such as walking and cycling, opportunities from climate change in the transport sector are largely centred on anticipated reductions in the cost of winter maintenance as winters become milder, and reduced disruption due to icy or snowy conditions.

There is significant potential for the transport system to adapt to average changes in climate and to reduce the risk of vulnerability to extreme events. The focus for adaptation will be to increase resilience, resistance and adaptive capacity of the transport infrastructure, including through improvements in coastal flood defences, increasing

drainage capacity along highways and railways, the use of more durable materials, and improvements in emergency and contingency planning.

### 5.2.3 Strawman objectives

Table 5 sets out the key climate risks and opportunities for road and rail that were considered in the study. Potential outcomes from adaptation, and illustrative examples of extreme objectives are indicated. Bearing in mind the sectoral, cross-sectoral and regional issues outlined in Table 5, we have proposed the strawman objectives in Box 4.

#### **Box 4. Strawman adaptation objectives for road and rail transport**

1. To improve stability of earthworks in wet weather
2. To develop appropriate solutions to combat increasing risk to infrastructure of subsidence
3. To reduce susceptibility of coastal routes to flooding
4. To improve performance of road network in extreme high temperatures
5. To improve drainage from transport networks during episodes of extreme/intense rainfall
6. To reduce disruption on transport networks from flooding
7. To improve rail track resilience under extreme high temperatures
8. To build greater flexibility into capacity of transport systems for weather-related demand changes

Solutions to achieve Objective 1 are likely to involve both aspects of “living with risk” in the short term, along with improved design and re-engineering in the longer term. Given current policy emphases on protecting and enhancing the environment, wholesale re-engineering of earthworks would seem inappropriate, although cost-effectiveness of different approaches will be important to determine the most appropriate portfolio of responses in each region. Changes in flood management, and water extraction regimes will affect the scale of risk to be addressed.

For Objective 2, a range of approaches will be possible; with some more appropriate in given situations than others. It may be possible to enhance insurance cover for some buildings. In some cases, early relocation of severely-affected infrastructure may be prudent and possible. For most cases, the solution will be budgeting for an increasing maintenance and repair bill. Where earthworks are increasingly susceptible to desiccation, improvements in engineering may be needed. Since the risk of subsidence is confined to areas with underlying clay geologies, this objective may only be relevant in some regions.

## Objective Setting for Climate Change Adaptation Policy

*Table 5. Transport sector: Using key risks/opportunities to identify desired outcomes and possible objectives*

<b>Risk</b>	<b>Desired adaptation outcome</b>	<b>Possible objectives</b>	<b>Sectoral issues</b>	<b>Cross-sectoral issues</b>	<b>Regional issues</b>
<b>Impaired stability of earthworks</b> and <b>increased risk of sudden failure</b> from higher winter rainfall and more frequent intense rainfall	Better stability of earthworks in wet weather [OR Fewer occurrences of earthwork failure]	<u>Climate-proof</u> : To re-engineer existing and new earthworks to prevent landslips in wet weather <u>Live with risk</u> : To improve speed and efficiency of earthwork repairs after landslips	DfT: improve punctuality and reliability of rail; improving safety and respecting environment; better use of existing road network; cost-effectiveness	Use of embankments, earthworks as green space, for biodiversity. Policy / operational decisions about flood protection, water storage, etc. Accessibility of remote areas for tourism.	SE Plan – Improve maintenance of existing system; increase accessibility; improve rural transport provision; enhance the environment
<b>Increased incidence of road /rail /buildings and earthworks subsidence</b> from reduced summer rainfall (and hotter summer temperatures?)	Better resilience of infrastructure to increasing subsidence [OR Less travel disruption related to subsidence]	<u>Climate-proof</u> : To upgrade infrastructure foundations and earthworks engineering to withstand subsidence <u>Avoid risk</u> : To relocate infrastructure away from subsidence-prone areas, remove street trees <u>Live with risk</u> : To improve efficiency and frequency of infrastructure and earthworks repairs following subsidence <u>Share risk</u> : To insure infrastructure?	FTWP: “get ever greater performance out of the road network through improved management” DfT: improve punctuality and reliability of rail	Insurance premiums may increase as weather-related damage increases. Community atmosphere affected if street trees removed.	SE Plan – To maintain existing infrastructure as an asset; develop road links to improve inter and intra-regional connectivity; local transport plans “to improve the maintenance of existing transport system”
<b>Increased flooding of coastal roads/rail</b> (routes impassable, damaged or lost) from sea level rise and more frequent storm surges	Less susceptibility of coastal routes to flooding [OR Less flood-related disruption to coastal travel]	<u>Climate-proof</u> : To improve coastal sea defences to withstand future SLR and surges <u>Avoid risk</u> : To relocate coastal routes further inland / uphill <u>Live with risk</u> : To improve	FTWP: improved safety on roads; improved management of road network; value for money from rail; improved reliability on rail; invest for greatest benefits.	Strongly influenced by regional/local flood and coastal erosion strategies; road/rail embankments double as coastal defences. Implications for coastal biodiversity of	SE Plan – To improve road and rail links along the south coast to improve spatial connectivity and realise economic opportunities; increase accessibility by public transport

# Objective Setting for Climate Change Adaptation Policy

Risk	Desired adaptation outcome	Possible objectives	Sectoral issues	Cross-sectoral issues	Regional issues
		maintenance and repair of coastal infrastructure.	DfT SD aim of integrating transport and land-use planning	different decisions.	
<b>Increased incidences of road surface deformation</b> under extreme summer high temperatures	Better performance of road surfaces at high temperatures [OR Less disruption to road travel in high temperatures OR Less road surface repair due to high temperatures]	<u>Climate-proof</u> : To resurface roads with high temperature resilient tarmac <u>Live with risk</u> : To improve speed and efficiency of road surface repairs during heatwaves	FTWP has an aim “get ever greater performance out of the road network”; keen to facilitate smarter individual choices about trips, link transport decisions to other issues, like new housing development, wise investment. DfT SD aim of integrating transport and land-use planning.	Reliable road network for new development. Freight transport for industry. Transport for sustainable tourism.	SE Plan – Growing concern about impact of transport on environment; rebalance away from car; maintaining existing transport infrastructure as an asset; improving road links in selected areas
<b>Insufficient drainage and culvert capacity</b> for more frequent intense rainfall	Greater drain / culvert capacity along road and rail networks [OR Better drainage from networks]	<u>Climate-proof</u> : To enlarge all drains and culverts to withstand future extreme rainfall <u>Live with risk</u> : To improve systems to divert traffic and trains around surface flooding	FTWP: “get ever greater performance out of the road network” DfT: improving safety DfT SD aim of integrating transport and land-use planning.	Increasing throughflow of drains/culverts puts greater pressure on system – managed by water companies. More rapid run-off from travel networks may increase pollution in watercourses?	SE Plan – Improve maintenance of existing system; develop road links in some areas; improvements in journey time reliability; increasing share of freight by rail
<b>Increased congestion at flooding hotspots and increased incidence of road/rail closure</b> from flooding, higher winter rainfall, more frequent intense rainfall	Less flooding on road/rail network [OR Less disruption to road/rail travel from flooding]	<u>Climate-proof</u> : To improve flood defences and drainage to protect networks from future flood <u>Live with risk</u> : To improve diversions and alternative routes around flooding hotspots	FTWP: improved safety on roads; improved management of road network; value for money from rail; improved reliability on rail. DfT SD aim of integrating transport and	Viability of different options strongly influenced by regional/local flood protection strategies. Maintain open routes for emergency services provision.	SE Plan – Develop road links in some areas; improvements in journey time reliability; increase accessibility; addressing identified bottlenecks

# Objective Setting for Climate Change Adaptation Policy

Risk	Desired adaptation outcome	Possible objectives	Sectoral issues	Cross-sectoral issues	Regional issues
			land-use planning.		
<b>Increased incidences of rail buckling</b> under extreme summer high temperatures	Better performance of track at high temperatures [OR Less disruption to rail travel in high temperatures OR Safer rail travel in high temperatures]	<u>Climate-proof</u> : To replace track with more resilient materials <u>Live with risk</u> : To restrict train speeds during heatwaves	FTWP focus on improving reliability of rail, efficiency, value for money, investment where it delivers benefit. Providing alternatives to the car. DfT policy to deliver modern, safe, reliable transport	Provision of transport for business and industry. Transport options for sustainable tourism.	SE Plan – Compatibility with Euro-network (ie fast, efficient); dependency on rail for commuting; rebalance away from car; improve transport links for growth areas, improvements in journey time reliability; increasing share of freight by rail.
<b>Changes in demand</b> (greater seasonality, modal shifts) from changes in average summer/winter weather	Greater flexibility in road/rail capacity	<u>Climate-proof</u> : To improve flexibility of all aspects of transport system to support weather-related changes in demand	FTWP: keen to facilitate smarter individual choices about trips (alternatives to car), increase walking and cycling. Tackling congestion	Health improvements from walking and cycling. Modal choice strongly influenced by patterns of spatial development.	SE Plan – rebalancing of the transport system in favour of non-car modes; improved and integrated network of public transport; increase walking and cycling

Objective 3 addresses increasing risks of coastal flooding and the most appropriate adaptation will depend strongly on local/regional flood management and coastal protection strategies. The solution(s) may involve some aspects of hard engineering, relocation and improved emergency repair, but the precise timing and balance of these options may be locally-determined. Some transport routes may justify higher expenditure on hard engineered flood defences than others, though the principles of improving rural accessibility and promoting sustainable transport for tourism will have some bearing.

Objective 4 focuses on the risks of damage to the road network from extreme high temperatures. There is a need to retain scope for flexibility in approach to achieving this objective, allowing appropriate decisions on whether materials are replaced or simply maintained and repaired more regularly to be made. These decisions may depend on whether the area wishes to promote or disincentivise car travel, on links with spatial planning policies and new developments.

Both road and rail networks are susceptible to increased overland flood risk if drainage systems are not improved. Given policy priorities to reduce travel disruption, the option of living with the risk of flooding during heavy rainfall is not really viable. Additionally, to improve safety particularly on roads the focus for this objective must be to prevent standing water on routes. So a major part of the solution for Objective 5 may be to use larger drains or culverts, but alternatives include inserting additional drains along routes, and softer sustainable drainage options such as run-off into green spaces could also be considered. It will be important to consider possible knock-on effects for wider flood management of increasing the run-off and drainage from transport networks. A co-operative approach involving stakeholders in other sectors is recommended.

Objective 6 is similar and connected to Objective 5, but the focus is on reducing travel disruption from flooding, rather than improving drainage from networks. This will be achieved through a combination of improved protection from flooding (i.e., defences), improved drainage, and improved contingency measures (diversions). The main aim of each of these actions should be to improve reliability, reduce journey times and congestion, and regional and local level decisions over the most appropriate balance of solutions is again important.. Longer term options should include spatial planning to avoid routes through flood-prone areas. A possible extension to this objective might be to specify a level of future flood risk against which all routes should be defended (for example, a 1 in 50 year flood event in 2050). However this overlaps very strongly with the objectives and policies in the flood management sector and may be best covered there.

Objective 7 addresses the risk of disruption to rail travel from very high temperatures. Although there were significant problems with the hot weather during August 2003, as has been mentioned, many of these are not expected to recur in Network Rail's new management and monitoring landscape. Improving rail track resilience to high temperatures fits with the high priority in transport policy to improve reliability and safety of rail travel, and improved track condition arguably promotes the use of rail in place of cars. Investment in such improvements could therefore bring additional benefits. A further consideration is the need to improve the UK's "gateway to Europe" by providing reliability and track conditions that match the best in North West Europe. In practical terms, this objective should be fairly easily achieved by factoring in improved specifications as rail is routinely replaced, since most rail track has a lifetime of only 20 to 30 years.

The impact of climate change on demand for transport is covered by Objective 8. At this stage, it is difficult to predict how climate may drive changes in demand, and further research is needed in this area. Adaptation options should contribute to transport policy aims to increase walking and cycling and provide smarter individual choices for trips, and should look to reduce congestion. The flexibility needed to cope with potential changes in demand will be required at all levels, from local transport planning upwards.

The proposed objectives have been developed to address particular risks from climate change. These objectives fall into the broad categories of network infrastructure impacts from extreme weather and by subsidence, and a range of climate effects on transport demand,

So it is possible to express three high level objectives for adaptation in the (road and rail) transport sector:

- To improve resilience of transport network infrastructure to future extreme weather conditions
- To improve resilience of transport network infrastructure to future subsidence risks
- To improve flexibility of transport system to meet changing modal demands in future climates

### 5.2.4 Targets

Illustrative targets for transport objectives 1 and 4 are provided in Table 6.

*Table 6. Transport sector targets*

*a) Targets for objective: to improve stability of earthworks in wet weather*

	<b>NOW</b> (<2010)	<b>SOON</b> (2010–2030)
<b>Administrative</b>	Consideration of climate change included in key policies & plans Contingency plans developed for re-routing when earthworks fail.	
<b>Operational</b>	Efficiency and standard of emergency repairs improved Flood defences improved in most vulnerable locations	New earthworks engineered to improved design
<b>Standards &amp; Regulation</b>		Revised design standards for earthworks
<b>Research &amp; Monitoring</b>	Damage to earthworks in wet weather monitored Causes of embankment instability researched	
<b>Education &amp; Comms</b>		
<b>Partnerships</b>	Cross-modal interest in earthwork design? transport – flood – water supported	



*b) Targets for objective: to improve performance of road network in extreme high temperatures*

	<b>NOW (&lt;2010)</b>	<b>SOON (2010–2030)</b>
<b>Administrative</b>	Climate change considered in key policies & plans Develop contingency plans for re-routing when road surfaces fail.	
<b>Operational</b>	Efficiency and standard of emergency repairs improved Surfacing materials upgraded during routine maintenance in selected areas	Improved materials used for road surfacing as standard
<b>Standards &amp; Regulation</b>	Procedures for imposing restrictions on road use during hot weather developed	Design standards for surfacing materials revised
<b>Research &amp; Monitoring</b>	Hot weather damage to road surfaces monitored New materials developed Heatwave forecasting improved	
<b>Education &amp; Comms</b>	Campaign to improve driving during heatwaves for greater safety and less road damage	
<b>Partnerships</b>	Partners, e.g. HA, LAs, research bodies? identified.	

## 5.3 ENERGY

### 5.3.1 Policy analysis

The policy lead for the energy sector falls mainly to the Department of Trade and Industry, though there is some responsibility within Defra given the strong links to climate change policy and sustainability. The Energy White Paper (EWP, 2003) defined a long-term strategic vision for energy policy combining environmental, security of supply, competitiveness and social goals. Because energy requires very long-term investment, the overall context is set by a look ahead to 2050. Key challenges facing the energy sector include not only environmental issues (particularly climate change) but also the decline of UK indigenous energy supplies and the need to update energy infrastructure. The EWP set out four goals for energy policy:

- cut carbon dioxide emissions (including the long term goal to put ourselves on a path to cut the UK's carbon dioxide emissions by some 60% by about 2050 with real progress by 2020)
- maintain reliable energy supplies
- promote competitive energy markets
- ensure homes are affordably heated

Alongside reporting on the EWP, Government has published UK energy sector indicators which are a set of detailed indicators to monitor annual progress towards the policy goals. These are grouped into key, supporting and background Indicators, and as well as monitoring annual progress towards EWP goals, they are designed to show the extent to which secure, diverse and sustainable supplies of energy to UK businesses and consumers, at competitive prices, are delivered.

Government has recently announced a new review of UK energy policy to bring forward policy proposals in 2006. The review will be broad in scope, including aspects of both

energy supply and demand and will focus on policy measures to help deliver objectives beyond 2010. The Review will aim to ensure the UK is on track to meet the goals of the EWP in the medium and long term. Policy proposals that come from this review will have a large impact on the sector, and issues such as changes to proposed mix of supplies to deliver UK energy (e.g., balance between nuclear, renewables and fossil fuel) will affect not only decisions about adaptation needs, but also the nature and priority of climate risks faced by the sector.

The sector is dominated by very large, generally multinational, energy companies. The energy delivery network is the responsibility of National Grid, which owns, operates and develops the high-voltage electricity transmission network in England and Wales and Great Britain's principal natural gas transportation system. As such, the key drivers and influences on the sector and its adaptive capacity stem from national level policy, global markets and innovation within the large companies. However, regional and local level influence on the energy sector is increasing and is likely to continue to do so with a move towards micro-generation and distributed electricity generation.

For this study we have focused on the electricity sector.

### **5.3.2 Climate risk analysis**

The energy sector will face impacts from climate change both directly through physical pressures on infrastructure and resources, and indirectly through changes in consumer demand. Higher temperatures and more frequent extreme high temperatures are likely to mean increased demand for electricity for air conditioning and space cooling, and may bring risks of damage or disruption to power transmission cables. Reduced rainfall and drier summers could mean reduced river flows for hydro-electric power (HEP) generation and reduced availability of water for power stations. Warmer winters are likely to mean reduced energy demand for space heating, and less cold weather damage (e.g. icing) to infrastructure. Wetter winters and more frequent episodes of intense rainfall increase risks of flooding, potentially bringing disruption to electricity distribution (e.g. if substations are flooded). More frequent landslips arising from waterlogged slopes may damage transmission infrastructure or affect HEP. Rising sea levels and increasing risks of storm surges increases the vulnerability of plants and infrastructure in vulnerable coastal locations. Some scenarios indicate a possible increase in storminess and higher winds in the UK, and this brings risks of damage to overhead transmission cables, and to wind turbines and the potential for significant power cuts.

Since many renewable sources of energy depend upon weather (e.g. wind power, production of biofuels), climate change may bring some benefits in these areas through longer growing seasons and increased potential for production at certain times of year.

The impacts of climate change on energy demand are difficult to quantify. However with an increase in summer air conditioning, and a decrease in winter space heating, there may be implications for the energy mix (electricity vs gas) and it is possible that the peak in demand may switch from winter to summer during the course of the century. This switch would have management implications since currently most maintenance is carried out during the quieter summer period.

Because an increasing proportion of UK energy is sourced from European and global markets, the impact of climate change at a global scale and in different parts of the world may have indirect consequences for the UK. However in this study we have focused on those impacts directly affecting UK energy demand and infrastructure.

Many of the adaptation challenges for the energy sector are aligned with current policy goals, particularly those to increase security of supply, and to increase use of renewables.

The focus for adaptation will be to increase resilience of electricity network infrastructure, and to increase flexibility of energy supply.

### 5.3.3 Strawman objectives

Table 7 sets out the key climate risks and opportunities for energy that were considered in the study. Potential outcomes from adaptation, and illustrative examples of extreme objectives are indicated. Bearing in mind the sectoral, cross-sectoral and regional issues outlined in Table 7, we have proposed the strawman objectives in Box 5.

#### **Box 5: Strawman adaptation objectives for energy sector**

1. To improve flexibility of energy supplies to cope with incremental climate-related demand changes
2. To improve flexibility of energy supplies to cope with sudden (extreme) weather-related demand changes
3. To increase electricity network resilience to more frequent storms and extreme high winds
4. To increase electricity network resilience to future flooding and landslips
5. To improve availability of water for generation processes under drier conditions
6. To reduce vulnerability of power generation equipment to high temperatures
7. To reduce vulnerability of energy transmission infrastructure to high temperatures
8. To reduce vulnerability of coastal energy infrastructure to sea-level rise and flooding
9. To increase energy production from weather-dependent renewable sources

Objectives 1 and 2 address the different challenges of both incremental climate change and changes in extreme weather for energy demand. A wide range of initiatives on both demand and supply sides could be used to build flexibility into the system, including through education and behaviour change, more distributed energy generation, and enhanced grid capacity. These kinds of activities align well with policies to enhance energy security.

Objective 3 focuses on the vulnerability of overhead transmission infrastructure to extreme weather. It is likely to involve improved management of potential wind damage from trees and proximal vegetation, but should also include improved responses to extreme events (contingency planning and repairs) and customer care and communication. Major energy infrastructure is vulnerable to flooding and landslips, with the potential for power cuts. Activities under Objective 4 may therefore involve enhanced flood defences, the possible relocation of infrastructure, and also improved responses to power cuts. Greater resilience might also be achieved by increasing diversity of energy supplies and using small-scale distributed generation.

## Objective Setting for Climate Change Adaptation Policy

*Table 7. Energy sector: Using key risks/opportunities to identify desired outcomes and possible objectives*

<b>Risk / Opportunity</b>	<b>Desired adaptation outcome</b>	<b>Possible objectives</b>	<b>Sectoral issues</b>	<b>Cross-sectoral issues</b>	<b>Regional issues</b>
<b>Fail to maintain supply to meet changes in demand</b> <ul style="list-style-type: none"> <li>▪ Annual average consumption by mode</li> <li>▪ Change in timing of peak electricity demand</li> </ul>	Greater flexibility in supply to meet both incremental and sudden demand changes linked to weather	<u>Climate-proof</u> : To increase available energy capacity in line with potential demand changes <u>Live with risk</u> : To improve contingency plans for energy restrictions and emergency energy provision at critical periods	EWP: maintain reliability of energy supply; enhance network resilience; investing in expanding Grid capacity; energy efficiency	Energy needs of new developments – building regulations, Code for Sustainable Buildings, etc.	Expect stronger peaks for air conditioning in the south-east and cities
<b>More frequent damage to overhead infrastructure from wind-blown debris and tree-fall due to higher wind speeds and more frequent winter storms</b>	Greater electricity network resilience to storms and high winds OR Improved speed of repair to damaged infrastructure	<u>Climate-proof</u> : To remove all proximal tree/vegetation hazards OR <u>Live with risk</u> : To improve contingency plans for emergency network repair	EWP: maintain reliability of energy supply; enhance network resilience	Biodiversity / quality of local environment conflicts with wholesale clearance of potentially dangerous trees	Maximum wind gusts can be located in any region.
<b>More frequent power cuts due to flooding of substations and underground transmission infrastructure from higher winter rainfall and more frequent intense rainfall</b>	Less flooding of electricity infrastructure OR More secure transmission and distribution of electricity under extreme rainfall conditions	<u>Climate-proof</u> : To protect vulnerable electricity infrastructure from future flood risks <u>Live with risk</u> : To improve speed and efficiency of repairs to electricity infrastructure after flood events	EWP: maintain reliability of energy supply; enhance network resilience	Strongly influenced by national and regional flood management policies and strategies	Eastern Scotland, northern, eastern and south-eastern England most affected
<b>Generation capacity of power stations constrained by low water availability due to decreased summer rainfall</b>	Greater security of water supply for power generation during low rainfall periods	<u>Climate-proof</u> : To invest in additional water resources to cope with dry periods <u>Live with risk</u> : To increase energy from alternative sources for water-constrained periods <u>Reduce risk</u> : To improve	EWP: maintain reliability of energy supply; increase diversity of energy supplies; promote small-scale distributed electricity generation	Regional water resource plans and abstraction licences	Mainly an issue in the south-east, south-west and West Midlands

# Objective Setting for Climate Change Adaptation Policy

Risk / Opportunity	Desired adaptation outcome	Possible objectives	Sectoral issues	Cross-sectoral issues	Regional issues
		water efficiency of processes			
<b>More frequent damage to power generation equipment</b> from extreme summer high temperatures	Greater resilience of generation equipment to high temperatures	<u>Climate-proof</u> : To replace vulnerable equipment and buildings with more resilient designs <u>Live with risk</u> : To improve cooling of equipment	EWP: maintain reliability of energy supply; increase diversity of energy supplies; promote small-scale distributed electricity generation	Extent of impact determined to a large extent by demand and hence energy efficiency in industrial and domestic sectors	Mainly an issue for the south-east
<b>More frequent damage to transmission infrastructure</b> from extreme summer high temperatures	More secure transmission and distribution of electricity under extreme high temperature conditions	<u>Climate-proof</u> : To increase resilience of transmission networks to extreme high temperatures <u>Live with risk</u> : To improve speed and efficiency of repairs to transmission infrastructure	EWP: maintain reliability of energy supply; enhance network resilience		Mainly an issue for the south-east
<b>Increased flooding of coastal plants / infrastructure</b> (causing increased damage) from sea level rise and more frequent storm surges	Less flooding of coastal energy infrastructure OR Improved resilience of energy infrastructure to SLR impacts	<u>Climate-proof</u> : To defend vulnerable plant and infrastructure from future coastal flooding <u>Live with risk</u> : To improve speed and efficiency of repairs to infrastructure after flooding	EWP: maintain reliability of energy supply; enhance network resilience	Strongly influenced by national and regional flood management and coastal erosion policies and strategies	
<b>Increased potential for energy generation from renewable sources</b> (biofuels, HEP, wind, wave/tidal) from changes in climate	More production of energy from renewable sources	To increase production of energy from weather-dependant renewable sources.	EWP: cutting carbon emissions; increasing renewables capacity	Implications / opportunities for UK agriculture. Biodiversity / conservation issues associated with wind and wave power	Different regions experience different conditions for renewable generation – HEP in Wales and Scotland, biofuels linked to agricultural regions.

In some parts of the UK, climate change is likely to mean significant issue for water supply. As large consumers of water, energy plants in vulnerable regions may face restrictions. Actions under Objective 5 might involve improving water efficiency of processes, making arrangements with water companies, contingency planning, and increasing the diversity of energy portfolio to reduce the potential impact of water shortages.

Objectives 6 and 7 address the problems that high temperatures may pose for generating equipment and infrastructure. Solutions might include considering new cooling systems, new designs and materials, improved repair and maintenance of affected components and areas. Additionally, vulnerability to impacts on transmission infrastructure could be reduced by increasing energy diversity and using small-scale distributed generation.

For power stations and other infrastructure located on the coast, sea-level rise and increased threats from storm surges may present risks. Objective 8 could involve a range of actions, from enhanced flood defences, to longer-term plans for location of new plants and relocation of infrastructure, as well as contingency planning and improved response to power cuts.

Objective 9 focuses on some of the opportunities that climate change may bring for renewables. There will be a need to factor trends in climate into energy projections, cost-benefit analysis and impact assessments, and to develop longer term plans for areas/regions that become more or less favourable (e.g. for short rotation coppice).

The proposed objectives have been developed to address particular risks from climate change. These objectives fall into the broad categories of supply and demand issues, network resilience to extreme weather and impacts from climate for renewable sources that depend on weather.

So it is possible to express three high level objectives for adaptation in the energy sector:

- To improve security of supply to meet changing energy demands in future climates
- To improve electricity network resilience to future extreme weather conditions
- To take advantage of opportunities from climate change for energy production from weather-dependent renewable sources.

### 5.3.4 Targets

Illustrative targets for one of the energy objectives is provided in Table 8.

*Table 8. Targets for objective: to increase electricity network resilience to more frequent storms and extreme high winds*

	<b>NOW</b> (<2010)	<b>SOON</b> (2010–2030)	<b>LATER</b> (>2030)
<b>Administrative</b>	Climate change considered in long-term security forecasts		
<b>Operational</b>	Contingency plans for storm repairs improved Existing guidance on tree management enforced	New guidance on vegetation management	Increased proportion of supply from distributed generation At-risk o/h cables moved underground
<b>Standards &amp; Regulation</b>		More resilient infrastructure design introduced	
<b>Research &amp; Monitoring</b>	More resilient materials and network design developed Projections of future storms / wind improved		
<b>Education &amp; Comms</b>	Procedures for customer communication in case of extreme events improved	Officers trained on new standards for vegetation management	
<b>Partnerships</b>	Partnerships established with Met Office / NGT / DTI for planning; and NGT-DNOs-BT-media for extreme event communication		

## 5.4 WATER

### 5.4.1 Policy analysis

The policy frameworks for water planning in the UK are well articulated, although they do evolve over time (a sign of adaptive capacity). Three processes frame how climate change adaptation might be further developed. The EU Water Framework Directive sets an over-arching water policy, with a particular emphasis on catchment/basin planning, stakeholder participation and environmental concerns. The WFD does not include specific guidance on climate change at this point, but its implementation in member states is flexible (a working party on agriculture and climate change is underway). The Environment Agency leads on concerns for resource availability, abstraction and environmental quality. The Office of Water Regulation (Ofwat) periodically reviews water company plans for water pricing and investment, and other matters related to economic performance. The Government (Defra) lead on policy, spanning both the environmental and economic regulation. These stakeholders have the key responsibilities for managing current and future climatic risks.

### 5.4.2 Climate risk analysis and management decision making

Two clusters of concerns from a water management perspective are water resources (supply and demand) and water quality and environmental planning including sewage treatment. The management decisions related to each cluster and their exposure to climatic risks are shown in Tables 9 and 10. The main climatic risks are related to the combination of warmer temperature and longer seasons (with increased demand for irrigation) and long term drought during the winter recharge period. Floods affecting water infrastructure are also important.

*Table 9: Water management clusters*

	<b>Water resources</b>	<b>Water quality &amp; sewage treatment</b>
<b>Issue</b>	Balancing supply and demand.	Pollution of rivers and lakes (and to some extent groundwater) due to flooding and intense storms that overwhelm combined sewers (sewage and storm drains) or treatment works.
<b>Management decision making</b>	Abstraction permits from EA; Economic investment allowed by Ofwat; Company resource plans; Operational decisions, including drought plans; Requests for drought orders such as hose pipe bans; Setting level of service standards Investment in leakage control and metering; Setting environmental standards, affects abstraction permits.	Investment in new sewers and treatment works; Operational management during a flood; Setting of environmental standards Catchment land cover management.
<b>Climate drivers</b>	Increasing mean temperatures, longer growing season (irrigated horticulture as well as gardens); Shorter recharge period Shift in seasonal resource patterns with drier summers and wetter winters (catchment yield, balance of rainfall and evapotranspiration): might alter abstraction permits; Hot summers and peak demand Burst pipes with more shrink-swell or frost-warm cycles; Outage due to flooding, storms; Sea level rise, tidal range and salt water intrusion affecting abstraction; Increased seasonal and inter-annual climate variability; increased risk for long term droughts.	Warmer temperatures lowers dissolved oxygen, increases incidence of algal blooms, requires more frequent cleaning of sand filters; Intense rainfall and storm runoff adds nitrogen and other pollutants, included sewage overflow Increased volume of water at peak times (mostly storm rather than household or industrial use) Coastal and riverine flooding affecting treatment works; Altered freshwater and marine ecology may change environmental status and standards.



Table 10. Synthesis of risks and opportunities

Expected climate change (& confidence)	Impact on water	Risk	Opportunity
Increasing summer temperatures (high)	Longer growing season, more irrigation of gardens	Increased peak summer water demand Reduced water quality	Higher value placed on water for recreation
Increased frequency of extreme high temperatures (high)	Increase heat stress and demand for water: consumption of drinks, cooling, water features; livestock	Increased peak summer demand	
Increasing winter temperatures (high); Fewer frost days (high)	Longer growing season, more warm-cold cycles	Possible increase in pipe burst Longer irrigation season, including double cropping	Reduced frost damage
Reduced snowfall (high)	Small effect in UK, some local changes in hydrology	Higher variability in surface water in some places	
Increased winter precipitation (high)	Riverine flooding; groundwater recharge might change	Changes in groundwater recharge regime Soil erosion and water quality effects	Increased groundwater recharge
More frequent intense rainfall (high)	Increase in soil erosion and runoff; overflowing of sewage system	Degradation of water quality	
Decreased summer precipitation (medium)	Shorter recharge season; reduced water supply; higher dependence on winter storage	Increased risk of water shortages Need for greater storage infrastructure	
Sea-level rise (high); increased frequency of extreme SL / high tides (high)	Increase risk of flooding and erosion; Increased saline intrusion	Interruption of services; change in abstraction points	
Increased frequency of winter deep depressions (low)	Higher winds; wind-related damage to infrastructure; more frequent stormy conditions	Flash flood risk increases Physical damage to infrastructure	
Changes in seasonality	Increased variability	Increase risk of shortages	

### 5.4.3 Strawman objectives and targets

Table 11 sets out the key climate risks and opportunities for the water sector that were considered in the study. Potential outcomes from adaptation, and illustrative examples of extreme objectives are indicated. Bearing in mind the sectoral, cross-sectoral and regional issues outlined in Table 11, we have proposed the strawman objectives in Box 6.

## Objective Setting for Climate Change Adaptation Policy

*Table 11. Water sector: Using key risks/opportunities to identify desired outcomes and possible objectives*

<b>Risk</b>	<b>Desired adaptation outcome</b>	<b>Climate proofing through engineering</b>	<b>Climate resilience through mixed approach</b>	<b>Pursue minimal resilience through existing policies</b>	<b>Working objectives</b>	<b>Issues: sectoral, cross sectoral and regional</b>
Increased demand and variability in supply (and in some places decreased supply)	Manage supply/demand balance to satisfaction of all uses/users, while protecting the environment	Maintain supply sufficient to meet projected demand by massive increases in engineered infrastructure, without imposing bans on use (e.g., national grid, desalinisation, limited irrigation from PWS)	Increase robustness of existing infrastructure and regulation to use water more wisely through significant increases in demand regulation (e.g., spatial planning, dual use systems, garden design)	Continue with present incremental regulation and adjusting the baseline as climate changes	Manage supply demand balance by increasing efficient use of water for domestic, industrial and agricultural purposes, accepting a reasonable level or risk	Balance between environmental services and abstraction Willingness to accept altered levels of service Role of pricing in limiting average and peak demand Competition and markets for water use in industry and agriculture Irrigation for agriculture from PWS increasing for horticulture Integration of water grid Availability of information at post-code and local authority level Southern vs northern different risks
Pollution from intense rainfall and flooding caused by overflow of storm drains and sewage treatment works, as well as catchment runoff	Maintain environmental quality to acceptable standards by limiting pollution from flooding	Re-engineer all sewage infrastructure to higher standards of protection and storage to prevent pollution from a design risk (say 1 in 200 year event)	(less clear that a demand management approach is appropriate)	Maintain existing systems but reduce environmental restrictions to allow more frequent discharges and lower water quality; modify environmental standards to match altered water regimes of the future (lower flows, seasonality)	Reduce flood risks by placing new treatment works in safer locations, protecting high priority works, increasing storage and implementation of the WFD catchment management plans	Cost of new and protected infrastructure needs to be assessed, who pays and how? Pollution affects recreational use and tourism Energy costs of pumping sewage if not gravity fed Dilution flows are lower in south but flooding is a risk in most places

**Box 6. Strawman adaptation objectives for water**

1. Manage supply demand balance by increasing efficient use of water for domestic, industrial and agricultural purposes, accepting a reasonable level of risk
2. Reduce flood risks by placing new treatment works in safer locations, protecting high priority works, increasing storage and implementation of the WFD catchment management plans.

The working objectives described represent the middle ground that the three expert water sector stakeholders agreed should be pursued. For water supply/demand balance, two high cost options are possible, one relying on costly infrastructure and the other on social changes and a mix of demand management, leakage control and least-cost supply enhancement. The minimal response is to continue the present management regime; after all water is a sector based on climate risk management. For water quality and sewage a demand management option is not possible (or not judged effective).

The main sectoral issues are:

- Cost of investment and who will pay and who will benefit? The existing economic regulation allows water companies to charge rates deemed adequate to cover essential infrastructure, with operational targets for metering, leakage control, headroom, etc. One option, to price water at marginal values especially during a crisis, would yield significant income to water companies, and this was not judged to be desirable. Although we talked about other financial mechanisms—an industry-wide insurance/adaptation fund for instance—they did not seem easy to implement or necessary at present.
- What are desirable environmental standards of the future? With major changes in seasonal water regimes, the current species and uses of water may not be appropriate in the future. A logical outcome would be to plan on adjusting environmental standards. However, this is likely to accelerate impacts on biodiversity, especially for species struggling to maintain populations under added stresses.
- Implementation of the European Water Framework Directive will promote many of the adaptation strategies that were deemed necessary—catchment planning, stakeholder participation, etc. The WFD is only beginning to have an effect in the UK. However, climate change adaptation is not a primary target in the WFD.
- Agriculture, especially horticulture, is increasingly using the public water supply (PWS) for high value crops, often as part of management agreements with supermarkets. The trade-offs between domestic/industrial and agricultural use will need to be addressed, particularly in times of shortage.
- Drought contingency plans are in place for all of the water companies. However, it is not clear whether these will be adequate if drought becomes a common occurrence or lasts for periods longer than a couple of years. Most of the plans are not tested against recent drought experience.
- Large users may have significant scope for reducing demand. Some have contracts that allow interruptions to their water supply. However, the industry norm is supply all water as demanded and not rely on restrictions (which incur modest economic penalties). A change in risk perception and sharing of the consequences of shortages may be required in the future.

### 5.4.4 Targets

The time scale for almost all of the targets was the next 10 years. These objectives and targets were based on an acceleration of existing management regimes, so this time frame was judged necessary to manage the changing risks and achievable. The targets tended to be qualitative—a change in direction of the trend, a stabilisation of use, an added emphasis (see Table 12). These could be translated into quantitative targets, but this would require a specific regional approach. The project team was undecided how specific the regional targets would need to be—some would apply to the river basin (and water company), some would need to be implemented at a local community/postcode level, and some are very site specific (e.g., protection of key treatment works). Targeting the process of planning such risk measures would be more important than guidelines for each exposure (in our view).

*Table 12. Water sector targets*

*a). Targets for objective: to manage supply demand balance by increasing efficient use of water for domestic, industrial and agricultural purposes, accepting a reasonable level or risk*

	<b>NOW</b> (by 2010-2015)	<b>SOON</b> (after 2015)
<b>Policies &amp; Plans</b>	Majority of water use metered Rising block tariffs applied Interruptible water supply licences for large users increased Water conservation encouraged	Step pricing (large increases during a shortage) developed to limit peak demand
<b>Operational</b>	Water into supply (WIS) stabilised, letting water companies apply a balance of leakage control, altered abstraction and demand management Stable demand (at current levels?) by 2015	
<b>Standards &amp; Regulation</b>	Penalties removed for using drought orders and hosepipe bans, encourage their use as an operational tool in managing risks	
<b>Research &amp; Monitoring</b>	Innovation by water companies, rather than micro-management of all users, assisted.	
<b>Education &amp; Comms</b>	Awareness of water conservation raised Support gained for consumers sharing risk of shortages (target=70% of population) Awareness and acceptance of a 'acceptable risk management' culture among stakeholders Information included on water bills, such as carbon footprint Users to calculate their per capita consumption using on-line wizards and brochures	
<b>Partnerships</b>	Nothing suggested: continued regulatory framework presumed	

*b) Targets for objective: to reduce flood risks by placing new treatment works in safer locations, protecting high priority works, increasing storage and implementation of the WFD catchment management plans*

	<b>NOW</b> (by 2010-2015)	<b>SOON</b> (after 2015)
<b>Policies &amp; Plans</b>	Identify priority works for flood protection; working guidelines for acceptable risk and protection measures Integration into sustainable development framework and indicators Plans for flood emergencies, restoration of service Sewage network planning (as for water resources) including links to water quality and flood management	
<b>Operational</b>	New works are located in safe areas, or protected Primary treatment and filtering of storm flows Increased storage capacity, at treatment works and within the drainage system Restrictions on releases during low flows	
<b>Standards &amp; Regulation</b>	Increased adoption of sustainable urban drainage (SUDS) including retention ponds, soakaways Buffering strips for agriculture and other catchment regulations (WFD)	
<b>Research &amp; Monitoring</b>	Nothing suggested: measures are available	
<b>Education &amp; Comms</b>	Awareness of flood and sewage risk among homeowners	
<b>Partnerships</b>	Nothing suggested: Continued regulatory framework presumed	

## 5.5 FLOOD AND COASTAL RISK MANAGEMENT

### 5.5.1 Policy analysis

Flood Management in the UK is undertaken primarily by the Environment Agency, though Defra has overall responsibility for its provision. In Defra's Business Planning it has a strategic priority to "ensure that risk from flooding and coastal erosion is managed in a way which furthers sustainable development". The 2005 – 2008 Spending Review sets a target thus: Defra will manage flood and coastal erosion risk so as to contribute to sustainable development, including minimising loss of life and improving the standard of protection for at least 100,000 households using efficiency savings to maintain outputs at equivalent levels to 2005-6. The recently published "Making Space for Water" outlines a more holistic approach to flood management than the historical emphasis on "hard" flood defence schemes. Climate change is likely to further exacerbate the extent of many current risks, particularly through higher projected winter rainfall amounts, more intense rainfall episodes, and through sea level rise.

### 5.5.2 Climate risk analysis

Under climate scenarios, changing patterns of rainfall are projected, such that winter rainfall will increase, summer rainfall will diminish, though generally there are likely to be more extreme precipitation events. The chief consequence of these events is that there is an increased likelihood of riverine and urban flooding. There may therefore be an increase in associated impacts on built structures (e.g. buildings, transport infrastructure), agricultural production, transport flows, health and habitat. For example, the projected increased frequency of intense rainfall will increase the likelihood of flash-flooding, possibly leading to landslides and damage to built structures. Drainage systems may be overwhelmed, with the possibility of untreated sewage entering sea and resulting adverse effects on marine life. It should be borne in mind, however, that projected higher mean temperatures will lead to less snow-melt flooding and so less damage to those same impact categories.

In coastal areas, the main – most likely - risk from flooding is likely to be from sea level rise which will be associated with gradual coastal inundation and increased frequency of extreme tidal movements. Consequently, there is likely to be greater coastal erosion and an increased risk of flooding at coastal and estuarine sites, with associated threat of damage to built structures and degradation of coastal recreational resources (e.g. beaches, cliff walks).

Climate scenarios project increases in wind speeds in southern regions, though with lower levels of certainty. A consequence may be increased wave magnitudes and resulting risks of coastal flooding and erosion and storm damage to buildings and infrastructure. Storm surges may also increase in frequency and intensity, with resulting saltwater intrusion and damage to property and the natural environment.

For more detailed information on the impacts of climate change related to flooding, and the economic costs of damage, readers are referred to the Foresight Future Flooding report that was released in 2004 by the Department of Trade and Industry (DTI).

### **5.5.3 Strawman objectives**

Table 13 sets out the key climate risks and opportunities for tourism that were considered in the study. Bearing in mind the sectoral, cross-sectoral and regional issues outlined in the Table 13, we have proposed the strawman objectives in Box 7.

The four objectives listed are derived directly from consideration of the climate change risks and opportunities. That is, possible adaptation objectives were initially framed in terms of two radically contrasting approaches relating to i) total climate proofing, and ii) living with the risk. These objectives were considered in the real-world context of current sectoral policy objectives in order to derive an objective that was likely to be acceptable to stakeholders. These objectives were then discussed with the sectoral stakeholders and rejected or modified as appropriate.

The four objectives associated with flood management and coastal defence adopt a common structure, reflecting the current emphasis in strategic and operational thinking within the sector of a more holistic philosophy. Thus, the acceptable level of risks and impacts are framed in terms of those that are acceptable in relation to their economic, social and environmental consequences. The explicit reference to climate scenarios is therefore the only distinction between these climate adaptation objectives and those that are currently promoted for the sector.

## Objective Setting for Climate Change Adaptation Policy

*Table 13. Flood and coast risk management sector: Using key risks/opportunities to identify desired outcomes and possible objectives*

<b>Risk</b>	<b>Desired adaptation outcome</b>	<b>Possible objectives</b>	<b>Sectoral issues</b>	<b>Cross-sectoral issues</b>	<b>Regional issues</b>
Riverine flooding Damage to: built structures (e.g. buildings, transport infrastructure); agricultural production; transport flows; health habitat	Reduced riverine flood risk	<u>Climate proof:</u> To develop riverine flood defences to a standard of preventing flooding from a specific probability rainfall event  <u>Live with risk:</u> To organise managed retreat from riverine flood plains	MSFW: Take action to ensure adaptability to CC becomes an integral part of all flood management decisions. MSFW: Adopt a whole catchment approach consistent with, and contributing to implementation of the Water Framework Directive	Riverine Flooding impacts are cross-sectoral e.g. domestic & business property; transport; health; agriculture. Therefore requires wide stakeholder consultation	Issues specific to regional land use patterns
Urban flooding – urban drainage overflow Damage to: built structures (e.g. buildings, transport infrastructure); transport flows; health habitat	Reduced urban flood risk	<u>Climate proof:</u> To develop sustainable urban drainage systems (SUDS) to a standard of a specific probability rainfall event  <u>Live with risk:</u> To discourage new development on land currently vulnerable to urban flooding	MSFW: Take action to ensure adaptability to CC becomes an integral part of all flood management decisions. MSFW: Adopt a whole catchment approach consistent with, and contributing to implementation of the Water Framework Directive	Urban drainage flooding impacts are cross-sectoral e.g. domestic & business property; transport; health. Therefore requires wide stakeholder consultation	Regional issues may relate to specific urban landscape features
Sea level rise: Loss of habitats & other coastal resources from, and disruption to, coast-based services, including erosion	Minimise damage to coastal-based resources	<u>Climate proof:</u> To develop coastal defences to a standard that prevents any further sea level inundation <u>Live with risk:</u> To organise managed retreat from coastal zones	MSFW: Take action to ensure adaptability to CC becomes an integral part of all coastal erosion management decisions. MSFW: Adopt a whole shoreline approach consistent with, and	Cross sectoral in nature: threat to range of coastal zone resources and activities. Therefore requires wide stakeholder consultation	

# Objective Setting for Climate Change Adaptation Policy

Risk	Desired adaptation outcome	Possible objectives	Sectoral issues	Cross-sectoral issues	Regional issues
			contributing to implementation of the Water Framework Directive		
Storm surges: flood damage to property; disruption of transport etc.	Protect coastal assets and minimise disruption	<p><u>Climate proof:</u> To develop riverine flood defences to a standard that prevents flooding from a specific probability storm surge event</p> <p><u>Live with risk:</u> To organise managed retreat from coastal zones</p>	<p>MSFW: Take action to ensure adaptability to CC becomes an integral part of all coastal erosion management decisions.</p> <p>MSFW: Adopt a whole shoreline approach consistent with, and contributing to implementation of the Water Framework Directive</p>	Cross sectoral in nature: threat to range of coastal zone resources and activities. Therefore requires wide stakeholder consultation	



**Box 7. Strawman objectives for Flood Management**

1. To limit riverine flood risks under alternative future climate scenarios to levels acceptable in terms of their economic, social and environmental consequences
2. To limit urban flood risks under alternative future climate scenarios to levels acceptable in terms of their economic, social and environmental consequences
3. To limit sea level rise impacts under alternative future climate scenarios to levels acceptable in terms of their economic, social and environmental consequences
4. To limit storm surge risks under alternative future climate scenarios to levels acceptable in terms of their economic, social and environmental consequences

The stakeholder consultation emphasised the need to be flexible with regard to defining specific levels of risk, in order to differentiate between what is acceptable in given local contexts. For example, lower urban flood risk levels are likely to be negotiated than those in rural, non-agricultural areas. It is also likely that notions of what is acceptable may change over time, thus arguing against the strict definition of risk levels.

Flood and coastal risk management is one of the sectors that needs urgent attention if the UK is to minimise future costs in managing flood risk. To resolve the issue of climate change in a cost-effective way requires the use of a range of techniques that encourage the development of holistic and innovative policy. Floods are perceived negatively, yet not all floods cause serious damage and a change in the existing mindset may help to move society towards the concept of ‘living with water’ (e.g. use of roads as a flood pathways). Depending on the views of stakeholders in the sector, it may be appropriate during the next iteration to add further objectives that set out to address these issues

**5.5.4 Targets**

In this project possible targets have been derived from considering the range of adaptation-related activities that can be undertaken and expressing those as time-bound targets. Since at present, and in the near future, adaptation activity is likely to be mainly related to building adaptive capacity the targets are generally process-based i.e. they reference the type and nature of adaptation activity that is being undertaken but do not relate to the effectiveness of such activity in reducing climate change impacts. In the sectoral case studies, each adaptation activity type is thought about in relation to specific targets that might best guide this activity. An example of these targets is presented in Table 14, where they relate to Objective 1. It should be noted that flood management is a sector where climate change adaptation options may in effect be being implemented, since the current FCDPAG guidance with regard to flood management project appraisal suggests incorporating sensitivity analysis that takes account of risk changes under climate scenarios. Thus, in Table 14, flood defence construction measures may currently include a climate adaptation component.

*Table 14. Target for objective: to limit riverine flood risks under alternative future climate scenarios to levels acceptable in terms of their economic, social and environmental consequences*

	<b>NOW (&lt;2010)</b>	<b>SOON (2010–2030)</b>
<b>Policies &amp; Plans</b>	Consideration of climate change included in key policies & plans	
<b>Operational</b>	Flood defence construction measures put in place	Flood defence construction measures
<b>Standards &amp; Regulation</b>	Climate change sensitivities incorporated in project/programme appraisal	
<b>Research &amp; Monitoring</b>	Projections of precipitation patterns, hydrological simulations Impacts modelled under alternative scenarios	Projection & modelling work improved as new information becomes available
<b>Education &amp; Comms</b>	Revised guidance issued on flood defence appraisal to account for precipitation patterns under climate change scenarios; Information relating to flood risk – land use trade-offs	Information relating to flood risk – land use trade-offs e.g. planning guidance
<b>Partnerships</b>	Local & regional stakeholder research network developed	Local & regional stakeholder research network developed

## 5.6 AGRICULTURE

### 5.6.1 Policy analysis

Defra have already identified the key issues within each of their divisions where adaptation will be required under climate change and where they will have responsibility (Defra, 2003). The CAP, rural development schemes, agri-environment schemes and regional, national and international markets all affect the choices farmers and land managers are making. Discussions with our stakeholders revealed that the sectors water, health, tourism, energy, biodiversity would all have cross cutting issues that affect adaptation of agriculture to climate change. Other government departments (e.g DTI and the Treasury) will also have responsibilities as well as other agencies e.g. the Environment Agency and English Nature. EU policy subsidies and world prices and markets will also be a major influence and, finally but crucially, mitigation policy that includes the introduction of perennial biomass crops; energy pricing and combined heat and power units in horticulture will all influence the ways in which agriculture will respond and adapt to climate change.

### 5.6.2 Climate risk analysis

A range of changes in climate variables are expected to cause impacts on agriculture. The increase in year round temperatures will bring opportunities and problems for the sector. Growing season will be longer and crops will grow faster, but pest, diseases and weeds may become more problematic and new pests may appear. Extreme high temperatures can have impacts on quality particularly during flowering. Higher minimum temperatures are important for horticultural crops including tree fruit and soft fruit because of a cool temperature requirement known as vernalisation. Temperature increases and increased flooding risk will also be crucial for livestock welfare and grazing, resulting in requirements for new buildings, ventilation and transport. The period of outside grazing may be extended, but dry summer conditions may reduce grazing in the early autumn.

Increased winter precipitation which will result in flooding and waterlogging of soil will be problematic for livestock and cause soil damage. Flooding could affect run-off from agricultural land of nitrate, phosphate and pesticides, which will result in increased river and land pollution. Dryer summers will cause water issues and conflicts between agriculture and public water supply. Policies relating to abstraction licences and on farm reservoirs will need to be revised. Sea level rise will increase the risk of coastal flooding, resulting in increased saline intrusion and increased risk of soil erosion.

### 5.6.3 Strawman objectives

Table 15 sets out the key climate risks and opportunities for the agriculture sector for two highlighted areas that were considered in the study. Potential outcomes from adaptation, and illustrative examples of extreme objectives are indicated. Bearing in mind the sectoral, cross-sectoral and regional issues outlined in Table 15 and from the climate risk assessment, we have proposed the strawman objectives in Box 8.

The project team discussed climate proofing objectives and climate resilience, and the minimal resilience to climate change through existing policies with stakeholders. The focus was on two working objectives (1 and 2 in Box 8), representing the middle ground that we agreed could realistically be pursued.

Other risk specific objectives that were not discussed in detail but came out of our broad climate risk assessment are shown as objectives 3 and 4 in Box 8. The objectives were focused on clusters within the sector, which the stakeholders considered important, rather than on individual risks, e.g. to crops or livestock. The idea was that these broader objectives would include specific risk objectives such as adapting management of livestock feed because of changes in the availability of autumn grazing; investing in irrigation and on-farm reservoirs to allow for dryer summers or investing in new housing for livestock to avoid higher summer temperatures. All the traditional suggestions for adaptation to changes in climate that farmers might make such as changes to planting dates, crop type, land cultivation, changes in work-days to avoid damage to soils, would be considered as actions or decisions that may come out of policy and research targets under the first strawman objective.

#### Box 8. Strawman objectives for agriculture

1. Enable farmers and markets to take advantages of new opportunities and manage changes in climate resources and risks
2. Anticipate climate change and ensure national strategy of adaptation is incorporated into agri-environment schemes and regulations
3. To develop regional specific plans and anticipate new regional agro-processing needs due to shifts in regional suitability of agricultural activity/ crop.
4. To anticipate new requirements for crops from plant breeding programmes particularly because of increases in temperature and summer drought conditions.

## Objective Setting for Climate Change Adaptation Policy

*Table 15. Agriculture sector: Using key risks/opportunities to identify desired outcomes and possible objectives*

<b>Risk</b>	<b>Desired adaptation outcome</b>	<b>Climate proofing through funding</b>	<b>Climate resilience through mixed approach</b>	<b>Pursue minimal resilience through existing policies</b>	<b>Working objectives</b>	<b>Issues: sectoral, cross sectoral and regional</b>
Farm-level risk and opportunities for economic benefit due to changes in climate and length growing season. Opportunities to improve sustainable farm management	Manage risk and embrace opportunities to the benefit of farmers and to make farms sustainable	Climate change adaptation fund to invest in new infrastructure, compensate losses, research, market exploitation. Divert funds from SF payments to the value of 1/3 of existing funds	Farming link service for advice on climate change adaptation to raise awareness and mobilise options  Funding from supermarket and other buyers through longer term contracts or pilot schemes if feasible  Increase Rural Development Fund to include climate adaptation	Farming link service for advice on climate change adaptation to raise awareness and mobilise options	Enable farmers and markets to take advantage of new opportunities and manage changes in climate resources and risks	Regional rural development plans will need to be revised Supermarkets and agribusiness will have to adapt to new conditions, timing and costs of production New skills/new equipment might be required
National environmental quality and planning	Maintain high national environmental standards which allow for future climate conditions	Maintain environmental standards and objectives by letting agriculture absorb impacts – possible with the consequence of loss of farm land and production	Maintain environmental standards by actively adapting agri-environment schemes	Continue policy as now but shift targets and objectives as they become unachievable such as agri-environment schemes and high winter water levels. Modify agri-environment schemes to adapt to climate change	Anticipate climate change and ensure national strategy of adaptation is incorporated in agri - environment schemes and regulations (WFD, Habitats directive, BAP)	Water abstraction permits will need to be revised Include cc into catchment water planning. Encourage methods to conserve water and use more efficiently

For objective 1 decisions needed will be commitment to aiding farmers with decision making through development of tools and from advice and awareness. If changes to farm enterprise or investment in new crops, irrigation or farming practice are considered necessary then further time will be required to identify available market and secure contracts with new buyers. If relevant, agro-processing industry will need to be available locally. Risks to changes to enterprise could be the variability of production from year to year and in the longer term as climate changes. There may also be new environmental impacts which are hard to predict. Cost –benefit analysis would be need if high investment is required for on-farm-reservoirs or for new ventilated livestock housing. EU policy and world markets will still dominate decision and profitability of any new enterprise. Advice will also be required on changing needs for agro-chemicals and fertilizers.

For objective 2, to anticipate climate change and ensure national strategy of adaptation is incorporated into agri-environment schemes and regulations, other evaluations are necessary. Environment schemes and regulations will need to be updated to accommodate adaptation through cross sector partnerships. Finding a balance between the needs of agriculture and the environment will be difficult and there will be trade offs which will come through modified sector policies. There may be resistance to changes from farmers, conservationists and others. Increasing irrigation and allowing more on-farm reservoirs to be built will affect stream flow and soil moisture downstream, so an overarching river catchment management plan will be required. Further research on climate change impacts on the boundaries and relationships between agriculture and biodiversity will help to inform decisions. The Environment Agency and Defra will be major stakeholders for this objective.

#### 5.6.4 Targets

Illustrative targets for the agriculture working objectives 1 and 2 are provided in Tables 16 a) and b) respectively.

*Table 16. Agriculture sector targets*

*a) Targets for objective 1: Enable farmers and markets to take advantage of new opportunities and manage changes in climate resources and risks*

	<b>NOW</b> (by 2010-2015)	<b>SOON</b> (after 2015)
<b>Policies &amp; Plans</b>	Funding sources – longer term contracts from buyers Increased rural development funding to include climate adaptation – e.g. encourage pilot schemes to investigate what measures work. Regional agencies involved Increased percentage of minor crops in production (quantitative, but with no specific threshold set)	It was noted that there were no targets to be introduced later rather than sooner. The emphasis was more that we should not anticipate too far forward but modify objectives as time moves on
<b>Operational</b>	Farm management changes implemented to suit new climate resources/ risks, through decisions such as enterprise, new crop type, changes to planting dates, diversification based on research, and information and decision tools	
<b>Standards &amp; Regulation</b>	Climate adaptation introduced into corporate planning and reporting Involvement of regional development	

	agencies	
<b>Research &amp; Monitoring</b>	Tools develop and applied to aid decisions on land use and adaptation to climate change, e.g. Agricultural Land Classification System as a predictive tool to help plan for climate change	
<b>Education &amp; Comms</b>	Awareness improved through farming-link service and advice provided on climate change adaptation for a diversity of options e.g. advice on changes in soil water at a regional level	
<b>Partnerships</b>	Partnerships across supply chains with regional planning	

*b) Targets for objective 2: To anticipate climate change and ensure national strategy of adaptation is incorporated into agri-environment schemes and regulations*

	<b>NOW</b> (by 2010-2015)	<b>SOON</b> (after 2015)
<b>Policies &amp; Plans</b>	Abstraction permits revised to cover climate conditions e.g. low flow/summer restrictions WFD adapted to include climate change needs (before 2015)	It was noted that there were no targets to be introduced later rather than sooner. The emphasis was more that we should not anticipate too far forward but modify objectives as time moves on.
<b>Operational</b>	Biannual review of climate change and agriculture	
<b>Standards &amp; Regulation</b>	Environmental conditions targets, standards and policy needs met, e.g. England Soil Strategy	
<b>Research &amp; Monitoring</b>	Agro-ecological definitions of land quality updated to current and projected climatic baseline (categorical, or % of country covered in rolling out a new soil classification) e.g. Soil Action Plan, Agricultural Land Classification Climate change questions (categorical) included in annual survey of farmers 50% of farmers with basic knowledge of climate change (from the annual survey) by 2010 (quantitative)	
<b>Education &amp; Comms</b>	Farmers advised on methods to conserve and use water more efficiently. Soil conservation practices that increase soil organic matter content encouraged with incentives through agri-environment schemes, e.g. reduced tillage / conservation tillage adopted; crop residues and animal and green manures used. Perennial forage crops used.	

## **5.7 TOURISM**

### **5.7.1 Policy analysis**

Provision for tourism in the UK is largely in the hands of (a large number of) private sector suppliers. Tourism promotional activities are provided at national, regional and local levels by public funding. DCMS is the central government department that has formal responsibility for the activities in the sector. It has the policy objective of raising productivity in the tourism sector. Because of the disparate and fragmented nature of the activity in the tourism sector, there are many ways in which climate change can impact on this activity. It is useful to distinguish between climate changes that affect tourist activity directly and those that are exacerbated in other sectors. An example of the former is that higher mean summer temperatures may be expected to result in an increase in tourism numbers in some parts of the country. An example of the latter is the increased pressure on water resources that climate change is thought likely to bring about and that would be exacerbated by increased tourism numbers. As a consequence many potential climate change adaptation objectives for the tourism sector are fundamentally cross-cutting and as such, have primary relevance to other stakeholders.

### **5.7.2 Climate risk analysis**

As mentioned above, increasing summer temperatures under future climate scenarios may result in increased domestic holiday tourism and increased incoming foreign tourism. Thus, the tourist industry in the UK may be expected to benefit. One might further expect there to be more take-up of outdoor leisure pursuits including water-related leisure bringing about associated health benefits. However, such an increased demand for tourism and leisure travel puts pressure on travel infrastructure and water resources in key areas. Furthermore, maintenance of heritage sites, through, for example, plant management, pest/disease control, and management of subsidence may become more demanding. These risks are likely to be exacerbated by extreme high summer temperatures that are projected under climate scenarios along with an increased fire risk.

Higher future mean winter temperatures will result in reduced snowfall that further limits the length of the winter skiing season and reduces the number of ski slopes available thus limiting the potential size of the ski industry in the UK. However, this risk may be outweighed by the opportunities that arise from more lucrative uses of ski slopes for other outdoor pursuits. There is also likely to be a reduced likelihood of snow-related travel disruption and accidents

Reduced summer rainfall projected under climate scenarios will result in reduced reservoir levels, water flow in some rivers and reduced levels in lakes as well as a reduced water table. Thus, there may be restricted recreational activity on rivers and lakes and an increased likelihood of algal blooms. There will also be excessive pressure on water resources in crowded tourist sites at peak times.

Sea level rise associated with climate change may result in coastal erosion, a loss of some wetland SSSI's and SAC's, and a reduction in the attractiveness of the visitor experience to coastal areas. An increased frequency of extreme tidal movements may also result in flooding at coastal sites.

### **5.7.3 Strawman objectives**

Table 17 sets out the key climate risks and opportunities for tourism that were considered in the study. Bearing in mind the sectoral, cross-sectoral and regional issues outlined in the Table 17, we have proposed the strawman objectives in Box 9.

**Box 9. Strawman adaptation objectives for tourism**

1. To accommodate changing patterns of visitor numbers projected under alternative climate scenarios in regional planning and tourism infrastructure provision, taking into account seasonality
2. To minimise likelihood of travel disruption for tourists and leisure travellers
3. To ensure no increased pressure on water resources for tourists, and as a result of tourists and leisure travellers
4. To limit the risk of structural damage at heritage sites to acceptable levels
5. To ensure effective maintenance of National parks and gardens to minimise risks of loss
6. To maximally exploit opportunities to increase participation in outdoor pursuits
7. To limit potential disruption to utilities to acceptable levels at key tourist sites

The seven objectives listed above are derived directly from consideration of the climate change risks and opportunities. That is, possible adaptation objectives were initially framed in terms of two radically contrasting approaches relating to i) total climate proofing, and ii) living with the risk. These objectives were then considered in the real-world context of current sectoral policy objectives in order to derive an objective that was likely to be acceptable to stakeholders. These objectives were then discussed with the sectoral stakeholders and rejected or modified as appropriate.

A key feature of a number of the objectives above is that they are cross-sectoral. Not only that but they are cross-sectoral in different dimensions. Objectives 2, 3, 5, 6 and 7 have cross-sectoral characteristics. For example, Objective 3 is to ensure no increased pressure on water resources for tourists and as a result of tourists and leisure travellers. The principal issue is therefore water resource management, and tourists are likely to be both a part of the cause of the problem as well as be adversely impacted. In the case of Objective 2 - to minimise likelihood of travel disruption for tourists and leisure travellers – the travel disruption caused e.g. by extreme summer temperatures causing road subsidence is principally a transport sector objective that relates to tourism activities.

The objectives 1 and 4, that are focused directly on the visitor experience, are those where stakeholders in the tourism industry are likely to be principal movers in achieving them. Given the fragmented nature of the tourist provision industry, there is therefore likely to be a need for adaptive capacity building and subsequent actions to be planned within partnerships and representative umbrella organisations.



## Objective Setting for Climate Change Adaptation Policy

*Table 17. Tourism sector: Using key risks/opportunities to identify desired outcomes and possible objectives*

<b>Risk or opportunity</b>	<b>Desired adaptation outcome</b>	<b>Possible Objectives</b>	<b>Sectoral issues</b>	<b>Cross-sectoral issues</b>	<b>Regional issues</b>
<p>Pressure on travel infrastructure - due to extreme high temperatures (rail buckling, road deformation) and impact on visitor numbers</p> <p>(Key sectoral stake-holding – Transport)</p>	<p>Less disruption to road and rail travel Or No increased disruption to road and rail travel And/or No increase in road congestion</p> <p>(Less applicable to rail – only 30% tourist trips by rail)</p>	<p><b>Climate proof:</b> To replace rails and road surfaces with more resilient materials <b>Live with risk:</b> To improve speed and efficiency of rail and road repairs</p>	<p>FTWP focus on improving reliability of rail, efficiency, value for money, investment where it delivers benefit. Getting 'ever greater performance out of the road network. Keen to facilitate smarter individual choices about trips and link transport decisions to other issues, e.g. new housing. Providing alternatives to cars DfT policy to deliver safe, reliable transport</p>	<p>Provision of transport for business and industry. Transport options for sustainable tourism</p>	<p>Particularly relevant to South East and Cornwall, Greater Manchester</p>
<p>Pressure on water resources due to increased tourism</p> <p>(Key sectoral stake-holding – Water Management)</p>	<p>Less disruption of water utilities Or Less rationing</p>	<p><b>Climate proof</b> – improved water resource management; create more water capture facilities <b>Live with risk</b> – devise water rationing plan <b>Avoid risk</b> – avoid increasing pressure on water resources via effective planning for new building</p>	<p>Water Framework Directive</p>	<p>Clear cross cutting issues with planning policy. Planning Policy Guidance notes PPG21 and PPG17, shortly to be replaced by Planning Policy Statements</p>	<p>Regional Spatial Strategies and Local Development Frameworks. Potentially particularly relevant in North West where much tourism and leisure development predicted</p>
<p>Increased maintenance requirement at heritage sites due to increased</p>	<p>Avoid loss of heritage sites And/or</p>	<p><b>Climate proof</b> – improve foundation infrastructure</p>	<p><i>Little relevant policy/sectoral information to be</i></p>		

# Objective Setting for Climate Change Adaptation Policy

likelihood of subsidence (Key sectoral stake-holding – Tourism)	Ensure safety of heritage sites	<b>Live with risk</b> – improve speed and efficiency of infrastructure repairs	<i>found</i>		
Increased maintenance requirement for National parks, heritage, civic and private gardens and visited landscapes (Key sectoral stake-holding – Tourism)	Avoid loss of gardens or garden species And/or Adapt gardens for warmer temperatures And/or	<b>Climate proof</b> – improve irrigation; take measures to protect vulnerable species <b>Live with risk</b> – exploit opportunities presented by warmer temperatures Identify points at which it is no longer sustainable to defend status quo and find suitable alternatives	National Parks Plans should incorporate climate change issues	Scottish Tourism and Environment Forum Operational Plan incorporates the concept of carrying capacity within it's strategy, and this has also been related to climate change issues	
Increased health benefits from extended range and duration of outdoor pursuits (Key sectoral stake-holding – Health)	Increase participation in outdoor leisure pursuits	<b>Exploit opportunity</b> - take measures to promote outdoor leisure activity And/or Develop new outdoor activity destinations	Regional Planning and Tourism strategies clearly need integration	Involvement of Dept of Health in education around this issues. Also Local Authority education departments	
Increased likelihood of skin cancer (due to higher exposure to sun) (Key sectoral stake-holding – Health)	Stabilisation in incidence of skin cancer	<b>Avoid risk</b> – improve public awareness of risks of sun exposure and improve use of risk reduction measures	Dept of Health – educational apparatus	D of H working with pharmaceutical companies to promote education in this area	
Reduced use of public transport and increased use of private cars (through likelihood of travel disruption) (Key sectoral stake-holding – Transport)	Improve effectiveness of road networks around tourist destinations Or Improved efficiency and effectiveness of public transport to key tourist	<b>Climate proof</b> – plan to improve road and rail network efficiency <b>Avoid risk</b> – take further measures to discourage the use of private cars	FTWP focus on improving reliability of rail, efficiency, value for money, investment where it delivers benefit. Getting 'ever greater performance out of the road		

# Objective Setting for Climate Change Adaptation Policy

	destinations		network. Keen to facilitate smarter individual choices about trips. Providing alternatives to cars DfT policy to deliver safe, reliable transport		
Restricted recreational activity on rivers and lakes – due to low volumes of water  (Key sectoral stake-holding – Tourism)	Minimise restricted use of rivers and lakes for recreational activity	<b>Climate proof</b> – develop alternative water-based recreational sites in less vulnerable areas <b>Avoid risk</b> – develop more effective management of water resources <b>Live with risk</b> – reduce pressure on such sites via rationing system or charging for use	Local authority development plans, and tourism strategies	Need for local tourist boards to work with Water management companies	
Disruption to utilities at coastal and other tourist destinations (as a result of sea level rises, extreme tidal movements and flash-flooding)  (Key sectoral stake-holding – Water management)	Minimise disruption to utilities	<b>Climate proof</b> – replace vulnerable systems with more resilient ones <b>Live with risk</b> – Improve speed and efficiency of repairs to network infrastructure			

### 5.7.4 Targets

An example of targets relating to Objective 1 is presented in Table 18.

*Table 18. Targets for objective: to accommodate changing patterns of visitor numbers projected under alternative climate scenarios in regional planning and tourism infrastructure provision, taking into account seasonality.*

	<b>Now (&lt;2010)</b>	<b>Soon (2010-2030)</b>
<b>Administrative</b>	Consideration of climate change included in key policies and plans	
<b>Operational</b>		New infrastructure constructed Long term maintenance and renewal plans developed
<b>Standards &amp; regulation</b>	None identified in tourism sector itself. But impacts on other sectors e.g. transport	
<b>Research &amp; monitoring</b>	Socio-economic change relating to changes in local visitor numbers assessed	
<b>Education &amp; communication</b>	Awareness built of implications for regional sustainability if exacerbating changes in tourism.	
<b>Partnerships</b>	Partnerships developed between DfT/HA. NetworkRail /DfT/rail companies/ RDAs, LAs	

## 6 Indicators for Adaptation Policy

Indicators can play a valuable role in turning environmental data into policy-relevant information. Within the UK and the EU, a variety of datasets and indicators are currently used to show trends in the state of the environment and to monitor progress in achieving environmental policy targets. By their very nature, indicators often simplify a complex reality, focusing on relevant aspects for which suitable data are available. Indicators are important for monitoring government's performance in achieving policy outcomes. They can also be powerful tools in raising public awareness on environmental issues and encouraging positive action by stakeholders.

### 6.1 SOME RELEVANT INDICATORS IN USE

We have reviewed a number of different indicator sets and monitoring frameworks to identify an illustrative list of indicators that are currently in use and are linked in some way to climate impacts or adaptation in our six sectors. This list is by no means exhaustive and does not reflect equally all of the sectors. The full list is presented as a table in Appendix VI. The review covered not only whether the indicator was relevant to adaptation but also some of its characteristics, as shown in Table 19.

*Table 19. Information collected on potential adaptation indicators*

Characteristic	Explanation
Measure of ...	The indicators could be most closely affected by: Impact of climate change, Adaptation response, or Other drivers (or a combination)
Relevant sector	Of the six considered in the study
Level of most relevance	National, regional or local level statistics
Links to other indicator sets	Name of any other set that includes a similar indicator
Possible data source	Main owner of existing datasets
Time series?	Are the data available over a period of years?
Regularly updated?	Are the data already updated regularly?
Trends	Summary of recent trends in the indicator
Comments	General comments about the usefulness of the indicator for adaptation.

The following indicator sets have been reviewed.

- UK Indicators of climate change
- UK Energy Sector Indicators
- UK Sustainable Development Strategy Indicators (2005)
- SE Integrated Regional Framework Indicators
- SE Regional Monitoring Report (2004)
- NW Action for Sustainability Programme (2005)
- State of the Environment Indicators (EA)
- Quality of Life Indicators (precursor to UKSDS)
- Local Quality of Life Indicators
- ODPM Core Output Indicators for Regional Planning
- Best Value Performance Indicators

- Finland National Adaptation Strategy.

## 6.2 ADAPTATION ISSUES FOR INDICATORS

The nature of adaptation makes it unsuitable for monitoring via traditional individual indicators, because of the:

- Long timescales of climate change, distinguishing the ‘noise’ of natural climate variability from actual climate change, and indirect impacts from climate-driven socio-economic change;
- Multi-sectoral nature of adaptation, involving a large number of responsible organisations and delivery partners; each may have different requirements for indicators, and their own monitoring and information networks.
- Absence of existing performance criteria and the wide range of potential adaptation activities; not every sector has a policy target that defines what is acceptable performance at the various levels of decision making, notions of acceptable risk are essential.
- Mix of hazards and opportunities; taking advantage of some opportunities (such as longer growing seasons) may increase exposure to hazards (such as mid-season drought)

These factors mean that performance monitoring in this policy area is challenging and will be complex. Performance management of any cross-cutting strategy is difficult as most existing administrative instruments are designed for single-sector policies. Contributions to a cross-cutting area have to be secured by engagement and persuasion of each individual sector. In order to comment effectively on progress in adaptation, a new approach to monitoring and reporting may need to be determined and agreed.

Successful adaptation may mean in large part that adverse impacts are avoided. But the absence of events is difficult to measure. In many cases, the impacts to be avoided are not expected to occur until some time in the future: progress in advance of the event will be difficult to monitor. Good adaptation usually involves a range of incremental activities in related sectors: no single indicator could monitor all such activity. If ‘successful’ adaptation also means ‘cost-effective’ adaptation, then the best options are likely ‘to go with the grain’ of sectoral policy development: progress in adaptation may therefore be difficult to distinguish from any wider sectoral advances.

Experience with indicators for vulnerability, adaptive capacity and adaptation measures is gaining ground in a number of areas (see Adger et al. 2004, Downing et al. 2006, 2003). The decision context is critical: whether present-day or future vulnerability is the target, relevance to specific stakeholders and their planning frameworks, and use in different decision analyses (from narratives and policy exercises to cost-benefit analysis). The need for precision, robustness, transparency, and objectivity are common concerns. Scale issues require consideration, including the resolution of the indicator (e.g., the water resource zone or government planning districts), time period for events and trends, and aggregation to the national level (e.g., loss of information about ‘hotspots’).

In addition to the particular difficulties of monitoring adaptation, we also recognise that many parts of government are experiencing “indicator overload”. Some of the indicators in use in various sectors are already related to adaptation, even if only tangentially. So where established monitoring and reporting systems on sectoral issues related to adaptation are already in place, any indicator framework for adaptation should avoid duplicating them. Instead, monitoring of adaptation policy should include an element of interpreting the extent to which sectoral policies and actions are contributing to progress in adaptation. Finally, if indicators are to be a useful communication tool, they should be simple, clear and easy to understand.

### 6.3 SUCCESSFUL INDICATORS

From national and international experiences over past years, several success factors have been identified relating to the use of indicators<sup>4</sup>. These show that indicators should ideally:

- Report progress over time and should be accompanied with an assessment of the reasons explaining their development;
- Be relatively few in number, and users should get used to their presentation;
- Relate directly to the specific issue and impact classifications ('fitness to a purpose');
- Allow specific policy questions related to air quality impacts to be addressed
- Be consistent and comparable over time and space;
- Prevent duplication of efforts by taking closer account of national and international work and related indicator sets in practice;
- Be clearly defined, understandable and usable;
- Be measurable – based as much as possible on existing routinely collected and quality-controlled data and accessible (input/ output of the information system) at different levels (e.g. national, regional, municipal);
- Meet a number of general methodological criteria concerning validity, sensitivity, timeliness, accuracy;
- Be transparent (e.g. composite indicators are less transparent, useful for comparison, less useful for disentangling influence of actions);
- Be acceptable for all stakeholders involved.

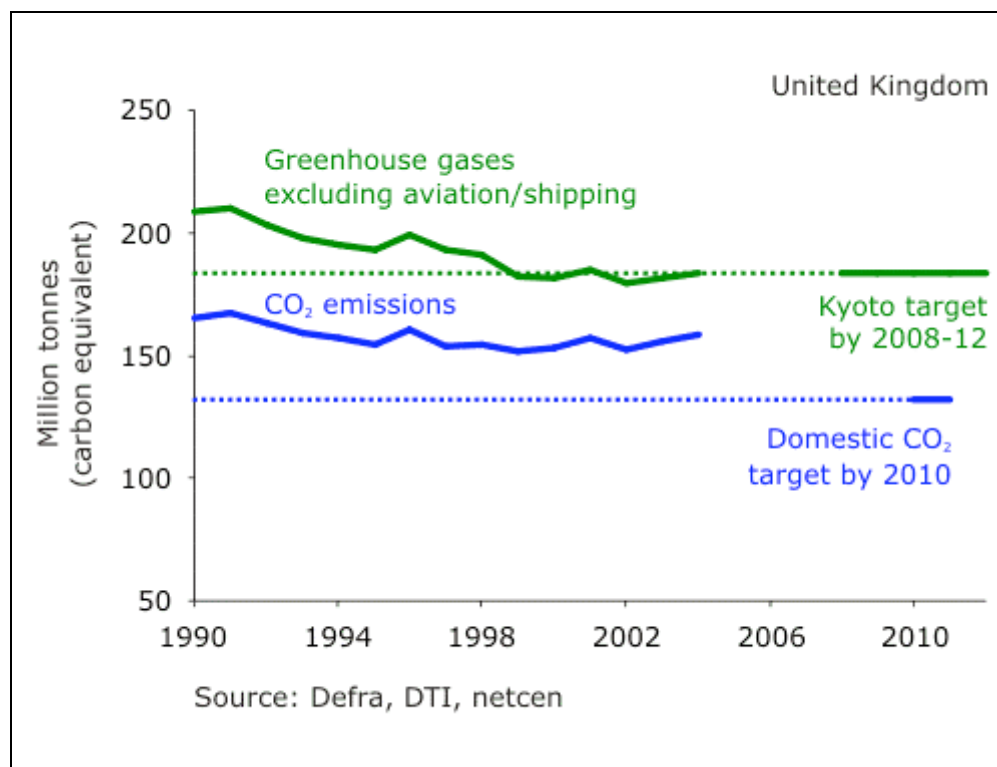
An example of a successful indicator of the traditional type is shown in Box 10, taken from the UK sustainable development indicators<sup>5</sup>. The full set of UK sustainable development indicators are included in Appendix VI. A number of these have potential for overlap (or applicability with some development) for adaptation.

The UK sustainable development indicators include a set of high-level indicators: the UK Framework Indicators give an overview of sustainable development and the priority areas shared across the UK. Following this, there are a further 48 indicators related to the priority areas. Nearly all of these are high-level and supporting indicators that are numerically based and report on an environmental or social outcome that is consistent with the progress towards sustainable development (in other words they are outcome-based). There are also supporting indicators and analysis that involves wider information, including action plans on lower level progress. Many of these lower level indicators relate to activities that contribute to awareness raising or capacity building (and these are process-based).

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<sup>4</sup> See 'Indicators in the Kiev Report' from the EEA (2001) and the Baseline Report on "Environment & Health Indicators" in the framework of the European Environment and Health Strategy (COM(2003)338 final)', produced by the technical working group on Environment and Health Indicators, formed under the European Commission SCALE programme (2003).

<sup>5</sup> <http://www.sustainable-development.gov.uk/performance/performance.htm>

**Box 10: Example indicator: greenhouse gas emissions 1990 to 2012**

**Greenhouse gas emissions since:**

1990



1999



- Emissions of the 'basket' of six greenhouse gases in 2004 were provisionally estimated to have been about 12.5 per cent below the base year. (The base year is 1990 for carbon dioxide, methane and nitrous oxide, and 1995 for fluorinated compounds.)
- Emissions of carbon dioxide, the main greenhouse gas, were provisionally estimated at some 158.5 million tonnes (carbon equivalent) in 2004, about 4 per cent lower than in 1990. Emissions increased by about 1.5 per cent between 2003 and 2004, mainly owing to increases in industrial and transport sector emissions.

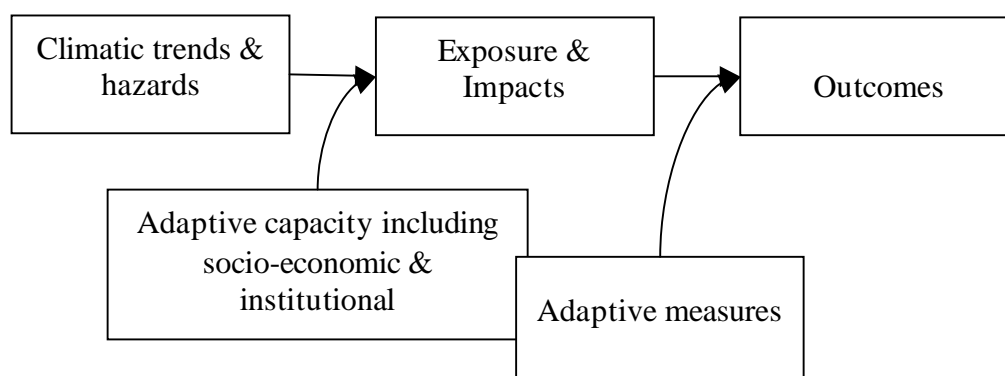
## 6.4 DEVELOPING INDICATORS FOR ADAPTATION

Indicators should serve two functions in the adaptation framework:

- Monitoring performance in achieving policy outcomes, across the broad range of risk-responses and for the relevant stakeholders
- Communicating the range of risk to raise awareness and encourage positive action by stakeholders.

Figure 4 indicates a simple causal chain, from the realisation of climatic trends (already apparent in many cases) and incidences of extreme events (such as droughts and floods). Both are critical drivers of climate impacts, in conjunction with the underlying exposure or vulnerability.



*Figure 4. Risk response chain*

Adaptive capacity tends to reduce exposure by altering the links between events and their outcomes. For example, building design and air conditioning reduce personal exposure to heat waves (whether in homes or in safe refuges such as shopping centres).

Specific adaptive measures also reduce outcomes. For instance, the dose-response function that might characterise deaths in a heat wave can be dramatically altered by targeting the elderly in an effective response to a forecast of a heat wave. The chain is iterative and the expectation of specific events is as important as the actual experience in motivating development of further adaptive capacity as well as implementing specific responses.

The indicators used to measure progress along this risk-response chain may be ‘outcome-based’ or ‘process-based’ (see Section 1.3 for definitions). Some of the principal advantages and disadvantages of the two approaches are summarised in Table 20.

In broad terms, the process-based approach may be seen as more appropriate in this context because the high uncertainty and long timescales attendant with climate change impacts will not allow us to evaluate the effectiveness of any given adaptation measure or strategy. Experience also suggests that it is extremely difficult to distinguish between climate change-specific adaptation measures and measures taken in the natural course of sectoral development<sup>6</sup>. Thus, attribution of progress to climate change adaptation alone is unlikely to be possible.

The process-based approach also allows the flexibility to bring in new information at later stages and allow experts in the field to make final decisions about the adaptation objectives and targets to be adopted. However, it is also possible for a process to be specified (and followed), yet not to result in effective adaptation if it is too limited in its initial definition. It is also likely to be challenging to define and measure stages in a process of adaptation without ambiguity.

<sup>6</sup> See for example “Linking adaptation research and practice” report (Tyndall Centre, 2005) for Project F in Defra’s Climate Change Impacts and Adaptation Cross-regional Research Programme.

Table 20. Process-based vs outcome-based indicators

Process-based indicators	Outcome-based indicators
<u>Advantages</u>  Allows stakeholders / sectoral experts to choose the most appropriate adaptation action to meet an outcome  Flexible approach – can adjust to new information as it becomes available	<u>Advantages</u>  Most other government policy objectives / targets are outcome-based  Easier to measure in principle  May be possible to link adaptation objectives with objectives in other policy areas  Likely to be sector-specific
<u>Disadvantages</u>  Defining a process does not guarantee successful adaptation  A different approach from most other government targets, so more limited experience  May be difficult to integrate adaptation targets with objectives in other policy areas (because they are different in nature)  Not necessarily sector-specific	<u>Disadvantages</u>  Defining an outcome does not guarantee successful adaptation  Risk of being overly prescriptive of adaptation options (specifying sub-optimal options)  May be inflexible, and make it difficult to introduce new information (though great scope for flexibility in implementing specific actions to achieve outcome)

Advantages of the outcome-based approach include comparability with most other policy areas, and a clear goal on which to focus. For this reason, in principle, progress is likely to be easier in practical terms to assess. However, there is a danger that an initial choice of endpoint based on incomplete information at the outset could constrain effective adaptation so that what is assessed is not a cost-effective or feasible adaptation action.

In summary, there are two important areas to highlight here:

- First, given current knowledge of adaptation, and the early state of policy development, it may be appropriate to have more process-based indicators in the short-term (consistent with the aim of building capacity), leading to more outcome-based indicators in the longer term (i.e. from 2010).
- Second, many of the outcome-based indicators for adaptation are likely to be similar to other areas (including the sustainable development indicators, and other economic indicators), though they may require some subtle differences to capture climate effects fully. There is therefore the potential to integrate with other areas and mainstream indicators through a detailed review of other UK indicators.

## 6.5 SUGGESTED APPROACH FOR UK ADAPTATION POLICY

Until specific objectives and targets have been set, it is not possible to develop a short list of robust indicators to be adopted. In response to the issues discussed above, we suggest the following strategy for developing indicators for a UK adaptation policy.

1. Indicators should be drawn from the full chain of climatic risk, exposures and responses. Within each sector, baskets of indicators should be drawn from existing

monitoring schemes and collected by the relevant stakeholders. Taken together, they provide a profile of current risks and responses and a general benchmark of progress in the sector towards stated objectives (whether “climate proofing” or “climate resilience”). For example, a basket of indicators for the energy sector could include:

- Household energy use
- Proportion of electricity generated by renewables
- Electricity and gas plant margin (total generating capacity over and above peak demand)
- Security and availability of electricity supply for the average customer
- And/Or other relevant examples (e.g., see Appendix VI).

The advantages of this approach are that adaptation builds on existing datasets and monitoring processes, avoids indicator overload, and demonstrates that adaptation links into other activities. The main disadvantages are that these kinds of indicators are not explicitly monitoring adaptation (or adaptive capacity), nor are they likely to be able – initially at least – to indicate that movements in the indicators are related to climate change. Thus:

2. An additional indicator or indicators in each sector should be designed specifically to show a much stronger link to one aspect of climate change impacts and adaptation. This we refer to as the ‘basket-plus’ approach. It provides a more powerful communication of the nature of adaptation (though it is by no means an exhaustive measure of adaptation in the sector). It also helps to ensure that adaptation policy retains some identity, and is not ‘mainstreamed’ to the point where it disappears. For the energy sector example, an additional indicator more strongly related to adaptation might be “Length of electricity transmission infrastructure resilient to future 1 in 10 storms”. There are several elements of this that would require careful definition, but it links the potential climate risk to the resilience of one aspect of the sector.
3. The indicators could include categorical checklists that gauge progress in adaptation as a process. These are likely to be institutional actions oriented toward adaptive capacity.
4. A reference benchmark of adaptive capacity could be prepared. This would include the indicators chosen, as well as the expected range of performance that might be achieved within the sector given different socio-economic and climatic scenarios. It could also include comparison with other countries and sectors.
5. An annual (or possibly bi-annual) commentary on progress with respect to the identified process-targets for each adaptation objective should be compiled. This might be a centralised service or a compilation and synthesis of reporting from lead stakeholders.

This strategy for defining indicators and monitoring progress promotes mainstreaming to an extent, while ensuring that adaptation policy retains its identity. While it is important to define indicators relevant and measurable at different levels (e.g., local, regional and national within sectors), it is not essential to establish a large scale, additional effort. It is also not desirable to focus on a limited view of adaptation or to define headline indicators. In the context of adaptation, a headline indicator cannot adequately summarise or represent progress with all other indicators, and therefore risks focusing too much attention on one particular sectoral target. The initial focus should be on measures of progress across the board in preparing for climate change in the shorter term.

## **7 Completing the policy framework**

This section examines how the different elements of a complete adaptation policy (the objectives, targets and indicators) fit together. It also discusses links between different levels of government in adaptation policy, the cross-cutting issues that should be made explicit in the policy, and the potential for policy conflicts. These are issues that fall outside the scope of this project, but which have a considerable bearing upon adaptation policy and its evolution.

### **7.1 AN EXAMPLE FRAMEWORK**

We have identified a set of objectives and high level objectives for each sector, some example targets and a range of possible indicators. Figure 5 shows how these different components of the adaptation policy link together in an adaptation policy framework. Note that the numbers of objectives and targets presented are indicative; the project team anticipates perhaps 4-8 objectives per sector, each associated with one or more targets, and 2-3 high level objectives.

There are potentially two sets of outputs from the policy framework. One set ensures that genuine progress is made on implementation of specific adaptation measures in order to reach stated objectives; the other ensures that summary information on progress can be presented to a wider audience. The ownership of the different outputs varies, with local government and the regions taking a more active role in development of indicators.

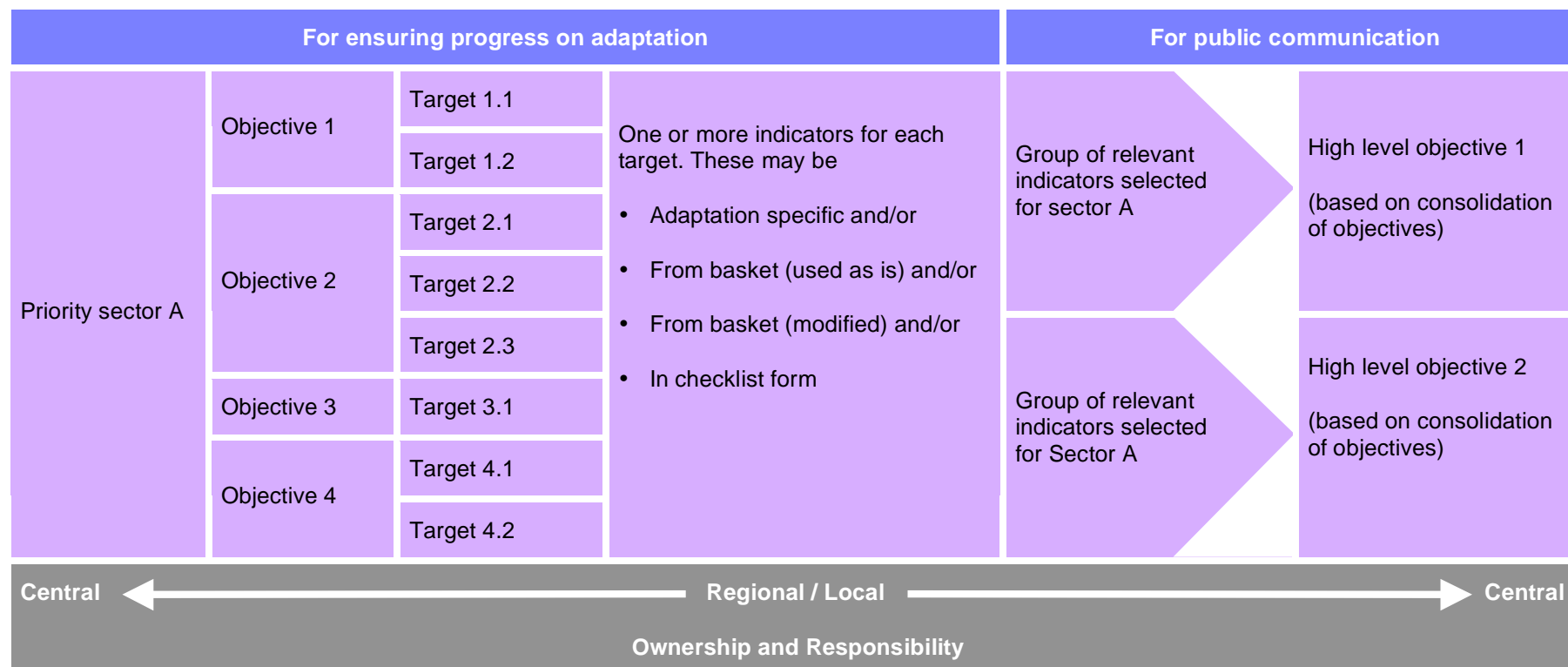
### **7.2 LINKS BETWEEN LEVELS OF GOVERNMENT**

#### **7.2.1 Devolved administrations**

Devolution has implications for adaptation policy. Should policy objectives be nation-specific? Since impacts (and also adaptation responses) will run across administrative boundaries, it is helpful for policies to be integrated across boundaries. However, devolved administrations may recognise different priorities in terms of climate risks and therefore also adaptation objectives in each sector. In addition, the different administrations can mean that sectoral responsibilities and processes are established differently across boundaries. So while it should be possible to agree on high-level objectives, and on process-based targets, the specific actions/options may need to be determined on a devolved basis. Discussion and agreement on objectives will certainly be needed, rather than the UK government working in isolation to impose them.

## Objective Setting for Climate Change Adaptation Policy

Figure 5. Example adaptation policy framework



### 7.2.2 Regional and local level responsibilities

There are two main reasons why policy-making for climate change adaptation requires a strong lead at the regional level within the UK. The first is that the *impacts* of climate change are experienced differently from region to region, both as a result of regional variability in projections of climate change and because of regional variations in vulnerability. The second is that the *adaptation* strategies most appropriate in each region are likely to vary, even for very similar impacts, because of regional variability in socio-economic priorities and political drivers. Very often there are several potential adaptation options available, and the choice between them may depend not only on cost-effectiveness but also on pre-existing constraints, pressures and attitudes within the region.

So, the UK's policy framework for adaptation must contain an appropriate blend of flexibility, along with the consistency of approach that is intended. Adaptation actions will be most effectively implemented at regional and local levels if policies and objectives are cascaded effectively from national to regional frameworks and then to the local level. This could be achieved by setting clear adaptation objectives within sectors at UK level, but with the regions then defining their own regional adaptation frameworks to include those objectives which are most relevant to the region. In some cases, this kind of regional level leadership on climate change issues is already being demonstrated: in the South East, for example, a Climate Change Implementation Plan is being developed to go alongside the new Regional Spatial Strategy (the "South East Plan" which is due for adoption in 2006). Given the range of policy drivers with which local level stakeholders have to contend, adaptation objectives will need to be embedded within other relevant policy areas too, avoiding the potential for policy conflict.

One model for allocating regional and local adaptation responsibilities is that of sustainable development, in which the UK Government's Sustainable Development (SD) Strategy sits under an overarching UK SD framework (alongside the devolved administrations' own SD strategies). Each English region sets up its own regional SD framework (with priorities / commitments etc), and beneath that, local authorities have responsibility in delivery of SD. Traditionally, adaptation has been embedded within SD: truly sustainable development will mean taking account of climate change, along with all other future impacts/drivers. Should adaptation policy therefore sit within the SD framework? If this approach is taken, progress in adaptation may be limited.

A final point worth emphasising is the potential for facilitating adaptation at local levels through standards and guidance defined by national bodies. There are many instances where the standards set by chartered institutes, professional bodies and trade associations are the main influence over decisions and actions taken by local level delivery agents. By linking these national bodies into UK adaptation policy initiatives so that the guidance they issue includes criteria for climate change, UK government may exert a very useful influence "on the ground". This kind of approach has already been promoted through the UK Climate Impacts Programme initiative "Changing Climate for Business", and there could be merit in increasing this activity.

### 7.2.3 European dimension

The Second Phase of the European Climate Change Programme (ECCP II) was announced in October 2005, and ECCP II will include a much stronger emphasis on adaptation. The development of the European adaptation framework will take place through a series of thematic meetings under Working Group 2 on Impacts and Adaptation. Just as the policy framework for adaptation in the UK should retain a level of flexibility that allows different regions to refine policy objectives, targets and indicators as appropriate for the priorities and impacts within each region, so also a European adaptation framework should

provide the right balance of overarching co-ordination and provision of generic guidance and principles, and flexibility at the level of individual member states.

### **7.3 CROSS-CUTTING ISSUES**

The study has not allowed a detailed consideration of cross-cutting issues, since only six sectors have been included. Procurement is one area common to all sectors that may provide a route to address some adaptation options. We recognise that flood management impinges on all other sectors, and that biodiversity issues are often affected by adaptation decisions in many sectors. Both of these areas carry significant policy burdens in their own right, so it will be important that they are featured as individual policy sectors. However there may be scope to reference the adaptation objectives in flood management and biodiversity sectors as cross-cutting themes where appropriate in other sectors. Spatial planning may be best featured in a similar way.

There are a number of categories of action that cut across all sectors and levels of the policy-making process. These include the need to develop adaptive capacity through education, training and research activities. There is still a need for improved awareness of the impacts of climate change at a range of levels, including policy-makers, operational staff within the various sectors, and the highest level decision-makers. There is an opportunity for a collaborative approach to this issue. At a general level, training materials and information about climate change could be developed centrally, and the government's recent initiatives on climate change communications<sup>7</sup> are certainly moving in this direction, at least for the general public audience. The benefits would include not only a cost saving by avoiding duplication of effort, but would also ensure a consistency of message that might avert potential conflicts in understanding and approach further down the line.

A collaborative approach to science and research could also be beneficial. The EPSRC's research programme "Building Knowledge for a Changing Climate" has brought together stakeholders and researchers from a number of sectors with cross-cutting interests in utilities or the built environment. This approach encourages sharing of good adaptation practice across sectors, and may help to avoid conflicts. As new UK climate change scenario information becomes available, there will be a need across all sectors to understand the new data and its implications for adaptation policy objectives: the role of interpreting and including new climate research could be featured as a cross-cutting theme in the adaptation policy framework.

The development of an agreed system for monitoring and evaluation of adaptation activities, in the context of Defra's APF, and in response to any objectives which are set in future, may also need to be considered. This is an area where a collaborative cross-cutting effort could be pursued to ensure consistency in approach so that a coherent picture of adaptation can be obtained.

### **7.4 RISK OF POLICY CONFLICTS**

Given that the APF has yet to be formulated, it may seem premature to discuss policy conflicts. However, there already exists a range of policies in different sectors that could conflict with objectives for adaptation to climate change. We highlight these here to indicate how lack of joined up thinking on policy may have adverse consequences for adaptation.

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<sup>7</sup> [www.climatechallenge.gov.uk](http://www.climatechallenge.gov.uk)

Urwin<sup>8</sup> (in press) found that a number of individuals believed that policies outside their own sector would have a bigger impact on their adaptive capacity than their own sectoral policies. She points to a number of interesting examples:

- The Habitats Directive provides a high degree of protection to species and habitats at particular sites, which have to be maintained in a “favourable conservation status”, but climate change is not factored into the assessment of conservation status. It may become unsustainable to maintain the sites under a future climate. In general, UK conservation policy focuses on designating and protecting specific sites, undermining the capacity of organisations to take a wider landscape approach to managing habitats and movement of species.
- In contrast, Biodiversity Action Plans can offer a robust approach to adaptation, focusing on species and habitats themselves rather than the location. However, climate change has yet to be considered in a systematic way within regional habitats and may be ignored as a threat to individual species.
- The plans released under the Sustainable Communities Initiative by the Office of the Deputy Prime Minister (ODPM) for housing developments are aimed at areas in the south-east of England that are already short of water. Given anticipated future reductions in rainfall, the ability of water companies to ensure security of supplies and removal of wastewater is in some doubt. Water companies are not statutory consultees in the planning process, yet are legally obliged to provide water to all new developments.
- The Water Framework Directive (WFD) establishes a planning framework for management of water resources and the ability to integrate climate change consideration into management plans. However, the way the WFD addresses issues such as climate change and flooding depends on existing measures and regulation, which are not designed to meet WFD requirements. According to some stakeholders, this undermines the climate proofing of the system.
- On-farm storage reservoirs provide one means to enhance security of future water supply, but the 1975 Reservoirs Act creates many obstacles for farmers, increasing the cost and effort of saving water.

These findings are supported by the Environment Agency, which makes the following observation (Environment Agency 2005):

- Development in inappropriate locations can exacerbate the problems associated with flood risk and limited water supply. To avoid creating problems in the future it is essential that planners and developers work with us to ensure that development is located in the best place and is resilient to climate change. There is need better application of national policy to prevent inappropriate development on flood plains or areas of flood risk – over half the planning proposals that objected to by the Environment Agency last year lacked appropriate assessment of flood risk. Almost 12 per cent of the proposals objected to by the Environment Agency were approved contrary to our advice by local planning authorities. In some areas water supplies are already almost fully used by the existing population.

There is a risk that adaptation responses, or the capacity to deliver adaptation, will be undermined by high-level policies like those described above. The government can improve adaptation policies by ensuring that misfitting policies are minimised and sectoral policies do not undermine implementation of local adaptive responses.

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<sup>8</sup> PhD thesis on Adapting to the Impacts of Climate Change in the UK: Policy Fit and Misfit (Tyndall Centre, UK)



Urwin presses for an emphasis on cross-sectoral approach to policy setting, particularly in sectors that are strongly interconnected (e.g. agriculture, water resources and nature conservation sectors). To ensure joined up thinking, she suggests this be combined with a bottom up approach, so that local organisations have a say in how practical policy can be set. This approach is very much in line with the method used in this project. Urwin's five key recommendations are to:

1. review existing policy goals to ensure sustainability
2. set policy targets over longer time-scales
3. enhance policy implementation
4. increase legislative support to no regrets measures
5. increase the flexibility of interpretation of policies.

## 8 Conclusions

### 8.1 GENERAL FINDINGS

#### **The nature of adaptation and implications for policy-setting**

As both a process and a condition, adaptation is a relative term since it involves an alteration in the system of interest, activity, sector, community, or region to the climate-related stress or stimulus. A complete description of an adaptation thus requires specification of who, or what adapts, the stimulus for which the adaptation is undertaken, and the process and form it takes. Adaptation is therefore only truly meaningful in its application to particular systems (in this case, policy areas or sectors). This makes the formulation of relevant *adaptation* policy a particularly complex and challenging process.

Adaptation usually requires a learning-by-doing, adaptive management approach that is to some extent “experimental” and involves continuous monitoring, evaluation and adjustment as new information becomes available. It is not immediately apparent that this kind of approach may be reconciled with traditional central government leadership through policy setting based on adoption of specific objectives and concrete targets. How is it possible to provide strong leadership, vision and direction from central government without setting inflexible targets and pre-determining a specific course of action? Or to maintain a flexible, evolving, learning and inclusive approach to management and provide clear leadership, that ensures actions are eventually taken? However, we have shown in this report that it is possible to define a flexible and iterative methodology for policy-setting in central government that includes clear steps, allocates roles and responsibilities at different stages, and also allows for the evaluation and adjustment that is crucial in adaptation.

The strategic outcome for adaptation policy provided by Defra is stated as the “UK successfully adapting to unavoidable climate change”. The concept of successful adaptation requires definition: we have discussed this and propose a definition that focuses on cost-effective and proportionate adaptation. This could imply a three-tiered approach for the adaptation planning process:

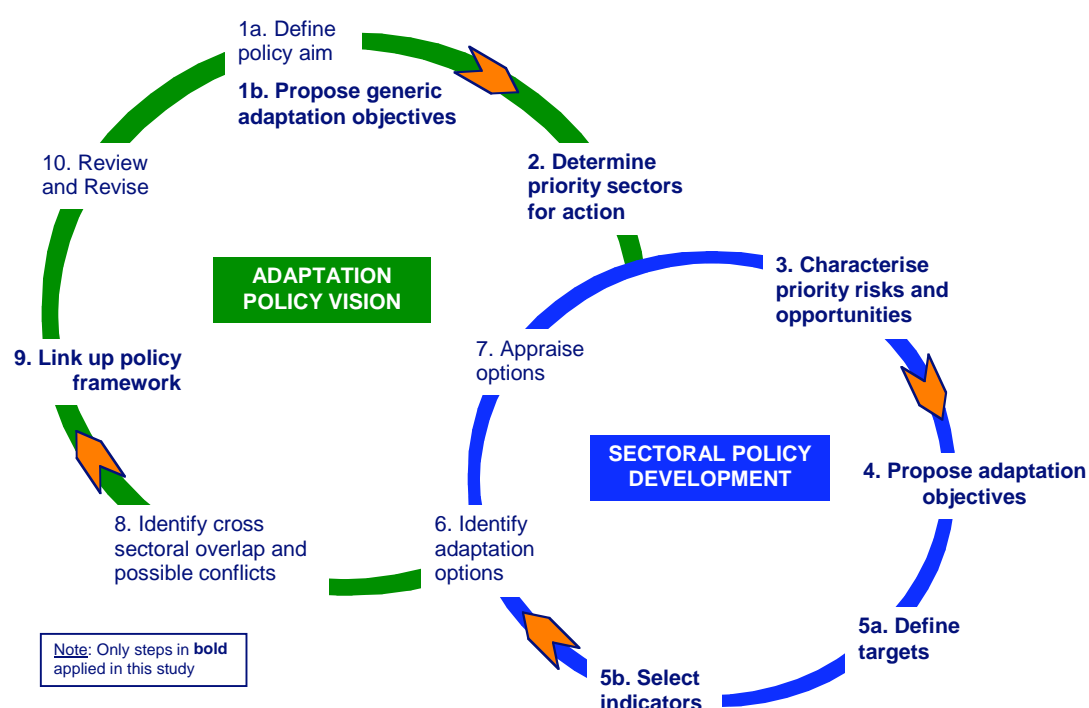
- That successful adaptation should initially focus on developing actions/building capacity (i.e. raising awareness), followed by
- Identification of win-win or no regrets options (prioritisation on low cost or highly cost-effective actions);
- Then consider other possible actions, and investigate in detail looking at the costs and benefits of options, and considering how uncertainty might influence any decision. Key to this final stage is the prevention of mal-adaptation, i.e. taking actions that actually lead to a net cost (where the costs of adaptation exceed the costs of inaction).

Another key principle in adaptation is the importance of a participatory approach, involving all relevant stakeholders at crucial stages, from planning through to implementation. To date, Defra has pioneered a stakeholder-led approach in adaptation, not least through the development of the UK Climate Impacts Programme. It will be important for this wide stakeholder engagement to continue as adaptation policy starts to be articulated more formally: with the APF stakeholder consultation, Defra has already indicated this view to share responsibility for climate change across many organisations in the adaptation policy setting process. Some of the stakeholders consulted during the course of this project emphasised that the sharing of responsibility should not be seen as a substitute for strong leadership from central government. The two can be complementary.

One further principle commonly linked to adaptation is “mainstreaming”, in which climate change is drawn into all other areas. Ultimately, it could be argued that adaptation as a specific policy area or framework should disappear, once all sectors and policy areas automatically consider climate change alongside other future drivers and risks. However, the feeling of the project team and many working at local level is that mainstreaming alone does not work (for adaptation or anything else), because there are so many issues that should be considered together at any given point or decision. There will always be a role for an adaptation policy framework to marshal the cross-cutting, multi-sectoral issues and potential conflicts.

### Method for objective-setting

We have identified a policy cycle for adaptation, shown below. We believe this forms the basis for development of adaptation policy, from defining the policy vision, through to the implementation of indicators, monitoring and review. This has taken the best practice from conventional policy frameworks in use, and combined it with elements that are specifically relevant to climate change (e.g., in relation to uncertainty) and adaptation (e.g., in relation to stakeholder consultation).



The criteria for prioritising six sectors within this study focused on determining where climate change will have a significant impact. Defra’s current stakeholder consultation on the APF indicates that the priority sectors to be featured in the first phase are those where (a) climate change will have a significant impact; or (b) considerable co-ordination between departments or with other bodies will be needed to make progress on adaptation. Whilst this study has been led by criteria under (a), future work might usefully be focused on sectors where criteria under (b) are given more weight. This would be a sensible pragmatic addition for the purposes of Defra’s role in providing some high level orchestration adaptation activities across sometimes conflicting sectors.

Our prioritisation of climate impacts and risks involved limited stakeholder consultation. The risk assessment approach follows UKCIP principles for adaptation, starting with identification of risk, prioritisation based on risk probability and magnitude, and considering uncertainty in the climate (and other) information available. Given the scope

of the study, the risk assessment has largely been based on qualitative statements, which should ultimately (where possible) be supported by quantitative analysis. Risk prioritisation should ideally take into account agreed levels of risks, information on financial/economic costs, and considerations of existing adaptive capacity, thus linking the characterisation of the risk and opportunities step with the options appraisal step. Prioritisation should also take into account knock-on effects in other sectors. The risk assessments could, in most cases, be carried out by the departments with responsibility for sector in question, in consultation with stakeholders.

The danger of prioritising the risks / opportunities is that the top few are addressed, and all others are forgotten. The fact that the method is circular and iterative is important here: on successive reviews, as more information and experience is available, the priorities could change (and the policy framework needs to allow for this flexibility).

One of the challenges in formulating adaptation objectives is remaining focused on defining an objective for *adaptation to climate change* rather than something that is a broad goal for the policy area in general. The approach of first recognising what is the desired *outcome* from adaptation in each case can help to retain this focus. The discipline of first considering the extremes (i.e. climate-proofing vs living with risk) should help to retain an appropriate level of flexibility in the final suggested working objective. It is essential that the wording of the objective retains a link to the climate issue that it is addressing – this is the only distinction that makes the objective a proper *adaptation objective*.

Some of the most difficult areas of climate impacts for which to formulate objectives are those where people's responses to changing climate (and socio-economic changes) are less predictable. For example how climate change will influence individual choices of travel modes. Warmer weather could mean more cycling and walking, but perhaps also greater use of air-conditioned cars rather than public transport options. An objective to build more flexibility into the transport system will therefore require greater knowledge about behavioural choices, and actions to address those aspects of the system that exert strongest influence over those choices (e.g., standards of overcrowding, ventilation and temperature control on public transport)

There is a major distinction between objectives for climate-proofing and climate resilience (i.e. living with risk). In most of the sectors we have reviewed, the immediate concern is with climate resilience – increasing capacity to manage opportunities to the changing climate and reduce risks to acceptable levels. The alternative, of an objective to categorically prevent the impact of climatic trends and extreme events by climate-proofing, is less desirable at present, given uncertainties not only about impacts but also about the degree to which climate-proof adjustments would prove cost-effective. The balance between climate-proofing and living with risk may change if we wish to prepare now for much longer term climate change where the impacts could well become intolerable. It is also likely that in some sectors and for some risks in some areas, climate-proofing is already a viable and desirable option. An example is the impact of climate change on flooding in London. Potential sea level rise during this century is relatively well-predicted, so that, within the context of the wider Thames Estuary 2100 project, the Environment Agency will be able to design some “climate-proofed” flood defence strategies for key areas of London where the assets at risk are so high that a “living with risk” strategy is unacceptable.

The working objectives that have been suggested as “strawmen” in this report have generally been worded very flexibly, to occupy a middle ground. This is because we recognise that the best adaptation solutions to identified climate risks are, in most cases, likely to involve a mix of responses, some of which are “climate-proofing” (such as changes in design specifications), and some of which are “living with risk” (such as

contingency planning). Solutions are also likely to take the form of an evolving process, the balance of which will change over time.

### **Monitoring progress in adaptation**

We have considered two kinds of targets. The first type of target is linked explicitly to a measurable indicator (e.g., 20% reduction in CO<sub>2</sub> emissions by 2010). These kinds of outcome-based targets have value in being simple, clear and non-prescriptive about how the target may be achieved (which in turn allows for a range of actions and regional variation). They provide comparability with other policy areas, and a clear goal on which to focus. For this reason, in principle, progress is likely to be easier in practical terms to assess.

However, it was recognised in our regional level consultation that adaptation is not easily fully represented by this kind of target, and that a further danger with this approach is to focus solely on achieving the target at the expense of many of the broader aspects of good adaptation. An initial choice of endpoint based on incomplete information at the outset could constrain effective adaptation so that what is assessed is not a cost-effective or feasible adaptation action.

So a second type of target has been considered. This is process-based, and linked more closely to the adaptation objectives. These targets take the form of an identified segment of work that should be completed within a stated timeframe, so that each objective is represented by a suite of such targets that together map out the process that should culminate in the achievement of the objective. They are often focused on building capacity (i.e. the first in our three stages of adaptation, above). With process-based targets, there is a risk that the process is defined in too prescriptive a manner (thereby excluding some adaptation options at the outset). Each target should state “what” is required, but not “how” it should be done, in order to retain flexibility. Moreover, each target will require a responsible owner, and the suite of targets will need to be monitored by reportage more than data collection. Process-based targets can form the basis for the early steps towards adaptation, though for real policy progress, they need to be complemented by outcome-led policy. This is likely to emerge at later date in the evolution of the adaptation policy framework.

We proposed targets for sample objectives under six categories that spanned both building capacity and delivering adaptation action. However, an alternative template for developing targets (and subsequently, indicators) that could also be of value, sets out three categories of targets, based around planning, good practice and partnerships. These, and pointers for types of targets within these categories are set out below:

- Planning priorities
  - Strategic planning: to what extent is climate change adaptation incorporated into sectoral planning?
  - Regulation and standards: do regulatory frameworks use climate information about changing risks?
  - Research and monitoring: is the capacity in place to know when to adapt effectively?
  - Education and communication: is the nature of climate change understood by the stakeholders leading adaptation?
- Good practice in resource management:
  - Operational decision making: are the operational rules adapted to the new opportunities and risks?
  - Impacts: are specific impacts of climate change to be avoided?
- Partnerships:
  - Are stakeholders effectively organized to prepare for climate change?

Although a number of existing indicators that are relevant to adaptation have been identified, we have not defined new adaptation-specific indicators. It was felt that it was

premature to do this for three reasons: 1) the lack of a defined policy, and targets, makes the identification of specific indicators premature; 2) the majority of targets identified are process-based and not formulated specifically-enough to identify a relevant indicator; and 3) indicator identification and selection should be carried out by the organisation responsible for data collection and reporting, and thus based on practical considerations of resources and existing processes. Annual reportage of progress in relation to the process-based targets suggested under each objective is likely to form a crucial element of monitoring in the early stages of an adaptation policy.

New adaptation-specific indicators should be drawn from different components of a risk assessment and reflect:

- Risk: the changing climatic regimes
- Exposure: underlying vulnerability
- Adaptive capacity and adaptation measures: strategies and actions put into place to prepare for climate change
- Impacts: a climate proofing objective seeks to reduce the impacts or repeated climatic events; a living with risk strategy might have different indicators of performance, such as value added in agriculture rather than variability in yields of specific crops.

## 8.2 SUMMARY OF ACHIEVEMENTS

The original terms of reference for the project included the following detailed requirements. Here, we have summarised what we have achieved in relation to each point.

1. A desk-based study to review objective-setting methods used in a range of environmental policy areas and in the relevant literature (e.g. Royal Commission on Environmental Pollution's Report on Setting Environmental Standards). The review should examine different approaches such as using quantified targets, indicators, valuation, risk management methods or process based indicators (possibly drawing on the 10 adaptation principles developed by UKCIP) etc, and gather experience from other countries in the area of adaptation policy-making (e.g., Finland).

We have reviewed a range of adaptation initiatives in the UK at local, regional and national levels. We reviewed national approaches to adaptation in Canada, Australia, New Zealand, Norway, Finland and the Netherlands, and looked at international processes. The review of adaptation initiatives is presented in Appendix II. We have reviewed 8 different approaches for policy-making and/or target-setting, including both generic and adaptation-specific models. These are presented in Appendix III.

2. To identify lessons that can be transferred to develop soundly-based principles and methods for setting objectives and targets for adapting to climate change, against which it will be possible to measure progress as well as developing new and innovative ways to measure progress in adaptation.

We identified key principles for adaptation policy from the review material. These were translated into the development of a new methodology for developing objectives, targets and indicators in adaptation policy. This methodology is presented in Section 2, along with an explanation of how it was derived and applied in the project.

3. To identify priority sectors (at least 6) in which the methods will be applied. This list will be drawn up on the basis of previous scoping work on climate change impacts (e.g., Defra's IHPC report, audits of climate impacts carried out by other Government Departments, scoping studies carried out as part of the UK Climate Impacts Programme, etc.), and ongoing work in drafting the APF. The principles and methods

identified from the review and analysis should be used to suggest potential “strawman” objectives, targets and indicators in these priority sectors using the methods identified in 1 and 2.

We proposed criteria which could be used to determine priority sectors, and applied them to select the 6 sectors for the study, which were transport, energy, agriculture, tourism, water resources and flood management. This discussion is presented in Section 4. We used our proposed methodology to suggest “strawman” objectives which were the subject of limited stakeholder consultation in each of the sectors. We proposed illustrative process-based targets for sample objectives. These sectoral results are presented in Section 5, with additional impact and risk analyses provided in Appendix IV. We reviewed some indicators currently in use, discussed the merits of different kinds of indicators in adaptation, and suggested an approach to developing suites of indicators to monitor progress in adaptation. This is presented in Section 6, with the review of current indicators in Appendix VI.

4. To apply the principles and methods at local government level, to develop potential local authority indicators of adaptation, which might integrate with existing local sustainable development indicators.

We have suggested how the adaptation policy framework could be developed to integrate local level action with regional priority-setting in the context of national adaptation objectives. This discussion is presented in Section 7. We have not been able to develop potential local authority indicators of adaptation as these should logically follow the agreement of objectives and targets in sectors and regions. We have included a discussion of the relationship between adaptation and the sustainable development framework in Section 7.

5. To use stakeholder workshops to consider whether the principles and methods identified are appropriate for target-setting in adaptation policy, and to develop refinements to both methods and targets.

We agreed with Defra that it was not desirable to host large-scale workshops during autumn 2005 given the timetable of other climate change activities already planned. We consulted sectoral experts either through individual interviews or small group discussions. We consulted regional and local government representatives in two English regions (North-West and South-East) through discussion workshops. The workshop reports are provided in Appendix V. The stakeholders consulted are listed in Appendix VII.

6. To produce a final report documenting principles, methods, suggested objectives and indicators to inform the development of adaptation policy. In addition, to produce short briefing papers on the sectors considered, outlining potential objectives, targets and indicators for climate change adaptation and how they might be applied in the short and long term.

This document is the final report. Short sectoral briefing papers are provided in Appendix I. They set out the methodology for objective-setting, strawman objectives in the sector, and possible next steps. Further sectoral detail is located in Section 5.

### **8.3 RECOMMENDATIONS**

We offer the following recommendations with regard to the future application of the proposed policy-setting method:

- To facilitate the development of adaptation policy, it would be useful for Defra to progress the definition of “successful adaptation”. A definition might, for

example, focus on ensuring cost-effective and proportionate adaptation, but it could also be based on categories such as 'living with risk' or 'climate-proofing'. Whichever approach is taken, it will be important for the definition to be agreed among key stakeholders. It is not possible to define objectives, targets and indicators properly until this overarching vision for adaptation is set.

- Lower level objectives, targets and indicators follow from this goal for adaptation policy, once the definition is clear. We believe that the policy cycle presented in this report would be a valuable and practical process through which to draw down the more detailed policy components from this high level goal.
- Of course, an effective adaptation policy needs to draw on the evidence base from a wide range of disciplines, reflecting existing knowledge, expertise and practical experience, throughout its development and implementation. This evidence base is large, fragmented and complex. In leading the adaptation policy setting initiative, Defra would benefit from building on the established participatory and inclusive approach, interacting with organisations in a range of sectors, particularly during the process of setting objectives, targets and indicators.
- Policy-setting action in those sectors that do not take policy lead from Defra may be more effective if led by the appropriate government departments. Consistent with the existing approach, Defra should continue to involve other government departments at an early stage and encourage adaptation to be seen by these departments as a priority issue. Without real commitment and leadership in each sector, it is unlikely that adaptation will be effectively integrated into relevant sectoral policies and the impacts of the policy will be limited. This point parallels UKCIP advice for an "adaptation champion" at the organisational level.
- The project identified six priority 'sectors' for adaptation (transport, energy, agriculture, tourism, water resources and flood management). However the project team strongly believes that other priority sectors need to be assessed using a similar approach to the current study. Perhaps some of the most important sectors that we omitted are health, ecosystems (biodiversity and nature conservation), spatial planning (though this could be featured as a cross-cutting theme) and the built environment.
- The limited scope of the study prevented a comprehensive analysis of cross-cutting issues. However, we suggest that a number of areas may be suitable for inclusion as cross-cutting themes in the adaptation policy framework. These include procurement, education and training, science and research (in particular connected with interpreting new climate change scenarios) and monitoring and evaluation.
- Regional variations in both climate impacts and preferred adaptation strategies can affect adaptation within each sector, and may lead to the development of different policy objectives or targets at the regional level. However there are some sectors over which the regional and local level can exert minimal influence (such as perhaps agriculture and tourism which are so strongly market-driven). Sectoral leads responsible for developing adaptation policies will need to bear such issues in mind.
- Successful adaptation activities require the co-operation of a wide range of organisations and individuals. Adaptation policy development therefore also requires extensive stakeholder involvement. This involvement needs to be structured to ensure that it is properly focused. We have found the use of a staged approach, i.e. the iterative method described in this report, to be extremely useful in identifying when, and which, stakeholders can best have an input at a given stage. This approach might be useful for managing stakeholder input to subsequent phases of the APF.
- One of the difficulties we faced was keeping the process moving against the uncertainty inherent in climate change and gaps in the evidence base. The preferred choice of an objective or target might depend on, for example, the results of appraisal of various adaptation measures or more detailed understanding of existing sectoral policies. As this policy-setting method is applied in practice,



similar challenges will be encountered. In most instances it will not be possible to delay decisions until all of the evidence is available. One solution is to use the process-based approach. Whilst this means that there may be some uncertainty over outcomes, it does at least enable progress to be made. Subsequent iterations could help clarify or refine process-based targets and indicators, or replace them with outcome-based targets and indicators if this becomes possible.

- Whilst adaptation remains at an early stage of development, it is inevitable that objectives, targets and indicators will focus on building capacity. To this end, there is a need for a balanced mix of process-based and outcome-based targets and indicators. As the area progresses, we would envisage a shift towards outcome-based indicators, that focus on measuring the delivery of actual adaptation.

We offer the following recommendations with regard to the strawman objectives, targets and indicators:

- The strawman objectives and targets in this report have been designed to provoke discussion, leading to further development and refinement during future sector-based work. Although they might be suitable, none of the objectives or high-level objectives proposed in this report is anything other than an example. They are based on the opinions of the project team and a small number of informed stakeholders, but should not be presented as agreed sectoral objectives and targets.
- Targets and indicators could be further developed with organisations that have the responsibility for meeting and monitoring them. The project team has proposed some initial ideas; the next stage in developing these could take place amongst key stakeholders in existing sectors. Without this early involvement of stakeholders, targets will not be “owned” and access to a full range of data for indicator development is not possible.
- We suggest using a basket of existing indicators to communicate progress towards adaptation. Use of these indicators will also promote ‘mainstreaming’ of adaptation issues within sectors. However, these basket indicators will not be appropriate for measuring progress towards adaptation targets. For these, new adaptation-specific indicators will be required, in conjunction with checklists to ensure that key steps towards individual targets are achieved. The project team recommends the use of only one or two adaptation-specific indicators per sector, given existing pressures on organisations responsible for data collection and indicator reporting.
- Whilst headline indicators are sometimes useful for communication and can provide adaptation with a separate ‘identity’, it may be too early to focus attention on headline indicators. A headline indicator cannot adequately summarise or represent progress across all other indicators. We recommend that the focus could be placed more appropriately on measures of progress across the board in preparing for climate change, i.e. building capacity, consistent with our overall policy recommendations above.

Finally, we offer the following recommendations for future work, the most immediate priorities being:

- To develop a definition of successful adaptation for the UK. This is linked to our first recommendation, above, and could underpin future progress on the APF.
- To initiate adaptation policy analysis in priority sectors not covered by this project (including health, biodiversity and the built environment, among others).
- To engage more thoroughly with sectoral stakeholders in order to reject or refine specific strawman objectives.
- To specify targets related to revised objectives in greater detail.
- To continue to develop baskets of indicators that will be useful for communicating progress towards adaptation (perhaps to include examining trends in existing sectoral indicators against climate impacts in recent years).



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## **Appendix I: Sectoral Briefing Papers**

The following pages set out briefing pages for each of the six sectors investigated.

## Objective-setting for climate change adaptation policy: Transport

### Introduction

This briefing paper was produced as part of a Defra-funded research study into Objective-setting for Climate Change Adaptation Policy. The study was commissioned to identify and develop soundly-based principles and methods for setting objectives and targets for adaptation to climate change, and to suggest “strawman” objectives, targets and indicators in several priority sectors. It is anticipated that this project will be a starting point for both government and stakeholders to develop objectives and indicators to inform adaptation policy and drive forward their agenda. The full project report and executive summary are expected to be available on Defra’s website in due course.

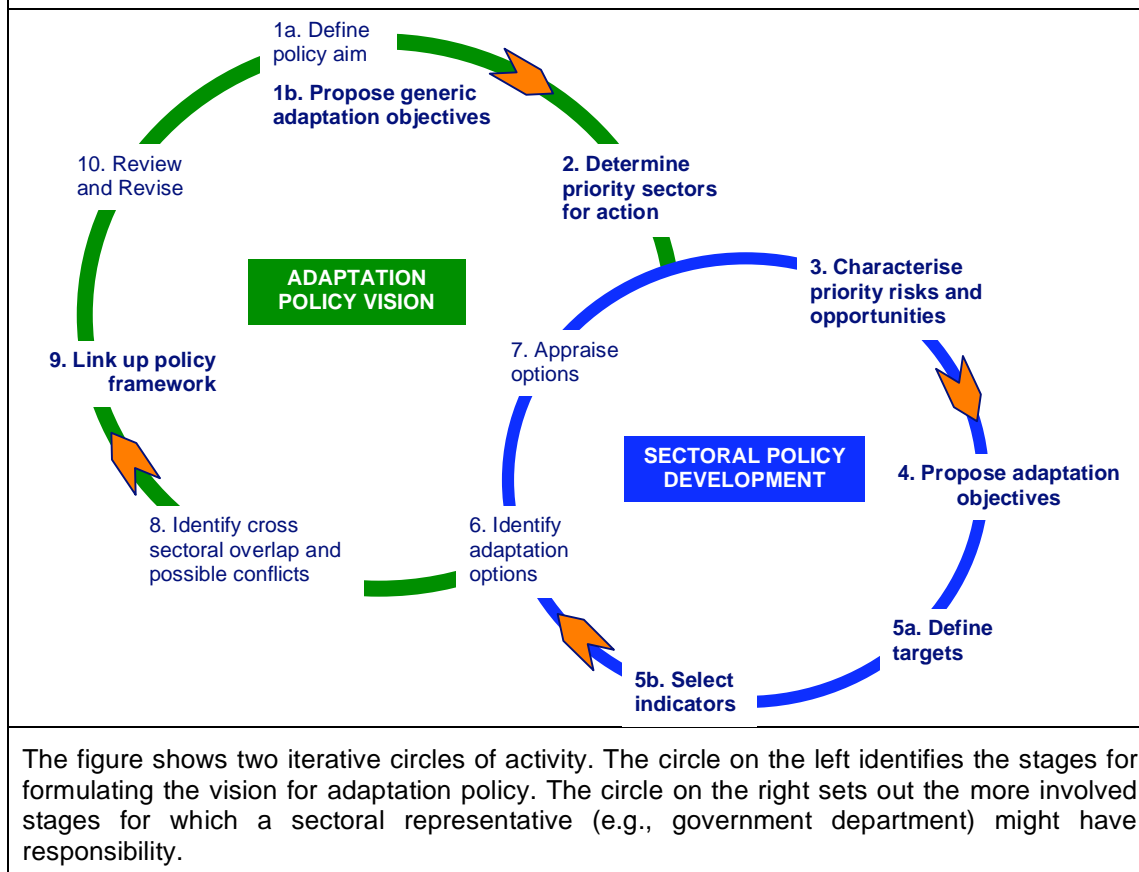
*The project has been delivered by a team from AEA Technology Environment in association with Metroeconomica and Stockholm Environment Institute (Oxford).*

### Method for adaptation policy-setting

The steps that make up the proposed adaptation policy process are illustrated in the figure below. This has taken the best practice from conventional policy frameworks in use, and combined it with elements that are specifically relevant to climate change (e.g., in relation to uncertainty) and adaptation (e.g., in relation to stakeholder consultation).

The process was derived theoretically and then refined following limited stakeholder discussion and practical application in several case study sectors.

The approach, in common with many processes for policy making and also for adaptation, is circular and iterative. The concept of a continuous and evolving process is particularly important for adaptation, since adaptation itself is by nature a continuing process. Other key features are that it requires simultaneous input from several sectors, and that it requires stakeholder input at various stages in its application.



The figure shows two iterative circles of activity. The circle on the left identifies the stages for formulating the vision for adaptation policy. The circle on the right sets out the more involved stages for which a sectoral representative (e.g., government department) might have responsibility.



**Adaptation policy aim**

The overarching aim for UK adaptation policy, expressed as a strategic outcome of Defra's climate change and energy strategic priority, is:

"The UK successfully adapting to unavoidable climate change"

**Sectoral "strawman" objectives**

Given this policy aim, the project team worked through various steps in the policy-setting method (highlighted in bold in the figure above) to develop potential "strawman" adaptation objectives in six priority sectors. The analysis was informed by limited consultation with sectoral stakeholders.

The following objectives were proposed for road and rail transport:

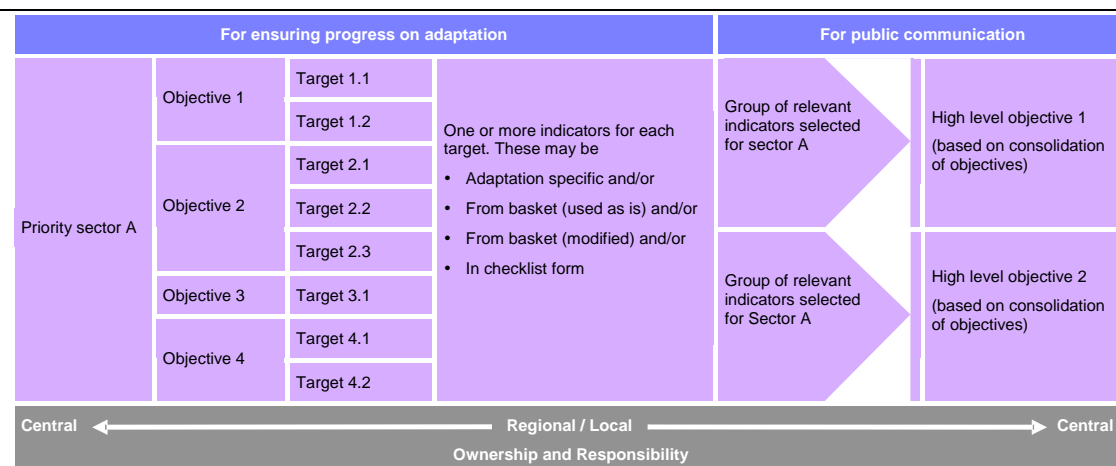
1. To improve stability of earthworks in wet weather
2. To develop appropriate solutions to combat increasing risk to infrastructure of subsidence
3. To reduce susceptibility of coastal routes to flooding
4. To improve performance of road network in extreme high temperatures
5. To improve drainage from transport networks during episodes of extreme/intense rainfall
6. To reduce disruption on transport networks from flooding
7. To improve rail track resilience under extreme high temperatures
8. To build greater flexibility into capacity of transport systems for weather-related demand changes

The proposed objectives were developed to address particular risks from climate change. They fall into the broad categories of network infrastructure impacts from extreme weather and subsidence, and a range of climate effects on transport demand.

**Next Steps**

The strawman objectives have been designed to provoke discussion, leading to further development and refinement during future sector-based work. They are based on the expert judgment of the project team and a small number of informed stakeholders.

The full report contains illustrative suggestions for process-based targets for sample objectives in categories spanning building capacity and delivering actual adaptation. It also contains recommendations for a range of indicators to monitor progress in adaptation. The figure below shows conceptually how these different components might link together in an adaptation policy framework.



The next steps in developing UK adaptation policy may include developing a definition of "successful adaptation" for the UK, initiating adaptation policy analysis in priority sectors not covered by this project, and engaging more thoroughly with sectoral stakeholders in order to reject or refine specific strawman objectives.

## Objective-setting for climate change adaptation policy: Energy

### Introduction

This briefing paper was produced as part of a Defra-funded research study into Objective-setting for Climate Change Adaptation Policy. The study was commissioned to identify and develop soundly-based principles and methods for setting objectives and targets for adaptation to climate change, and to suggest “strawman” objectives, targets and indicators in several priority sectors. It is anticipated that this project will be a starting point for both government and stakeholders to develop objectives and indicators to inform adaptation policy and drive forward their agenda. The full project report and executive summary are expected to be available on Defra’s website in due course.

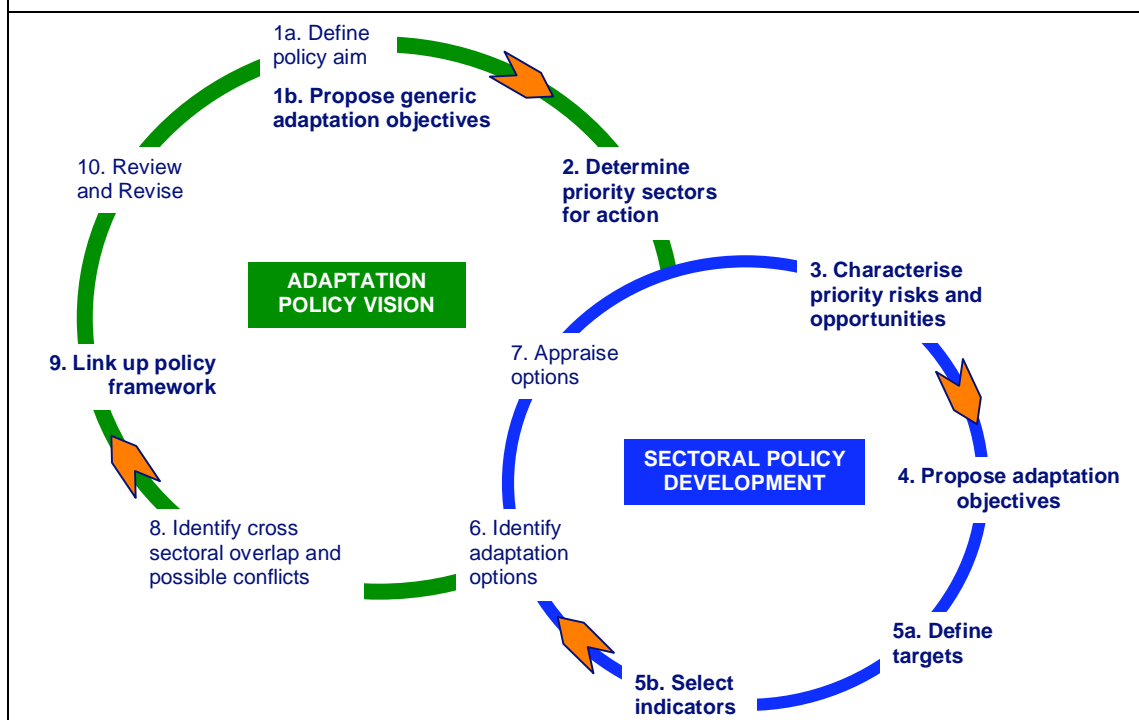
*The project has been delivered by a team from AEA Technology Environment in association with Metroeconomica and Stockholm Environment Institute (Oxford).*

### Method for adaptation policy-setting

The steps that make up the proposed adaptation policy process are illustrated in the figure below. This has taken the best practice from conventional policy frameworks in use, and combined it with elements that are specifically relevant to climate change (e.g., in relation to uncertainty) and adaptation (e.g., in relation to stakeholder consultation).

The process was derived theoretically and then refined following limited stakeholder discussion and practical application in several case study sectors.

The approach, in common with many processes for policy making and also for adaptation, is circular and iterative. The concept of a continuous and evolving process is particularly important for adaptation, since adaptation itself is by nature a continuing process. Other key features are that it requires simultaneous input from several sectors, and that it requires stakeholder input at various stages in its application.



The figure shows two iterative circles of activity. The circle on the left identifies the stages for formulating the vision for adaptation policy. The circle on the right sets out the more involved stages for which a sectoral representative (e.g., government department) might have responsibility.

**Adaptation policy aim**

The overarching aim for UK adaptation policy, expressed as a strategic outcome of Defra's climate change and energy strategic priority, is:

"The UK successfully adapting to unavoidable climate change"

**Sectoral "strawman" objectives**

Given this policy aim, the project team worked through various steps in the policy-setting method (highlighted in bold in the figure above) to develop potential "strawman" adaptation objectives in six priority sectors. The analysis was informed by limited consultation with sectoral stakeholders.

The following objectives were proposed for energy:

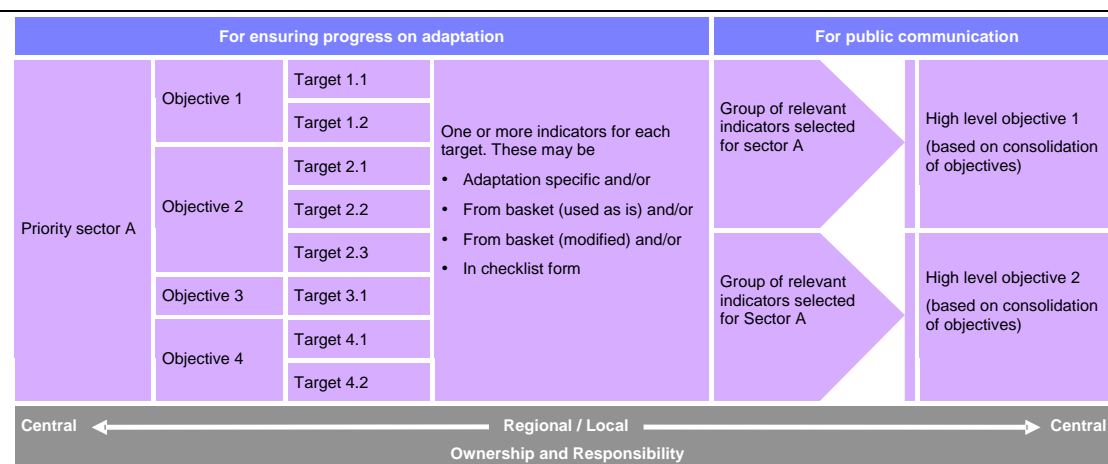
1. To improve flexibility of energy supplies to cope with incremental climate-related demand changes
2. To improve flexibility of energy supplies to cope with sudden (extreme) weather-related demand changes
3. To increase electricity network resilience to more frequent storms and extreme high winds
4. To increase electricity network resilience to future flooding and landslips
5. To improve availability of water for generation processes under drier conditions
6. To reduce vulnerability of power generation equipment to high temperatures
7. To reduce vulnerability of energy transmission infrastructure to high temperatures
8. To reduce vulnerability of coastal energy infrastructure to sea-level rise and flooding
9. To increase energy production from weather-dependent renewable sources

The proposed objectives were developed to address particular risks from climate change. They fall into the broad categories of supply and demand issues, network resilience to extreme weather and impacts from climate for renewable sources that depend on weather.

**Next Steps**

The strawman objectives have been designed to provoke discussion, leading to further development and refinement during future sector-based work. They are based on the expert judgment of the project team and a small number of informed stakeholders.

The full report contains illustrative suggestions for process-based targets for sample objectives in categories spanning building capacity and delivering actual adaptation. It also contains recommendations for a range of indicators to monitor progress in adaptation. The figure below shows conceptually how these different components might link together in an adaptation policy framework.



The next steps in developing UK adaptation policy may include developing a definition of "successful adaptation" for the UK, initiating adaptation policy analysis in priority sectors not covered by this project, and engaging more thoroughly with sectoral stakeholders in order to reject or refine specific strawman objectives.

## Objective-setting for climate change adaptation policy: Water

### Introduction

This briefing paper was produced as part of a Defra-funded research study into Objective-setting for Climate Change Adaptation Policy. The study was commissioned to identify and develop soundly-based principles and methods for setting objectives and targets for adaptation to climate change, and to suggest “strawman” objectives, targets and indicators in several priority sectors. It is anticipated that this project will be a starting point for both government and stakeholders to develop objectives and indicators to inform adaptation policy and drive forward their agenda. The full project report and executive summary are expected to be available on Defra’s website in due course.

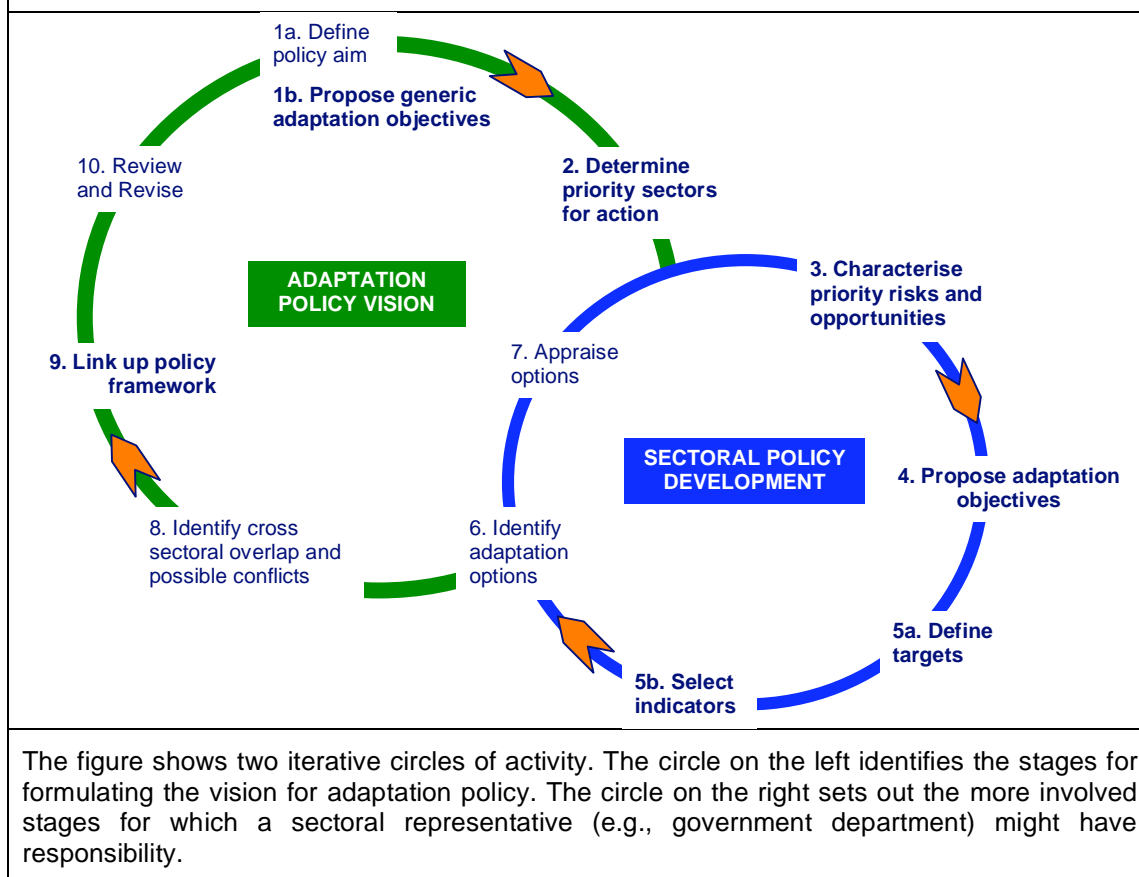
*The project has been delivered by a team from AEA Technology Environment in association with Metroeconomica and Stockholm Environment Institute (Oxford).*

### Method for adaptation policy-setting

The steps that make up the proposed adaptation policy process are illustrated in the figure below. This has taken the best practice from conventional policy frameworks in use, and combined it with elements that are specifically relevant to climate change (e.g., in relation to uncertainty) and adaptation (e.g., in relation to stakeholder consultation).

The process was derived theoretically and then refined following limited stakeholder discussion and practical application in several case study sectors.

The approach, in common with many processes for policy making and also for adaptation, is circular and iterative. The concept of a continuous and evolving process is particularly important for adaptation, since adaptation itself is by nature a continuing process. Other key features are that it requires simultaneous input from several sectors, and that it requires stakeholder input at various stages in its application.



The figure shows two iterative circles of activity. The circle on the left identifies the stages for formulating the vision for adaptation policy. The circle on the right sets out the more involved stages for which a sectoral representative (e.g., government department) might have responsibility.

**Adaptation policy aim**

The overarching aim for UK adaptation policy, expressed as a strategic outcome of Defra's climate change and energy strategic priority, is:

"The UK successfully adapting to unavoidable climate change"

**Sectoral "strawman" objectives**

Given this policy aim, the project team worked through various steps in the policy-setting method (highlighted in bold in the figure above) to develop potential "strawman" adaptation objectives in six priority sectors. The analysis was informed by limited consultation with sectoral stakeholders.

The following objectives were proposed for water:

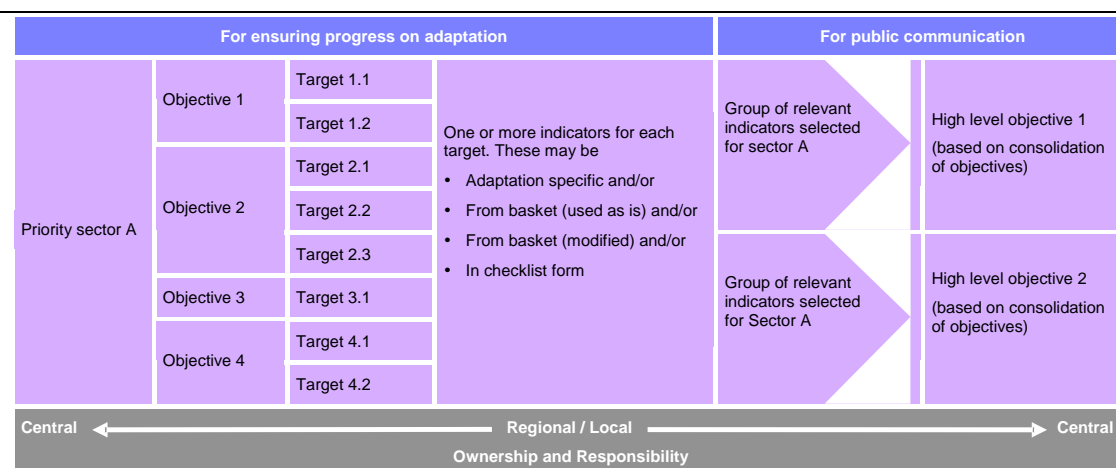
1. To manage supply–demand balance by increasing efficient use of water for domestic, industrial and agricultural purposes, accepting a reasonable level or risk
2. To reduce flood risks by placing new treatment works in safer locations, protecting high priority works, increasing storage and implementation of the WFD catchment management plans.

These objectives represent the middle ground that three expert water sector stakeholders agreed should be pursued. For water supply–demand balance, two high cost options are possible, one relying on costly infrastructure and the other on social changes and a mix of demand management, leakage control and least-cost supply enhancement. The minimal response is to continue the present management regime; after all water is a sector based on climate risk management. For water quality and sewage a demand management option is not possible (or not judged effective).

**Next Steps**

The strawman objectives have been designed to provoke discussion, leading to further development and refinement during future sector-based work. They are based on the expert judgment of the project team and a small number of informed stakeholders.

The full report contains illustrative suggestions for process-based targets for sample objectives in categories spanning building capacity and delivering actual adaptation. It also contains recommendations for a range of indicators to monitor progress in adaptation. The figure below shows conceptually how these different components might link together in an adaptation policy framework.



The next steps in developing UK adaptation policy may include developing a definition of "successful adaptation" for the UK, initiating adaptation policy analysis in priority sectors not covered by this project, and engaging more thoroughly with sectoral stakeholders in order to reject or refine specific strawman objectives.

## Objective-setting for climate change adaptation policy: Flood and coastal risk management

### Introduction

This briefing paper was produced as part of a Defra-funded research study into Objective-setting for Climate Change Adaptation Policy. The study was commissioned to identify and develop soundly-based principles and methods for setting objectives and targets for adaptation to climate change, and to suggest “strawman” objectives, targets and indicators in several priority sectors. It is anticipated that this project will be a starting point for both government and stakeholders to develop objectives and indicators to inform adaptation policy and drive forward their agenda. The full project report and executive summary are expected to be available on Defra’s website in due course.

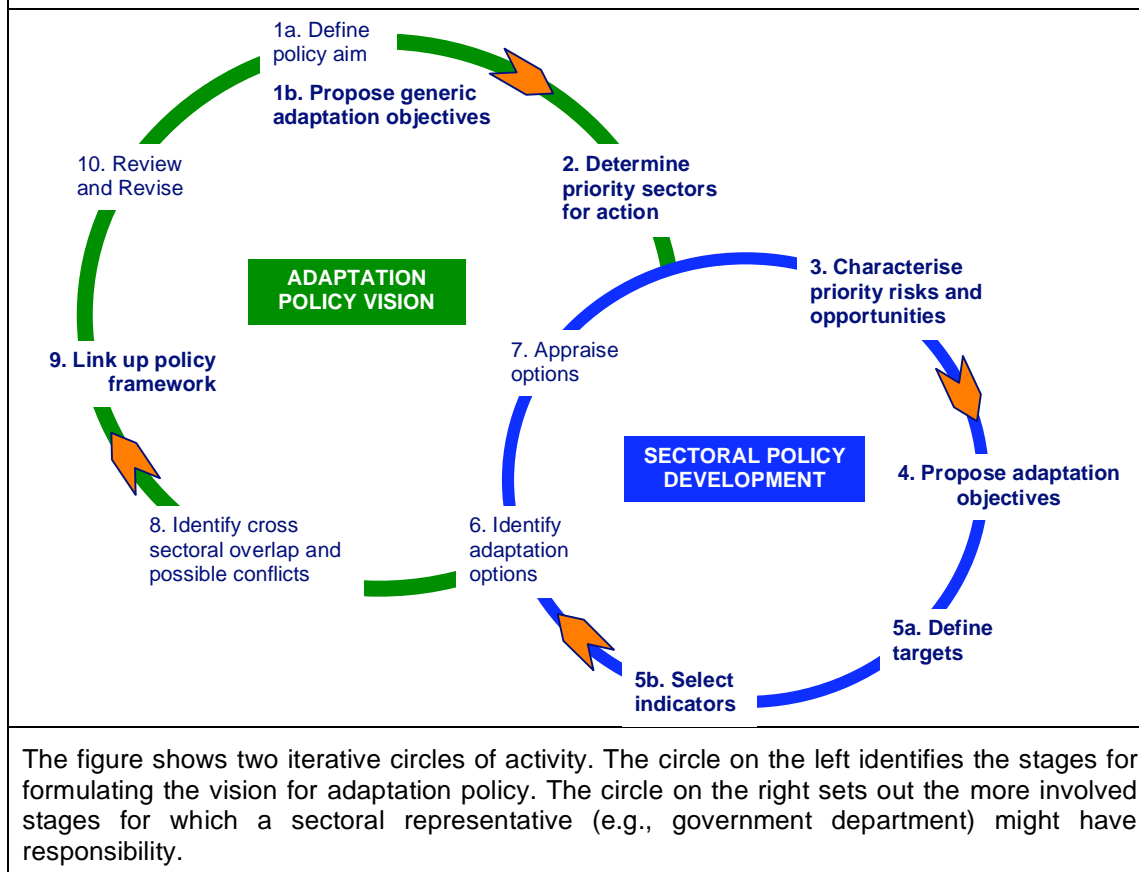
*The project has been delivered by a team from AEA Technology Environment in association with Metroeconomica and Stockholm Environment Institute (Oxford).*

### Method for adaptation policy-setting

The steps that make up the proposed adaptation policy process are illustrated in the figure below. This has taken the best practice from conventional policy frameworks in use, and combined it with elements that are specifically relevant to climate change (e.g., in relation to uncertainty) and adaptation (e.g., in relation to stakeholder consultation).

The process was derived theoretically and then refined following limited stakeholder discussion and practical application in several case study sectors.

The approach, in common with many processes for policy making and also for adaptation, is circular and iterative. The concept of a continuous and evolving process is particularly important for adaptation, since adaptation itself is by nature a continuing process. Other key features are that it requires simultaneous input from several sectors, and that it requires stakeholder input at various stages in its application.



The figure shows two iterative circles of activity. The circle on the left identifies the stages for formulating the vision for adaptation policy. The circle on the right sets out the more involved stages for which a sectoral representative (e.g., government department) might have responsibility.

**Adaptation policy aim**

The overarching aim for UK adaptation policy, expressed as a strategic outcome of Defra's climate change and energy strategic priority, is:

"The UK successfully adapting to unavoidable climate change"

**Sectoral "strawman" objectives**

Given this policy aim, the project team worked through various steps in the policy-setting method (highlighted in bold in the figure above) to develop potential "strawman" adaptation objectives in six priority sectors. The analysis was informed by limited consultation with sectoral stakeholders.

The following objectives were proposed for flood and coastal risk management:

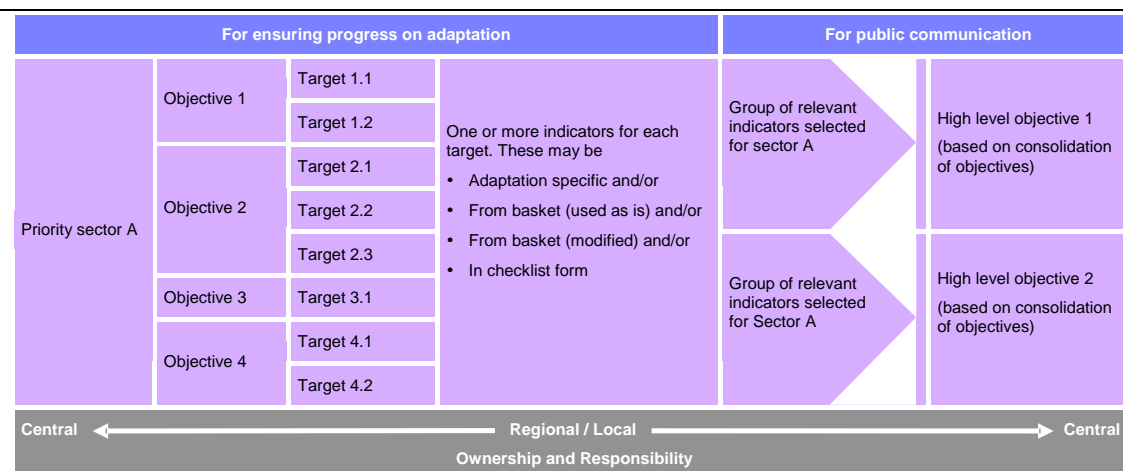
1. To limit riverine flood risks under alternative future climate scenarios to levels acceptable in terms of their economic, social and environmental consequences
2. To limit urban flood risks under alternative future climate scenarios to levels acceptable in terms of their economic, social and environmental consequences
3. To limit sea level rise impacts under alternative future climate scenarios to levels acceptable in terms of their economic, social and environmental consequences
4. To limit storm surge risks under alternative future climate scenarios to levels acceptable in terms of their economic, social and environmental consequences

The objectives were derived directly from consideration of the climate change risks and opportunities. They adopt a common structure, reflecting the current emphasis on a more holistic philosophy within the sector. Thus, the acceptable level of risks and impacts are framed in relation to their economic, social and environmental consequences. The reference to climate scenarios is the only distinction between these *adaptation* objectives and existing objectives in the sector.

**Next Steps**

The strawman objectives have been designed to provoke discussion, leading to further development and refinement during future sector-based work. They are based on the expert judgment of the project team and a small number of informed stakeholders.

The full report contains illustrative suggestions for process-based targets for sample objectives in categories spanning building capacity and delivering actual adaptation. It also contains recommendations for a range of indicators to monitor progress in adaptation. The figure below shows conceptually how these different components might link together in an adaptation policy framework.



The next steps in developing UK adaptation policy may include developing a definition of "successful adaptation" for the UK, initiating adaptation policy analysis in priority sectors not covered by this project, and engaging more thoroughly with sectoral stakeholders in order to reject or refine specific strawman objectives.



## Objective-setting for climate change adaptation policy: Agriculture

### Introduction

This briefing paper was produced as part of a Defra-funded research study into Objective-setting for Climate Change Adaptation Policy. The study was commissioned to identify and develop soundly-based principles and methods for setting objectives and targets for adaptation to climate change, and to suggest “strawman” objectives, targets and indicators in several priority sectors. It is anticipated that this project will be a starting point for both government and stakeholders to develop objectives and indicators to inform adaptation policy and drive forward their agenda. The full project report and executive summary are expected to be available on Defra’s website in due course.

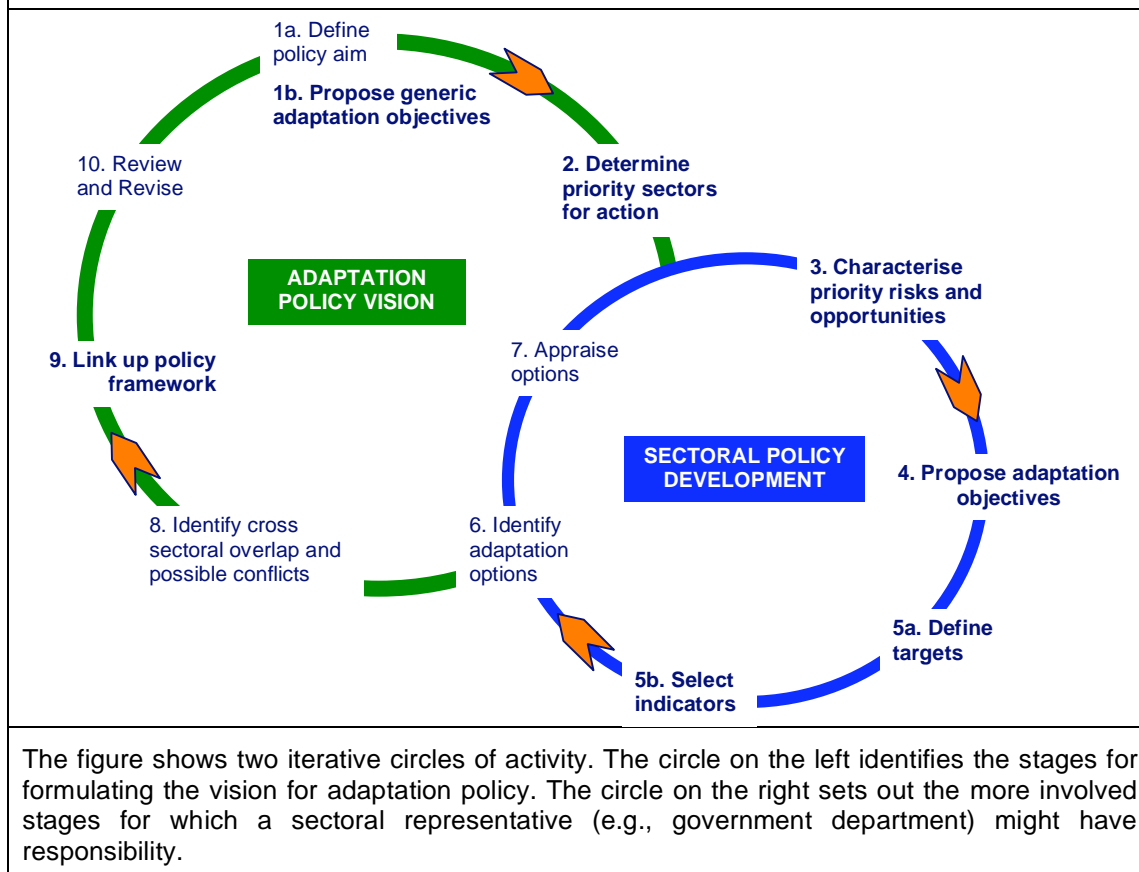
*The project has been delivered by a team from AEA Technology Environment in association with Metroeconomica and Stockholm Environment Institute (Oxford).*

### Method for adaptation policy-setting

The steps that make up the proposed adaptation policy process are illustrated in the figure below. This has taken the best practice from conventional policy frameworks in use, and combined it with elements that are specifically relevant to climate change (e.g., in relation to uncertainty) and adaptation (e.g., in relation to stakeholder consultation).

The process was derived theoretically and then refined following limited stakeholder discussion and practical application in several case study sectors.

The approach, in common with many processes for policy making and also for adaptation, is circular and iterative. The concept of a continuous and evolving process is particularly important for adaptation, since adaptation itself is by nature a continuing process. Other key features are that it requires simultaneous input from several sectors, and that it requires stakeholder input at various stages in its application.



The figure shows two iterative circles of activity. The circle on the left identifies the stages for formulating the vision for adaptation policy. The circle on the right sets out the more involved stages for which a sectoral representative (e.g., government department) might have responsibility.



**Adaptation policy aim**

The overarching aim for UK adaptation policy, expressed as a strategic outcome of Defra's climate change and energy strategic priority, is:

"The UK successfully adapting to unavoidable climate change"

**Sectoral "strawman" objectives**

Given this policy aim, the project team worked through various steps in the policy-setting method (highlighted in bold in the figure above) to develop potential "strawman" adaptation objectives in six priority sectors. The analysis was informed by limited consultation with sectoral stakeholders.

The following objectives were proposed for agriculture:

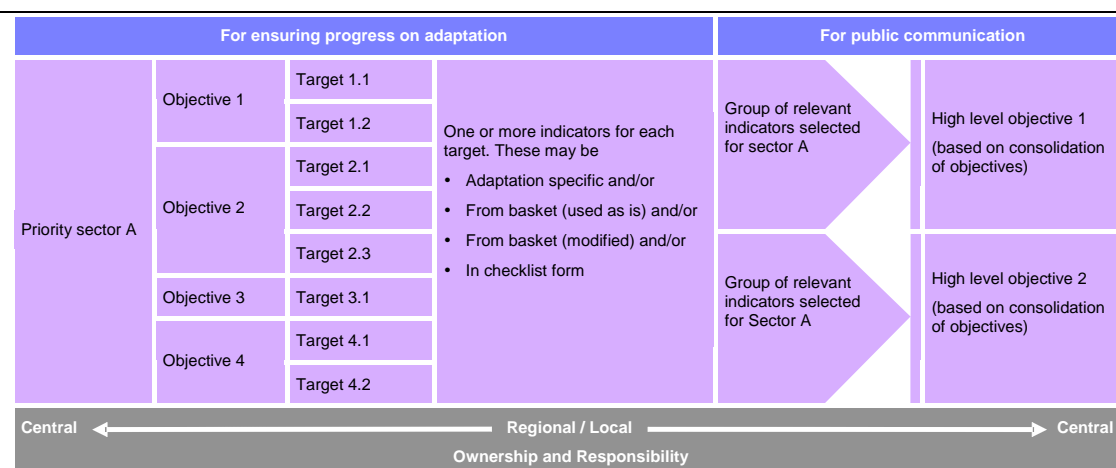
1. To enable farmers and markets to take advantages of new opportunities and manage changes in climate resources and risks.
2. To anticipate climate change and ensure national strategy of adaptation is incorporated into agri-environment schemes and regulations.
3. To develop regional specific plans and anticipate new regional agro-processing needs due to shifts in regional suitability of agricultural activity/ crop.
4. To anticipate new requirements for crops from plant breeding programmes particularly because of increases in temperature and summer drought conditions.

The objectives focus on clusters within the sector rather than on individual risks to crops or livestock. These broad objectives could encompass solutions to specific risks such as adapting management of livestock feed because of changes in the availability of autumn grazing; investing in irrigation and on-farm reservoirs to allow for drier summers or investing in new housing for livestock to avoid higher summer temperatures.

**Next Steps**

The strawman objectives have been designed to provoke discussion, leading to further development and refinement during future sector-based work. They are based on the expert judgment of the project team and a small number of informed stakeholders.

The full report contains illustrative suggestions for process-based targets for sample objectives in categories spanning building capacity and delivering actual adaptation. It also contains recommendations for a range of indicators to monitor progress in adaptation. The figure below shows conceptually how these different components might link together in an adaptation policy framework.



The next steps in developing UK adaptation policy may include developing a definition of "successful adaptation" for the UK, initiating adaptation policy analysis in priority sectors not covered by this project, and engaging more thoroughly with sectoral stakeholders in order to reject or refine specific strawman objectives.

## Objective-setting for climate change adaptation policy: Tourism

### Introduction

This briefing paper was produced as part of a Defra-funded research study into Objective-setting for Climate Change Adaptation Policy. The study was commissioned to identify and develop soundly-based principles and methods for setting objectives and targets for adaptation to climate change, and to suggest “strawman” objectives, targets and indicators in several priority sectors. It is anticipated that this project will be a starting point for both government and stakeholders to develop objectives and indicators to inform adaptation policy and drive forward their agenda. The full project report and executive summary are expected to be available on Defra’s website in due course.

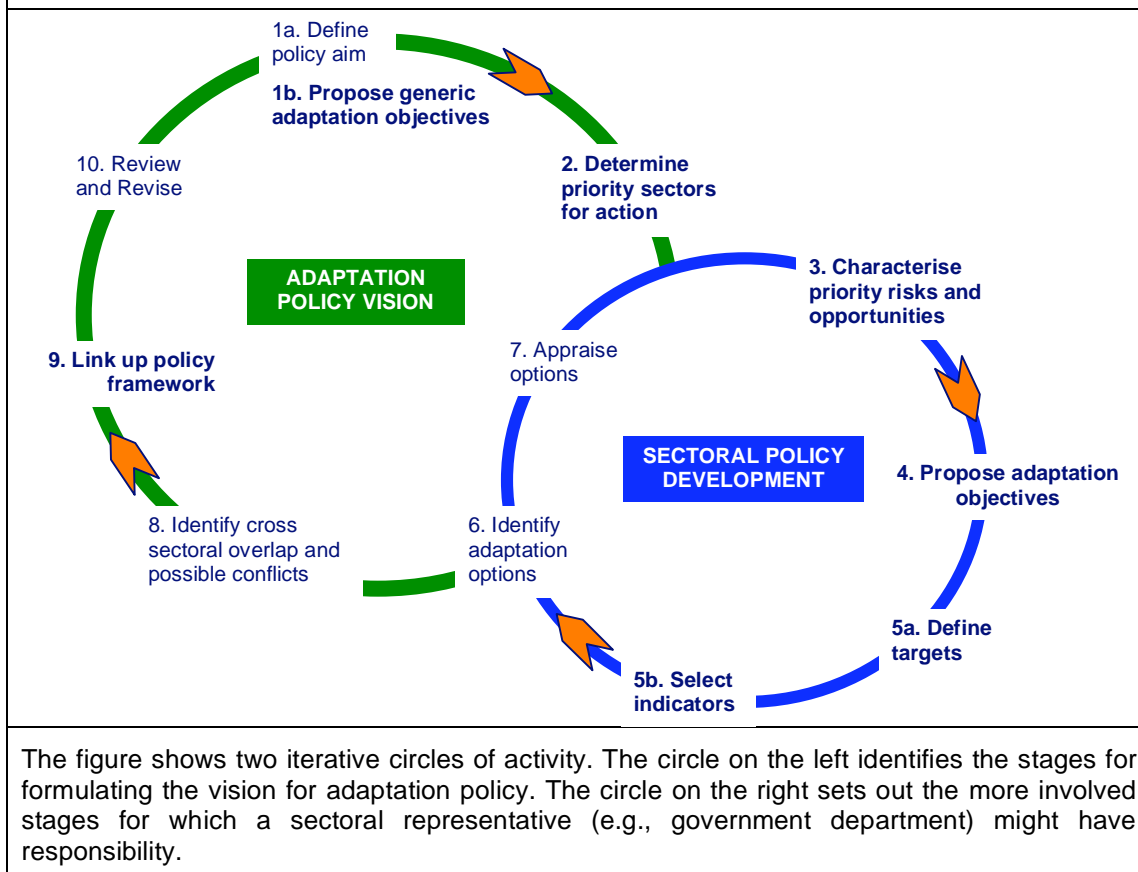
*The project has been delivered by a team from AEA Technology Environment in association with Metroeconomica and Stockholm Environment Institute (Oxford).*

### Method for adaptation policy-setting

The steps that make up the proposed adaptation policy process are illustrated in the figure below. This has taken the best practice from conventional policy frameworks in use, and combined it with elements that are specifically relevant to climate change (e.g., in relation to uncertainty) and adaptation (e.g., in relation to stakeholder consultation).

The process was derived theoretically and then refined following limited stakeholder discussion and practical application in several case study sectors.

The approach, in common with many processes for policy making and also for adaptation, is circular and iterative. The concept of a continuous and evolving process is particularly important for adaptation, since adaptation itself is by nature a continuing process. Other key features are that it requires simultaneous input from several sectors, and that it requires stakeholder input at various stages in its application.



**Adaptation policy aim**

The overarching aim for UK adaptation policy, expressed as a strategic outcome of Defra's climate change and energy strategic priority, is:

"The UK successfully adapting to unavoidable climate change"

**Sectoral "strawman" objectives**

Given this policy aim, the project team worked through various steps in the policy-setting method (highlighted in bold in the figure above) to develop potential "strawman" adaptation objectives in six priority sectors. The analysis was informed by limited consultation with sectoral stakeholders.

The following objectives were proposed for tourism:

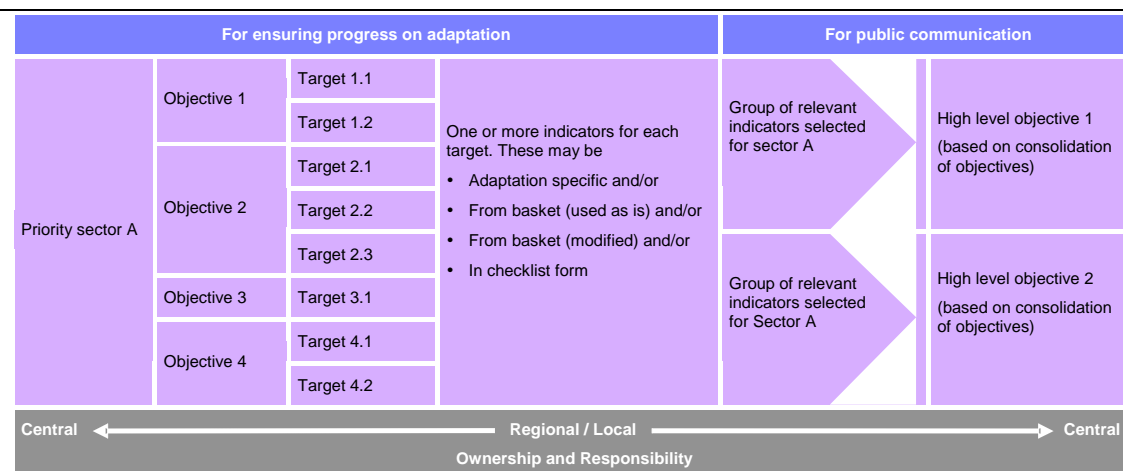
1. To accommodate changing patterns of visitor numbers projected under alternative climate scenarios in regional planning and tourism infrastructure provision, taking into account seasonality
2. To minimise likelihood of travel disruption for tourists and leisure travellers
3. To ensure no increased pressure on water resources for tourists, and as a result of tourists and leisure travellers
4. To limit the risk of structural damage at heritage sites to acceptable levels
5. To ensure effective maintenance of National parks and gardens to minimise risks of loss
6. To maximally exploit opportunities to increase participation in outdoor pursuits
7. To limit potential disruption to utilities to acceptable levels at key tourist sites

The proposed objectives were derived directly from consideration of the climate change risks and opportunities. A key feature of a number of the objectives above is that they are cross-sectoral. Only the objectives (1 and 4) that focus directly on the visitor experience are those where stakeholders in the industry are likely to be the principal movers in achieving them.

**Next Steps**

The strawman objectives have been designed to provoke discussion, leading to further development and refinement during future sector-based work. They are based on the expert judgment of the project team and a small number of informed stakeholders.

The full report contains illustrative suggestions for process-based targets for sample objectives in categories spanning building capacity and delivering actual adaptation. It also contains recommendations for a range of indicators to monitor progress in adaptation. The figure below shows conceptually how these different components might link together in an adaptation policy framework.



The next steps in developing UK adaptation policy may include developing a definition of "successful adaptation" for the UK, initiating adaptation policy analysis in priority sectors not covered by this project, and engaging more thoroughly with sectoral stakeholders in order to reject or refine specific strawman objectives.

## Appendix II: Current Policy and Policy-related Initiatives on Adaptation

There is currently no single international policy on adaptation to climate change. The Kyoto Protocol addresses the challenge of climate change mitigation, but addresses adaptation only through the surcharge on the Clean Development Mechanism. Subsequent negotiations, such as the Marrakech Accords, outline concerns for adaptation and development, and establish some funding mechanisms including the National Adaptation Programmes of Action. However, there is no protocol on adaptation with specific policy aims, reporting and monitoring requirements (beyond the National Communications) and mechanisms for achieving adaptation as contained in the Kyoto Protocol for greenhouse gas emissions.

The European Union (EU) is starting to address the adaptation issue and has begun to look at the impacts of climate change on EU countries and the costs of adaptation (see CEC 2005), but the evolution of EU policies on adaptation is not imminent. No other international trading blocs have addressed the issue.

The Intergovernmental Panel on Climate Change (IPCC) has had, and will continue to have international influence on national adaptation responses. Since all countries look to this organisation for guidance, its policy-related work is briefly reviewed here.

A number of foreign Governments have made progress on adaptation. Their experiences are also reviewed, but few have considered how to factor adaptation into national policy.

In the UK, the Government has set objectives and priorities for adaptation, but there is no national policy. However, the Government, Devolved Administrations, regional and local government have started to consider possible responses to the threat of climate change. Some have progressed to the point of building adaptation into their policies. Defra's APF seeks to build on the progress made so far. This work is reviewed and key elements of these public sector initiatives in the UK are summarised.

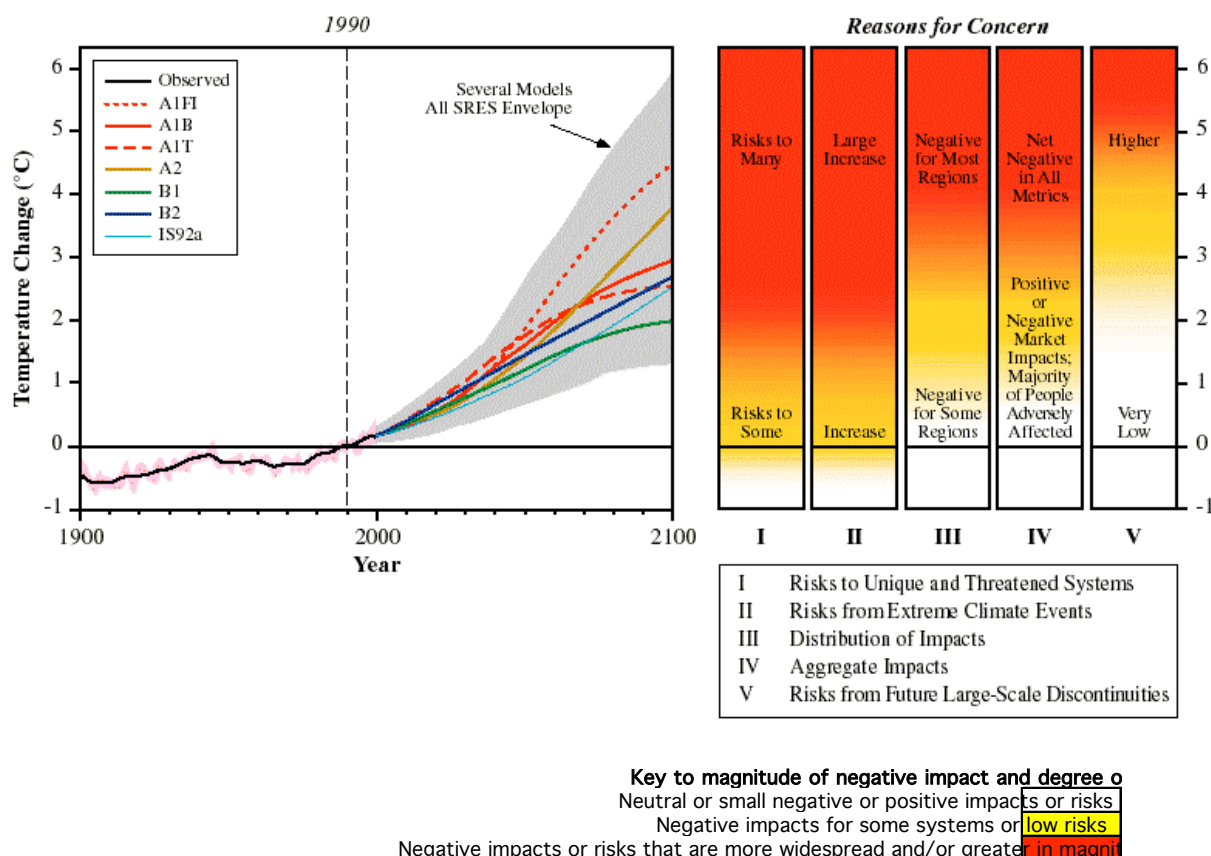
### A2.1 INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

Although not responsible for policy setting, the IPCC has produced a number of key outputs that have strongly influenced national and international thinking on climate change. One of these outputs is The Third Assessment Report, which confirms that risks of adverse impacts from climate change increase with the magnitude of climate change.

Figure A1 highlights the magnitude of the negative impact and the risk of this occurring in relation to increased temperature change. The left part of the figure displays the observed temperature increase (relative to 1990) and the range of projected temperature increase after 1990 as estimated by Working Group I of the IPCC from the Special Report on Emissions Scenarios (SRES). The right side displays five causes for concern regarding climate change risks evolving in the period to 2100. Risks from large-scale discontinuities only start to become significant above a 3°C temperature change. Negative impacts on unique or threatened systems and risks from extreme climate events occur with a temperature change as small as 1°C and these impacts and risks are projected to become significant and widespread for changes of 2 to 3°C. Above 2°C temperature increase, the vast majority of market impacts are predicted to be negative and most regions will suffer adverse effects from climate change.

The IPCC reported that the assessment of impacts or risks takes into account only the magnitude of change and not the rate of change. Global mean annual temperature change is used in the figure as an approximation for the magnitude of climate change, but projected impacts will be a function of a number of factors including the magnitude and rate of global and regional changes in mean climate, extreme events and socio-economic conditions.

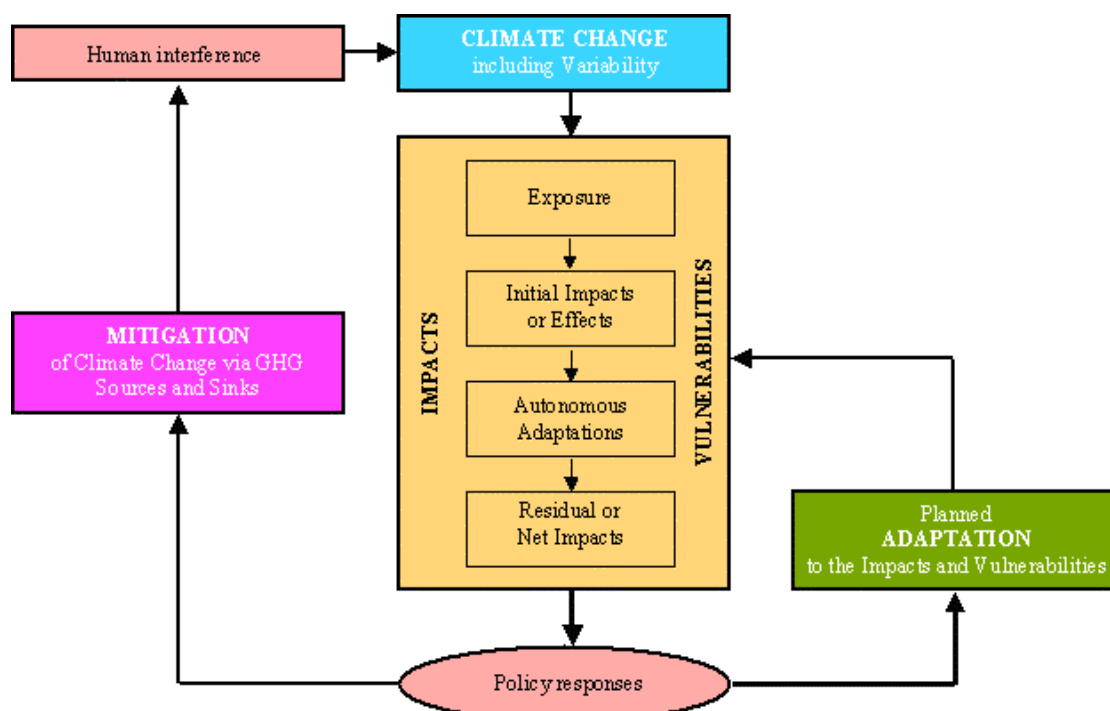
Figure A1. The risks of adverse climate change impacts with the magnitude of climate change (IPCC Summary for Policy Makers, see [www.ipcc.ch](http://www.ipcc.ch))



This summary diagram raises the prospect of a multi-dimensional risk assessment. Rather than reduce climate change to a single dimension (e.g., the cost of damages per ton of carbon), the figure shows five 'reasons for concern' and their potential status regarding future climate change (the shading in red). A policy framework might seek to derive such risks for key sectors or regions using methods in social risk assessment.

The IPCC has also reported several frameworks that have influenced the thinking of researchers and policy makers in adaptation. One example that shows the interrelationship between adaptation and mitigation is shown in Figure A2. This sequence of analysis has been applied in the IPCC Working Group II and is referred to in national adaptation studies in northern Europe. It shows adaptation as a necessary policy response to lessen the adverse effects of climate change (or to enhance the beneficial effects), thus complementing the policies of mitigation.

Figure A2: The relationship between adaptation and mitigation (after Smit et al. 1999)

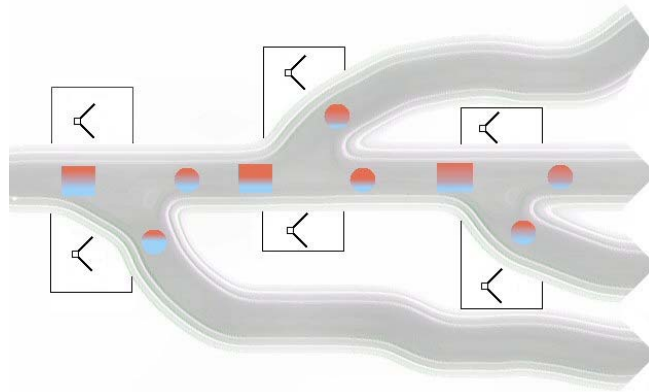


The Fourth Assessment Report (AR4) is exploring frameworks based on learning over time for adaptation and mitigation. The notion is that both are embedded in many decision contexts other than just climate change, yet the linkages (a) between mitigation and adaptation and (b) between climate-driven and other decision processes are not well documented.

Particular climate policy decisions, and the climate policy decision problem itself, are rooted in the larger context of response capacity and development paths. Thus the act-learn-act-again framework is connected to a larger set of policy decisions that are not driven by climate policy. Ideally, those connections would be explicit and the act-learn-act-again framework would be expanded to include, insofar as possible, explicit consideration of those larger contextual factors. In some cases this might involve only an explicit consideration of the implications of climate policy measures for sustainable development. In others it might extend to the development of a sustainable development policy framework in which climate goals are embedded. In either case, the decision framework connects climate policy to the larger world of sustainable development analysis and policy.

Figure A3 shows schematically how decisions on climate policy relate to development paths. Climate policy decisions (the rectangular panels of decision nodes) connect to underlying socio-economic and technological development paths (the branching streams). The development path frames and constrains response capacity—indicated by the squares with a blend of mitigation (red) and adaptive (blue) capacity. Climate policy choices (the square nodes) may not be related to development policy, either at the international scale (above the path) or local actors who are unlikely to influence development pathways (below the path). Climate responses may occur at key junctures. The outcomes of these branch-decisions, sometimes called tipping points, is represented by the circular nodes, also shaded according to the balance of mitigative or adaptive capacity. As the path unfolds, different adaptation options may be available and the success of their outcomes may change.

*Figure A3. Climate policy decision-making and development paths framing climate policy decision making.*



At COP10, EFIEA, RIVM and the Tyndall Centre held a side event entitled, “Towards a long-term European strategy on climate change policy”<sup>9</sup>. Relevant recommendations arising from their meeting were to:

- Pay more attention to impacts and adaptation to enhance support for mitigation. In the last decade the focus in the negotiations has been too much on the costs of mitigation: there is a great need to complement this with attention to impacts and adaptation, as well as to the link between impacts and mitigation strategies, within the EU and externally.
- Increase the visibility of impacts and the need for adaptation helps to trigger involvement of both North and South.
- Develop criteria for determining which adaptation policies would benefit from a common (EU) approach. The subsidiary principle (i.e., take action on lowest possible level) should be applied here, but there may be a need for specific regional support.
- Address the importance of long-term irreversible impacts (the slowing of the THC, disintegration of the WIS, melting of the Greenland ice cap).
- Develop EU adaptation knowledge and capacity that will be useful for other regions and create new market opportunities also.

However, an EU adaptation strategy and accompanying policy appears to be some way off.

## A2.2 NATIONAL – FOREIGN GOVERNMENTS

Of the various foreign governments that have taken a proactive response to the adaptation issue, the Government of Canada is probably the most advanced. Here, there are adaptation programmes on the provincial level and analyses by sector but, in addition, adaptation is now being taken into account in national climate policy. The Australian Government is also starting to consider how existing policy should be modified to reflect the need to adapt to climate change. Adaptation is not yet a part of Norwegian or Finnish climate policy, but both countries have research programmes on climate change and adaptation. In the Netherlands, adaptation is discussed within the context of water policy and it is one of the research topics in the national research programme on climate change. Progress on adaptation in these countries is reviewed below.

The authors are aware of adaptation studies in Belize, St. Lucia, Antigua and Barbuda, but in these countries, the gap between research and policy setting appears to be considerably

<sup>9</sup> More details of discussion on impacts, mitigation and adaptation can be seen at: [http://tyndall.e-collaboration.co.uk/events/past\\_events/past\\_events.shtml](http://tyndall.e-collaboration.co.uk/events/past_events/past_events.shtml)



greater and there are fewer useful lessons for Defra to draw on. For this reason, these studies are not further examined here.

### **A2.2.1 Canada**

The Canadian Climate Change Plan, set out in 2002, included science, impacts and adaptation objectives. The science and adaptation agenda is currently being developed through Project Green. Policy related work is being carried out through the Climate Change Impacts and Adaptation programme, which is investigating the analysis of climate change implications for existing policies and developing a National Adaptation Framework.

The Canadian approach to adaptation has been sectorally focused. After an examination of climate impacts, Government of Canada (2004) consider various adaptation strategies by sector. These include:

- structural adaptations – changing physical infrastructure, planning design and construction standards
- institutional adaptations – enhancing the ability of government, agencies and local communities to adapt together and facilitating the response
- knowledge gaps and research needs – focusing effort on vulnerable regions and systems

More recent thinking on adaptation by the Government of Canada was elaborated in a workshop (May 2005), *Adapting to Climate Change in Canada 2005: understanding risks and building capacity*. In his presentation, Alrick Huebener (Natural Resources Canada) discussed the Federal government policy directions on climate change impacts and adaptation; his views are described in the following paragraphs.

The Government of Canada takes a three way view on adaptation:

- By region, particularly the north, coast zones, the Prairies and British Columbia (water resources), Great Lakes and St. Lawrence
- By sector, particularly agriculture, forestry, fisheries, tourism, transportation and energy
- By cross cutting issues, particularly hazards and extreme events, communities, health and well-being and infrastructure.

Adaptation now needs to make the transition from an issue driven mainly by research to one driven by policy objectives. To achieve this, it needs to have a greater reach to the policy and decision makers, and to become better integrated into government planning systems. Knowledge gaps need to be addressed, but a trade off is acknowledged: decisions cannot wait for “perfect knowledge”. Partnership and communication are critical to the entire process.

The Canadian Adaptation Framework aims to identify where different tiers of government (federal, provincial and territorial) can work together. It aims to raise awareness of adaptation

- facilitate and strengthen capacity for coordinated action on adaptation
- incorporate adaptation into policy and operations
- promote and coordinate research on impacts and adaptation
- support knowledge-sharing networks
- provide methods and tools for adaptation planning.

The Canadian Government is moving towards a risk management approach. It envisages three stages, which involve:

- assessing risks – improving knowledge and understanding of risk and resilience



- risk management planning – building decision tools and evaluating adaptation options
- reducing risks – taking action by implementing policies and programmes.

Prudent action to reduce risks will involve:

- building knowledge of current and future climate vulnerabilities and current and future adaptive capacity
- awareness and engagement of key opinion leaders and planning communities, accompanied by improved interaction between science and applied decision making community
- tools that enable risk assessment methodologies appropriate for sectors and regions, and for decision-making and risk management (e.g. financial tools for costing of impacts and adaptation options)
- mainstreaming – integration of climate change into existing planning systems.

### **A2.2.2 Australia**

The Australian Government announced the National Climate Change Adaptation Programme in the May 2004 budget, with the aim of preparing government, vulnerable industry and communities for the unavoidable impacts of climate change.

After wide consultation of government and government agencies, ACG (2005) produced a report on climate change risk and vulnerability. The authors view vulnerability as the combination of *adaptive capacity* and *potential impact* (where potential impact is a combination of *exposure* and *sensitivity* to climate change). Also factored into the vulnerability equation are the broader *adverse implications* of climate change and the *potential to benefit*. Prioritising adaptation action requires the identification of vulnerable systems.

A number of vulnerable systems are identified within both sectors (ecosystems and biodiversity, agriculture, water supply, settlements and emergency services and energy) and regions (the Murray Darling Basin, south-west Western Australia, the Cairns and Great Barrier Reef, coast and central Queensland, alpine regions, northern Australia and rangeland communities). The report favours a risk management approach and suggest a number of analytical techniques for decision-making under uncertainty.

Stakeholder consultation indicated that the role of government is to:

- improve understanding of science and provide a framework for a collaborative and multi-disciplinary effort
- to co-ordinate reviews and development strategies for identifying and managing risk in vulnerable sectors and regions
- to provide decision support tools that could assist local government, the private sector and households to integrate climate risks into decision-making.

The report identifies a number of existing Australian Government policies and programmes, and responsible departments, whose goals could be considerably affected by climate change, and which should take account of adaptation needs.

### **A2.2.3 New Zealand**

An international workshop on adaptation practices and strategies in developed countries was held in October 2004 in New Zealand. The aim was to share experiences in practical adaptation, including the role of research, risk assessment, and evaluation and monitoring. The workshop also considered whether there are useful criteria to prioritise early and proactive

adaptation actions, and to identify drivers, barriers, and solutions to enable proactive adaptation.

Richard Warrick (International Global Change Institute, University of Waikato, New Zealand) outlined a possible framework to describe adaptation in practice. This approach considers adaptation as a continuous process, consisting of the provision of knowledge, data and tools, risk and vulnerability assessments based on this information, the “mainstreaming” of adaptation into policies and plans, evaluation and monitoring of adaptation strategies, and awareness raising and capacity building. All five elements jointly contribute to the actual implementation of adaptation measures.

It was observed that many countries had encountered a barrier to move from (mostly topdown) vulnerability assessments towards mainstreaming and implementing adaptation, since this generally required the engagement of a broad range of stakeholders inside and outside of central government with different needs or expectations of central government guidance, and consequently various combinations of bottom-up and top-down approaches. A top-level support for adaptation was seen as equally important as a demand amongst stakeholders for relevant information and actions. Working alongside stakeholders in developing action plans was also described as critical by some participants. Merely providing information to stakeholders about climate impacts does not generally achieve the expected or intended adaptation response.

A coordination across government departments was considered beneficial to assist with mainstreaming adaptation at the top level in policies, identifying areas of national priority, avoiding duplication or major gaps, and showing leadership for stakeholders who are still unsure about the reality, significance and adaptation options for climate change impacts.

Government-funded research into climate change impacts and adaptation options needs to be integrated into real-world decision-making problems by stakeholders, and solutions need to be developed in partnerships with stakeholders to be effective. Participants were reminded that past experiences of adapting to current climate conditions should be used as effective models for adaptation to future climate changes, and that it was often sufficient to apply existing models and solutions to adapt to future changes - the biggest challenge was to maintain the appropriate balance between a long-term perspective of sustainability and attention to current challenges and priorities for decision-makers.

#### **A2.2.4 Norway**

Work on adaptation in Norway is being led by the Centre for International Climate and Environmental Research. Over the past few years, several projects have been undertaking in Norway to enhance understanding of the socioeconomic impacts of climate change and develop models for understanding Norway’s economic and social vulnerability. These studies have developed a methodological framework for impacts and vulnerability analysis, identified the most vulnerable sectors in the regions of Norway and the factors that contribute to this vulnerability, and analysed institutional structures that promote or constrain adaptation.

In a review of recent research work, Sygna *et al.* (2004) conclude that vulnerability to climate change is highly differentiated between regions and sectors. The authors advocate a multi-method, multi-sector and multi-scale interdisciplinary approach to adaptation, warning that risks and opportunities may not be captured by using a more narrow focus.

Norland *et al.* (in press) investigate what makes climate change vulnerability assessments matter in a local context. Their (so far unpublished) research addresses two key issues

ultimately affecting actions taken at the local level: first, how assessment information can be made relevant for local stakeholders, and second, how assessments can be used in local policy and administrative processes. The study concludes with an argument for a dialectic approach between “top-down descriptive” and “bottom-up interpretive” assessment approaches, and an emphasis on “process” over “product”.

Adaptation in Norway is still principally a research issue and, so far, has not been integrated into relevant national policy.

### **A2.2.5 Finland**

In their preliminary review of adaptation in Finland, Carter and Kankaapää (2003) conclude that climate change adaptation and adaptive capacity is insufficient for reliable evaluation of adaptation policies in Finland. Many of research gaps are identified in their review, are now being addressed by the FINADAPT project (2004-5). This project, coordinated by the Finnish Environment Institute (SKYE), is the first Finnish in-depth study on the ability of the Finnish environment and society to adapt to climate change. The primary objective of FINADAPT is to produce a scoping report on vulnerability and adaptive capacity under a changing climate in Finland. The report should:

- outline knowledge about current climate variations
- describe future changes in climate and other environmental and socio-economic factors projected for the 21st century
- characterise adaptive capacity to cope with present-day climatic conditions
- provide estimates of potential impacts under future climate change, including costs where appropriate
- list potential measures/strategies for adapting to climate change (including costs)
- assess the relative vulnerability of different systems, regions, sectors or communities to climate change, identifying priority areas for attention
- identify the major gaps in knowledge and needs for new research
- distil the major findings in a summary for policy makers

In September 2005 Finland’s National Strategy for Adaptation to Climate Change was launched by the Ministry of Agriculture and Forestry following the creation of an inter-ministerial task force (67 ministries plus the Finnish Meteorological Institute and the Finnish Environment Institute), consultation with experts, the research community and main stakeholders and a public hearing of the proposal. Broad participation and transparency during the whole process was considered essential to achieve widely accepted objectives and measures and ensure wide sectoral and political commitment. The strategy (see Marttila *et al.* 2005) involves mainstreaming implementation and adaptation into sectoral planning with the aim of increasing capacity and adapting to future climate change. Some activities have already begun- looking at current variability and win-win activities (extreme weather events, long-term investments). Monitoring of the strategy is planned through follow-up measures of sectoral strategies and programmes. The strategy will be reviewed in 6 to 8 years.

### **A2.2.6 Netherlands**

The Netherlands is responding to climate change through activity coordinated at the national level across a number of ministries, led by the Netherlands Ministry of Spatial Planning, Housing and the Environment. Much research on climate change impacts and adaptation measures focuses on flood risk and sea-level rise and also the impacts of dry periods on dykes. This is feeding into the government’s adaptation responses. Work conducted as part of the ESPACE (European Spatial Planning Adapting to Climate Events) project - a four year European Commission to develop a knowledge and information base ESPACE (2004) - reports that spatial planning is particularly important in the Netherlands for implementing an adaptation response (for example, through

allocating space in land use plans for natural flooding of water courses). The project is also specifically addressing implications for biodiversity.

## A2.3 NATIONAL - UK GOVERNMENT

The issue of adaptation was addressed in some detail in the *UK Climate Change Programme* (HMG 2000). The programme outlined a number of priorities for adaptation:

- improved water resource management;
- coastal and river flood defence programmes;
- enhanced resilience of buildings and infrastructure;
- management of wildlife, forestry and agriculture;
- coordinated approaches to planning;
- awareness raising of climate change impacts; and
- improved long term and short term risk prediction.

New initiatives and progress on adaptation was reported by sectors (see Appendix I), which broadly reflected central government departmental responsibilities. The aim was to start the process of embedding adaptation to climate change in existing sectoral policy and regulatory frameworks and associated decision making processes.

By 2003, some useful progress had been made on integration of climate change policy making at Defra. The Flood Management Division had produced practical guidelines for flood risk management and an investment appraisal procedure for coastal defences that factored in climate change. The Water Resources Division had produced a framework for 25 year plans by water companies, with climate change as one of the criteria for assessment used by Environment Agency.

However, policy-making on adaptation was still considered “patchy” (see *The impacts of climate change: implications for Defra*). The following is Defra’s own appraisal at the time:

“Across the rest of the Department, however, there is little evidence of practical incorporation of climate change considerations into policy-making. This includes Divisions within Environment Protection Group (EPG) with whom the issues were discussed in 2001 in the context of the DETR report. While there is work in hand in several areas looking at what might need to be done in future to take account of climate change, (for example in relation to implementation of the Water Framework Directive, in the context of the soil strategy, and on sustainable drainage), few are yet at the point of practical decision-making.”

The main constraints to integrating into policy were considered to be:

- Uncertainty about how to factor in climate change;
- Focus on shorter-term targets, which may be in tension with the longer-term implications of climate change, for example, site designation targets on biodiversity potentially in tension with longer term climate impacts on ecosystems; and
- Institutional barriers to working across sectors, with potential tensions between policy objectives which are highlighted by climate change – for example reducing overall flood risk while also delivering objectives on rural development, urban regeneration and biodiversity.

To make further progress, the report identifies a number of key priorities for proactive planning (see Appendix II). These include the development of long term planning frameworks that ensure sustainability in a changing climate, and the need for a robust evidence base that addresses the interactions between different policy areas and climate

change policy. The report also outlines some internal recommendations, aimed at the Management Board and Global Atmosphere Division, to improve Defra's own ability to deliver effective climate change policies.

By the time the *Review of the UK Climate Change Programme* was published in 2005, the regions and local government had started to take a keen interest in adaptation, due in a large part to the influential work UK Climate Impact Programme and the evolution of proactive regional Climate Change Partnerships. Regional climate change partnerships in seven of the nine English regions have been established, involving Government Offices in the Regions, regional and local government representatives, the Environment Agency, and a range of wider stakeholders. The Review, the Government recognises that the implementation of the real adaptation action is frequently carried out at regional or local levels and by public and private sector stakeholder organisations. The Government's present thinking, therefore, is that effective and appropriate adaptation must be "stakeholder-led", rather than enforced. However, the possibility of supporting legislation and regulation to provide an incentive for adaptation action has not been ruled out.

## **A2.4 DEVOLVED ADMINISTRATIONS, REGIONAL ASSEMBLIES AND LOCAL GOVERNMENT**

This section describes a range of adaptation related initiatives in the UK. Much of the work is not led by government, but by groups that involve government and other concerned stakeholders, including the several regional Climate Change Partnerships that have been established. Regions have focused on sectors that are regionally important.

### **A2.4.1 Scottish Executive**

The Scottish Executive commissioned a report on adaptation strategies for Scotland (Kerr and McCleod 2001), which examines potential Scottish opportunities to moderate the adverse impacts of the changing climate and to realise concomitant opportunities.

The report emphasises the need for a partnership approach between the Scottish Executive and stakeholders, including local authorities, Scottish Environmental Protection Agency (SEPA), land and property owners, insurers, water authorities, transport, energy supply companies and NGOs. One good example of such a partnership is the Scottish Coastal Forum, which provides a national context for the work of local Coastal Fora that draw on representatives from the public and private sector with an interest or responsibility in local coastal issues. However, there is a need for a strategic overview of activities in Scotland, both to enable the distribution of appropriate climate scenario information, as it becomes available over the coming years, and to encourage stakeholders to integrate such information into adaptation management plans.

A risk based approach to adaptation is advocated. Adapting to climate change requires that the risks and opportunities associated with shifts in the weather be calculated, as with any external socio-economic or environmental change in conditions. The challenge is to integrate climate risk management into the normal organisational planning process. Managing climate risk requires awareness of the opportunities and risks associated with the changing weather patterns. The key roles for the Scottish Executive are as educators, to improve awareness and disseminate information on climate risk, and as facilitators, to encourage groups of stakeholders to integrate climate risk into their management strategies.

Adaptation related policy in Scotland is the responsibility of the Environment and Rural Affairs Department. Although the Scottish Executive has funded follow up studies on

flood risk, there is currently no clear policy on adaptation in Scotland. Further work and planning for adaptation is being carried out by government agencies, such as SEPA and the Forestry Commission (Scotland).

A report that considers the climate change activities of Scottish local authorities has been published by Scottish and Northern Ireland Forum for Environmental Research (CAG 2005). Members of SNIFFER include the Scottish Executive Environment and Rural Affairs Department (SEERAD).

Information on the climate change adaptation and mitigation activities of the 32 Scottish Local Authorities and investigates support for a Scottish Local Government Network on Climate Change. The report highlights good practice examples from a number of Scottish local authorities and found widespread support for a Scottish Local Government Network on Climate Change. There was also local authority involvement in a Climate Change Network involving private, public and voluntary organisations.

A large number of local authorities have considered the likely impacts of climate change on their own services, including flood prevention, coastal protection, water conservation, drainage, subsidence, transport infrastructure, estate management, storm damage, biodiversity and landscape, waste management and emergency planning.

The report indicates that more leadership on the issue is required by central (Scottish and UK) government. The recommendations call for:

- Provision of more detailed local information on the likely impacts of climate change
- Support for comprehensive reviews to evaluate the adaptation response for individual services
- Action to further strengthen national standards – e.g. Building Regulations
- Identification of new indicators to allow standardisation and effective monitoring of progress
- Further action to raise public awareness of the issue.

#### **A2.4.2 Welsh Assembly Government**

The Welsh Assembly Government develops and implements policy and is accountable to the National Assembly for Wales. Department for Environment, Planning and Countryside is responsible for many of the sectors that will be affected by climate change (agriculture, environmental issues, fisheries, food, forestry, water and flood defence, town and country planning).

The impacts of climate change on Wales were raised by the National Assembly in 2002 (NAW 2002). Adaptation measures for flooding, natural hazards and land use have been discussed, although no adaptation policies were considered.

The Department for Environment is planning to undertake a Welsh Climate Change Communications Programme to raise awareness amongst the general public, as well as the private and public sectors, about the cause, impacts and solutions to climate change. The programme aims to generate support for the Assembly's own sustainable development objectives. One of a broad range of objectives would be to make the general public, private and public sectors in Wales aware of the cause, impacts and solutions to climate change to accelerate the solutions to this problem.

#### **A2.4.3 Northern Ireland - Department of the Environment**

Environment and Heritage Service (EHS), an agency operating within the Northern Ireland Department of the Environment, takes the lead in advising on, and in implementing, the Government's environmental policy and strategy in Northern Ireland. The agency carries out a range of activities, which promote the Government's key themes of sustainable development, biodiversity and climate change.

EHS has issued guidance for public bodies on climate change (EHS 2005). Here, climate change impacts and adaptation measures are considered by government departmental categories (Transport and Highways, Health and Social Services, Environmental Services and Awareness, Planning, Housing and Buildings). Policies that would facilitate these measures have not been suggested, although public bodies are urged to develop corporate plans and coordinate actions between departments.

We were not able to establish whether the public bodies in question had taken action in response to the guidance. Climate change policy setting is the responsibility of the Sustainable Development Division of the Department of the Environment. However, adaptation is not a priority area in the group business plan for 2005-6. There is no other evidence that any adaptation policies have been developed in Northern Ireland.

#### **A2.4.4 Three Regions Climate Change Group**

The Three Regions Climate Change Group is a group made up of the London Climate Change Partnership, the South East Climate Change Partnership and the East of England Sustainable Development Roundtable. The Group believes that the south-eastern part of England is particularly vulnerable to climate change. It aims to provide a joined up approach to adaptation across the three regions.

The Group has recently produced a consultation document with a checklist and guidance to ensure that new developments are adapted to climate change (TRCCG 2005). It is designed primarily for developers, their partners, design teams, architects, surveyors and engineers, but it is expected that it will also be useful to those within the wider development community, for example, investors, land purchasers, insurers, as well as planners and experts, for example, from the Environment Agency.

The consultation has implications for policy making, highlighting the possible long term climate effects on development, and implications for location and design. The main opportunities for climate adapted developments include lower long term running costs, including insurance, higher future asset value, ease of securing finance from long-term investors (including Socially Responsible Investment funds), the ability to command a higher price for well-designed buildings and possibility of product differentiation. The risks of failing to adapt include increasing maintenance costs and falling asset values over time, the cost of future adaptation-oriented building regulations and remedial measures, storm damage and flood damage.

This checklist covers location, site layout, buildings, ventilation and cooling, other development infrastructure and services.

#### **A2.4.5 South East England Regional Assembly (SEERA)**

SEERA has produced a Climate Change Adaptation and Mitigation Implementation Plan, which has recently been out for consultation (CEP and LUC 2005). The plan sets out some practical guidance for policy making, identifying 25 climate change indicators for the South East Region. The following six are proposed as headline indicators:

- Annual average surface temperature.
- Quantity of summer rainfall.

- Quantity of winter rainfall.
- Sea level rise at Sheerness, Kent.
- Emissions of greenhouse gases.
- Installed capacity for energy production from renewable sources.

Two categories of adaptation are considered for the region: building adaptive capacity and developing adaptive actions (see Table A1).

*Table A1. Examples of Adaptation for the South East*

Type of adaptation	Examples for region
<i>Building adaptive capacity</i>	
Research	Further research in areas identified as gaps
Data collection and monitoring	Monitoring environmental changes and associated impacts Development of regional climate change indicators
Awareness raising	Use local conferences to raise awareness of issues/regional work
Changing standards and developing policy	Ensure climate change impacts, adaptation and mitigation are included in all regional and local policies and strategies as plans are reviewed and developed
Organisational learning	Build capacity and understanding of climate change issues in “unaware” business sectors
Working in partnership	Use the regional partnership to promote learning from best practice and to co-ordinate regional activity
<i>Develop adaptive actions</i>	
Share loss or share risk	Develop new insurance or financial products to offset risk
Bear loss	Accept loss of some coastal land to sea level rise and coastal erosion, where losses cannot be avoided or compensated
Prevent effects or avoid/reduce risk: technical or structural change	New flood management techniques for the Thames Estuary by 2100
Avoid or exploit changes in risk	Cultivate new agricultural crops and develop alternative land use, for example by diversification to maize and viticulture

The report recognises that some degree of adaptation to climate change will be required, whether or not future emissions are reduced. Furthermore, some action is needed now to avoid risks and future costs. However, adaptation is considered to be a “long-term process that needs to be tackled in a staged, prioritised way.”

Some of the most immediate adaptation priorities fall on those responsible for planning and developing major infrastructure, such as new buildings or roads, since these types of adaptation can have a long lead in time. Plans and policies, even if they have a relatively short planning or review horizon, should fully consider the implications of climate change. For example, Local Development Documents (LDDs) may be reviewed every three years but they set the framework for built environment that may have a life of at least 50 years.

#### **A2.4.6 South East Climate Change Partnership (SECCP)**

SECCP recently commissioned a report to assess the expected climate change impacts on key sectors in the region, to consider responses and to identify sector-based adaptation strategies and indicators (Atkins and OBU 2004). The investigation also aims to map existing datasets and data collection systems relating to climate change; to develop a set of regional climate change indicators; to map existing research activities relevant to climate change impacts and adaptation within the region; and to advise on the development of a GIS tool to aid adaptive planning in the region.



The work included a survey of stakeholders in different sectors. Despite the differences between the sectors, the responses showed a remarkable similarity in estimating when climate change might affect their activities. 81 per cent of respondents agreed that climate change would affect their business or organisation within the next 10 years, and 88 per cent beyond the next 10 years, while 62 per cent agreed that climate change was already affecting them. Very few (only five respondents altogether) considered that climate change would never affect them.

The consultants took the view that an adaptation strategy might take the form either of a specific policy or a strategic change in practice or behaviour. Three possible approaches were proposed, which SECCP could use to improve awareness and planning:

- Adaptation hierarchy: promoting a conceptual framework that encourages organisations to move up a 'ladder', starting with understanding current practices and ending with a prioritisation of adaptation strategies and adopting these in forward planning.
- Tiered response: assessing and planning for impacts, by being active, engaging with the future; and reviewing and revising organisational position.
- Function-based response: capturing generic responsibilities within a range of organisations (e.g. employer, estate manager / property owner, purchaser / supplier, influencer / champion).

Given the strong degree of interconnectedness both within and between many of the sectors, a number of generic or cross-cutting themes emerged for adaptation. Generic themes were considered to be particularly important for buildings and infrastructure management, integrated water management, land use planning, biodiversity, soils and land use management and energy management.

The report recommended the following actions relating to the further development of climate change indicators in the South East:

- The indicators developed should be used now, with further work undertaken or data collected to assess and improve newly suggested indicators;
- A hierarchy approach is recommended with "headline" indicators to measure basic changes in state or responses, together with more specialist indicators for particular sectors (e.g. mean temperature as a headline indicator for the region, with summer night time temperatures pertinent to the health sector to aid understanding of summer mortality);
- Sector groups should adopt specialist indicators. Sector groups could also identify indicators gaps collate new or existing data in support of possible new indicators.
- Headline indicators would be useful for political and public awareness, while more detailed indicators would benefit policy makers and technical specialists. The indicators could be used for cross-regional comparison in the future.
- There should be a focus on adopting 'ready-made' indicators i.e. those indicators already maintained as part of other indicator sets, often by SECCP members. This will reduce the cost and effort in maintaining an indicator set for the South East and will provide effective linkages with other regional strategies and plans.
- The indicators should, where possible, be mapped and graphically represented, to facilitate understanding and made available on the internet to allow access to a wide range of interested parties.
- The indicators should be updated periodically, probably on an individual basis in association with the 'host' indicator set.

#### **A2.4.7 South West Climate Change Impacts Partnership (SWCCIP)**

A scoping study initiated by SWCCIP (Chambers *et al.* 2003) describes the likely impacts of climate change in the 21<sup>st</sup> Century and appropriate action to address associated challenges and opportunities. The study found that generally the region has poor

awareness of the issues associated with ‘adaptation’ to climate change. At the time of writing, only a small number of regional stakeholders are aware of UKCIP data, or have explored their implications for their sector.

In addition to a number of recommendations relating to profile raising and coordination of activities, the following practical priorities for policy making in the region were identified:

- Review regional and sub-regional arrangements for emergency planning in anticipation of extreme weather events;
- Co-ordinate the development of climate change strategies within local authorities;
- Co-ordinate the development of climate change strategies within sectors in the region;
- Identify those issues at a regional level where central government action is required;
- Undertake further research within selected sectors to better understand the significance of local impacts.

#### **A2.4.8 Sustainability Northwest**

Sustainability Northwest is the regional champion for sustainability, backed by business and public sectors, including the North West Climate Group. Sustainability Northwest is responsible for a number of publications on adaptation, with a strong emphasis on the impacts of tourism, which provides a major source of revenue for the region.

The issues facing the tourism industry in the north-west were first tackled at a workshop organised by Sustainability Northwest (Glynn 2004) in an effort to engage with both regional and national stakeholders. Opportunities and threats that climate change presents to the visitor economy in the Northwest were examined for the rural uplands, rural coast, coastal resorts and urban areas / the urban fringe.

The workshop produced a number of policy related recommendations. At the EU level, there was a view that Common Agricultural Policy reform that rewarded stewardship, rather than production was compatible with adaptation. At the local level, adaptation could be served by better, more sustainable promotion of attractions and diversion of visitors away from current ‘honeypot’ locations. Adaptation needs to link all levels of policy setting (EU, national and local) and cut across a broad range of sectors (e.g. transport, water, agriculture and health).

In its brochure entitled *Climate Change and the Visitor Economy in England’s Northwest*, it outlines eight areas for detailed study:

1. The influence of weather on visitor behaviour
2. Possible changes in visitor behaviour under future climate change scenarios for the UK (UKCIP02)
3. Changes in established trends in tourist demand
4. Possible interactions between behaviour and demand and how the tourism sector might respond to any opportunities within the context of ‘sustainable tourism’
5. Environmental capacity and how this may be influenced by climate change especially in the coastal zone and rural uplands
6. Measures that policy makers and land managers can take to sustain environmental capacity and whether such measures will be cost effective.
7. The potential to develop new tourism and recreational resources in less vulnerable areas.
8. The interaction between regional tourist development and other key sectors (health, agriculture and forestry) in the face of socio-economic and climate change.

Some of these issues have been discussed in more recent regional work. Glynn (2005) investigated both the physical impacts of climate change and its impacts on economic sectors, concluding: “it is essential that these (climate change and adaptation) issues become a central consideration in the decision-making processes of organisations in the region.”

#### **A2.4.9 Essex Partnership**

The Essex Partnership aims to shape the delivery of action on climate change in Essex, drawing on a range of evidence that currently exists across a breadth of organisations within Essex and beyond. In its Draft Action Plan, it identifies ‘no regret’ and ‘low regret’ actions’, classifying them by their timescales:

- Full implementation within the short-term (~2-5 years).
- Plan ahead for implementation within 5-10 years.
- Monitor situation and review action plan or implement actions as required.

Actions have been given a relative significance, which reflects a qualitative assessment of the relative change in probability of the hazard and the spatial extent of the impact. The plan outlines actions for:

- Ensuring public health and safety
- Domestic properties
- Businesses
- New development
- Agriculture, fishing and forestry
- Transport
- Utilities
- Protecting the natural environment
- Protecting the landscape, heritage and archaeology

#### **A2.4.10 County Councils**

Devon County Council is already looking to develop a long term response to climate change. The council views adaptation as part of the sustainability equation, which balances the environment with society and economy. To help achieve its adaptation goals, it sets out a number of adaptation principles to guide this response (DCC 2005):

- Adaptation should focus on seasonal extremes and short duration hazards for the period to 2040;
- Climate events of the recent past should be used to identify potential adaptations required over the next 20 years;
- All adaptation measures should be climate-proofed for a minimum of 50 years;
- Long-term business/investment decisions (i.e. + 30 years) must take into account changes in mean climate;
- The business case for long-term adaptations must use the precautionary principle as the basis for action.

Cambridgeshire County Council is promoting good practice with regards to climate change adaptation. The focus is on development (for example, of buildings and highways), vulnerable people and flood protection (CCC 2005).

As part of the ESPACE project, West Sussex County Council has an awareness campaign called ‘A Climate for Change’. It aims to develop a model for engaging local communities and businesses that can be applied across North West Europe. Hampshire County Council is working on behavioural change to assist in developing a better understanding of how to engage with stakeholders on the topic of climate change.

Other councils have adopted policies that relate to climate change, but may not have a specific policy statement per se. For instance, the Vale of White Horse District Council has limited housing development in flood plains, in accordance with Defra planning guidance. Preservation of green belts would be another common planning decision related to climate adaptation (for ecosystems and ecological corridors).

## Appendix III: Review of Objective and Target Setting Methods

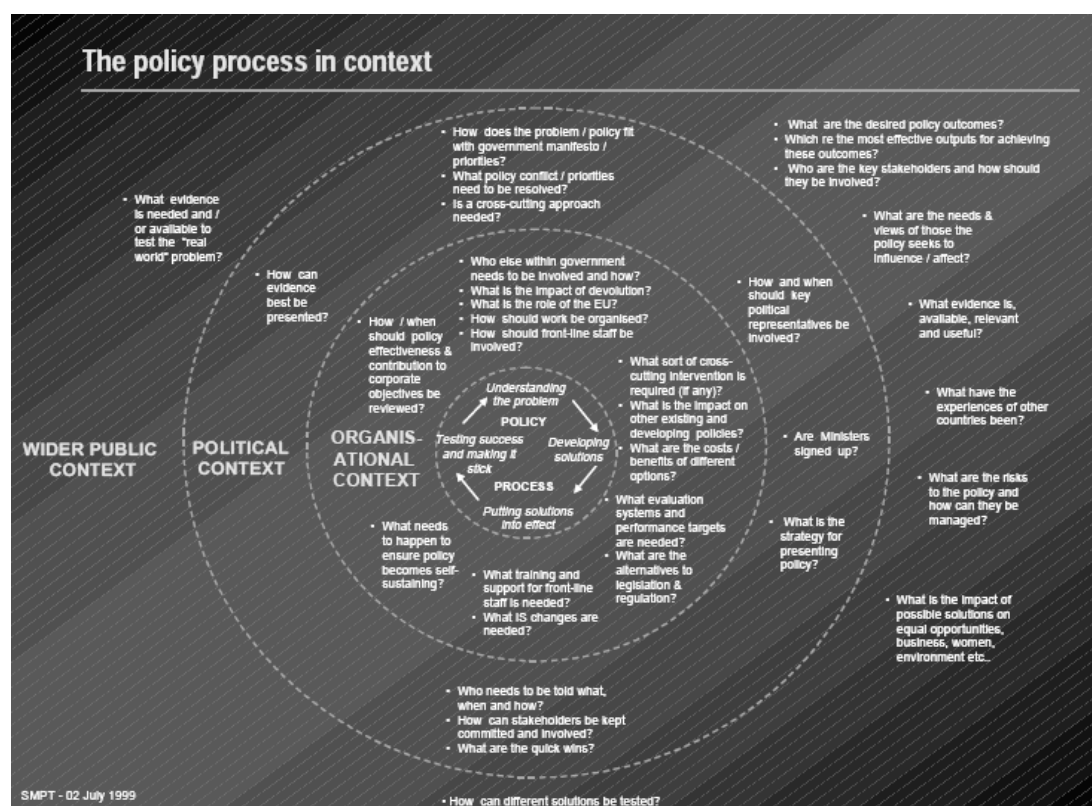
### A3.1 GENERIC METHODS

#### A3.1.1 UK Government - policy setting approaches

Generic policy setting methods tend to be based on a circular, iterative process that involves a number of stages, typically understanding the problem, developing the solution, implementing the solution and monitoring / review to ensure continuous improvement. However, there is a great deal of variety in the application of this basic process.

In the UK, the Government's policy setting methods have traditionally focused on the Departments involved and the political process (see Figure A4). The diagram does in fact contain most of the elements of effective policy making. However, the organisational focus and structured approach is now considered to be an out of date. Practitioners understand the merits of the framework, but do not believe that it helps put policy making into practice (Bullock *et al.* 2001). Furthermore, the emphasis of the policy setting process has changed. For example, development of an evidence base, particularly for complex climate change related policy, is now considered a prerequisite to effective policy setting. From the arrangement of elements in Figure A4, development of the evidence base appears to be a secondary consideration.

Figure A4:



In response to the changing nature of policy making, the Government produced two publications, *Professional Policy Making for the 21<sup>st</sup> Century* and (more recently) *Better Policy Making*, which outline a more pragmatic approach and build on positive policy making experiences in a wide range of Government Departments. Instead of using a framework, the documents list what are considered to be institutional preconditions for effective policy making. Nine core competencies are identified, grouped under three themes (vision, effectiveness and continuous improvement) (see Box A1).

### **Box A1: Core competencies for Better Policy Making**

#### Vision

- Forward looking – takes a long term view, based on statistical trends and informed predictions, of the likely impact of policy
- Outward looking – takes account of factors in the national, European and international situation and communicates policy effectively
- Innovative and creative – questions established ways of dealing with things and encourages new ideas; open to comments and suggestions of others

#### Effectiveness

- Using evidence – uses best available evidence from a wide range of sources and involves key stakeholders at an early stage
- Inclusive – takes account of the impact on the needs of all those directly or indirectly affected by the policy
- Joined up – looks beyond institutional boundaries to the Government's strategic objectives; establishes the ethical and legal base for policy

#### Continuous improvement

- Evaluates – builds systematic evaluation of early outcomes into the policy process
- Reviews – keeps established policy under review to ensure it continues to deal with the problems it was designed to tackle, taking account of associated effects elsewhere
- Learns lessons – learns from experience of what works and what doesn't

The approach outlined in Boxes A1 and A2 provides some guidance, but do not constitute an explicit methodology. In a sense, the competencies represent overarching principles that are required for effective policy setting. Nevertheless, a methodology is implicit and the list provides policy makers with a strong steer, whilst giving the desired flexibility to apply their preferred approach to policy development.

The need for an outward looking approach (one of the competencies listed above) has been emphasised in other literature. The use of international comparisons is an essential element of modern, professional policy making (*Beyond the Horizon, the Centre for Management and Policy Studies*). International examples can provide invaluable evidence of what works in practice, help avoid re-inventing the wheel or repeating mistakes and provide a new understanding of shared problems, which is a particularly relevant approach for tackling climate change. They can also help identify new mechanisms for implementing policy and improving the delivery of public services. The outward-looking approach favoured by the CMPS for more effective policy making is summarised in Box A2.

More recently, in response to the complexities of environmental policy making, Defra developed an evidence based policy method, which is used in its Evidence and Innovation Strategy 2005-8 (Defra 2005). The method incorporates a combination of innovative principles in the form of questions or prompts, and a set of stages for evidence-based policy making (see Figure A5). The method indicates Defra's move towards risk based decision making and focus on use of scientific evidence in the policy setting process.

**Box A2: An outward looking approach to policy making**

SCAN the horizon widely for interesting approaches and innovative developments. It is impossible to study everything in depth, so start with a general look at a range of countries, avoiding preconceptions about where useful ideas might be found. This will be easier if you have made keeping up to date a part of your normal work routine, and identified some sources of information to help you do so.

SELECT one or more promising comparators for closer systematic examination. This takes time, effort and money to do properly, so be clear why you have chosen to expand your horizon in this direction. You might opt to look at the most similar system to our own that you can find; but remember that countries that appear very different may also offer valuable lessons. The places that provide the most fashionable comparisons may not always turn out to be the most useful.

UNDERSTAND thoroughly whether, and if so how, your comparator works in practice. Any policy or programme can be reduced to a simple model of key elements linked by cause and effect. As well as this model, you need to understand the detailed context within which the policy functions. It may not be obvious to an outsider like you what factors in the social, economic, cultural and institutional environment are critical to its success - and the insiders who are your informants may simply take them for granted.

ASSESS the relevance of the comparator. Think objectively about the key elements of the model and its context, and about the comparable factors in your own policy environment - including the nature of the problem you are trying to solve. How great, if any, are the differences? What effect would they have on the policy or programme? Can they be offset? If not, be prepared to recommend that this example is not followed.

RECOMMEND what lessons should be learnt. The question is not just "would it work here?", but would part of it work, or with modifications? If we modify it, are we certain it will still work? Should we simply be inspired by this example to devise something similar, but better suited to local conditions? What can be learnt from what did not work, as well as what did work, in the original setting?

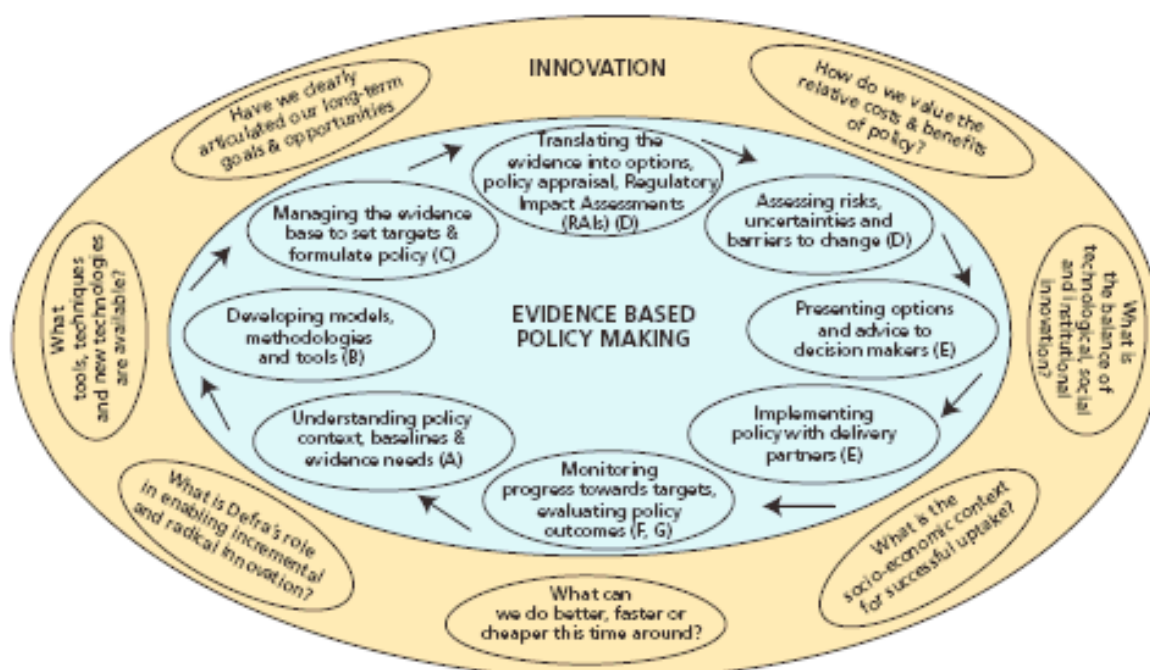
With regard to long-term policy setting, an important development was production of The Energy White Paper, *Our Energy Future – Creating a Low Carbon Economy* (DTI 2003). This influential document establishes the longer term framework for the UK's energy policy and sets the scene for future climate change and adaptation-related policy. It has set the precedent for long-term setting of relatively complex policies in the UK.

The Energy White Paper is based on the 2050 goal – that the UK should put itself on a path to reducing carbon dioxide emissions of some 60% (from 1990 levels) by 2050. This target was identified by the Royal Commission on Environmental Pollution's (RCEP):

‘A reduction in carbon dioxide emissions of 60% by 2050 is consistent with the level of reduction likely to be needed by developed countries in order to move towards stabilisation of carbon dioxide concentrations in the atmosphere at no more than 550 ppm, taking account of a realistic assessment of emissions growth in developing countries.’

The 550 ppm value is set on the current scientific knowledge about human impact on climate, and that this is an upper limit that should not be exceeded.

*Figure A5: Defra's evidence based policy making method*



Extensive analytical work was undertaken to look at the costs and the implications of meeting the Government long-term goal before the commitment was made in the energy White Paper. In particular, the technological feasibility and the costs implications of reaching such a target were analysed through a major modelling exercise involving the calibration of the MARKAL model to the UK. The Energy White Paper also referred to the Government estimates of Social Cost of Carbon (SCC), and observed that until 2020 most of the carbon savings required to put the country on a path towards the 60% reduction can be achieved at a cost that is lower than the estimated range for the SCC.

### Summary of value for adaptation policy setting

Criteria	Verdict
1. Principles for effective policy setting?	Yes. Core competencies serve as useful principles
2. A robust framework that tackles all policy setting stages?	Not in papers reviewed. Prescriptive frameworks for generic application are not favoured by Government policy makers.
3. A means for cross-sectoral integration of policies?	Considered, but little substance provided.
4. An outward-looking approach?	Yes. An approach to looking at experiences in other countries has been defined.
5. Tools for developing and utilising an effective knowledge base?	Considered, but little substance provided.
6. A means for tackling institutional barriers within Government?	Not in papers reviewed.



7. A means for encouraging long-term thinking?	Not in papers reviewed. However, the Energy White Paper produced by the DTI sets a useful precedent for effective long-term policy making.
8. Tools to handle uncertain outcomes?	Not in papers reviewed.
9. A means for developing targets and indicators?	Not in papers reviewed.
10. An inclusive approach that seeks the views of many stakeholders?	Yes. There is now strong emphasis on stakeholder consultation.

### **A3.1.2 UNEP – Policies to control ozone depleting substances**

Most countries have already begun to address the technical, legal and economic issues raised by compliance with the Montreal Protocol's schedule of freezes and phase-outs. However, much of the actual investment in developing countries thus far has addressed production and manufacturing sectors, where economies of scale and ease of project implementation make such investments relatively cost-effective for reducing Ozone Depleting Substances (ODSs). The main challenge now is to reduce consumption in sectors where ODS use is distributed across many uses and many small and medium enterprises. In recognition of this, the United Nations Environment Programme (UNEP) aims to foster sector-wide and country-wide approaches, taking into account the often widely distributed nature and small size of the targeted ODS uses. These require comprehensive, sectoral approaches, backed up by supportive and sustainable policy frameworks.

UNEP has therefore produced a handbook to facilitate the development of planning, designing and implementing policies to control ODSs. The handbook sets out general guidelines to assist policymakers in setting the stage for successful environmental policymaking. Although focusing on the control of ODSs in developing countries, the handbook has potential for generic application in policy setting. The premise for UNEP's policy setting approach is that effective laws and policies must be part of a broader culture that is supportive of the rule of law and of the implementation of policies. Laws and policies can then help create that broader culture – in a reinforcing circle between the context and the law. The handbook outlines a series of steps that are considered to be critical for developing a socio-economic and political context to make policies more effective (see Box A3).

The UNEP hand book also sets out seven criteria that are considered essential for effective policy making in.

- Visionary and aspirational;
- Consistent with other policy goals, including international obligations;
- Accessible, clear and understandable;
- Fair, equitable and balanced;
- Affordable and realistic;
- Comprehensive and flexible; and
- Enforceable and measurable.

It is suggested that existing and proposed policies should be evaluated against these criteria. Even if not used in a quantitative manner, the criteria also provide a useful set of principles for policy making.

**Box A3: The environmental policy making process (abridged)**

2. *Survey ODS production and use patterns.* This requires development of a knowledge base through collection and analysis of data. In the context of adaptation, the data could be on future climate impacts.
3. *Identify major stakeholders*
4. *Choose a strategy and set the priorities*
5. *Create and sustain political will.* This involves a number of supporting activities, including: designing policy approaches that support political will; involving top government leaders in designing and launching a national programme; implementing public awareness and education campaigns that make responses more attractive politically and inclusive to main stakeholders; working cooperatively with industry to demonstrate and replicate success stories; supporting stakeholder efforts to promote action; and supporting other government initiatives that highlight the importance and value of protecting the environment.
6. *Strengthen the institutional framework by assessing the existing framework.* The key elements are: developing a plan to fill gaps; obtaining the necessary legal authority and financial, administrative and human resources; and creating mechanisms for coordination between different national agencies and between different levels of government;
7. *Expand access to information.* It is important to ensure that: information is presumed to be accessible; anyone in the public should be able to request information; public authorities should proactively collect and disseminate environmental information that may be of broad interest; and public authorities should broadly inform the public of their right to information and of their right to participate in decision-making.
8. *Prepare and implement a public participation plan.* This involves: selecting the purpose and targets for public participation; providing proper notice; scheduling sufficient time for decision-making; selecting appropriate public participation mechanisms; and considering and responding to public input.
9. *Promote regulatory independence.* This is required to achieve: fair and transparent procedures and decisions; separation of the regulatory function and regulated interests; reliable and predictable sources of funding for implementing bodies; clear "Conflict of Interest" standards; and separation of responsibility of regulation and enforcement functions.
10. *Develop an effective feedback loop.*

**Summary of value for adaptation policy setting**

Criteria	Verdict
1. Principles for effective policy setting?	Yes. The criteria serve as useful principles.
2. A robust framework that tackles all policy setting stages?	Yes. A comprehensive, multi-stage approach has been set out.
3. A means for cross-sectoral integration of policies?	Considered, but not in sufficient detail to assist with adaptation policy.
4. An outward-looking approach?	Considered, but received surprisingly little attention given the international remit of the Montreal Protocol.
5. Tools for developing and utilising an effective knowledge base?	Considered, but the emphasis is on accessibility of information, rather than use.
6. A means for tackling institutional barriers within Government?	Yes. Aimed at developing countries, so these issues were tackled in detail.
7. A means for encouraging long-term thinking?	No.
8. Tools to handle uncertain outcomes?	No.
9. A means for developing targets and indicators?	No.
10. An inclusive approach that seeks the views of many stakeholders?	Yes. The method outlines the development of a plan for public participation. Emphasis on the socio-economic context makes it suitable for adaptation policy setting, which will rely heavily on active involvement of a wide range of stakeholders

**A3.1.3 RCEP - Environmental standard setting**

In 1998, the Royal Commission on Environmental Pollution (RCEP) produced a comprehensive report entitled *Setting Environmental Standards*. The focus on standards is because “they are often the most tangible and precise expression of the judgements that underlie environmental policies”. However, much of what is said in the report is of general relevance to environmental policies.

The report was commissioned because there seemed to be “widespread confusion and misunderstanding” about the purpose and mechanisms of environmental regulation. Protection of the environment is a complex process and creates potential conflicts with other objectives. All environmental policies involve making judgements, which have an impact on other policies. The aim of the report was to see whether a more consistent and robust basis could be found for the setting of standards for environmental policies.

The emphasis in environmental policy during the 1970s and 80s was on scientific issues and expertise lay within national or regional control agencies or government bodies. With

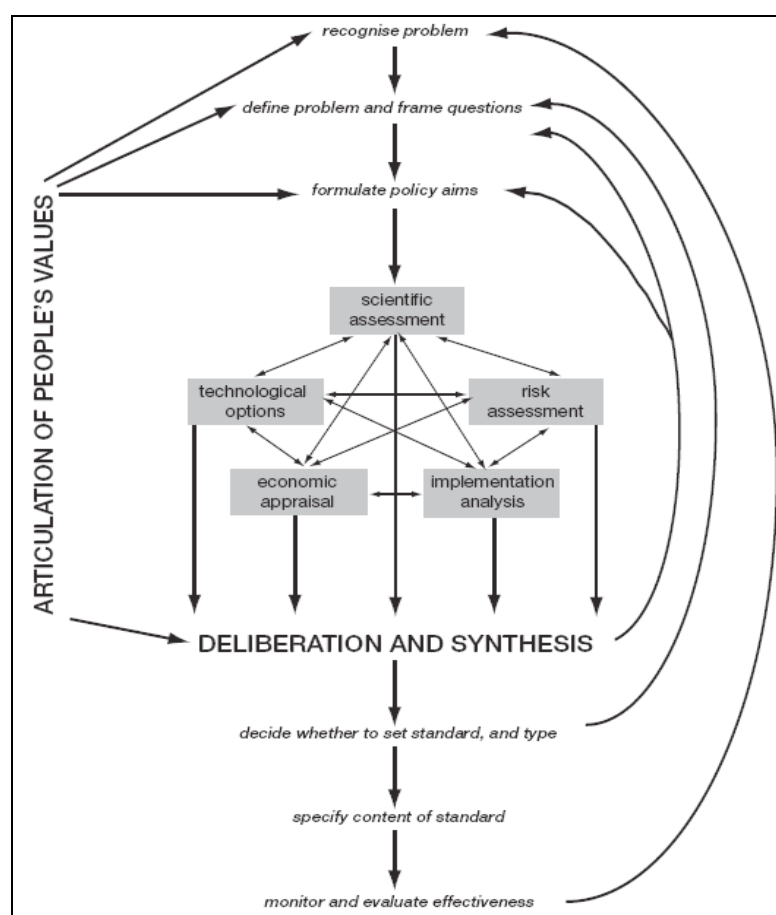
increased public awareness and improved legal rights to environmental information, a far wider circle of people is now recognised as having an interest in regulatory decisions. It is no longer considered acceptable for decisions to be negotiated privately between regulator and polluter. The balance has shifted further towards broad consultation, as a result of erosion of public trust in government as a result of BSE and GMO policies. The report indicates that better ways need to be developed for articulating people's values and taking them into account from the earliest stage in the process.

The RCEP describes a methodology for standard setting in detail (see Figure A6 for a summary). Once the problem has been recognised and defined and policy aims formulated, the stages in the policy process involve:

- Rigorous and dispassionate investigation and analysis
- Deliberation and synthesis, informed by people's values;
- The decision whether to set a standard, and if so what type of standard;
- Specifying the content of the standard;
- Monitoring and evaluating its effectiveness

In the presentation to decision makers of the results of the 5 analyses above, assumptions and limitations should be clearly stated. It will usually be necessary to offer several options and their implications.

*Figure A6. Environmental policy process*



The method ensures that “practical judgement” is utilised. Judgement is reached by a process of deliberation, which seeks ways of meeting a multiplicity of constraints and viewpoints.

The report recommends that bodies involved in setting standards are well-known and that the data, models and assumptions they are using being readily available to the public. It describes how standard setting bodies should operate. Key features are:

- Openness and transparency,
- Taking people's values into consideration from the earliest framing stage, and
- Clear separation between scientific and other analyses on the one hand and decision-making on the other

With regard to adaptation, the main drawback of the report is its focus is on pollution and standards to be applied to a polluter. For adaptation, policy is not aimed at the polluter but at the management of effects of pollution on society.

### Summary of value for adaptation policy setting

Criteria	Verdict
1. Principles for effective policy setting?	Yes. Key features of standard setting bodies are described. Emphasis is placed on appropriate and transparent use of scientific information.
2. A robust framework that tackles all policy setting stages?	Yes. The framework is based on a very detailed analysis of the issues. However, the process starts with steps of problem recognition and identification. These are not necessarily clear for adaptation, which may make the next step (formulation of policy aims) problematic.
3. A means for cross-sectoral integration of policies?	Considered, but no clear method for assessing the impact of other policies on adaptation presented.
4. An outward-looking approach?	No. Focused on UK standard setting.
5. Tools for developing and utilising an effective knowledge base?	Yes. The analytical stage of the policy process has several complementary and closely inter-related components that produce a structured evidence base. This is one of the key strengths of the method.
6. A means for tackling institutional barriers within Government?	Considered, but not included in the framework.
7. A means for encouraging long-term thinking?	Yes. The approach is designed to deal with long term environmental issues, though perhaps not quite on the adaptation scale.
8. Tools to handle uncertain outcomes?	Yes. Advocates incorporation of an assessment of risk and uncertainty in the decision making process.
9. A means for developing targets and indicators?	Considered, but no method outlined. However, analysis of geographical scope, which is particularly relevant to development of targets and indicators for adaptation, is a key

	element.
10. An inclusive approach that seeks the views of many stakeholders?	Yes. Seeks articulation of stakeholder values at all stages of policy formulation.

### **A3.1.4 European Environment Agency - DPSIR**

The Drivers, Pressures, States, Impacts and Responses (DPSIR) framework was developed by RIVM for the European Environment Agency (EEA) primarily to help inform an overall strategy for Integrated Environmental Assessment. The framework has been widely adopted by the EEA to provide an integrated approach for reporting (e.g. in the EEA's State of the Environment Reports). It has been tried and tested over several years.

The framework provides a structure within which the indicators needed to enable feedback to policy makers on environmental quality can be presented. This helps to examine the resulting impact of current policies, or inform future ones. For this reason, the DPSIR framework does not describe a policy setting method – policy setting is just one of its elements. However, it could be used as a framework for policy evaluation.

The DPSIR framework identifies a chain of causal links starting with 'driving forces' (economic sectors, human activities) through 'pressures' (emissions, waste) to 'states' (physical, chemical and biological) and 'impacts' on ecosystems, human health and functions, eventually leading to political 'responses' (prioritisation, target setting, indicators) (see Box A4 for an analysis of the elements and Figure A7 for their interrelationships). Describing the causal chain from driving forces to impacts and responses is a complex task, and tends to be broken down into sub-tasks, e.g. by considering the pressure-state relationship.

The DPSIR framework is useful for describing the relationships between the origins and consequences of environmental problems. In order to understand the dynamics, it is necessary to focus on the links between DPSIR elements (see Figure A8). The relationship between the 'D' and the 'P' by economic activities is a function of the eco-efficiency of the technology and related systems in use, with less 'P' coming from more 'D' if eco-efficiency is improving. Similarly, the relationship between the impacts on humans or eco-systems and the 'S' depends on the carrying capacities and thresholds for these systems. Whether society 'Responds' to impacts depends on how these impacts are perceived and evaluated; and the results of 'R' on the 'D' depends on the effectiveness of the Response.

**Box A4: Explanation of the DPSIR elements****Driving Forces**

A 'driving force' is a need. Examples of primary driving forces for an individual are the need for shelter, food and water, while examples of secondary driving forces are the need for mobility, entertainment and culture. For an industrial sector a driving force could be the need to be profitable and to produce at low costs, while for a nation a driving force could be the need to keep unemployment levels low.

**Pressures**

Driving forces lead to human activities such as transportation or food production to meet the need generated. These human activities exert 'pressures' on the environment, as a result of production or consumption processes, which can be divided into three main types: (i) excessive use of environmental resources, (ii) changes in land use, and (iii) emissions (of chemicals, waste, radiation, noise) to air, water and soil.

**States**

As a result of pressures, the 'state' of the environment is affected; that is, the quality of the various environmental compartments (air, water, soil, etc.) in relation to the functions that these compartments fulfil. The 'state of the environment' is thus the combination of the physical, chemical and biological conditions.

**Impacts**

The changes in the physical, chemical or biological state of the environment determine the quality of ecosystems and the welfare of human beings. In other words changes in the state may have environmental or economic 'impacts' on the functioning of ecosystems, their life-supporting abilities, and ultimately on human health and on the economic and social performance of society.

**Responses**

A 'response' by society or policy makers is the result of an undesired impact and can affect any part of the chain between driving forces and impacts. An example of a response related to driving forces is a policy to change mode of transportation, e.g. from private (cars) to public (trains), while an example of a response related to pressures is a regulation concerning permissible SO<sub>2</sub> levels in flue gases.

Figure A7: Generic DPSIR Framework

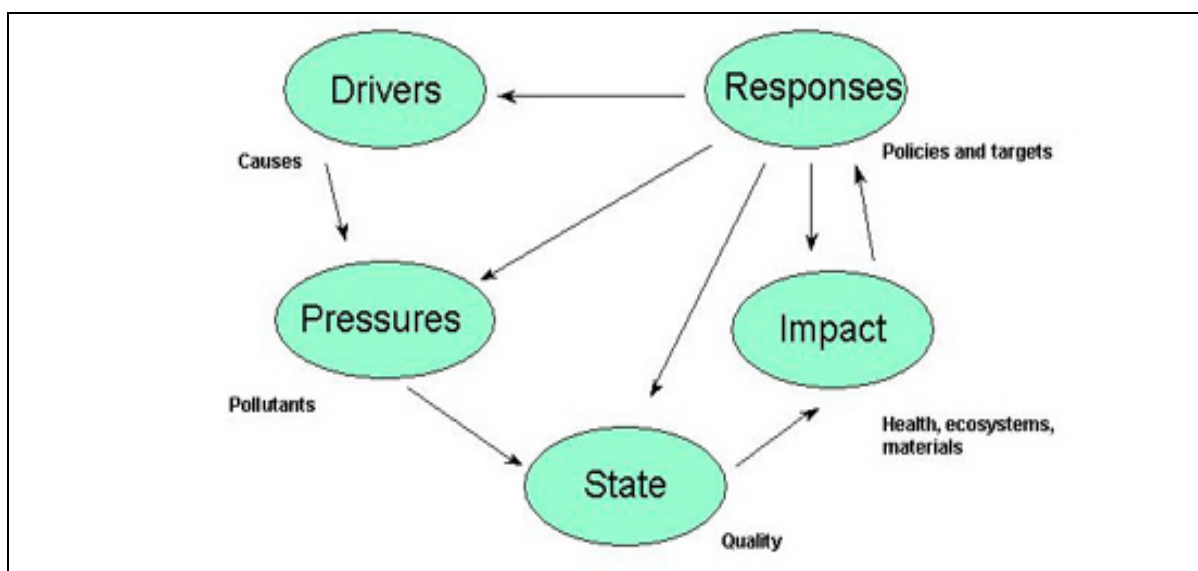
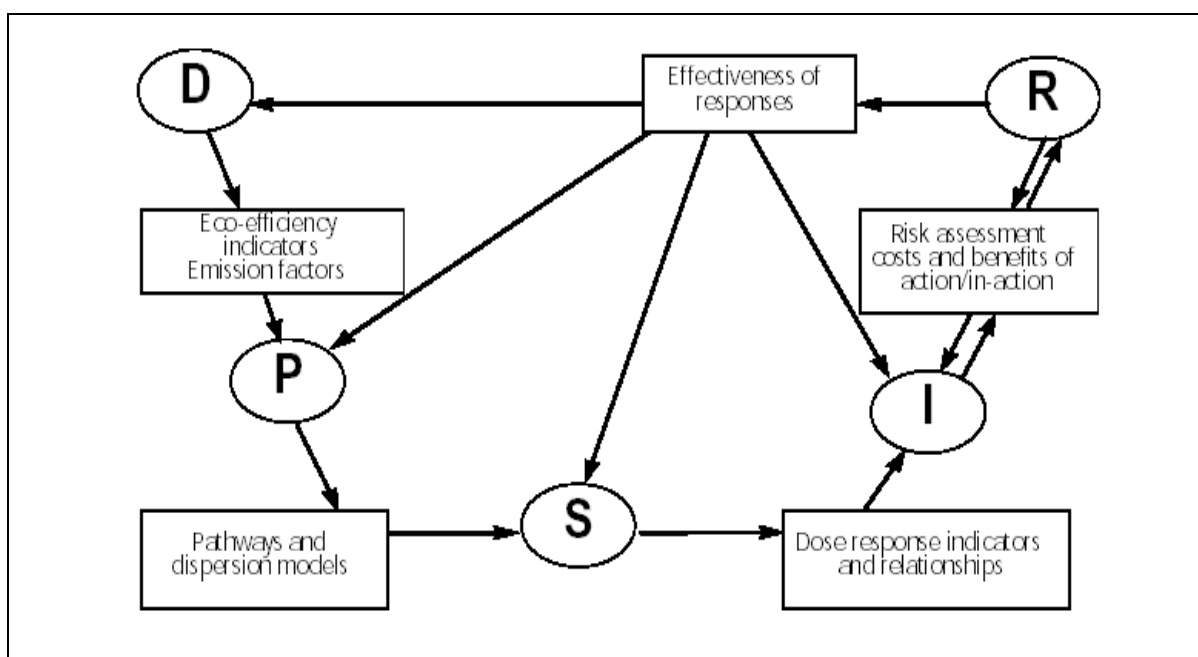


Figure A8: Indicators and information linking DPSIR elements (EEA 1999).



### Summary of value for adaptation policy setting

Criteria	Verdict
1. Principles for effective policy setting?	No.
2. A robust framework that tackles all policy setting stages?	No. Policy setting is one component of the framework, and associated processes are not described.
3. A means for cross-sectoral integration of policies?	Partly. Ties policy setting into a broader environmental monitoring framework.
4. An outward-looking approach?	No.
5. Tools for developing and utilising an effective knowledge base?	Partly. The framework proposed offers a possible structure for a knowledge base.
6. A means for tackling institutional barriers within Government?	No.
7. A means for encouraging long-term thinking?	Partly. The emphasis on monitoring serves long-term policy objectives.
8. Tools to handle uncertain outcomes?	No. For adaptation, the driver (climate change) and pressure (carbon dioxide) are clear, but there is considerable uncertainty over 'state' and 'impact'. The framework does not provide any guidance for tackling



	these uncertainties
9. A means for developing targets and indicators?	Yes. The framework provides a rational approach for developing indicators.
10. An inclusive approach that seeks the views of many stakeholders?	No.

## A3.2 POLICY SETTING METHODS USED FOR ADAPTATION

Organisations working on adaptation have published a number of frameworks for responding to climate change. All of these are of relevance to policy setting, though the focus tends to be broader.

### A3.2.1 UKCIP risk-uncertainty-decision-making framework

In its 2003 publication, *Climate Adaptation: risk, uncertainty and decision-making*, UKCIP describes, in detail, an approach to assist decision-making in policy, changes in legislation, government, policy or regulatory guidance, or review of ongoing programmes of activity. The methodology can also be used to address public concerns, pressure from interest groups, new scientific information or new technologies.

The concern of the authors is that many decisions will be taken without considering the potential effects of climate change to influence the outcome. Even when climate change is factored in, the sensitivity of the decision to assumptions (regarding future climate) may render the outcome inappropriate. The focus of the report is therefore on identifying and treating the risk and uncertainty associated with decisions where climate change may be a significant factor.

The UKCIP uses an IPCC typology to examine the resilience of both man-made and natural systems to climate change. It considers:

- Sensitivity – the degree to which a system would be affected by a change in climate; sensitivity affects the impact of climate change
- Adaptive capacity – the ability of a system to adjust to climate change, to moderate potential damage or take advantage of opportunities
- Vulnerability – the extent to which a system is susceptible to, or unable to cope with adverse effects of climate change (therefore dependent on sensitivity and adaptive capacity).

Decisions should be based on an assessment of these attributes. Policies can help enhance adaptive capacity and reduce vulnerability.

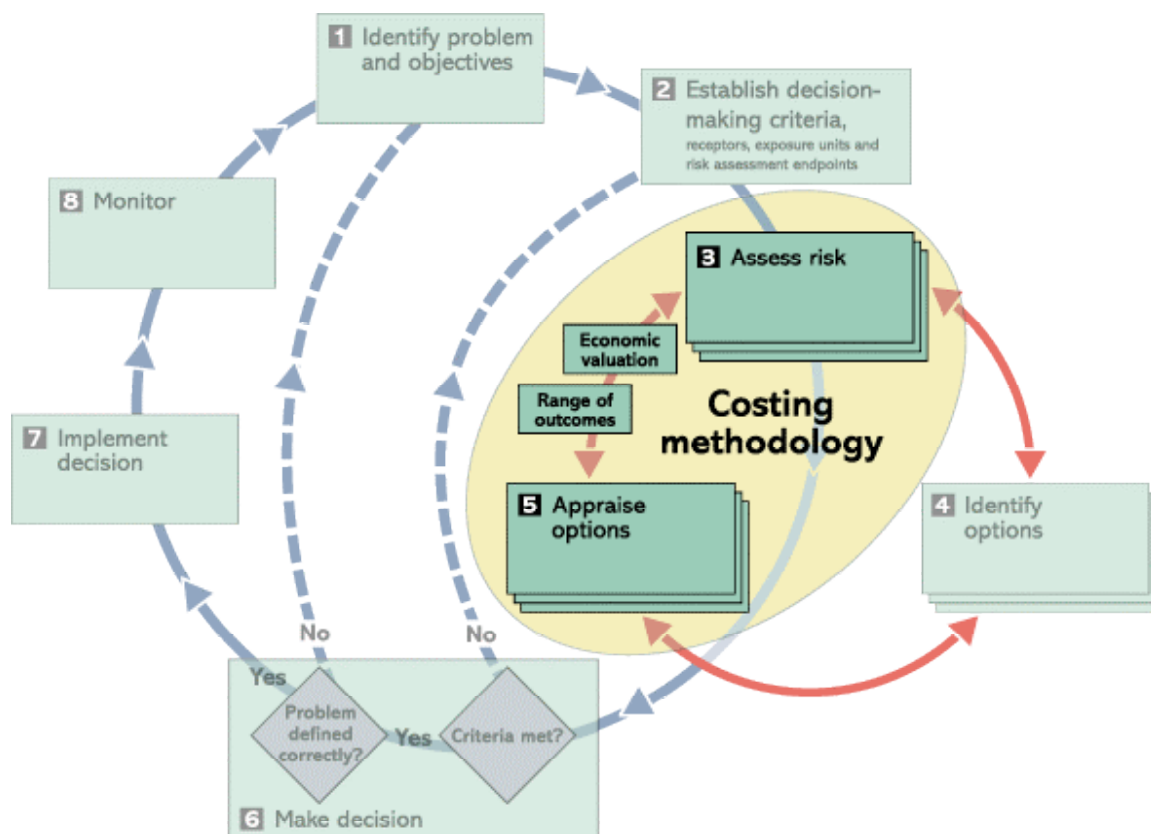
The eight stage process covers the whole decision making process from problem identification to implementation and monitoring (see Figure A9). It is based on ‘good practice’ in decision-making.

The UKCIP recognises four different types of adaptation decision:

- Climate adaptation decisions
- Climate-influenced adaptation decisions
- Climate adaptation constraining decisions
- Climate independent decisions.

At key stages in the decision process, different approaches ('tiers') are suggested for the different decision types. Practical steps for carrying out each stage are set out in detail in the report, and are not reproduced here.

Figure A9: A framework to support good decision-making in the face of climate change risk



Separately, the UKCIP has identified a set of principles of good adaptation (see Box A5). Although aimed at individual organisations, the principles are relevant to policy setting.

#### Box A5. UKCIP – Principles of good adaptation

##### 1. Work in partnership

In many cases you will need to work with others – either within your own organisation, or externally – to develop your climate adaptation strategy. Partnership working is important since adaptation in one area or sector may have knock-on effects elsewhere. Make sure you involve all relevant stakeholders, so you don't miss any important issues. If you keep them involved throughout the process, they can help you develop a robust adaptation strategy and will be more likely to agree with what you are doing.

##### 2. Keep a handle on uncertainty

Keep a record of the uncertainties, any assumptions, and your degree of confidence in your assessments as you move through the stages of developing your strategy. This information is

vital for you and others to know how confident you can be about the findings.

**3. Frame your objectives carefully before you start**

Thinking carefully about what you are trying to achieve is a critical step in the development of your strategy, policy, programme or project. The way an issue has arisen will also determine whether climate risks have been considered from the outset. If not, the objectives may need reframing to take account of them.

**4. Take a balanced approach to managing climate and non-climate risks**

You aim should be to manage risks appropriately, according to their importance. Risk assessments provide a structured approach to assist you in understanding the relative significance of different risks.

**5. Focus on actions to manage priority climate risks**

You should focus on identifying your priority climate risks, as these will be your priorities for adaptation. The most immediate priorities will be where you are already experiencing weather-related problems. 'Scoping the impacts' first, before doing more detailed risk assessments, should help you to identify your own priority risks.

**6. Use adaptive management to cope with uncertainty**

Adaptive management is a flexible approach for handling uncertainties. It involves putting in place incremental adaptation options, rather than undertaking large-scale adaptation in one fell swoop. This approach reduces the costs of being wrong, since if your initial predictions of the future are proved incorrect, you can change tack more easily. On average though, it will be more costly overall than implementing a large-scale strategy.

**7. Try to find no-regret adaptation options**

'No regret' options will deliver benefits that exceed their costs, whatever the extent of climate change. So you should always implement them if they exist. If you are already experiencing weather-related problems, then cost-effective actions to deal with them should be 'no regret' options.

**8. Try to find win-win options**

Win-win options are those that contribute to desired outcomes (be they environmental, social or economic), and also improve your ability to adapt to climate risks.

**9. Avoid actions that will make it more difficult to cope with climate risks**

You should try to avoid making decisions that will make it more difficult for you, or others, to manage climate risks in the future. These are called adaptation-constraining decisions. One example is inappropriate development in a flood risk area.

**10. Review your adaptation strategy regularly**

You will need to keep your adaptation strategy under regular review, since climate risks and the other risks you face will change with time. It will probably be appropriate to review your adaptation strategy on an annual basis.

**Summary of value for adaptation policy setting**

Criteria	Verdict
1. Principles for effective policy setting?	Yes.
2. A robust framework that tackles all policy setting stages?	Yes. However, the risk-orientated approach may be better used to assist decision-making in policy setting, rather than serving as an overall policy setting methodology.
3. A means for cross-sectoral integration of policies?	No. Designed to inform a specific policy, rather than integrate a policy across sectors.
4. An outward-looking approach?	No.
5. Tools for developing and utilising an effective knowledge base?	Yes. Many accompanying tools are considered and some described in detail, including options appraisal and decision analysis.
6. A means for tackling institutional barriers within Government?	Yes. Key questions for decision-makers, including institutional culture, strategy and individual power are raised.
7. A means for encouraging long-term thinking?	Yes. The risk approach is suited to long term policy setting.
8. Tools to handle uncertain outcomes?	Yes. Particularly useful for tackling risk related issues, which are critical to effective adaptation policy setting.
9. A means for developing targets and indicators?	No. Does not examine tools for implementing policy.
10. An inclusive approach that seeks the views of many stakeholders?	Considered. Outlines tools for engaging a wide range of stakeholders, but consultation is not a part of the framework.

**A3.2.2 UNDP/GEF - Adaptation Policy Frameworks for Climate Change**

The United Nations Development Programme (UNDP) and Global Environment Facility (GEF) aim to guide studies, projects, planning and policy exercises toward the identification of appropriate adaptation strategies, policies and measures. Its report on adaptation policy frameworks (Lim *et al.* 2005) is targeted at developing countries, explaining how development projects that tackle adaptation can set about the process of incorporating adaptation into policy. The context for application of the document is therefore somewhat different from that of the UK; however, the approach is very relevant.

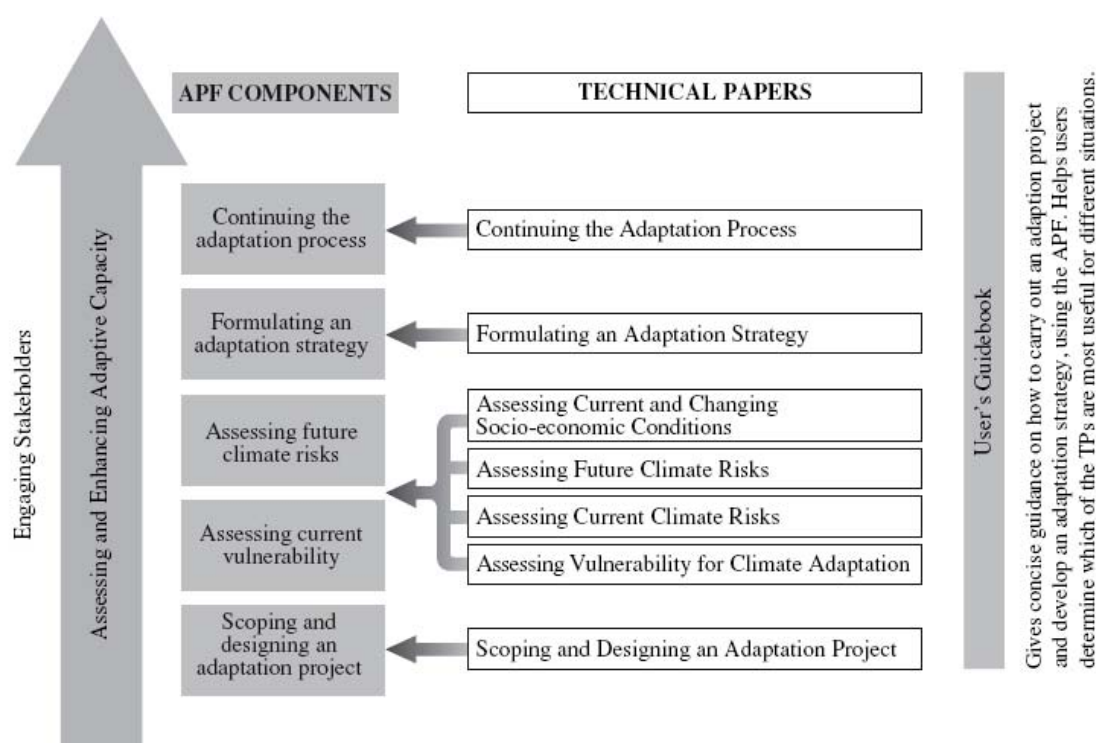
The APF comprises five components:

1. Scoping and designing an adaptation project to ensure that a project – whatever its scale or scope – is well integrated into the national policy planning and development process. This is the most vital stage of the APF process. The objective is to put in place an effective project plan so that adaptation strategies, policies and measures can be implemented.

2. Assessing current vulnerability by responding to several key questions: Where does a society stand today with respect to vulnerability to climate risks? What factors determine a society's current vulnerability? How successful are the efforts to adapt to current climate risks?
3. Assessing future climate risks by considering the development of scenarios of future climate, vulnerability, and socio-economic and environmental trends as a basis for considering future climate risks.
4. Formulating an adaptation strategy in response to current vulnerability and future climate risks. This involves the identification and selection of a set of adaptation policy options and measures, and the formulation of these options into a cohesive, integrated strategy.
5. Continuing the adaptation process involves implementing, monitoring, evaluating, improving and sustaining the initiatives launched by the adaptation project.

These implementation of each of these components is supported by detailed technical papers outlining methods for their completion, and a practical guidebook (see Figure A10).

*Figure A10: Components of the adaptation policy framework*



Implementing the APF is characterised by:

- Careful application of the scoping and design process;
- Strong stakeholder engagement;
- Assessing and enhancing adaptive capacity;
- Analysis of adaptation to cope with current and future climate change; and
- A programme to monitor, evaluate and improve the impact of the adaptation activity.

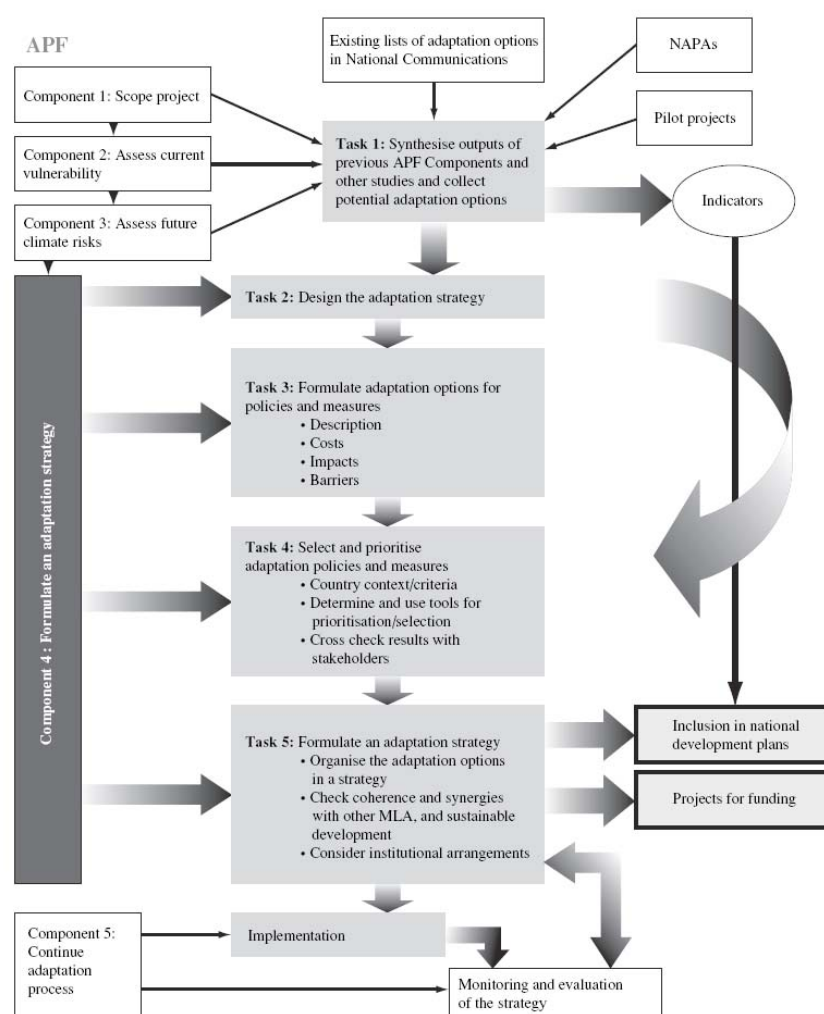
Engaging stakeholders in the adaptation process is seen as essential to each APF component, and is considered crucial to the successful implementation of an adaptation strategy. Engaging stakeholders requires an active and sustained dialogue among affected individuals and groups.

Of particular relevance to policy setting is the ‘Formulating an Adaptation Strategy’ component, described in detail in Niang-Diop and Bosch (2005). This involves 5 tasks:

1. Synthesising outputs of previous components (i.e. build a knowledge base) and other studies and collect potential adaptation options;
2. Design the adaptation strategy;
3. Formulate adaptation options for policies and measures;
4. Select and prioritise adaptation policies and measures;
5. Formulate and adaptation strategy.

The interrelationships between tasks and supporting information and activities are set out in Figure A11.

*Figure A11: Formulating an adaptation strategy*



The paper identifies four common types of policy instruments that could be used for adaptation:

- Legislative, regulatory and juridical instruments: to set limits and provide sanctions
- Financial and market instruments: to influence behaviour by sending price signals
- Education and informational instruments: to raise awareness and change societal values
- Institutional instruments: adopted by companies and communities to change behaviour.

The paper considers possible objectives for adaptation. Given that objectives for adaptation policy have received relatively little attention, the five generic objectives listed below may be of particular value in policy decision-making:

- Increasing robustness of infrastructure designs and long-term investments, e.g. by extending the range of precipitation a system can withstand without failure
- Increasing the flexibility of vulnerable managed systems, e.g. by allowing mid-term adjustments (changes of activity or location) or reduction in economic lifetime (increasing depreciation)
- Enhancing the adaptability of vulnerable managed systems, e.g. by reducing other (non-climatic) stresses and removing barriers to migration
- Reversing trends that increase vulnerability (maladaptation), e.g. by limiting development in vulnerable areas (floodplains and coastal zones)
- Improving societal awareness and preparedness, e.g. by informing the public of the risks and setting up early-warning systems.

The formulation of options for adaptation policy measures involves integration of adaptation policies and measures between different sectors, in order to ensure coordination with other policies and minimisation of potential conflicts. Evaluation of relevant sectoral policies may also be required to bring sectoral policies that relate or could relate to adaptation up to date and add new and supporting policies where appropriate.

Development of adaptation options at different time scales is key consideration. For example, it would be possible to have *long-term adaptations* that respond to mean changes in climate, *tactical adaptations*, such as flood proofing or water conservation concerned with the medium term and *contingency adaptations* related to short-term extremes, associated with increased climate variability, such as floods and drought planning. Each of these options could also be classified as *no regrets options*, justified by current climate conditions, and *low-regrets options*, made because of climate change but at minimal cost.

The result of the formulation process will be a series of measures that may be classified as:

- Sectoral – those that related to adaptations for specific sectors, such as agriculture
- Multisectoral – those that span sectors, e.g. water management, coastal zone management or biodiversity
- Cross sectoral measures – those that are generic and apply to all sectors, such as education, training, public awareness campaigns, changes to the fiscal regime, disaster management measures and monitoring systems.

The paper also outlines an approach for selection of policies, based on the existing policy arrangements. The four step process is as follows:

1. Identify current policies for a given sector (this forms the starting point for a list of policies)
2. Determine how these policies need to be improved to deal with *today's* climate (create a list of new options that supports the original list)
3. Determine how these policies need to be improved to deal with *future* climate (amend the revised list accordingly)
4. Prioritise these adaptation options and policies according to their ability to fill the gaps, feasibility, effectiveness and cost (using cost benefit analysis, cost effectiveness analysis, multi-criteria analysis or expert judgement).

It is recommended that:

- Policy setting is primarily a top-down approach and therefore needs strong backing from Ministers if it is to succeed;
- Clear goals are required to ensure opportunities are not missed;

- Suitable indicators must be chosen to ensure that the policy will help gauge its effectiveness at a later stage;
- Clear cross-sector communications (between, for example, policy, science, industry, regional areas) are required to minimise conflicts;
- The policy must be long term, covering a period of more than 10 years;
- The policy must be variable and iterative to allow for changing factors (such as climate or population needs).

## Summary of value for adaptation policy setting

Criteria	Verdict
1. Principles for effective policy setting?	No.
2. A robust framework that tackles all policy setting stages?	Yes. In addition to a clear process, a very comprehensive and useful array of typologies and matrices are set out (although the value of practical application is not always made clear).
3. A means for cross-sectoral integration of policies?	Yes. The report distinguishes between sectoral, multi-sectoral and cross-sectoral policies and sets out an approach for integration.
4. An outward-looking approach?	Yes. Points to the availability of National Adaptation Programmes of Action (NAPAs) developed in other countries.
5. Tools for developing and utilising an effective knowledge base?	Partly. Climate risk and vulnerability assessments are described in detail, but no review of the information required for effective policy making is provided.
6. A means for tackling institutional barriers within Government?	Partly. The importance of building adaptive capacity is acknowledged, but government institutions are not a focus.
7. A means for encouraging long-term thinking?	Yes. The importance of time horizons is acknowledged and a prioritisation process suggested.
8. Tools to handle uncertain outcomes?	Partly. Outlines and approach for assessment of current and future climate change risks, though less on how these risks affect policy decisions.
9. A means for developing targets and indicators?	Considered, the implication is that a gap analysis of existing sectoral policies is required.
10. An inclusive approach that seeks the views of many stakeholders?	Yes. Considerable attention has been paid to the stakeholder engagement part of the process.



### **A3.2.3 SEI – A Risk-Adaptation Decision Framework**

The Stockholm Environment Institute has recently developed an approach for planning climate change adaptation (Downing 2005) in which adaptation is examined by means of a decision tree. The method was developed in response to international adaptation priorities and the NAPA guidelines, with a focus on vulnerable socio-economic groups and a prioritisation of existing over future climatic risks.

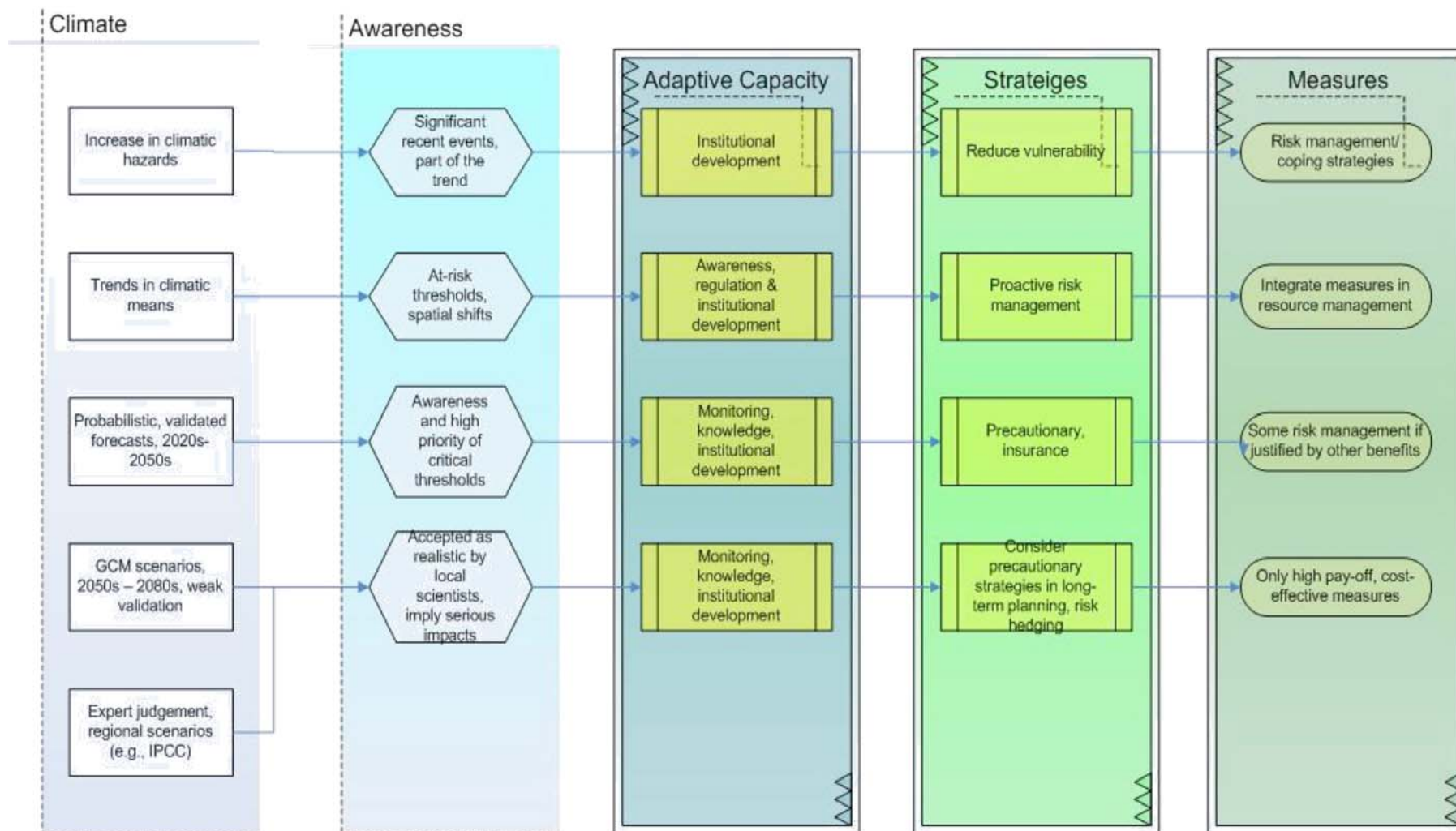
The framework (see Figure A12) sets out a list of choices that begin with our understanding of climate change, as perceived at the local (or strategic/operational level) and leading to actions that might be to build adaptive capacity, to develop adaptation strategies or to adopt specific measures. Although not a complete policy setting methodology, the framework could be used in policy setting to identify priorities for policy measures.

The first row reflects the major concern with climatic hazards. If hazards are increasing and the increase is apparent to local decision makers (e.g., ‘three of the worst heat waves this century have been in the past 10 years’), then a mixture of capacity, strategy and measures should be implemented. For instance, early warning systems should be strengthened in order to better detect trends (changes in frequency, magnitude and duration), provide useful forecasts (e.g., seasonal droughts and start of the rainy season), and build partnerships with vulnerable communities to ensure the warnings are matched by timely and effective responses. Much of this should already be in place, warranted by current climatic risks. However, some hazards are poorly covered and some regions are not well served at all. Development of climate outlooks and forecasts over a multi-annual time period is critical, as is the linkage to responses (e.g., defining thresholds for action at a strategic and operational level, ensuring false alarms are not detrimental to the vulnerable).

In the second row the major stimulus is an observed trend in the climatic resources (with or without a change in hazards). For example, warmer temperatures and melting of glaciers has increased the hazard of the failure of glacial lakes and downstream flooding. Local identification of critical thresholds and at-risk populations and regions should trigger proactive risk management, in the context of strengthened institutional mechanisms to monitor, plan and respond to the threats. Specific measures would be warranted where they can be integrated in resource management plans. For instance, a significant trend in temperatures may lead to less water resources in a catchment and long-term plans should encompass climate change. Perhaps the most common example along these lines are spatial planning in coastal areas subject to accelerated erosion and the choice of trees (and other vegetation) in afforestation, urban planning and land cover management.

## Objective Setting for Climate Change Adaptation Policy

Figure A12: A risk-adaptation decision framework



If observed changes in local climates (either hazards or trends in resources) are not apparent, the choice of adaptation responses is less clear. If probabilistic forecasts are available for the current planning time frame (say 20 years for resource developments) and it appears that there is a significant risk of critical thresholds being exceeded or highly vulnerable populations being affected, then there is a sound basis for urgent and priority action (as shown in the third row). This may be to put in place the institutional capacity to monitor trends and improve on the assessment of the risk. Alternatively, some precautionary strategies, such as insurance, might be desirable. Of course, reducing current vulnerability (e.g., poverty, poor resource management) is warranted on other grounds; further action would be justified as well.

The fourth and fifth rows attempt to capture the situation where there is no observed change in risk and where forecasts of risks within the planning period are not available. The only basis for planning adaptation is a few scenarios, such as a low and high scenario, a repeat of an historical event, expert judgement, or scenarios at the regional scale (such as provided by the IPCC). Here the barrier to effective adaptation may be the perception of how realistic this sort of information is and the relative importance compared to other development goals. Certainly further assessment is likely to be warranted. However, the priority for climate change adaptation is likely to be in precautionary strategies that have benefits for other objectives. In fact, it remains a daunting task to reduce the vulnerability of the poor, to increase resilience and sustainability of resource management and to implement spatial planning that does not increase future risks. An example might be to develop flood management institutions designed to 'live with nature' rather than rely solely on structural protection or to allow flood-prone areas to be developed with economically vulnerable infrastructure. However, there are some examples of mal-adaptation where future climate change has been added to infrastructure costs requiring vulnerable economies to pay now for protection that may or may not be realised many decades from now.

### Summary of value for adaptation policy setting

Criteria	Verdict
1. Principles for effective policy setting?	Partly, implied in the progression from adaptive capacity to strategies and measures
2. A robust framework that tackles all policy setting stages?	No, potentially useful as a quick method to screen potential strategies at different stages
3. A means for cross-sectoral integration of policies?	No, only if brought into the decision tree by stakeholders
4. An outward-looking approach?	Partly, can be adapted for different stakeholders to fit within their decision frameworks
5. Tools for developing and utilising an effective knowledge base?	Partly, one tool that could be linked to other assessment and decision techniques
6. A means for tackling institutional barriers within Government?	No, not considered except to clarify a logical approach
7. A means for encouraging long-term thinking?	Yes, makes explicit the need for capacity to adapt when necessary

8. Tools to handle uncertain outcomes?	Yes, decision trees help plan how to include uncertainty in choosing outcomes
9. A means for developing targets and indicators?	Partly, may help to ensure that the targets and indicators are appropriate for a full range of situations
10. An inclusive approach that seeks the views of many stakeholders?	Yes, can be built up from stakeholder knowledge, in which case it is interesting to see whether the individual decision trees (different stakeholders, sectors, regions) are vastly different

### A3.2.4 SEI - Local Decision Tree Approach

Most frameworks on climate adaptation start with some sense of the problem, whether trends and scenarios in climate or goals for reducing risk. An alternative way to think about adaptation is as a process of deciding which alternatives to adopt. This may be only part of a policy cycle (as in the UKCIP/EA approach). Often it would be the actual process of choices undertaken by a decision maker.

The illustration put forward here is from the Vale of White Horse District Council. One member of the project team sits on their Sustainability Panel and participated in preparation of the structure plan. The plan presents policies and criteria related to allocating some 3000 housing units across the district over the next 10 years. The example is one of the choices that relates to climate impacts (other criteria relate to energy use and climate mitigation).

The decision tree starts with the set of options that are available. In this case, a developer had requested planning permission for a plot in the flood plain. The Panel had to make a decision of whether or not to include the plot in the plan, that is to encourage development on that site. (Actual development plans would be screened in a separate process.) The choice set is simply:

{ Include in plans / Exclude from plans }

The first level of criteria in a decision tree can be considered as a screening checklist (sometimes known as preattentive or elimination by aspect). These are criteria that can be quickly checked, that relate to the context of the decision, and are often assumed or imposed by others. In this case, there is one such criteria:

1. < Do we have authority to exclude the plot on the basis of it being prone to floods? >

The answer, in this case, is yes, the Government had issued new guidelines reinforcing the responsibility of local authorities to not allow development in flood prone areas and further requiring them to allow the Environment Agency to comment on all such proposals. In fact the EA is represented on the Panel and an explicit criteria in the plan restricted development in the flood plain.

However, it is possible to allow development, if other conditions are met. Thus the decision tree might proceed:

2. < Could the development be protected from floods? >

3. < Is land available for compensation? >
4. < Are there unique benefits for developing this site? >
5. < Would development affect green spaces? >
6. < Is there access for emergency evacuation? >

Criteria 2 and 3 seemed to be the most important, and thus are high up the tree. In this case, the plot was adjacent to a gentle hill and it would have been relatively easy to fill in the site to elevate it above the design flood height. Also, there was land in the area that could be excavated so that the total volume of flood storage would not be affected. On these two criteria the plot was eligible for further consideration.

Criteria 4 is more subjective. Was there any real reason for building on this site? In this case, the Panel decided there was not sufficient reason for contravening the flood plain restrictions. There were other sites immediately adjacent that could be developed, there was no shortage of other sites in the area and the site would not have been appropriate for non-domestic use. Thus, the site was not included in the plan.

Criteria 5 and 6 were not considered by the Panel. In a formal tree, the decision was taken at Criteria 4. In reality the site visit noted the green space surrounding the river was pleasant and could be improved as a recreation area. Development of the plot would have constrained access and the total area of green space. So this criteria would likely have failed the test too.

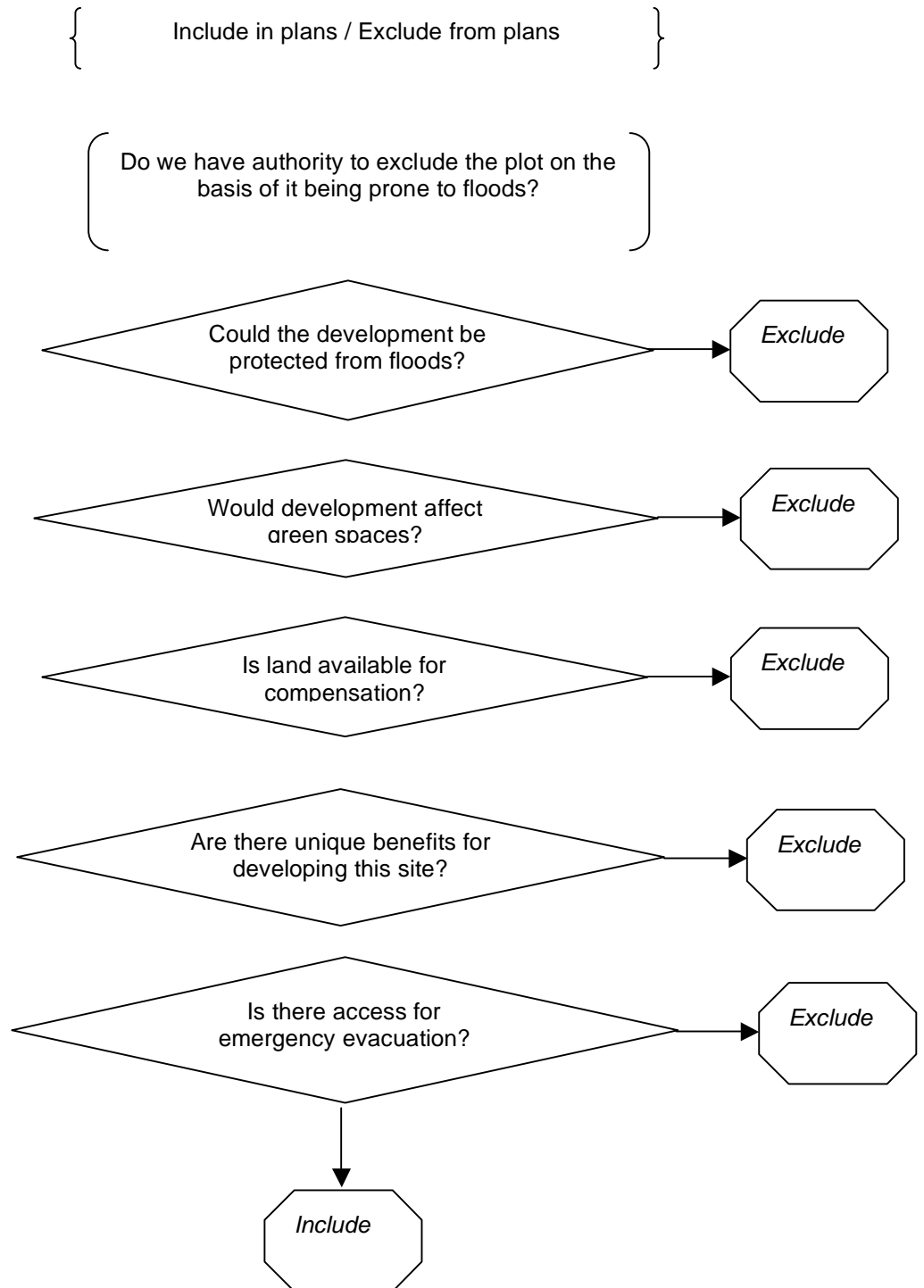
Criteria 6 is not included in the plans, and may be beyond the remit of local authorities. However, emergency planning might logically be included in some decisions, particularly for large installations in vulnerable regions. This is a formal criteria for nuclear power stations (along with operational plans) in the US.

It is not necessary to assume that the decision tree is the actual order and process that decision makers go through. Rather, the test is whether the tree predicts outcomes for a wide range of users in similar circumstances. A success rate of 80-90% is considered achievable. The formal logic may also help decision makers to think about the problem in consistent and collective ways.

The full tree is shown in Figure A13.

This example is slightly different from the risk-adaptation decision framework presented in the previous section. It begins with the assumption that there is a decision 'on the table', that is, some stakeholder has to make a choice among one or more alternatives. In contrast, the previous screening tree began with observations and predictions of present and future climate change. However, this decision tree approach is similar to the risk-adaptation approach in its characteristics.

Figure A13: A local decision tree example



**Summary of value for adaptation policy setting**

<b>Criteria</b>	<b>Verdict</b>
1. Principles for effective policy setting?	No, assumes policy and decision framework already exist
2. A robust framework that tackles all policy setting stages?	No, potentially useful as a quick method to screen potential strategies at different stages
3. A means for cross-sectoral integration of policies?	No, only if brought into the decision tree by stakeholders
4. An outward-looking approach?	Partly, can be adapted for different stakeholders to fit within their decision frameworks
5. Tools for developing and utilising an effective knowledge base?	Partly, one tool that could be linked to other assessment and decision techniques
6. A means for tackling institutional barriers within Government?	No, not considered except to clarify a logical approach
7. A means for encouraging long-term thinking?	No, assumes a decision must be made in the short term (although 'wait and see' could be one of the choices)
8. Tools to handle uncertain outcomes?	Yes, decision trees help plan how to include uncertainty in choosing outcomes
9. A means for developing targets and indicators?	Partly, may help to ensure that the targets and indicators are appropriate for a full range of situations
10. An inclusive approach that seeks the views of many stakeholders?	Yes, can be built up from stakeholder knowledge, in which case it is interesting to see whether the individual decision trees (different stakeholders, sectors, regions) are vastly different

## **Appendix IV: Sectoral Climate Impacts and Risks**

See following pages



## A4.1 TRANSPORT

### Impacts of climate change

Expected climate change (& confidence)	Impact on sector	Risk	Opportunity
Increasing summer temperatures (high)	Impacts on air quality. Increasing incidence of subsidence. Health and safety.	<ul style="list-style-type: none"> <li>Deteriorating air quality (particles and ozone) and health implications for travellers</li> <li>Increasing population of rodents in highways, and rail networks</li> <li>Worse odours from drainage/sewage systems</li> <li>Increased driver fatigue (leading to accidents)</li> <li>Increased demand for tourism/leisure travel – pressure on network capacities</li> <li>Increased incidence of overhead lines sagging</li> </ul>	<ul style="list-style-type: none"> <li><b>Modal shift</b></li> <li>Increased regional demand for travel for outdoor leisure</li> </ul>
Increased frequency of extreme high temperatures (high)	Hot temperature effects on infrastructure (road, rail); increased passenger discomfort	<ul style="list-style-type: none"> <li><b>Increased incidences of rail buckling</b></li> <li><b>Increased incidences of road surface deformation</b></li> <li>Increased incidences of points failure</li> <li>Maintenance issues: increased cracking of bridge joints, failure of vehicles and components, decreased ability to perform some activities</li> <li>Increased incidence of heat-related comfort and health issues for passengers, drivers, staff, leading to accidents / injuries</li> <li>Drought / heat damage to vegetation</li> </ul>	<ul style="list-style-type: none"> <li><b>Passengers may switch to other modes</b> (walking, cycling, river)</li> </ul>
Increasing winter temperatures (high); Fewer frost days (high)	Less icing of roads and rails; rapid snow melt and run-off; longer growing season and leaf-fall season.	<ul style="list-style-type: none"> <li>Increased cost of cutting verges</li> <li>Increased incidence of drain blockages, slippery roads from leaf fall, and “leaves on line” delays</li> <li>Increased possibility of vegetation-obscured signals (safety issue)</li> </ul>	<ul style="list-style-type: none"> <li>Fewer cold-related road accidents</li> <li>Reduced winter maintenance costs (e.g., for road/rail de-icing, to address freeze-thaw action, etc)</li> <li>Fewer winter delays (related to signalling or track issues)</li> </ul>
Reduced snowfall (high)	Fewer incidences of snow-affected travel (road, rail).		<ul style="list-style-type: none"> <li>Fewer delays on road or rail from speed restrictions</li> <li>Reduced maintenance costs (snow clearing)</li> <li>Reduced incidence of dangerous driving</li> </ul>

# Objective Setting for Climate Change Adaptation Policy

Expected climate change (& confidence)	Impact on sector	Risk	Opportunity
			conditions
More rain in winter (high)	Riverine flooding; groundwater flooding; landslips – affecting infrastructure (road, rail, underground)	<ul style="list-style-type: none"> <li>• Impaired stability of embankments, cuttings, tunnels (both natural and artificial slopes)</li> <li>• Increased congestion at flooding hotspots including tunnels (some routes impassable)</li> <li>• Increased damage to retaining walls</li> <li>• Impaired vehicle braking (leading to accidents)</li> <li>• Greater need for shelter at stations</li> <li>• Electrical failures</li> </ul>	
More frequent intense rainfall (high)	Urban flooding as drains are overwhelmed; increased flood risk to roads in valleys; transfer of silt from carriageways / verges into drains; more frequent standing water on roads	<ul style="list-style-type: none"> <li>• Increased incidence of road closure, rail closure and travel/traffic disruption due to floods</li> <li>• Insufficient drainage &amp; culvert capacity</li> <li>• Greater chance of sudden earthworks failures</li> <li>• Increased scour at base of bridges</li> <li>• Increased erosion damage to road surfaces</li> <li>• Greater occurrence of blocked drains (requiring increased maintenance)</li> <li>• Increased incidence of vehicle aquaplaning and poor visibility from spray (leading to accidents)</li> </ul>	
Less summer rainfall (medium); summer soil moisture decreases (high)	Groundwater extraction by trees not replenished – subsidence; increased drying out of ground beneath infrastructure; less frequent road run-off	<ul style="list-style-type: none"> <li>• Increased incidence of road/rail (and buildings) subsidence in clay/peat areas and by trees</li> <li>• Increased desiccation of earthworks on clay geologies and instability / subsidence</li> <li>• Polluted road run-off is less diluted</li> <li>• Greater incidence of line-side fires?</li> </ul>	
Sea-level rise (high); increased frequency of extreme SL / high tides (high)	Coastal flooding and erosion – affecting infrastructure (road, rail, ports)	<ul style="list-style-type: none"> <li>• Increased flooding of coastal roads/track in some locations – some routes impassable</li> <li>• Spiralling maintenance costs in vulnerable areas from increasing erosion/damage to (rail/road)</li> <li>• Potential loss of vulnerable coastal lines and stations</li> <li>• Damage to rolling stock and vehicles from salt water/spray</li> <li>• Electrical failures</li> </ul>	

# Objective Setting for Climate Change Adaptation Policy

Expected climate change (& confidence)	Impact on sector	Risk	Opportunity
		<ul style="list-style-type: none"> <li>More hazardous driving conditions (leads to road accidents)</li> </ul>	
Increased frequency of deep depressions (low)	Higher winds – wind-related damage to infrastructure; more frequent stormy conditions	<ul style="list-style-type: none"> <li>Increased incidence of damage to bridges, signs, overhead wires</li> <li>Increased incidence of blocked or closed roads/rail</li> <li>More ferry crossings delayed / cancelled</li> <li>More hazardous driving conditions (leads to more road accidents)</li> <li>“Leaves on the line” and more wind-blown debris</li> <li>Increased incidences of damage to electrics and electronics</li> </ul>	
Any /several /all changes	Changes in biodiversity on soft estate Changes in seasonal demand for different modes Disruption to journeys	<ul style="list-style-type: none"> <li>More difficult to meet biodiversity targets</li> <li>Increasing traveller delays (associated costs)</li> <li>Changes in seasonality of energy use for cooling/heating public transport and buildings</li> </ul>	<ul style="list-style-type: none"> <li>Increased travel by more sustainable modes (walking, cycling, boat)</li> <li>Species can migrate</li> </ul>

**Illustrative risk assessment**

<b>Risk (or Opportunity)</b>	<b>Magnitude, Probability (high, medium, low)</b>	<b>Extent (spatial, geographical)</b>	<b>Timeframe (now, short/med term, long term)</b>	<b>Lead stakeholders</b>
<b>Impaired stability of earthworks</b> and increased risk of sudden failure from higher winter rainfall and more frequent intense rainfall	High, High	Everywhere (but esp Scotland and NW).	Now or short/med term	NR, HA, LAs, regional bodies, DfT, ORR, RSSB, research bodies
<b>Increased incidence of road /rail /buildings and earthworks subsidence</b> from reduced summer rainfall (and hotter summer temperatures?)	High, High	In clay/peat areas and by street trees Dessication in clay/peat geologies	Now or short/med term	HA, NR, Las, ORR
<b>Increased flooding of coastal roads/rail</b> (routes impassable, damaged or lost) from sea level rise and more frequent storm surges	High, High	East SE, SW coast	Short/med or long term	HA, NR, LAs, Environment Agency, National Trust, DfT, TOCs
<b>Increased incidences of road surface deformation</b> under extreme summer high temperatures	High, High	England (esp south-east)	Now or short/med term	HA, LAs, regional bodies, DfT, research bodies
<b>Insufficient drainage and culvert capacity</b> for more frequent intense rainfall	High, High	Focused on flood-prone areas, esp urban areas	Now or short/med term	HA, NR, LAs, ORR
<b>Increased congestion at flooding hotspots and increased incidence of road/rail closure</b> due to flooding from higher winter rainfall and more frequent intense rainfall	High, Medium	Focused on flood-prone areas, esp urban areas	Short/med term	Environment Agency, water companies, regional bodies, LAs, HA, NR, TOCs, bus companies, emergency services, DfT
<b>Increased scour at base of bridges</b> from more frequent intense rainfall and flooding	High, Medium	Flood-prone areas	?	HA, NR, LAs, Environment Agency

# Objective Setting for Climate Change Adaptation Policy

Risk (or Opportunity)	Magnitude, Probability (high, medium, low)	Extent (spatial, geographical)	Timeframe (now, short/med term, long term)	Lead stakeholders
<b>Increased incidence of damage to bridges, signs, overhead wires</b> from increased storminess, higher winds (higher uncertainty)	Medium, Medium	Everywhere?	Short/med term	HA, NR, LAs, emergency services, electricity providers, TOCs
<b>Increased incidences of rail buckling</b> under extreme summer high temperatures	Medium, Low	England (esp south-east)	Now or short/med term	NR, RSSB, DfT, ORR, research bodies
General				
<b>Changes in demand</b> <ul style="list-style-type: none"> <li>Modal shift / seasonality</li> <li>More sustainable modes?</li> </ul>	High, Medium	Everywhere?	Now or short/med term	DfT, Regional bodies, LAs, Research bodies, Public
Greater incidence of wet or hot <b>weather-related travel disruption</b> <ul style="list-style-type: none"> <li>Traveller delays</li> <li>Reduced incidence of cold-related travel disruption</li> </ul>	Medium, Medium	Everywhere, greatest in cities and at flooding hotspots	Short/med term	Regional bodies, Public
<b>Changes to biodiversity</b> <ul style="list-style-type: none"> <li>Species shift, biodiversity targets missed</li> </ul>	Low, High	Upland areas, north	Short/med term	Regional bodies, LAs, NGOs, DfT, Defra

## A4.2 ENERGY

### Impacts of climate change

Expected climate change (& confidence)	Impact on sector	Risk	Opportunity
Increasing summer temperatures (high)	Overheating of buildings during summer increases energy demand for space cooling.	<ul style="list-style-type: none"> <li>• Change in overall energy demand (annual)</li> <li>• Greater summertime energy use affects prices?</li> <li>• Possible change from peak electricity demand in winter (now) to summer is difficult to manage.</li> <li>• Increased evapotranspiration leading to decreased stream flow, reduced water available for HEP</li> </ul>	<ul style="list-style-type: none"> <li>• Less early and late summer heating required in far north</li> </ul>
Increased frequency of extreme high temperatures (high)	High energy demand for space cooling. Hot temperature damage to transmission grid infrastructure Overheating of power generation and supply equipment	<ul style="list-style-type: none"> <li>• Peaks in demand risk overloading system?</li> <li>• Increased incidence of emergency maintenance, disruption to energy supply</li> <li>• Damage of expensive equipment, disruption in supply, environmental standards failed (eg return of overheated cooling water)</li> </ul>	
Increasing winter temperatures (high); Fewer frost days (high); reduced snowfall (high)	Reduced energy demand for space heating in winter Less cold weather damage to grid infrastructure. Earlier snowmelt. Longer growing season	<ul style="list-style-type: none"> <li>• Change in overall energy demand (annual)</li> <li>• Possible change from peak electricity demand in winter (now) to summer is difficult to manage.</li> <li>• Earlier snowmelt reduces effectiveness of HEP into late spring / early summer</li> <li>• Greater damage to transmission cables from wind throw as trees remain in leaf for longer</li> </ul>	<ul style="list-style-type: none"> <li>• Less fuel poverty</li> <li>• Less cold related disruption to electricity supply.</li> <li>• Reduced winter maintenance of transmission infrastructure</li> <li>• Increased potential for biofuel production from longer growing season</li> </ul>
More rain in winter (high)	Riverine and groundwater flooding impacts on infrastructure	<ul style="list-style-type: none"> <li>• Flood damage to substations and underground transmission infrastructure – power cuts and increased maintenance</li> </ul>	<ul style="list-style-type: none"> <li>• Increased potential for HEP production</li> </ul>
More frequent intense rainfall (high)	Urban flooding affects infrastructure Sudden high river flows overwhelm HEP capacity?	<ul style="list-style-type: none"> <li>• Substations flooded, causing power cuts and increased maintenance costs</li> <li>• More frequent damage to transmission infrastructure from landslips in mountainous regions</li> </ul>	

# Objective Setting for Climate Change Adaptation Policy

Expected climate change (& confidence)	Impact on sector	Risk	Opportunity
		<ul style="list-style-type: none"> <li>Problems with flooding for hydro power</li> </ul>	
Less summer rainfall (medium); summer soil moisture decreases (high)	Reduced summer river flows for HEP production Reduced availability of water for power stations	<ul style="list-style-type: none"> <li>Reduction in summer capacity from hydro-power.</li> <li>Power stations constrained by water availability</li> </ul>	
Sea-level rise (high); increased frequency of extreme SL / high tides (high)	Coastal flooding and erosion affecting infrastructure (supply and production plants)	<ul style="list-style-type: none"> <li>More frequent inundation in vulnerable areas causing disruption to supply</li> <li>Increased size of vulnerable area to protect in future</li> <li>Increased need for maintenance, repairs to power plants in coastal locations</li> <li>Safety issues for decommissioning of coastal power plants?</li> <li>Increased vulnerability of offshore production? (not considered a high risk)</li> </ul>	<ul style="list-style-type: none"> <li>Increased potential for wave / tidal power generation?</li> </ul>
Increased frequency of deep depressions (low); increased average wind speed (low)	Higher winds – wind-related damage to infrastructure; tree fall More frequent stormy conditions	<ul style="list-style-type: none"> <li>Increased incidence of damage to overhead transmission lines from tree-fall or wind-blown debris – power cuts</li> <li>Damage to offshore oil and gas infrastructure (rigs)?</li> <li>Damage to wind turbines (disrupting supply?)</li> <li>Reduced load factor (wind turbines)</li> </ul>	<ul style="list-style-type: none"> <li>Increased potential for wind production.</li> </ul>
Any /several /all changes		<ul style="list-style-type: none"> <li>Insurance cover problems</li> <li>Business and household disruption from power outages</li> <li>Potential changes in land cover and ecosystems viability, potentially affecting biomass resources.</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>

**Illustrative risk assessment**

<b>Risk (or Opportunity)</b>	<b>Magnitude, Probability (high, medium, low)</b>	<b>Extent (spatial, geographical)</b>	<b>Timeframe (now, short/med term, long term)</b>	<b>Lead stakeholders</b>
Fail to <b>maintain supply to meet changes in demand</b> <ul style="list-style-type: none"> <li>Annual average consumption by mode</li> <li>Change in timing of peak electricity demand</li> </ul>	High, Medium	Everywhere? SE and urban centres	Now or short/med term	DTI, OfGem, Generators, Suppliers
<b>More frequent damage to overhead infrastructure from wind-blown debris and tree-fall</b> due to higher wind speeds, more frequent winter storms and longer growing season	High, Medium	Everywhere / anywhere, but greatest increase in vulnerability in S	Now	Distributed Network Operators, National Grid Transco, OfGem
<b>More frequent power cuts due to flooding of substations and underground transmission infrastructure</b> from higher winter rainfall and more frequent intense rainfall	High, Medium	Urban areas, flooding hotspots	Now or short/med term	DNOs, NGT, OfGem
Generation <b>capacity of power stations constrained</b> by low water availability due to decreased summer rainfall	High, Low	Greatest impact in London / SE	Short/med term	Generators on inland sites, HEP generators
<b>More frequent damage to power generation equipment</b> from extreme summer high temperatures	Medium, Low	Greatest impact in London / SE	Now or short/med term	Generators
<b>More frequent damage to transmission infrastructure</b> from extreme summer high temperatures	Medium, Low	Greatest impact in London / SE	Now or short/med term	DNOs, NGT, OfGem
<b>Increased flooding of coastal plants / infrastructure</b> (causing increased damage) from sea level rise and more frequent storm surges	Medium, Medium	Coastal locations	Short/med term	Generators on coastal sites



# Objective Setting for Climate Change Adaptation Policy

Risk (or Opportunity)	Magnitude, Probability (high, medium, low)	Extent (spatial, geographical)	Timeframe (now, short/med term, long term)	Lead stakeholders
<b>More frequent failing of environmental standards</b> during heatwaves	Low, Medium	Greatest impact in London / SE	Now or short/med term	Fossil fuel and nuclear generators
General				
<b>Increased potential for energy generation from renewable sources</b> (biofuels, HEP, wind, wave/tidal) from changes in climate	Medium, Medium	Various	Short/med and long term	DTI, Defra, Renewable energy trade associations

## A4.3 WATER

### Impacts of climate change

Expected climate change (& confidence)	Impact on water	Risk	Opportunity
Increasing summer temperatures (high)	Longer growing season, more irrigation of gardens	<ul style="list-style-type: none"> <li>Increased peak summer water demand</li> <li>Reduced water quality</li> </ul>	<ul style="list-style-type: none"> <li>Higher value placed on water for recreation</li> </ul>
Increased frequency of extreme high temperatures (high)	Increase heat stress and demand for water: consumption of drinks, cooling, water features; livestock	<ul style="list-style-type: none"> <li>Increased peak summer demand</li> </ul>	
Increasing winter temperatures (high); Fewer frost days (high)	Longer growing season, more warm-cold cycles	<ul style="list-style-type: none"> <li>Possible increase in pipe burst</li> <li>Longer irrigation season, including double cropping</li> </ul>	<ul style="list-style-type: none"> <li>Reduced frost damage</li> </ul>
Reduced snowfall (high)	Small effect in UK, some local changes in hydrology	<ul style="list-style-type: none"> <li>Higher variability in surface water in some places</li> </ul>	
Increased winter precipitation (high)	Riverine flooding; groundwater recharge might change	<ul style="list-style-type: none"> <li>Changes in groundwater recharge regime</li> <li>Soil erosion and water quality effects</li> </ul>	<ul style="list-style-type: none"> <li>Increased groundwater recharge</li> </ul>
More frequent intense rainfall (high)	Increase in soil erosion and runoff; overflowing of sewage system	<ul style="list-style-type: none"> <li>Degradation of water quality</li> </ul>	
Decreased summer precipitation (medium)	Shorter recharge season; reduced water supply; higher dependence on winter storage	<ul style="list-style-type: none"> <li>Increased risk of water shortages</li> <li>Need for greater storage infrastructure</li> </ul>	
Sea-level rise (high); increased frequency of extreme SL / high tides (high)	Increase risk of flooding and erosion; Increased saline intrusion	<ul style="list-style-type: none"> <li>Interruption of services; change in abstraction points</li> </ul>	
Increased frequency of winter deep depressions (low)	Higher winds; wind-related damage to infrastructure; more frequent stormy conditions	<ul style="list-style-type: none"> <li>Flash flood risk increases</li> <li>Physical damage to infrastructure</li> </ul>	
Changes in seasonality	Increased variability	<ul style="list-style-type: none"> <li>Increased risk of shortages</li> </ul>	

**Illustrative risk assessment**

<b>Risk (or Opportunity)</b>	<b>Magnitude (high, medium, low)</b>	<b>Extent (spatial, geographical)</b>	<b>Timeframe (now, short/med term, long term)</b>	<b>Lead stakeholders</b>
Increased demand and variability in supply (and in some places decreased supply)	Low effect of trend in average values, but High for frequency of peak demand and low flow periods	Southern England is most affected, partially because of lack of storage, but central England at risk as well; likely to be less significant in north, Wales and NI	Increase is noted at present, particularly for horticulture; significant additional risks anticipated in next 10 years	EA: abstraction, water resources, environmental standards Ofwat: pricing and investment caps Defra: policy framework Local authorities: at present little direct influence, but significant role in urban planning including gardens and green spaces Water companies: implementing and innovation
Pollution from intense rainfall and flooding caused by overflow of storm drains and sewage treatment works, as well as catchment runoff	High, but event driven	Probably risk is increased for all of UK; some coastal zones are particularly vulnerable from storm surges; flash floods important but difficult to forecast	Increase in flooding is noted now, risk is judged to continue to increase in next 10 years	Same, with broader representation on environmental standards

## A4.4 FLOOD AND COASTAL RISK MANAGEMENT

### Impacts of climate change

Expected climate change (& confidence)	Impact on sector	Risk	Opportunity
Changing patterns of rainfall (MED)	Riverine flooding	Damage to: built structures (e.g. buildings, transport infrastructure; agricultural production; transport flows; health; habitat	
Changing patterns of Winter rainfall (MED)	Ground-water flooding	Damage to: built structures (e.g. buildings, transport infrastructure; agricultural production; transport flows; health; habitat	
Less snow-melt flooding (MEDIUM)	Riverine and groundwater flooding		Reduced damage to: built structures (e.g. buildings, transport infrastructure; agricultural production; transport flows; health; habitat
Increasing summer temperatures (HIGH)	Reduced groundwater Increased drying out of ground	Increased likelihood of subsidence at vulnerable coastal sites (natural and man-made) Increased potential for subsidence related accidents	
Increased wind speeds (LOW)	Increased wave magnitude at coast Increased likelihood of extreme wind events, eg tornados	Increased risk of coastal flooding Coastal erosion Storm damage to buildings and infrastructure Storm-gale related deaths Disruption to communications	
Sea level rise: gradual inundation & increased frequency of extreme tidal movements (HIGH)	Coastal erosion Flooding at coastal sites Flooding at estuarine sites	Loss of vulnerable buildings Loss of tourist destinations (eg beaches, cliff walks) Disruption to utilities at coastal sites Disruption to industry at estuarine sites (eg chemical/petrochemical industry on Merseyside) Increased repair and insurance costs associated with the above	

# Objective Setting for Climate Change Adaptation Policy

		Loss of some wetland SSSI's and SAC's Disruption to estuarine habitats	
Storm surges (LOW)	Coastal flooding; saltwater intrusion	Damage to property & natural environment	
Increased frequency of intense rainfall; likelihood of flash-flooding (LOW)	Landslides drainage systems overwhelmed	Possibility of untreated sewage entering sea – adverse effects on marine life Local urban flooding leading to e.g. property & transport damage and disruption Damage to fragile coastal sites – eg cliff slips onto beaches or into sea Increased likelihood of injury Increased repair and insurance costs associated with the above – passed on to tourists	

**Illustrative risk assessment**

<b>Risk (or opportunity)</b>	<b>Magnitude (High, medium, low)</b>	<b>Extent (spatial, geographical)</b>	<b>Timeframe (Now, short/medium term, long term)</b>	<b>Lead stakeholders</b>
Riverine flooding Damage to: <ul style="list-style-type: none"> <li>• built structures (e.g. buildings, transport infrastructure);</li> <li>• agricultural production;</li> <li>• transport flows;</li> <li>• health</li> <li>• habitat</li> </ul>	Medium?	Everywhere	Now, short/med term and long term	Defra, Environment Agency, LA's
Urban flooding – urban drainage overflow Damage to: <ul style="list-style-type: none"> <li>• built structures (e.g. buildings, transport infrastructure);</li> <li>• transport flows;</li> <li>• health</li> <li>• habitat</li> </ul>	Medium?	Everywhere	Now, short/med term and long term	Defra, Environment Agency, LA's
Ground-water flooding: Damage to: built structures (e.g. buildings, transport infrastructure); agricultural production; transport flows; health; habitat	Medium?	Everywhere	Now, short/med term and long term	
Coastal flooding	?	Low lying coasts with largest predicted sea level rises	Now, short/med term and long term	Environment Agency, Defra
Coastal erosion	High	Areas with largest predicted sea level rises and wind extremes	Now, short/med term and long term	Environment Agency, Defra
Storm damage: wave damage & storm surges	Medium?	All coastal sites	Now, short/med term and long term	ABI, Environment Agency, LA's
Loss of some wetland SSSI's and SAC's	Medium?	Particularly eastern seaboard	Short/med term and long term	Environment Agency, EU,

### Objective Setting for Climate Change Adaptation Policy

Loss of vulnerable buildings	Medium?	Extreme coastal locations with largest predicted sea level rises, therefore esp South East	Short/med term and long term	Environment Agency, National trust, English heritage
Loss of tourist destinations	Low	North east, south, east and south east of England	Short/med term and long term	Dept for Culture (?) National trust, English heritage
Disruption to utilities at coastal sites	Medium	Heavily populated locations generally	Now, short/med term and long term	Utilities companies, DTI, Emergency services
Storm related injuries	Low	Everywhere	Now, short/med term and long term	Dept of Health. Local Hospital Trusts
Disruption to industry in estuarine locations	Medium	South East and Northwest (especially Thames estuary and Merseyside)	Short/med term and long term	DTI, Emergency services, Industry bodies
Readiness of emergency services	Medium	Particularly outside south east England	Now, short/med term and long term	Home office, Local emergency services providers

## A4.5 AGRICULTURE

### Impacts of climate change

Expected climate change (& confidence)	Impact on sector	Risk	Opportunity
Increasing summer temperatures (high)	Faster growing crops Longer growing season	<ul style="list-style-type: none"> <li>Range of pest and diseases may increase</li> <li>Weeds may evolve faster</li> <li>Crop cultivars may not be optimal for new conditions</li> <li>Damage to cereal crops during flowering reduces yields</li> </ul>	<ul style="list-style-type: none"> <li>Agricultural diversification</li> <li>Energy crops</li> <li>Increased northern limit of some crops and some fruit and vegetables</li> </ul> <p>Increased quality and quantity of produce (dependent on nitrogen use and irrigation)</p> <ul style="list-style-type: none"> <li>Enhanced yields</li> <li>New crops, new cultivars</li> <li>Reduced need for cereal drying</li> </ul>
Increased frequency of extreme high temperatures (high)	Increase heat stress to crops and livestock (especially intensive production)	<ul style="list-style-type: none"> <li>Reduced quality of produce</li> <li>Soil damage</li> <li>Lower fertility for pigs poultry and cattle</li> <li>Deterioration in animal health</li> </ul>	
Increasing winter temperatures (high); Fewer frost days (high)	longer growing season	<ul style="list-style-type: none"> <li>Insufficient chilling for bud break</li> <li>Increased weeds pests and diseases</li> </ul>	<ul style="list-style-type: none"> <li>Reduced frost damage</li> <li>Extended growing season</li> <li>Multiple crops</li> </ul>
Reduced snowfall (high)			<ul style="list-style-type: none"> <li></li> </ul>
Increased winter precipitation (high)	Riverine flooding; groundwater flooding;	<ul style="list-style-type: none"> <li>Increased waterlogging</li> <li>Problems for stock on flooded fields</li> <li>Soil conservation</li> <li>Poaching damage by stock</li> </ul>	<ul style="list-style-type: none"> <li>Increased groundwater recharge</li> </ul>
More frequent intense rainfall (high)	Increase in soil erosion and nitrogen leaching	<ul style="list-style-type: none"> <li>Degradation of soil quality</li> <li>Degradation of water quality</li> </ul>	



# Objective Setting for Climate Change Adaptation Policy

Expected climate change (& confidence)	Impact on sector	Risk	Opportunity
Decreased summer precipitation (medium);	<ul style="list-style-type: none"> <li>increase in water supply problems</li> <li>summer soil moisture decreases (high)</li> <li>Summer water supply more dependent on winter storage</li> </ul>	<ul style="list-style-type: none"> <li>Increased risk of water shortages causing yield reduction</li> <li>Increased need for irrigation and irrigation infrastructure</li> </ul>	
Sea-level rise (high); increased frequency of extreme SL / high tides (high)	Increase risk of flooding and erosion  Increased saline intrusion	<ul style="list-style-type: none"> <li>Production interrupted</li> <li>Damage to agricultural soils</li> </ul>	
Increased frequency of winter deep depressions (low)	Higher winds – wind-related damage to infrastructure; more frequent stormy conditions	<ul style="list-style-type: none"> <li>Soil erosion risk increases</li> <li>Flash flood risk increases</li> <li>Lodging risk in arable crops</li> <li>Physical damage to trees</li> <li>Increase hailstone damage risk to vegetables and soft fruit</li> </ul>	
Changes in seasonality	Increased variability in agricultural crop regime	<ul style="list-style-type: none"> <li>Increase risk of frost damage to leaves and blossom after early bud burst</li> <li>Increase in wet-dry cycles in clay soil</li> </ul>	<ul style="list-style-type: none"> <li>Narrower window for soil cultivation in autumn</li> </ul>
Warmer summers/reduced precip	Affects grassland productivity	<ul style="list-style-type: none"> <li>Reduced availability of forage in summer and early autumn</li> <li>Increased costs of bought feed</li> </ul>	<ul style="list-style-type: none"> <li>Increase early grass production</li> </ul>

**Illustrative risk assessment**

<b>Risk (or Opportunity)</b>	<b>Magnitude (high, medium, low)</b>	<b>Extent (spatial, geographical)</b>	<b>Timeframe (now, short/med term, long term)</b>	<b>Lead stakeholders</b>
Reduced quality of produce caused by decrease in summer rainfall and increase summer temperatures	med			
Reduced yields caused by decrease in summer rainfall and increase summer temperatures	Low			
Increased need for irrigation	High	Partic E and SE		
Increase risk of damage (water logging, poaching) to soils though increase winter rainfall, flooding	Med	SE, west and North West and Wales		
Increased weeds, pest and diseases through higher winter temperatures and reduced frost days e.g spring aphids, sugar beet yellows virus	?			
Increased risk soil erosion	?			
Increase risk of unavailability of grazing in summer and early autumn due to decrease in summer rainfall		Particularly south and east		

# Objective Setting for Climate Change Adaptation Policy

<b>Risk (or Opportunity)</b>	<b>Magnitude (high, medium, low)</b>	<b>Extent (spatial, geographical)</b>	<b>Timeframe (now, short/med term, long term)</b>	<b>Lead stakeholders</b>
Increase risk of effects of heat stress (fertility, production, poor health) on stock due to higher summer temperatures and increase in extreme temperatures		North west		
Increased risk of saline intrusion into agricultural land due to sea level rise		Lincolnshire, East Anglia, South East		
General				
Longer growing season as a result of increase in temperature		All areas		

## A4.6 TOURISM

### Impacts of climate change

Expected climate change (& confidence)	Impact on sector	Risk	Opportunity
Increasing summer temperatures	Increased domestic holiday tourism. Increased incoming foreign tourism Increased range of outdoor leisure pursuits including water-related leisure Increased subsidence at Heritage sites	Increased demand for tourism/leisure travel puts pressure on travel infrastructure and accommodation resources Increased pressure on water resources in key areas Maintenance of Heritage sites, for example plant management, pest/disease control, controlling subsidence Loss of botanical heritage Loss of revenues at heritage sites/parks/gardens	Increased revenues from tourism and leisure Health benefits from extended range and duration of outdoor pursuits
Increased likelihood of extreme high temperatures	Potential damage to vegetation Potential effects on health Potential disruption of travel infrastructure	Increased cost of managing civic and heritage site gardens Potential fire risks Adequacy of awareness of effects and facilities for coping with heat exhaustion, sunburns and respiratory problems <b>Increased likelihood of drowning/water emergencies</b> <b>Heat related threats to working conditions</b> Loss of leisure time due to travel disruption Reduced use of public transport	Greater understanding of the potential for skin cancer and greater preventive measures taken
Increasing winter temperatures	Reduced snowfall Longer growing season	Reduced length of winter ski-ing season Reduction in number of ski slopes	Change of use of ski slopes for other outdoor pursuits Reduced likelihood of snow-related

### Objective Setting for Climate Change Adaptation Policy

		Increased garden maintenance costs (eg lawn mowing)	travel disruption Reduced likelihood of snow/ice related travel accidents Lengthening of tourism season
Reduced summer rainfall	Reduced reservoir levels Reduced water flow in some rivers and reduced levels in lakes Increased drying out of ground – subsidence Reduced water table	Excessive pressure on water resources in crowded tourist sites at peak times Restricted recreational activity on rivers and lakes Increased maintenance of culture and heritage sites and visited landscapes Increased likelihood of algal blooms	
Sea level rise: increased frequency of extreme tidal movements	Coastal erosion Flooding at coastal sites	Loss of some wetland SSSI's and SAC's Loss of tourist accommodation at coastal sites Flooding of tourist accommodation at coastal sites Flooding of coastal roads/tracks Disruption to utilities at coastal sites Un-preparedness of emergency services (eg evacuation and rescue planning) Increased repair and insurance costs associated with the above	Coastal defence developments may introduce opportunities to develop new wetland sites

**Illustrative risk assessment**

<b>Risk (or opportunity)</b>	<b>Magnitude (High, medium, low)</b>	<b>Extent (spatial, geographical)</b>	<b>Timeframe (Now, short/medium term, long term)</b>	<b>Lead stakeholders</b>
Pressure on travel infrastructure	Medium	Mainly southern England	Now, short/med term and long term	DfT, HA, LA's
Pressure on water resources for domestic and leisure uses	High	North east and south east of England, South West and East Anglia	Now, short/med term and long term	Water utilities companies, LA's
Increased maintenance costs at heritage sites	High	Everywhere	Short/med term and long term	National Trust, English heritage, Defra, Environment Agency, LA's
Increased maintenance costs for national parks, heritage, civic and private gardens and parks	High	Everywhere	Short/med term and long term	National Trust, English heritage, Defra, Environment Agency, LA's
Increased health benefits from extended range and duration of outdoor pursuits	Medium	Everywhere	Short/med term and long term	Dept of health
Increased preventive measures re skin cancer	Medium	Everywhere, esp southern England initially	Short/med term and long term	Dept of Health, NHS Trusts, LA's
Increased risk of skin cancers	High	Everywhere, esp southern England initially	Short/med term and long term	Dept of Health, NHS Trusts
Reduced use of public transport (through likelihood of travel disruption)	High	Major routes to key tourist destinations	Short/med term and long term	DfT, HA, LA's
Reduced number of ski slopes	Medium	Scotland	Short/med term and long term	Tourist boards
Restricted recreational activity on rivers and lakes	Medium	North west, and eastern England	Short/med term and long term	NRA, Environment Agency, Tourist boards
Loss of some wetland SSSI's and SAC's destinations	High	Particularly eastern seaboard	Short/med term and long term	Environment Agency, EU, Tourist boards
Flood damage to tourist accommodation	High	Extreme coastal locations with largest predicted sea level rises, therefore especially South East	Short/med term and long term (mainly applicable in winter)	Environment Agency, LA's ABI

# Objective Setting for Climate Change Adaptation Policy

Disruption to utilities (water, power, communications) at coastal and other tourist sites (as a result of sea level rises, extreme tidal movements and flash-flooding)	High	Major coastal and inland tourist destinations	Short/med term and long term	Utilities companies, DTI, Emergency services
Reduced water quality resulting from flooded drainage systems	High	Heavily populated locations (eg south east, north west and north east of England, south Wales, west and south of England)	Short/med term and long term	Dept of Health. Local Hospital Trusts, Water utilities companies
Readiness of emergency services	High	Particularly outside south east England	Now, short/med term and long term	Home office, Local emergency services providers

## Appendix V: Reports from Regional Consultations

### Note of Discussion Meeting at North West Regional Assembly, 24/11/05

#### Present:

Matthew Wilkinson	North West Regional Assembly
Steven Glynn	Sustainability North West
Conal Kearney	Cheshire County Council
Barry Simons	Bolton MBC
Lisa Horrocks	Future Energy Solutions / AEAT
Ian McCubbin	Future Energy Solutions / AEAT

#### *Background*

LH and IMcC introduced the project that formed the basis for the discussion meeting. The work was intended to assist the process of developing a UK climate change adaptation framework, and associated objectives, targets and indicators. This consultation meeting – along with another to be held in the South East – was intended to allow regional and local parties to comment on and input to the emerging project results.

#### *Initial Questions on the Project*

- Conal asked how a decision had been made on which sectors to choose as the “six illustrative examples”. LH explained that the choice had been determined by a number of criteria, including the possible economic and social consequences of climate change impacts on the sector, the temporal incidence of impacts, and stakeholder perceptions of priorities, as well as pragmatic considerations. The focus on 6 sectors was not intended to imply that other sectors were not important for adaptation.
- How would the results of the project be used to speed up the effective implementation of climate change policy? LH said that Defra would be expecting to make use of this work within the wider context of the climate change Adaptation Policy Framework, hopefully leading to quicker action “on the ground”. There might also be opportunities for existing “good practice” examples to become more widely disseminated as a result of this work.

#### *Key Points Emerging*

LH described the project and the key issues that it was seeking to address. This prompted a wide-ranging discussion of which the main points raised are described below:

- *Policy Priorities within the North West:* To help set the context for the subsequent discussion, key policy issues for the North West were briefly discussed. A number of inter-related priorities were identified, many of which were closely related to the fundamental driver of economic growth:
  - *Re-Generation issues* (primarily urban but also rural)
  - *Tourism*
  - *Industry Clusters*
  - *The Knowledge Economy*
  - *Sustainable Development*
  - *Demographic Change, including migration patterns*



➤ *Statutory (and non-statutory) Strategies and Policies*

- *Flexibility vs. Consistency:* Within the North West, as for other regions, policy-making at local level takes place within the regional framework. This encourages Local Authorities to set policies appropriate for their local areas within a broad set of regional objectives and priorities. To assist this process, a number of frameworks and toolkits (such as the Regional Sustainable Development Framework) provide a basis to strike the right balance between flexibility and consistency. **Potential approaches to climate change adaptation were seen to require an appropriate blend of flexibility and consistency;**
- *Local vs. National competence:* The illustrative example objective discussed<sup>10</sup> was seen to raise some questions concerning the degree to which local policies and actions could be effected in isolation from national issues and standards. The example quoted was that of specification standards for pipes and drainage materials, which in many cases might be set by agencies at national level<sup>11</sup>. **This in turn suggested that adaptation actions at local level could perhaps be greatly facilitated through targeting national bodies;**
- *Policy Coverage:* The group discussed the relative influence of “stand alone” climate change policies and objectives through reference to the draft policy statement in the North West’s Regional Spatial Strategy. **It was agreed that effective implementation of climate change adaptation actions would most likely be achieved if policies and objectives were (1) effectively cascaded from national to regional and local level (2) embedded within other policy areas (e.g. transport, energy, tourism etc.);**
- *Opportunities for Climate Change “Leverage”:* It was noted that some forms of policy implementation (e.g. sustainable procurement) could potentially be used to add impetus to the climate change agenda. In some cases, though, considerable technical detail on adaptation options would be needed. **The example of sustainable drainage suggested that procurement criteria could be very influential in focusing attention on “climate-proofed” solutions;**
- *Measurement of Costs and Benefits:* Following on from the point above, the group observed that some form of financial justification would probably be required for many changes to procurement practice<sup>12</sup>. This raised a wider point relating to the form of cost-benefit analysis that would be required to justify climate change adaptation actions. **Would such cost-benefit analyses be carried out at national level and cascaded to regions and local authorities, or would individual local authorities undertake this process themselves subject to local circumstances?;**
- *Monitoring:* The group were clear that it would be undesirable to adopt a completely new set of indicators related to climate change adaptation. However there might be scope to amend or adjust existing indicators to better serve the need for climate change adaptation. **Desirable features for CCA indicators would include (1) building on existing data collection processes (2) local relevance**
- *Approach to targets:* The group discussed the merits of targets based either on “process” or “indicators”. Targets based on indicators were seen to be nearer to the current ways in which targets were set and applied, and such targets were less prescriptive about the ways in which progress was achieved. However it was unlikely that indicators and linked targets could be found to cover all aspects of adaptation in all relevant sectors. Process-based targets would be simpler to define in those areas where it was already clear what needed to be done. **In practice, a**

<sup>10</sup> The objective “to improve drainage from road and rail networks during episodes of extreme/intense rainfall”

<sup>11</sup> For example, Chartered Institutes, Building Regulations.

<sup>12</sup> Local Authorities clearly have a duty to justify procurement and other practices that might appear to run counter to the current “Gershon efficiency savings” agenda.

**combination of process-based and indicator-based targets may be necessary**

- *Expressing local responsibilities:* It was argued that ultimately it might be desirable for adaptation policy objectives and indicators to be embedded within existing integrated regional frameworks. However it was likely that a phased approach would be needed – starting with a standalone adaptation framework. For best effect at local level, responsibilities should be outlined within national frameworks, drawn up into regional and local frameworks, and mainstreamed in all relevant strategies and plans. Integration within local area agreements would be helpful. Again both consistency (between different policy documents) and flexibility (to address locally identified priorities appropriately) were needed.

## **Note of Discussion Meeting at South East England Development Agency, 01/12/05**

### **Present:**

Mark Goldthorpe	SE Climate Change Partnership
Chitra Nadarajah	Hampshire County Council / ESPACE
David Payne	South East Regional Assembly
Phil Sivell	Surrey County Council / UKCIP regional CC co-ordinator
Louise Whall	Gov Office - SE
Lisa Horrocks	Future Energy Solutions / AEAT
Ian McCubbin	Future Energy Solutions / AEAT

### *Background*

LH and IMcC introduced the project that formed the basis for the discussion meeting. The work was intended to assist the process of developing a UK climate change adaptation framework, and associated objectives, targets and indicators. This consultation meeting – along with another one held in the North West – was intended to allow regional and local parties to comment on and input to the emerging project results.

### *Initial Questions on the Project*

- *Choice of sectors in the study.* The choice had been determined by a number of criteria, including the possible economic and social consequences of climate change impacts on the sector, the temporal incidence of impacts, and stakeholder perceptions of priorities, as well as pragmatic considerations. The focus on 6 sectors was not intended to imply that other sectors were not important for adaptation.
- *Was there any consideration of how the UK's adaptation objectives might link to the European adaptation framework in development?* The focus of this project is on UK policy and how it is reflected downwards at regional / local levels. However it will be important that the right links are made with the EU level work, but this is more likely to emerge by UK leading the way.

### *Key Points Emerging*

LH described the project and the key issues that it was seeking to address. This prompted a wide-ranging discussion of which the main points raised are described below:

- *Policy Priorities in the South East:* To help set the context for the subsequent discussion, key policy issues for the South East were briefly discussed. It was recognised by the group that policy drivers varied depending on the organisation and the internal and external influences upon it - however a number of common areas were identified:
  - *Statutory / Non-statutory Strategies and Policies (e.g. SE Plan, RES, RTS etc)*
  - *Affordable housing (both this and the next point suggested that "regional capacity" is an issue influencing priority areas)*
  - *Sustainable economic growth*
  - *Protecting the green belt (a Surrey priority)*
  - *The aging population – e.g. demographic and pensions issues*
  - *Sustainable development (though this means different things to different people)*
  - *Priorities perceived by the general public, including congestion, fear of crime*
  - *Some councils recognise climate change as a priority (e.g. Hants CC)*

- *Monitoring:* The “basket” approach to indicators was broadly supported, because it allowed some depth in coverage of adaptation issues. However it was also recognised that there would inevitably be gaps that weren’t monitored. A further suggestion was the idea of “**basket-plus**” so that one or two new indicators that were more closely related to adaptation or climate change could be included within the basket of more general indicators for each sector. **This “basket-plus” approach was also seen as a powerful communications tool, helping to illustrate both the nature and breadth of adaptation;**
- *Timescales for targets/actions:* The group supported the choice of three broad time periods for actions (Now, Soon, Later). Actions in the “Now” timeframe would include those things that are “no regrets”, and also those things that need long lead times or sustained action over a long period. Within the “Soon” timeframe there was a potential link to the timescales of land use and spatial planning within the SE Plan, e.g. actions that link in with areas such as water resources. The longest (“Later”) timescale was seen as more open to interpretation, given the timescales currently being used by organisations such as the ABI for insurance risks (70 years +). **There is inevitably a risk that only actions labelled “Now” will receive any priority – the Framework could usefully seek to allow for this in some way;**
- *Market-driven sectors:* Some sectors did not lend themselves particularly easily to the identification of regional or local level actions – for example the agriculture and tourism sectors, which are strongly market-driven and less easily affected by policies or strategies at regional level. To allow such sectors to be addressed in some way at regional level, it may be necessary to embed them more broadly, within – say - the regional economic or rural development context (the example was quoted of rural diversification grants delivered by SEEDA on behalf of Defra). The local level could be important for influencing consumer demand, thereby influencing the supply-demand levers for these sectors. It may be that in these sectors some of the actions involving communications, education and training may have a stronger role to play. **Therefore whilst it was difficult to generalise for each of the 6 sectors, the likelihood appeared to be that an Adaptation Policy Framework must be flexible enough to recognise the distinctions to be drawn between national, regional and local leverage, and must also identify the most appropriate levers to utilise, e.g:**
  - *Administrative*
  - *Operational*
  - *Standards & Regulation*
  - *Research & Monitoring*
  - *Education & Communications*
  - *Stakeholder Partnerships*
- *Levels of competence:* Activities related to water use (e.g. abstractions for irrigation) do have some regional and/or local level dimensions and responsibilities, but are driven by national or European policies, such as Environment Agency regulations and EU priorities on water efficiency. **This relates to the previous point, indicating that delivery of adaptation must be clearly embedded within the appropriate level(s) of responsibility;**
- *Regional differences in risks:* It was acknowledged that in many ways it might be sensible to devolve most of the responsibility in adaptation objectives/targets to the regional level, given that climate impacts and risks vary from region to region. Individual regions were in the best position to establish the appropriate levels of risk and the priority of adaptation alongside other responsibilities. However, this approach must still be consistent with a need for national level responsibility and oversight. **A difference was noted between standards being set and managed at national level, whilst others were set at regional level but informed by a national framework;**
- *Expressing local responsibilities:* The model of sustainable development was discussed. As noted above, a national level framework was needed before regions

could be required to develop regional strategies/frameworks. **While it would probably be possible to find capacity at the regional level to develop a regional framework in response to a national one (as had been done for sustainable development), it is likely that there would not be much spare capacity at the local level to flesh out local delivery actions, unless this became a statutory duty.**

## Appendix VI: Review of Current Indicators

### A. INDICATORS RELATED TO CLIMATE CHANGE ADAPTATION

Indicators from the following sets have been reviewed and included within the long list (overleaf).

Indicator Set	Code	Location
UK Indicators of climate change	UK CC	<a href="http://www.nbu.ac.uk/iccuk/">www.nbu.ac.uk/iccuk/</a>
UK Energy Sector Indicators	UK ES	<a href="http://www.dti.gov.uk/energy/inform/energy_indicators/index.shtml">www.dti.gov.uk/energy/inform/energy_indicators/index.shtml</a>
UK Sustainable Development Strategy Indicators	UK SDS	<a href="http://www.sustainable-development.gov.uk/performance/indicators/index.htm">www.sustainable-development.gov.uk/performance/indicators/index.htm</a>
SE Integrated Regional Framework Indicators	SE IRF	<a href="http://www.southeast-ra.gov.uk/our_work/planning/sus_dev/irf.html">www.southeast-ra.gov.uk/our_work/planning/sus_dev/irf.html</a>
SE Regional Monitoring Report (2004)	SE RMR	<a href="http://www.southeast-ra.gov.uk/publications/monitoring.html">www.southeast-ra.gov.uk/publications/monitoring.html</a>
State of the Environment Indicators (EA)	SoE	<a href="http://www.environment-agency.gov.uk/soe">www.environment-agency.gov.uk/soe</a>
Quality of Life Indicators (precursor to UKSDS)	QoL	<a href="http://www.sustainable-development.gov.uk/documents/publications/qolc04/annexa.pdf">www.sustainable-development.gov.uk/documents/publications/qolc04/annexa.pdf</a>
Local Quality of Life Indicators	LQoL	<a href="http://www.audit-commission.gov.uk">www.audit-commission.gov.uk</a>
ODPM Core Output Indicators for Regional Planning	RSS	<a href="http://www.odpm.gov.uk/index.asp?id=1143839">www.odpm.gov.uk/index.asp?id=1143839</a>
Best Value Performance Indicators	BVPI	<a href="http://www.odpm.gov.uk/index.asp?id=1136106">www.odpm.gov.uk/index.asp?id=1136106</a>
Finland National Adaptation Strategy	FNAS	<a href="http://www.mmm.fi/sopeutumisstrategia/">www.mmm.fi/sopeutumisstrategia/</a>

The following abbreviations for organisations are used in the list:

Code	Organisation
ABI	Association of British Insurers
AC	Audit Commission
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
DTI	Department of Trade and Industry
EA	Environment Agency
FC	Forestry Commission
HA	Highways Agency
LAs	Local authorities
NGT	National Grid Transco
NR	Network Rail
TOCs	Train Operating Companies

## Objective Setting for Climate Change Adaptation Policy

Number	Indicator title	Measure of... I=Impact A=Adaptation response O=Other drivers	Relevant sector Tr=Transport A=Agriculture T=Tourism W=Water resources F=Food management	Level of most relevance N=National R=Regional L=Local	Links to other indicator sets see key	Possible data source see key	Time series?	Regularly updated?	Trends	Comments
1	Average annual domestic consumption of gas and electricity (Energy consumption per capita) / Household energy use	A, O	E	N, R, L	UK SDS #6 LQoL #26 SE IRF #19a UK ES #1.2	DTI	y		Recent increases.	Expect less energy for heating, more for air conditioning. Other factors important eg average household spending. Could split into summer and winter figures?
2	Final energy consumption by sector	A, O	E	N	SE IRF #19b UK ES #1.2	DTI	y	y	Variable Recent increases. Expect to increase.	Poor indicator of adaptation, but could be useful contextual?
3	Installed capacity for energy production from renewable sources	A, O	E	N, R	RSS #9	DTI	y			Renewable sources like wind, HEP expected to be more reliable in future climates. But largely driven by energy policies
4	Percentage of electricity generated from renewable sources	A, O	E	N, R	SoE	DTI	y	y	Recent increases. Decrease in 1996 when drier than average weather limited generation from hydro	Renewable sources like wind, HEP expected to be more reliable in future climates. But largely driven by energy policies
5	Proportion of electricity generated by renewables	A, O	E	N	UK ES #1.6	DTI	y	y	Increasing in recent years	Indicator of adaptive action to benefit from climate opportunities. Other factors (eg renewables obligation) significant
6	Area and proportion of land used for production of energy crops	A, O	E, A	R	SE RMR #19				Unknown?	Are data available? A number of drivers, but links to adaptation.
7	Electricity and Gas plant margin (total generating capacity over and above peak demand)	A, O	E	N	UK ES #2	NGT / DTI	y	y	Fluctuating around 18-20 % for winter period Amount of gas that could be supplied to UK exceeds actual maximum winter demand by 21 to 39 %	Broad indicator of security of energy supply (though does not capture fully all the factors which may have an impact on the reliability of energy supply)
8	Gas capacity – maximum supply, maximum demand and peak 1 in 20 winter estimated demand	O	E	N	UK ES #2.2	NGT / DTI	y	y		An indicator of how resilient sector might be to demand changes linked to extreme weather
9	Electricity generating capacity, average load factor and simultaneous maximum load met for major power producers	O	E	N	UK ES #2.1	DTI	y	y	Load factor has been rising over recent years Fluctuating. Performance in 2002/03 was significantly affected by the October 2002 storms.	Difficult to make direct links with adaptation (though loads close to capacity indicate sector unable to cope with fluctuations from extreme weather)
10	Security and availability of electricity supply for the average customer	I, A, O	E	N	UK ES #2.3	OfGem	y	y	Reducing	An indicator of resilience of transmission/infrastructure to extreme weather events
11	Number of households in fuel poverty	O	E	N, R	UK ES #4	DTI	y	y		Not strongly linked to climate change impacts or adaptation
12	Temporary Road Closures: To monitor the number of days that road closures take place due to road works	I, A, O	Tr	L	BVPI #100	LAs?				Perhaps this could be amended to monitor road closures due to flooding / subsidence / landslips etc
13	Condition of principal roads: To give an indication of the proportion of road that may require structural maintenance.	I, A, O	Tr	L	BVPI #223	LAs?				Could this be amended to indicate the reason for structural maintenance – e.g. subsidence
14	Rail delays due to flooding (new)	I, A	Tr, F	N		NR, TOCs				Data may be hard to obtain
15	Rail delays due to hot weather (new)	I, A	Tr	N		NR, TOCs				Data may be hard to obtain
16	Traffic disruption due to flooding (new)	I, A	Tr, F	R, L		HA, LAs				Data may be hard to obtain
17	Annual number of road grit/salt applications (new?)	I, A	Tr	R, L	FNAS UK SDS #55 LQoL #45	LAs				Data may be hard to obtain
18	Proportion of travel by mode (miles travelled per person per year by mode)	A, O	Tr	N, R, L	SE IRF #15b	DIT	y	y	Variable	Modal shift influenced by other factors, like spatial development, socio-economic factors. Perhaps it could be split into winter and summer?
19	Passenger travel by mode (journeys per person per year)	A, O	Tr	N, R, L	SoE	DIT	y	y	Variable by mode	Modal shift influenced by other factors, like spatial development, socio-economic factors. Perhaps it could be split into winter and summer?
20	Freight transport by mode	A, O	Tr	N, R	SoE QoLC	DIT, EA	y	y	Variable	Indicator of modal shift - not climate driven, but more freight transported by most climate-reliable modes could count as adaptation!
21	The percentage of residents who think that for their local area, over the past three years, that a) public transport has got better or stayed the same; b) the level of traffic congestion has got better or stayed the same.	A, O	Tr	L	LQoL #44	LAs? AC?			Unknown?	How are data obtained? Congestion could be linked to weather-related disruption on roads etc
22	Occurrence of exceptional situations caused by weather events on sea traffic, air traffic and road traffic	I, A	Tr	N	FNAS				Unknown?	Strong links to weather, but not necessarily to adaptation?
23	Annual number of closures of Thames Barrier / Thames Barrier closures against tidal surges	I, A, O	F	N, R	UK CC #10 SoE	EA	y	y	Number of closures increasing over time. Trend expected to continue.	Barrier is closed for several possible reasons; need to record cause: e.g. just use tidal surges
24	River flows	I, A, O	F	N, R	SoE	EA	y	y	No clear trends	Year to year fluctuations in flow rates from eight selected rivers. Linked to other factors. Maintained river flows indicates good cross-sectoral adaptation?
25	Flooding	I, A, O	F	N, R	UK SDS #31	Defra / EA?			Under development	To be developed to monitor sustainable approaches to flood management
26	Flood levels in rivers	I, (A)	F	N, R	SoE	EA	y	y	Increase in frequency of peak river levels	Indicator of impacts, perhaps indirectly of adaptation. Data from 7 rivers in England & Wales

## Objective Setting for Climate Change Adaptation Policy

Number	Indicator title	Measure of...	Relevant sector	Level of most relevance	Links to other indicator sets	Possible data source	Time series?	Regularly updated?	Trends	Comments
27	Proportion of planning applications refused on grounds of flood risk	A, O	F	R, L		regional planning bodies			Recent increase?	EA would suggest more applications should be refused
28	Number of planning permissions granted contrary to the advice of the EA on grounds of flood risk	A, O	F	L	RSS #7	EA / local planning bodies			Unknown?	Monitors inappropriate development in flood plain (ie failure to adapt)
29	Proportion of new development incorporating SuDS	A	F, W	R, L	SE IRF #2b SE IRF #2a	regional planning bodies			Recent increases? Relatively static; expect to increase without adaptation	May relate to current climate concerns rather than adaptation
30	Number of properties at risk from flooding	I, A, O	F	N, R, L	SoE	EA	y	y		Strong links to SLR, increased amount and intensity of rainfall.
31	Number of homes flooded per year	I	F	N, R, L						
32	Number of domestic property insurance claims for flooding	I, A	F	N		ABI	y	y	Increasing	
33	Number of domestic and business property insurance claims for subsidence	I, A	F	N		ABI	y	y	Increasing	Only relevant for half the year?
34	Groundwater levels	I, A, O	F, W	N, R	SoE	EA	y	y	Below average water levels following dry winters	Linked to rainfall and amounts abstracted. Varies by region
35	Capacity to supply water without the need for restrictions during "critical periods"	I, A	W	R	SE IRF #12b UK SDS #16	water companies?			Unknown?	More relevant as an indicator of adaptation in SE than in NW
36	Daily domestic water use (per capita consumption)	(I), A, O	W	R	LQdL #27 SE IRF #18c	OfWat, water companies	y	y	Recent increases. Expect to increase in future	Social factors (eg water intensive appliances) also important
37	Abstraction from fresh waters	A, O	W	N, R	SoE	EA	y	y	Variable (household increases, industry decreases)	Simple adaptations include water efficiency; therefore reduced abstractions?
38	Household water use	A, O	W	N, R	SoE	EA	y	y	Increasing	Simple adaptations include water efficiency; therefore reduced household water use
39	Water demand and availability	I, A, O	W	N, R	SoE	EA	y	y	Various	Climate change impacts both demand and availability. Other factors also important, but ratio of demand and to supply is a general picture of adaptation
40	Water resource use (total abstractions and leakage losses)	A, O	W	N	UK SDS #15	Defra?	y	y	Recent increases in abstractions and in leakages	Many other factors at play. But reductions in leakages would help considerably in adaptation.
41	Leakage from public water supply	A, O	W	N, R	SoE	Ofwat	y	y	Varies from company to company	Other factors are key. Reductions in leakages would help adaptation.
42	Water stress (water availability)	I, A	W	N, R	UK SDS #17	Defra / EA?			<i>Under development</i>	To be developed. Strongly linked to climate
43	Rivers of good quality (chemical and biological)	I, A, O	W, F	N, R	SoE	EA	y	y	Various	Only loose links to adaptation.
44	Agricultural land use	A, O	A	N, R	SoE	EA / Defra	y		Recent decreases in land used for cereals.	Area of land used for growing cereals, oilseed rape, etc
45	Area of vineyards in production in the UK	A, O	A	R	UK CC #22	Defra	y		Recent increases. Trend expected to continue	Expansion of wine production may be an adaptation to real and perceived climate impacts.
46	Area of forage maize grown in the UK	A, O	A	N	UK CC #23	Defra	y		Recent increases. Projection uncertain.	Maize produces more forage than ryegrass in warm, dry conditions. But influenced by CAP etc
47	Use of irrigation water for agriculture	A	A, W	N, R	UK CC #19	EA / Defra	y	y	Recent increases. Without adaptation, expect increases in future	Abstractions limited by EA
48	Domestic holiday tourism (Annual number of overnight visitor stays)	A, O	T	R	UK CC #14 SE IRF #24b	Regional tourism bodies			Variable by region. Expect to increase in north in future.	Influenced by many other factors.
49	Leisure day visits (by destination type)	A, O	T	N, R	SoE	UK Day Visits Survey / EA	y	y	Total number of visits roughly increasing, proportions to coast, town or country static	Influenced by many other factors. But may be a useful indicator for the tourism sector (more hot weather, more beach trips?)
50	Land use	I, A, O	A, T, W, F	N	SoE	Defra, FC			Variable	Contextual



## B. UK SUSTAINABLE DEVELOPMENT INDICATORS

1. Greenhouse gas emissions*:	Kyoto target and CO <sub>2</sub> emissions
2. Carbon dioxide emissions by end user:	CO <sub>2</sub> emissions from industry, domestic, transport sectors (excluding international aviation and shipping)
3. Aviation and shipping emissions:	Greenhouse gases from UK-based international aviation and shipping fuel bunkers
4. Renewable energy:	Renewable electricity generated as a percentage of total electricity
5. Electricity generation:	Electricity generated, CO <sub>2</sub> , NO <sub>x</sub> and SO <sub>2</sub> emissions by electricity generators and GDP
6. Household energy use:	Domestic CO <sub>2</sub> emissions, domestic energy consumption and household spending
7. Road transport:	CO <sub>2</sub> , NO <sub>x</sub> , PM <sub>10</sub> emissions and Gross Domestic Product
8. Private cars:	Private car CO <sub>2</sub> emissions, car-kilometres and household spending
9. Road freight:	Heavy Goods Vehicle (HGV) CO <sub>2</sub> emissions, kilometres, tonnes and Gross Domestic Product
10. Manufacturing sector:	Manufacturing sector CO <sub>2</sub> , NO <sub>x</sub> , SO <sub>2</sub> , PM <sub>10</sub> emissions and output
11. Service sector:	Service sector CO <sub>2</sub> , NO <sub>x</sub> emissions and output
12. Public sector:	Public sector CO <sub>2</sub> , NO <sub>x</sub> emissions and output
13. Resource use*:	Domestic Material Consumption and Gross Domestic Product
14. Energy supply:	UK indigenous energy production and gross inland energy consumption
15. Water resource use:	Total abstractions from non-tidal surface and ground water, leakage losses and Gross Domestic Product
16. Domestic water consumption:	Litres per person per day
17. Water stress:	<i>(to be developed to monitor the impacts of water shortages)</i>
18. Waste*:	Waste: (a) arisings by sector (b) arisings by disposal
19. Household waste per person:	(a) Arisings (b) recycled or composted
20. Bird populations*:	Bird population indices (a) farmland birds* (b) woodland birds* (c) coastal birds* (d) wintering wetland birds
21. Biodiversity conservation:	(a) Priority species status (b) priority habitat status
22. Agriculture sector:	Fertiliser input, farmland bird population, ammonia and methane emissions and output
23. Farming and environmental stewardship:	Land covered by environmental schemes
24. Land use:	Area covered by agriculture, woodland, water or river, urban (contextual indicator)
25. Land recycling:	(a) New dwellings built on previously developed land or through conversions (b) all new development on previously developed land
26. Dwelling density:	Average density of new housing
27. Fish stocks*:	Sustainability of fish stocks around the UK
28. Ecological impacts of air pollution*:	Area of sensitive UK habitats exceeding critical loads for acidification and eutrophication
29. Emissions of air pollutants:	NH <sub>3</sub> , NO <sub>x</sub> , PM <sub>10</sub> and SO <sub>2</sub> emissions and GDP
30. River quality*:	Rivers of good (a) biological (b) chemical quality
31. Flooding:	<i>(to be developed to monitor sustainable approaches to ongoing flood management)</i>
32. Economic output*:	Gross Domestic Product
33. Productivity:	UK output per worker
34. Investment:	(a) Total investment (b) Social investment relative to GDP
35. Demography:	Population and population of working age (contextual indicator)
36. Households and dwellings:	Households, single person households and dwelling stock (contextual indicator)

37. [Active community participation\\*](#): Informal and formal volunteering at least once a month in the last 12 months
38. [Crime\\*](#): Crime survey and recorded crime for (a) vehicles (b) domestic burglary (c) robbery

39. Fear of crime:	Fear of crime: (a) car theft (b) burglary (c) physical attack
40. Employment*:	People of working age in employment
41. Workless households*:	Population living in workless households (a) children (b) working age
42. Economically inactive:	Percentage of people of working age who are economically inactive
43. Childhood poverty*:	Children in relative low-income households (a) before housing costs (b) after housing costs
44. Young adults:	16-19 year-olds not in employment, education or training
45. Pensioner poverty*:	Pensioners in relative low-income households (a) before housing costs (b) after housing costs
46. Pension provision:	Proportion of working age people contributing to a non-state pension in at least three years out of the last four
47. Education*:	19 year-olds with Level 2 qualifications and above
48. Sustainable development education:	<i>(to be developed to monitor the impact of formal learning on knowledge and awareness of sustainable development)</i>
49. Health inequality*:	(a) Infant mortality: differences between socio-economic groups (b) Life expectancy: differences in average life expectancy between local authority areas
50. Healthy life expectancy:	Healthy life expectancy (a) men and (b) women
51. Mortality rates:	Death rates from (a) circulatory disease and (b) cancer, below 75 years and for areas with the worst health and deprivation indicators, and (c) suicides
52. Smoking:	Prevalence of smoking (a) all adults (b) 'routine and manual' socio-economic groups
53. Childhood obesity:	Prevalence of obesity in 2-10 year-olds
54. Diet:	Proportion of people consuming (a) five or more portions of fruit and vegetables per day and (b) in low income households
55. Mobility*:	(a) Number of trips per person by mode (b) Distance travelled per person per year by broad trip purpose
56. Getting to school:	How children get to school
57. Accessibility:	Access to key services
58. Road accidents:	Number of people and children killed or seriously injured
59. Social justice*:	<i>(social measures to be developed)</i>
60. Environmental equality*:	<i>(social measures to be developed)</i>
61. Air quality and health:	(a) Annual levels of particles and ozone (b) days when air pollution is moderate or higher
62. Housing conditions:	(a) Social sector homes (b) vulnerable households in the private sector in homes below the decent homes standard
63. Households living in fuel poverty:	Households living in fuel poverty containing (a) pensioners (b) children (c) disabled/long-term sick
64. Homelessness:	(a) Number of rough sleepers (b) number of households in temporary accommodation (i) total (ii) households with children
65. Local environment quality:	Assessment of local environmental quality
66. Satisfaction in local area:	Percentage of households satisfied with the quality of the places in which they live (a) overall (b) in deprived areas
67. UK international assistance:	Net Official Development Assistance (a) per cent of Gross National Income (b) per capita
68. Wellbeing*:	<i>(wellbeing measures to be developed)</i>

## Appendix VII: Steering Group and Stakeholders consulted

The Steering Group for the project comprised the following individuals.

Emily Holmes (Defra, Global Atmosphere Division) – *Project Nominated Officer*

Stephen Bass (Defra, Natural Resources and Rural Affairs Division)

Roger Hoare (Environment Agency, Climate Change Unit)

Caroline Season (Defra, Strategy and Sustainable Development Division)

Shann Sobrun (Defra, Regional and Local Government Division)

The following stakeholder organisations were consulted during the project, either in individual interviews (in person, by telephone or by email) or in small group meetings.

ADAS	South East England Regional Assembly
Association of British Insurers	Surrey County Council
Atkins	Sustainability North West
Bolton Municipal Borough Council	University of East Anglia
Cheshire County Council	
Defra (Water Supply and Regulation Division)	
Defra (Flood Management Division)	
DCMS	
DfT (Strategy Division)	
DTI (Energy Strategy Unit)	
Environment Agency ( <i>Glenn Watts</i> )	
Environment Agency ( <i>James Letts</i> )	
Environment Agency (Thames Region)	
Government Office for the South East	
HR Wallingford	
Hampshire County Council	
Highways Agency	
National Farmers Union	
National Grid (Operations and Trading)	
National Trust	
Network Rail	
North West Climate Group	
North West Regional Assembly	
South East Climate Change Partnership	



## Appendix VIII: Matrix for Sector Prioritisation

Sector	Precipn. (M/E)	Temp (M/E)	+ve	-ve	Qual.	Quant.	Strategic	Econ signif.	Geog	Current	Non- lin.	X- sect	Vulner.	Cap. lv	Prep.
Agriculture	√	√	√	√		√	√	√	√	?	√		√?		√?
Forestry															
Fisheries															
Biodiversity															
Flood managemt.															
Water res.															
Energy		√		√		√	√		√	?			√?	√	√?
Buildings															
Heritage															
Transport															
Telecomms.															
Spatial plan.															
Solid waste man.															
Industry															
Finance & Insure.															
Tourism & rekn.	√	√	√	√	√			√	√	?					√
Emerg. planning															
Health															

Notes:

1. For temperature and precipitation, M = mean; E = extreme weather event
2. Qual = qualitative measure of sectoral impact; Quant = quantitative measure of sectoral impact
3. Non lin = non-linear temporal profile of climate impact
4. Prep. = sectoral preparedness

## Appendix IX: Project Specification

### STUDY ON OBJECTIVE SETTING FOR CLIMATE CHANGE ADAPTATION POLICY

The Department for Environment, Food and Rural Affairs (Defra) is responsible for the UK's policy on climate change. However successful we are in reducing future greenhouse gas emissions to avoid the most catastrophic climate change, some degree of climate change is already inevitable and a wide range of sectors need to begin to adapt to these impacts. In 2005 Defra will launch an Adaptation Policy Framework to draw together efforts on adaptation to climate change across Government. Public and private sector organisations at local, regional and national levels will be instrumental in delivering the actions identified under this framework. Alongside the framework, Government is keen to develop soundly-based methods for setting objectives, targets, and indicators for measurement of progress in this new policy area.

#### Background and Introduction

1. Government has a twofold response to the challenge of climate change. Mitigation is concerned with addressing the root cause – that of greenhouse gas emissions, and strong policies with ambitious objectives and targets have already been set (e.g., in the UK Climate Change Programme and the Energy White Paper). Adaptation is concerned with preparing for those impacts of climate change which are already inevitable, and this area of policy is still in its infancy. Adaptation is necessarily cross-cutting as it involves promoting an understanding of how the changing climate will affect all sectors, and then encouraging relevant parties to take action to reduce future risks and take advantage of future opportunities. The UK approach to adaptation has therefore been strongly stakeholder-led.
2. There is an increasing policy need to move beyond a broad description of the possible impacts of climate change, and to focus instead on risks and opportunities where action needs to be taken in the short, medium and longer-term to adapt to these impacts. There are a number of areas where it is particularly important to respond, because, for example, decisions taken now will affect long-term decisions on infrastructure (for example the design of flood defences with a lifetime of many decades), or where there is a chance to provide more sustainable solutions (e.g. through the planning system).
3. While there has been steady growth over recent years, both in the understanding of climate change impacts, and in the initiation of adaptation activities (within and beyond Government), co-ordination and coherence in these activities has been lacking. Ministers have endorsed the suggestion to develop an Adaptation Policy Framework (APF).
4. It can be hard to set long-term objectives and short term targets for adaptation to climate change, for four main reasons :
  - Cross-cutting nature of climate impacts. Impacts of climate change are felt by all sectors to varying degrees, making adaptation a truly cross-cutting issue. It is hard to know how to define and measure reductions in vulnerability to the impacts of climate change through adaptation.
  - The long-term nature of the problem. While some of the effects may be felt relatively soon, others will take decades to occur.

- Scientific uncertainty. The size of some of the climate changes is difficult to predict, and there will always be year-to-year variation in weather. This makes it harder to design adaptation options that will protect us by a given amount. Determining when over adaptation has occurred will also be more difficult than calculating under adaptation.
  - Interaction with socio-economic changes. The way the world develops will affect not only the degree to which greenhouse gas emissions drive climate change, but political and social decisions could crucially affect the extent to which societies are affected and our capacity to adapt.
5. There is a growing interest in adaptation and it is anticipated that this project will be the starting point from which stakeholders will begin to draw on indicators to inform adaptation policy and drive forward their agenda. We need indicators at both the national and local level so that progress can be measured across a range of sectors.

### **Aim**

6. To develop a set of potential objectives, targets and indicators for adaptation to climate change.

### **Supporting material**

7. Defra's five year strategy can be found at: <http://defraweb/corporate/5year-strategy/5year-strategy.pdf>
8. The Royal Commissions report on Setting Environmental Standards can be found at <http://www.rcep.org.uk/pdf/standardsfull.pdf>
9. Information on the sustainable development indicators can be found at [www.sustainable-development.gov.uk/indicators/index.htm](http://www.sustainable-development.gov.uk/indicators/index.htm)
10. The energy white paper can be found at <http://www.dti.gov.uk/energy/whitepaper/ourenergyfuture.pdf>
11. The consultation document for the Review of the UK Climate Change Programme can be found at <http://www.defra.gov.uk/corporate/consult/ukccp-review/index.htm>
12. Information on the UK Climate Impacts Programme can be found at [www.ukcip.org.uk](http://www.ukcip.org.uk) and further information on Defra's climate change programme can be found at <http://www.defra.gov.uk/environment/climatechange/>

### **Detailed requirements**

13. A desk-based study to review objective-setting methods used in a range of environmental policy areas and in the relevant literature (e.g. Royal Commission on Environmental Pollution's Report on Setting Environmental Standards). The review should examine different approaches such as using quantified targets, indicators, valuation, risk management methods or process based indicators (possibly drawing on the 10 adaptation principles developed by UKCIP) etc, and gather experience from other countries in the area of adaptation policy-making (e.g., Finland).



14. To identify lessons that can be transferred to develop soundly-based principles and methods for setting objectives and targets for adapting to climate change, against which it will be possible to measure progress as well as developing new and innovative ways to measure progress in adaptation.
15. To identify priority sectors (at least 6) in which the methods will be applied. This list will be drawn up on the basis of previous scoping work on climate change impacts (e.g., Defra's IHPC report' audits of climate impacts carried out by other Government Departments, scoping studies carried out as part of the UK Climate Impacts Programme, etc.), and ongoing work in drafting the APF. The principles and methods identified from the review and analysis should be used to suggest potential "strawman" objectives, targets and indicators in these priority sectors using the methods identified in 13 and 14.
16. To apply the principles and methods at local government level, to develop potential local authority indicators of adaptation, which might integrate with existing local sustainable development indicators.
17. To use stakeholder workshops to consider whether the principles and methods identified are appropriate for target-setting in adaptation policy, and to develop refinements to both methods and targets.
18. To produce a final report documenting principles, methods, suggested objectives and indicators to inform the development of adaptation policy. In addition, to produce short briefing papers on the sectors considered, outlining potential objectives, targets and indicators for climate change adaptation and how they might be applied in the short and long term.
19. Deliverables and timescales for the contracted elements of the research will be defined fully in an invitation to tender but will include:
  - Delivery of short review report surveying methods for objective-setting in environmental policy;
  - Identification of at least six priority sectors
  - Potential "strawman" adaptation objectives, targets and indicators developed for the priority sectors using the new methods.
  - At least two stakeholder workshops held, with good representative attendance to refine the methods and strawman targets
  - Delivery of a final report , including sectoral briefing papers, detailing the approaches developed and conclusions drawn.

The draft final report and briefing papers need to be completed by December 2005.