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Extract from Climate adaptation: Risk, uncertainty & decision-making

3. Key aspects of climate change risk assessment

3.1 Introduction

Climate change risk assessments form an important stage in the decision-making framework described in Part 1. This chapter describes the key issues to be considered when undertaking a risk assessment that may involve climate change as a significant factor. In this report, the term 'climate change risk assessment' is used to refer to any impact assessment that includes consideration of the probability or uncertainty associated with the consequences of climate variability or climate change. In most cases, probabilistic assessments of risk will not be possible. We emphasise that uncertainty is an integral component of a climate impact assessment, and therefore an approach based on risk assessment represents good practice.

Climate change risk assessments are used to determine how climate change could affect outcomes in a sector, and to evaluate the effectiveness of decisions regarding existing or new policies, programmes and projects. The risks associated with climate should be evaluated in comparison to other, non-climate- dependent risk factors. The objective of these assessments is to help decision-makers identify where adaptation to climate may be required, the adaptation options that could best accommodate the expected impacts of climate change, and the uncertainty associated with those impacts. Decisions made on this basis should lead to a better outcome in social, economic and environmental terms and can be considered as contributing to sustainable development.

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www.ukcip.org.uk/wordpress/wp-content/PDFs/Risk.pdf

3.2 Purpose and key components of a climate change risk assessment

The purpose of a climate change risk assessment is to assist the decision-maker in examining the possible consequences associated with an uncertain future climate.

It should help the decision-maker form an opinion of the:

i. likely sensitivity (see Box 3.1) of a particular sector or area of responsibility or concern (the 'exposure unit') to potential changes in climate;

ii. relative sensitivity of the exposure unit to climate factors compared with other, non-climate factors;

iii. the vulnerability of the exposure unit to climate change, including the identification of critical thresholds and coping ranges;

iv. the capacity of the exposure unit to adapt autonomously to climate change (adaptive capacity, see Box 3.1);

v. ease or difficulty of implementing adaptation measures; and

vi. (degree of success anticipated in mitigating any impact though an adaptive management strategy.

Box 3.1: Climate sensitivity, adaptive capacity and vulnerability

Sensitivity. The degree to which a system, receptor or exposure unit would be affected, either adversely or beneficially, by a particular change in climate or climate-related variable. (e.g. a change in agricultural crop yield in response to a change in the mean, range or variability of temperature.) Different systems may differ in their sensitivity to climate change, resulting in different levels of impact.

Adaptive capacity. The ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, take advantage of opportunities, or cope with the consequences. Adaptive capacity can be an inherent property of the system, i.e. it can be a spontaneous or autonomous response. Alternatively, adaptive capacity may depend upon policy, planning and design decisions carried out in response to, or in anticipation of, changes in climatic conditions.

Vulnerability. Vulnerability defines the extent to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. It depends not only on a system's sensitivity but also on its adaptive capacity.

Based on IPCC, 2001a, p. 238.

Consideration of adaptive capacity has largely been confined to national and regional assessments of climate change impacts, and the capacity of ecological systems to respond to climate change. Hertin et al (2003) consider some of the properties of businesses and management systems, that may increase the ability of organisations to adapt to climate change. These include flexible management processes that are able to integrate climate considerations into existing processes, technical capacity in climate change, risk assessment and risk management, and good relationships with key other decision-makers driving the adaptation issues.

A climate change risk assessment involves the following tasks, which are briefly discussed in this chapter:

i. Identify and define the nature and extent of the exposure unit and receptors, agree assessment endpoints and assessment period (Part 1, Stage 2);

ii. Identify and define a set of climate and non-climate variables to which the exposure unit may be sensitive (Part 1, Stage 3);

iii. Use climate scenarios to help determine the climate change-dependent risk (Part 1, Stage 3), by:

   » forming a knowledge-based opinion on the extent and nature of the exposure unit's sensitivity and potential vulnerability to changes in climate variables over the assessment period;

   » determining the uncertainty of the exposure unit's sensitivity and vulnerability to climate change over the assessment period; and

   » modelling of climate influence.

iv. Use non-climate scenarios to help determine the non-climate-dependent risk (Part 1, Stage 3), by:

   » identifying the vulnerability of the exposure unit to non-climatic changes over the period being considered; and

   » determining the uncertainty of the exposure unit's sensitivity and vulnerability to non-climate change factors over the assessment period.

The sensitivity of the exposure unit is assessed by reference to the component receptors.

3.3 Identification of exposure units, receptors and assessment endpoints

The exposure unit will in general be defined by the nature of the decision-maker's problem. The decision-maker will need to specify the location and geographical extent of the exposure unit and, in particular, the types of receptors at risk. These may be identified by preliminary risk assessment. Some of the receptors identified to be at risk may lie outside the decision-maker's initial boundaries for the exposure unit. The choice of receptors for more detailed risk assessment will need to be relevant to the decision-making criteria established by the decision-maker. The choice of receptor(s) and their relationship to decision criteria will need to be negotiated and agreed between the risk analyst and decision-maker.

Risk assessment endpoints represent an agreed frame of reference for the assessment of the significance of risk for the receptor(s). The choice of assessment endpoint is dependent on the exposure unit and receptor. Examples might include existing flood defence standards (e.g. a 1:200 year return period for coastal floods) or measures of water supply security.

Assessment endpoints are often referred to as 'thresholds' in the climate impact assessment literature (e.g. Jones, 2001; Smit & Pilifosova, 2001). Thresholds are often determined by reference to past records or experience of events or circumstances that define a tolerable limit to climate (see Yohe & Toth, 2000) (for example a particular dry summer or series of summers). A related concept is that of the **coping range** (Hewitt & Burton, 1971; Jones, 2001). This concept acknowledges that the majority of natural, social, and economic systems are adapted to and tolerate some (usually large) part of the range of climate variability normally experienced. Within this range of variability, conditions vary from beneficial to tolerable. However, limits beyond which intolerable levels of harm may be suffered often exist (see Figure 3.1) or can be defined as the basis of environmental management, climate adaptation or other policy.

Jones (2001) distinguishes two types of assessment endpoint or threshold. These can be either a fundamental property of the system or *biophysical threshold*, or a *behavioural* threshold. Biophysical thresholds '*mark a (bio)physical discontinuity on a spatial or temporal scale*'. Behavioural thresholds '*trigger a change in behaviour in the form of a social or economic outcome'*. Biophysical thresholds recognise environmental system thresholds that form a natural basis for defining risk. Examples include the water level or effective rainfall at which a river overtops its bank, or the wind speed that leads to the felling of large areas of forest.

In contrast behavioural thresholds represent points at which individuals, or society as a whole, would respond by a change in action, or points at which agreement can be reached that action would be required. Hence behavioural thresholds might be defined on the basis of a policy judgement, by decision-makers or other stakeholders, regarding the point at which climate change impacts can be regarded as intolerable. The choice of assessment endpoints in these cases will necessarily require value judgements as to the significance of the threshold (Swart & Vellinga, 1994; Parry et al, 1996), i.e such thresholds often require policy decisions regarding the level of risk that can be tolerated. This might also include consideration of practical and reasonable costs, through the use of criteria similar to those used to determine best practical environmental option (BPEO) and best available technology not entailing excessive cost (BATNEEC).

For these reasons, agreement upon practical assessment endpoints will usually need to be negotiated between the decision-maker, other stakeholders, and technical risk analysts. In certain circumstances, appropriate assessment endpoints might already be agreed, or can be easily adapted, based on existing practice. Where existing standards are being adapted, it will be important to determine whether the chosen standard is independent of climate change.

3.4 Identification of a set of climate variables for the climate change risk assessment

Some areas of climate risk assessment and risk management are well established, underpinned by empirical evidence and theoretical understanding of the current ('historical') influence of climate on the performance of systems. Many of these are areas that may require climate adaptation decisions as the climate changes.

However, as climate moves away from that which we have previous experienced (Hulme et al, 2002) there will be a need to take account of climate sensitivity in a wider range of decisions. In many of these areas there will be substantial uncertainty concerning the influence of climate. For climate-influenced decisions the choice of climate variables of potential relevance to the decision may be particularly unclear.

An important task of the risk assessment exercise, therefore, is to identify the particular climate variables that may be important in determining the nature of climatic risk. Hence the choice of climate variables should not be confined to those known in advance to be relevant to the exposure unit, or for which data are available, or for which climate forecasts or projections exist.

Nor should it be confined to those variables where significant change is anticipated, given the current state of uncertain knowledge.

In all cases it will be necessary to select a suite of 'key' variables, based on:

i. knowledge, information and data concerning the exposure unit's sensitivity or vulnerability to past climate variability;

ii. knowledge of analogous situations;

iii. conceptual models (including the use of process influence and dependency diagrams, event trees, etc); and

iv. empirical, statistical and/or process-based models (including simulation models).

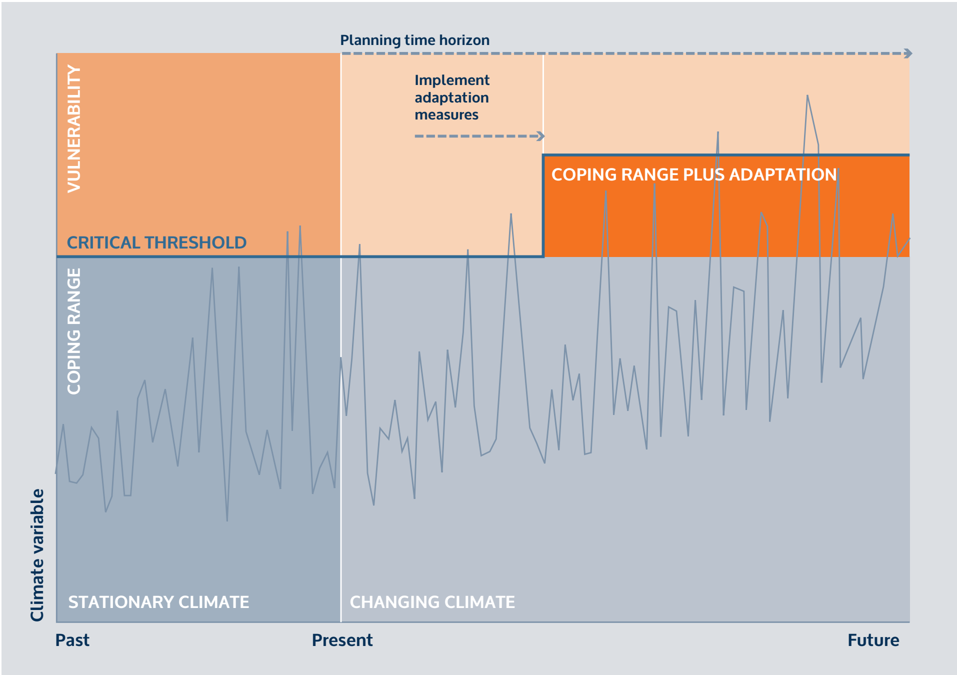

Figure 3.1: Schematic diagram showing the relationship between coping range, critical threshold, vulnerability, and a climate-dependent variable. The climate-dependent variable shows a significant degree of temporal variability. This variability is superimposed upon an upward trend, representing a change in climate that starts at the mid-point of the time series. The coping range represents the tolerable climate and the coping range boundaries may lie above and/or below the average value of the climate variable. Vulnerability to climate in this example is represented by an upper boundary, or critical threshold above which unacceptable impacts may be suffered. Adaptation aims to reduce vulnerability by increasing the critical threshold, countering the increased risk that the un-adapted threshold will be exceeded due to climate change. The figure indicates the relationship between the management of the critical threshold, and the time taken to plan and implement adaptation measures. The figure also indicates the time available to plan and implement adaptation measures from a given starting point.

A classification of climate variables is provided in Table 3.1 to help undertake preliminary climate change risk assessments. The table classifies climate variables as primary, synoptic, compound and proxy. In order to properly define the climate variables it is important to consider their statistical characteristics. These are described in Table 3.2. These tables have been combined into one checklist for use in preliminary climate change risk assessments (see Part 1, Table 7). Further information on the type and statistical characteristics of climate variables is provided in Section 3.5.

Knowledge of the sensitivity of the exposure unit, receptors and associated assessment endpoints to past variability in particular climate variable(s) can be of enormous value in determining the likely future response under a changed climate. The influence that these variables may have either individually or in combination should be considered, taking account of any statistical or other evidence of past or future dependence between the variables.

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