GENERAL APPROACHES TO CLIMATE IMPACT ASSESSMENT

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2.1 Purpose of Assessment

There are several different reasons for conducting climate impact assessments. First, there is a need to evaluate how climate affects human activities and natural systems along with estimates of the uncertainties surrounding these effects. The effects may be physical (e.g. on water availability), biological (e.g., on plant growth), economic (e.g., on industrial profitability), social (e.g., on regional employment) or a combination of these. Second, it may assist in evaluating sensitivities, vulnerabilities or thresholds to likely scenarios of climate change and in evaluating potential environmental standards. Third, it can identify and/or evaluate the range of possible options for adapting to and, where possible, exploiting the effects of climatic change. Fourth, it can identify impacts of limitation or adaptation options. Finally, it can alert public awareness to issues of common concern (for example, to educate people about the need for improving the efficiency of resources use) and establish a basis for political decisions.

One of the urgent priorities is to determine how best to include the effects of climate change in the formal processes of environmental impact assessment (EIA). Hitherto, decisions relating to the development of large-scale projects such as the construction of a power station, river diversion or refuge disposal have assumed that climate will not change, a premise that cannot now be relied upon. Although outside the scope of this report, a need clearly exists for some elements reported below to be incorporated within the EIA process (for instance, the development of state-of-the-art regional climatic scenarios). Similarly, many existing EIA procedures (particularly in areas of evaluating costs and benefits, risk and uncertainty) have considerable potential for adoption in the general area of climate impact assessment.

The ultimate objective is to provide the general public and policy-makers with estimates of the extent to which climate change may affect the environment and human activities and result in changes in social and economic welfare. The role of assessments is to assist in the development of alternative strategies for managing human activities under changeable climatic conditions.

2.2 Study Elements

Three general study elements for climate impact assessment are identified by Kates (1985): climate events, exposure units and impacts and consequences.

Climate events can be divided according to scale into three types: between-year weather extremes (such as floods, frost and snowfall), persistent periods or decade-long episodes (such as prolonged drought) and century or multi-century- long climatic trends (such as GHG-induced warming). The distinctions between these classes and the spatial scales they represent are sometimes blurred, but the important thing for the impact analyst is to select an appropriate scale of event, and then to describe its expected variation or change.

Exposure units represent the activity, group, or region exposed to a given climate event (Kates, 1985). These can be chosen on the basis: (a) of the climate event (e.g., within a particular climatic zone affected by the event), (b) of a specific geographical unit (e.g., physiographic characteristics of a river catchment), (c) of the specific type of activity or group affected by the climate (e.g., according to the sector of the economy or section of the population),or (d) of some other criteria (e.g., delimited by administrative unit such as a nation, or by the constraints on available information).

For a given climatic event acting on a given exposure unit there are many types and levels of impacts and consequences that can be studied. These are considered in detail in the following sections.

2.3 Approaches

Climate impact assessments may be conducted according to one of at least three general methodological approaches (Kates, 1985): impact, interaction and integrated approaches.

2.3.1 Impact approach

The simplest approach follows a straightforward 'cause and effect' pathway whereby a climatic event acting on an exposure unit has an impact (Figure 1). In layman's terms it can be thought of as an 'If-Then-What' approach: if the climate were to alter like this then what would be its impacts? In adopting the approach it is assumed that the effect of other non-climatic factors on the exposure unit can be held constant. Where this assumption is justified, the approach can be informative. However, the implicit identification of climate as the main determinant of human activities is also a major weakness of the approach. Another problem is that the whole assessment is reliant on the initial choice of a climatic event, which is not always selected according to criteria that are relevant to the climate-sensitivity of the exposure unit. Finally, a major drawback of this approach is an inability to assign a likelihood to the assumed changes in climatic factors.

The impact approach is usually adopted for studies of individual activities or organisms, but it is also applied to sectoral

Figure 1. Schema of the impact approach (after Kates, 1985)

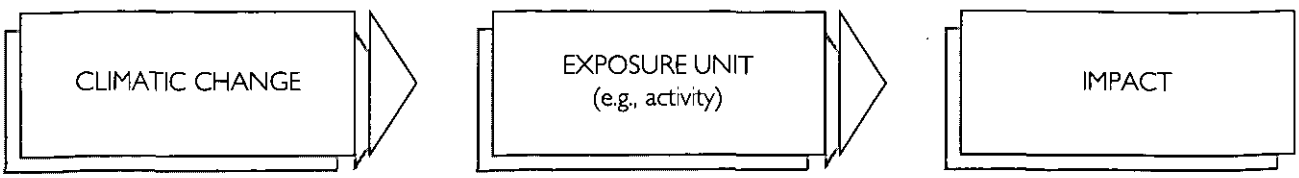
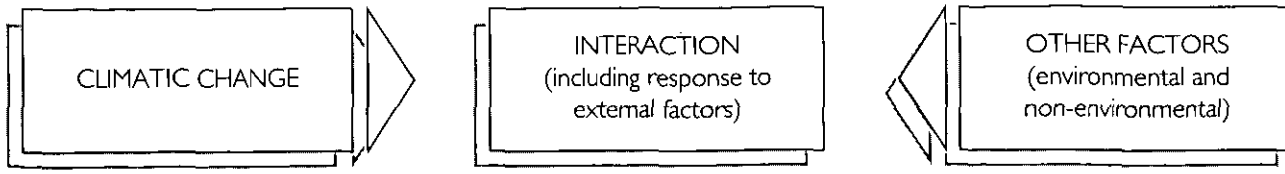


Figure 2. Schema of the interaction approach (after Parry and Carter, 1988)



studies where impacts may propagate through a hierarchy of levels. Thus, direct impacts represent the direct biophysical effects of climate on organisms or activities (e.g., on plants, animals, heating demand, water). The direct effects lead, in turn, to indirect impacts (e.g., changes in grass growth leading to changes in livestock productivity). The chain of impacts may then extend to higher-order economic and social impacts (e.g., changes in farm income, changes in national agricultural production, changes in farm employment).

In order to follow this hierarchical approach assumptions are required at each level of analysis. Inevitably, accompanying these assumptions are uncertainties, which may themselves propagate through the system. Given the large uncertainties, the exclusion of other influencing factors and the lack of consideration of possible feedback effects, it is rare that such a formal methodology can be followed successfully in impact assessment. More commonly an integrated or partially integrated approach must be adopted (see 2.3.3).

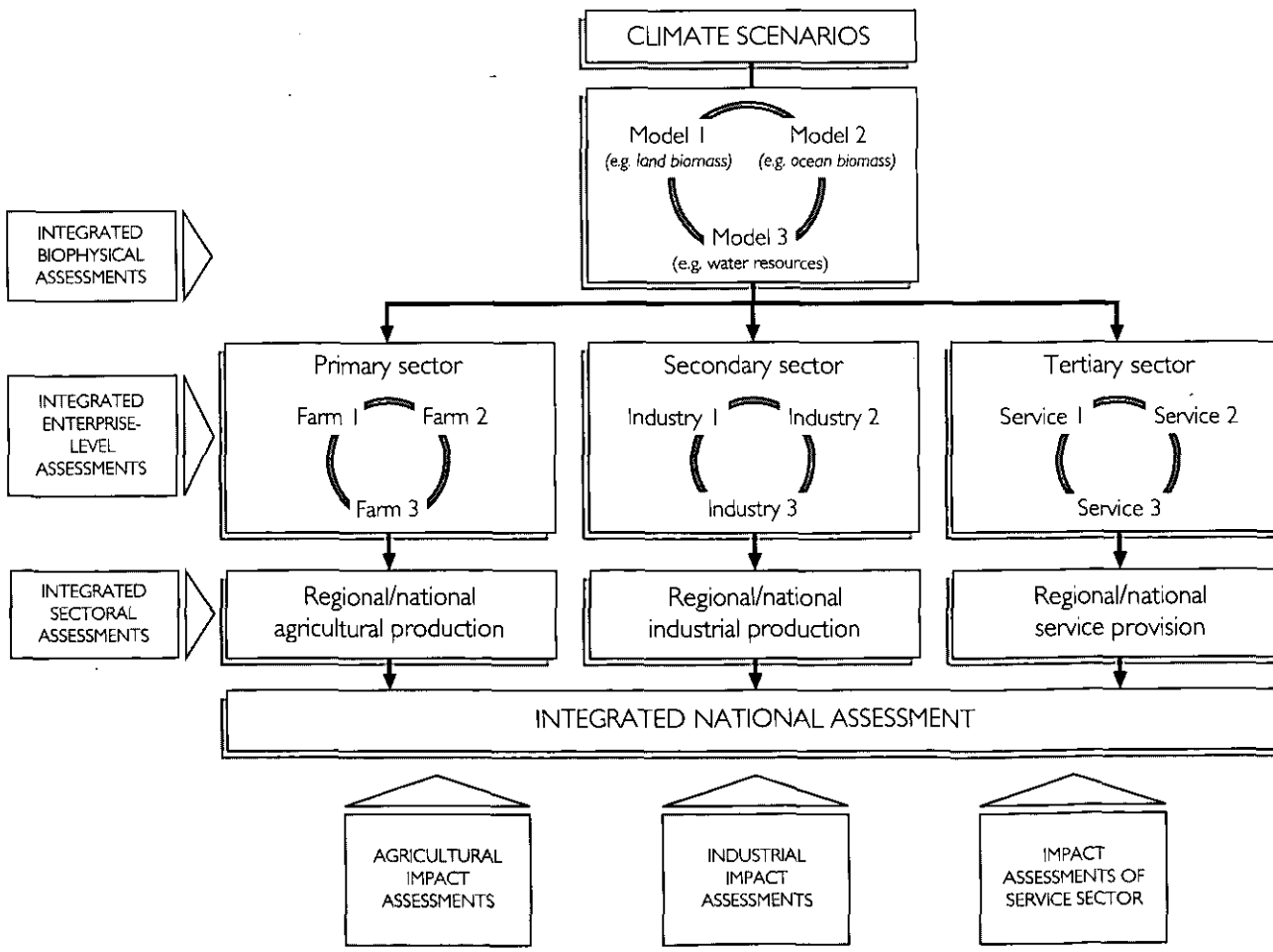
2.3.2 Interaction approach

The interaction approach recognizes that climate is only one of a set of factors that influence or are influenced by the exposure unit (Figure 2). For instance, the effects of an equivalent shortfall of rainfall may be felt quite differently in different parts of the world, some experiencing hunger or malnutrition due to underlying factors such as poverty, war or social marginalization, others profiting from increased food prices at a time of general shortage. Only if these other factors are fully accounted for will an accurate evaluation of the effects be achieved.

The interaction approach also allows for feedbacks that may regulate or enhance an effect. To illustrate a simple feedback at a global level: a change in climate may lead to a shift in natural vegetation zones. However, this shift in zones may itself influence the climate through changes in fluxes of gases to and from the atmosphere, and through changes in surface reflectivity.

A study method that fits closely into the structure of the interaction approach is the adjoint method (Parry and Carter,

Figure 3. An integrated approach to climate impact assessment (after Parry and Carter, 1988)



1988; Parry, 1990). In simple terms this can be thought of as a 'What-Then-If' approach: What points of a system are sensitive to what types of climatic change and then what might the impacts be if those changes in climate were to occur? It differs from the impact approach, described above, in that the climatic event is selected according to the climate-sensitivity of the exposure unit.

2.3.3 Integrated approach

An integrated approach is the most comprehensive treatment of the interactions of climate and society. It seeks to encompass the hierarchies of interactions that occur within sectors, interactions between sectors, and feedbacks, including adjustments that may mitigate or exploit the effects of a climatic event (Figure 3). In practice, since the knowledge base is insufficient to envisage conducting fully integrated assessments, only partially integrated assessments are feasible. These can be achieved by linking together parallel studies for different sectors in the same region (usually a nation or large administrative unit). This approach was advocated by Chen and Parry (1987), and has been implemented in a number of Integrated Regional Impact Assessments (IRIA) in Canada (Burton and Cohen, 1992) and in south-east Asia (Parry *et al.*, 1992). Other approaches focus on different sectors in a wide variety of regions to examine impacts on, for example, food supply or water resources (see, for example, Strzepek and Smith, in press).