

mate change. These projections are made using the climate projections and the biophysical models selected for the study (as described in Section 3.2.2.1). Because all changes in environmental conditions not due to climate factors should already have been incorporated in the development of the environmental trends in the absence of climate change, the only changes in the trends to be incorporated here are those due solely to climate change.

Future changes in climate can be expected to modify some of the environmental trends outlined in Section 3.4.3. Furthermore, there are likely to be a set of additional environmental changes that are directly related to the changes in climate themselves. The two factors most commonly required in assessments are greenhouse gas concentrations and sea level rise.

Projections of greenhouse gas concentrations are important for assessing effects, *inter alia*, on radiative forcing of the climate, on depletion of stratospheric ozone (e.g., CFCs) and on plant response (e.g., CO₂ and tropospheric ozone). In applying them, however, they should be consistent with the projected climate changes (see Section 3.4.2.2, above).

Sea level rise is one of the major impacts projected under global warming. Global factors such as the rate of warming, expansion of sea water, and melting of ice sheets and glaciers all contribute to this effect. However, local conditions such as coastal land subsidence should also be taken into account in considering regional impacts. In most assessments, the vulnerability of a study region to the effects of sea level rise will be apparent (e.g., in low lying coastal zones). However, some inland locations may also be affected (for example, through saline incursion of groundwater). The magnitude of future sea level rise is still under discussion, but the estimates reported by the IPCC may serve as a useful basis for constructing scenarios (IPCC, 1990a). Again, these should be consistent with projected changes in climate, and it should be noted that they are projected to vary regionally as well as temporally.

Other factors that are directly affected by climate include river flow, run-off, soil characteristics, erosion and water quality. Projections of these often require full impact assessments of their own, or could be included as interactive components within an integrated assessment framework (see Section 3.2.2.3).

3.4.7 Projecting socio-economic trends with climate change

The changes in environmental conditions that are attributable solely to climate change serve as inputs to economic models that project the changes in socio-economic conditions due to climate change over the study period. All other changes in socio-economic conditions over the period of analysis are attributable to non-climatic factors and should have been included in the estimation of socio-economic changes in the absence of climate change.

Socio-economic factors that influence the exposure unit may themselves be sensitive to climate change, so the effects of climate should be included in projections of those. In some cases this may not be feasible (e.g., it is not known how climate change might affect population growth) and trends estimated in the absence of climate change would probably suffice (see Section 3.4.4). In other cases, projections can be adjusted to accommodate possible effects of climate (e.g., future winter electricity demand may be reduced relative to trend due to climate warming).

Finally, many human responses to climate change are predictable enough to be factored in to future projections. These

are often accounted for in model simulations as feedbacks or 'automatic adjustments' to climate change. For example, as the climate changes, the growing season for crop plants would also change, and crop performance might be improved by shifting the sowing date. In some crop growth models the sowing date is determined by climate (e.g., the start of the rainy season), so it would be altered automatically to suit the conditions. Here, the model is performing internally an adjustment that a farmer might do instinctively.

3.5 Assessment of Impacts

Impacts are estimated as the differences over the study period between the environmental and socio-economic conditions projected to exist without climate change and those that are projected with climate change. The impacts provide the basis for the assessment.

The evaluation of results obtained in an assessment is likely to be influenced in part by the approach employed, and in part by the required outputs from the research. Some of the more commonly applied techniques of evaluation are described below.

3.5.1 Qualitative description

An evaluation may rely solely on qualitative or semi-quantitative assessments, in which case qualitative description is the common method of presenting the findings. The success of such evaluations usually rests on the experience and interpretative skills of the analyst, particularly concerning projections of possible future impacts of climate. The disadvantages of subjectivity in this have to be weighed against the ability to consider all factors thought to be of importance (something that is not always possible using more objective methods such as modelling).

3.5.2 Indicators of change

A potentially useful method of evaluating both the impacts of climate change and the changes themselves is to focus on regions, organisms or activities that are intrinsically sensitive to climate. For example, long-term changes in the average timing of phenological stages in hardy, well-adapted natural plant species might suggest a general warming of the climate. Moreover, changes in plant behaviour may indicate that certain critical thresholds of temperature change have been approached or exceeded. For instance, an increasing frequency of events where plants fail to flower may suggest that the chilling (vernalization) requirements of the plant have not been fulfilled. Another example is low lying coastal zones at risk from inundation, and the vulnerable populations located in such regions.

3.5.3 Compliance to standards

Some impacts may be characterized by the ability to meet certain standards which have been enforced by law. The standards thus provide a reference or an objective against which to measure the impacts of climate change. For example, the effect of climate change on water quality could be gauged by reference to current water quality standards.

3.5.4 Costs and benefits

Perhaps the most valuable results that can be provided to policy makers by impact assessments are those which express impacts as potential costs or benefits. Methods of evaluating these range from formal economic techniques such as cost-