Chapter E.1

Introduction

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The prevailing paradigm has been that climate variability and change can be projected decades or even a century or more into the future (e.g. IPCC 1996, 2001). However, for several reasons – e.g. imperfect representation of the full complexity of the Earth system, nonlinear spatial and temporal feedbacks, and imperfect foresight of human behaviour, it may not be possible to assess the range of potential future climate change accurately.

Therefore, a newer paradigm requires that our vulnerability to the entire spectrum of environmental threats be assessed, including the ranking of their seriousness. Once vulnerabilities have been so evaluated, whether or not they can be quantitatively predicted for the future can then be tested. This part of the BAHC synthesis discusses this perspective to assess risk associated with environmental variability and change. In particular, we should start the analysis by first assessing vulnerability, instead of projecting possible climate change scenarios, and then assessing vulnerabilities based on that subset of possible future climates.

This is a broader definition of vulnerability than that used by the impacts community. As discussed later, this approach involves first assessing all of the vulnerabilities of an environmental (or other) resource to environmental variability and change. Once these vulnerabilities are determined, estimates (with probabilities, if they can be quantified) of what scenarios would cause a vulnerability threshold to be exceeded are specified. Also, unlike the more narrowly defined concept of vulnerability, nonlinear feedbacks between the resource being affected and the forcings are included.

We will discuss first the relationship between prediction and vulnerability in Chapt. E.2 and E.3. The scenario approach will be reviewed later in Chapt. E.4 and its shortcomings illustrated. The reasons why a vulnerability approach as presented in Chapt. E.5 is more appropriate for environmental assessments is because it is regional and local in scale; it involves the evaluation of thresholds and the threat associated with extreme conditions; it can include a spectrum of threats, and can consider the effect of abrupt changes. In contrast, the existing paradigm for predicting the future starts from the global scale and then attempts to downscale to the regional and local scales; it focuses on averages, is long-term, and depends on skilful prediction of the future. It is therefore much less useful to policy-makers (Sarewitz et al. 2000). The in-depth discussion of why we need a vulnerability approach that then follows will be illustrated using water as an example.

Water is an essential component of life both in terms of its quality and quantity; however, this resource is threatened. For example, as reported in the Economist (May 29, 1999, p. 102), while 90% of the world's population have enough water at present, it is estimated that by 2050 more than 40% of the population will face some water shortage (see also Sect. E.6.1). The lack of access to safe water is even more serious. According to the same article in the Economist, developing countries often have very limited access to safe water supplies. Only about 30% of the residents in rural Brazil, for example, currently have access to safe water.

There is increasing recognition that threats to future water quality and quantity are influenced by a wide variety of environmental concerns. These concerns involve effects both from natural and human origin. Stahle et al. (2000), for example, document a 16th century megadrought in western North America that dwarfs any drought since then. Wilhite (2000) presents a series of articles that demonstrates the extensive effect of drought on human society. Kunkel et al. (1999) describe the importance of vulnerability to weather and climate extremes, and how this vulnerability changes in response to increases in human exposure, even when extreme weather statistics remain unchanged. Non-weather related influences include land-use change effects on runoff and stream flow, and deliberate engineering of water flow whereas human activities change the distribution and availability of water through engineering works. Examples of this kind of human activity include rerouting of rivers, creating artificial surfaces (reservoirs), changing surface water content through irrigation of drylands or drainage of wetlands, and through lifting groundwater to the surface.

In contrast with the current method for determining environmental risk by using scenarios based on general circulation model output, a vulnerability approach permits the inclusion of multiple environmental stresses associated with both short- and long-term threats, and involves local, regional, national and global scales. Chapter E.6 discusses this vulnerability perspective and provides specific case study examples.