A PROCESS FOR EVALUATING ANTICIPATORY ADAPTATION MEASURES FOR CLIMATE CHANGE

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Abstract. Many countries are preparing national climate change action plans that describe specific measures they are taking to mitigate greenhouse gas emissions and adapt to the potential effects of climate change. Among the reasons for preparing such plans are that climate change is likely to occur, and many anticipatory measures that would be taken in response to climate change are "no regret" measures that will produce benefits even if climate does not change. Additionally, these plans can serve as communications required by the U.N. Framework Convention on Climate Change. We propose here an assessment process for anticipatory adaptation measures that will enable countries to identify and select measures to adapt to climate change. These measures anticipate potential climate changes and are flexible enough to meet objectives under a wide variety of future climate conditions. The process builds on assessments of vulnerability by focusing on adaptation measures for the most sensitive regions, or populations, within a country. Potential anticipatory adaptation measures are identified, and two or three are chosen based on expert judgment and analysis regarding which measures would produce the greatest benefits and be easiest to implement. Analytic techniques are used to assess the benefits and costs of each of the measures and evaluate barriers to implementation. The measure that is most cost-effective and is easiest to implement is selected. We illustrate the application of the process by examining a hypothetical forest threatened by climate change.

Key words: adaptation, benefit-cost analysis, cost-effectiveness analysis, multicriteria analysis

1. Introduction

Many countries are preparing national climate change action plans that describe the specific measures they are taking to mitigate greenhouse gas emissions and adapt to the potential effects of climate change. Among the reasons for preparing such plans are that climate change is likely to occur (IPCC, 1995), and many measures that would be taken in response to climate change are "no regret" measures, which means that they will produce benefits even if climate does not change.

In addition, many developing countries and countries with economies in transition face numerous opportunities in the near future to incorporate climate change in their infrastructure and institutions. Many infrastructure projects for managing climate-sensitive resources will be built in these countries. These projects include reservoirs, hydropower facilities, coastal development, and irrigation systems. In addition, institutions and plans for managing climate sensitive resources, such as agriculture extension services, coastal zone management plans, sustainable development plans, and others, are being developed. The design of these infrastructure projects, institutions, and plans can and should incorporate the potential for climate change to significantly affect the natural resources being addressed.

A few articles have been published on how governments could address adaptation to climate change (e.g., Titus, 1990; Goklany, 1995; Fankhauser, 1996; Smith, in press a). Carter *et al.* (1994) described general steps that can be taken to assess adaptation. This paper describes specific techniques that can be applied by governments to assess adaptation needs, identify anticipatory adaptation measures, and select those measures that are most cost-effective and can be most readily implemented. In describing this process, a hypothetical example is offered to

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present and illustrate the specific analytic techniques. (This process is also described in Smith, in press b, although the example is for water resources.)

For this example, we assume we are examining a tropical forest region that is highly fragmented as a result of past and ongoing development. Furthermore, we assume that these fragments contain a large number of locally endemic species, including some relic species that are especially sensitive to climate change and that the forest supports an indigenous population. We assume that annual precipitation is usually high, but that changes in climate may decrease precipitation and increase average temperature.

2. Selection of Vulnerable Sectoral Components

The first step in the anticipatory adaptation assessment process is to select a vulnerable region, population, or other sectoral component (e.g., natural reserves) to focus on. This should begin with an assessment of the vulnerability to climate change of regions, populations, or other sectoral components. These assessments should fully consider baseline changes in socioeconomic and environmental conditions, biophysical and socioeconomic impacts, and the capacity for systems to react to climate change through autonomous adaptation (Carter *et al.*, 1994; Benioff *et al.*, in press). In this selection process, governments should consider not just the magnitude of potential climate change impacts (e.g., where forests may change the most), but also the value (e.g., some forests may have more highly valued uses than others), the irreversibility of impacts (e.g., species extinction is irreversible), and the uniqueness of the resource (e.g., some areas such as the Monteverde Cloud Rain Forest in Costa Rica are considered unique habitats).

If quantitative vulnerability assessments have not been conducted, expert judgment may be used to identify particularly vulnerable regions, populations, or other sectoral components. For example, there is extensive literature on potential climate change impacts on forests upon which to base judgments of the relative vulnerability of these resources. Studies of vulnerability at regional levels include Tegart *et al.* (1990), Smith *et al.* (1992), World Wildlife Fund (1992), Melillo *et al.* (1993), Morse *et al.* (1993), Asian Development Bank (1994), Markham and Malcolm (1996), and IPCC (in press).

Examples of characteristics indicating forest ecosystems that are the most sensitive to climate change are:

- forests/species with limited geographic range
- forest/species that are drought/heat intolerant
- forests/species at boundaries of compatible climate regions, particularly at their heat tolerant or drought tolerant limits of range
- species with limited seed dispersal/migration capabilities
- highly fragmented forests or species populations
- regions where estimated changes in climate are relatively large