BIODIVERSITY AND CLIMATE CHANGE ADAPTATION

The effects of climate change on biodiversity and their negative consequences for human well-being are now widely recognized. It is clear, however, that the links between biodiversity and climate change flow both ways and that biodiversity has a key role to play in climate change adaptation. Healthy, intact ecosystems provide critical ecosystem services, including food and shelter and protection against drought and floods, and form the basis of traditional knowledge, innovations and practices. The conservation of natural terrestrial, freshwater and marine ecosystems and the restoration of degraded ecosystems, including their genetic and species diversity, are therefore crucial in adapting to climate change.

Current picture and future trends

The changes observed in the Earth's climate have already adversely affected biodiversity at the species and ecosystem levels by changing the timing of key life events, increasing vulnerability to invasive alien species and other pests, increasing the frequency and intensity of natural disasters and altering habitat conditions, among other things. Additional changes in biodiversity are inevitable as climate change progresses, threatening the continued provision of ecosystem services. Some of these changes may be irreversible once "tipping points" are reached; the widespread collapse of coral reef systems is projected, for example, if the mean global temperature increases by more than 3°C.

Once ecosystems are no longer able to deliver critical services, people living in and around them will immediately be exposed to widespread negative effects on health, livelihoods, culture and security. Adaptation strategies that aim to conserve biodiversity and maintain the ecosystem services upon which people depend are therefore needed to respond to the full range of adverse climate change impacts.

The interlinkages between biodiversity, climate change and sustainable development have long been recognized in international forums such as the United Nations Framework Convention on Climate Change and the Convention on Biological Diversity. Article 2 of the Framework Convention on Climate Change, for example, recognizes the importance of limiting climate change to a level that would allow ecosystems to adapt naturally to it. In 2008, in recognition of the urgent need to build a solid knowledge base on the links between biodiversity and climate change, the Conference of the Parties to the Convention on Biological Diversity adopted decision IX/16 B, establishing an ad hoc technical expert group on biodiversity and climate change.

Reducing the impacts of climate change on biodiversity

Biodiversity's ability to adapt naturally to climate change is central to effective and efficient adaptation strategies. This natural adaptive capacity is threatened, however, both by the accelerating pace of climate change and by other pressures on biodiversity and associated ecosystem services.

Options to increase the adaptive capacity of species and ecosystems in the face of climate change include:

- Reducing non-climatic stresses such as pollution, over-exploitation, habitat loss and fragmentation and invasive alien species;
- Wider adoption of conservation and sustainable use practices, including through the strengthening of protected area networks;
- Facilitating adaptive management by strengthening monitoring and evaluation systems;

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- Implementing climate change mitigation strategies to limit the magnitude of climate change;
- Maintaining intact and interconnected ecosystems to increase resilience;
- Restoring or rehabilitating fragmented or degraded ecosystems and re-establishing critical processes, such as water flow, to maintain ecosystem functions;
- Collecting, conserving and disseminating traditional and local knowledge, innovations and practices related to biodiversity conservation and sustainable use with the prior and informed consent of traditional knowledge holders.

Relocation, assisted migration, captive breeding and ex-situ storage of germ plasm could contribute to maintaining the adaptive capacity of species. Such measures, however, are often less effective than in situ actions, expensive, applicable only to some species and feasible only on a small scale. Furthermore, they rarely maintain ecosystem functions and services and, in the case of relocation and assisted migration, can have unintended ecological consequences that must be considered.

Ecosystem-based approaches for adaptation

Ecosystem-based approaches for adaptation, which integrate the use of biodiversity and ecosystem services into an overall adaptation strategy, can be cost-effective and can generate social, economic and cultural co-benefits while contributing to biodiversity conservation. The Economics of Ecosystems and Biodiversity study (referred to as "TEEB") reveals that some of the most cost-effective climate change adaptation options involve conserving and restoring ecosystems and biodiversity.

Ecosystem-based approaches for adaptation include the sustainable management, conservation and restoration of ecosystems that provide services to help people adapt to the adverse effects of climate change. Such approaches can be useful because they:

- Can be applied at the local, national and regional levels, on both project and programmatic scales, and yield benefits over the short and long term;
- May be more cost-effective and more accessible to rural or poor communities than measures based on hard infrastructure and engineering;
- Can integrate and maintain traditional and local knowledge and cultural values.

Ecosystem-based approaches for adaptation, if designed, implemented and monitored appropriately, can also:

- Generate multiple social, economic and cultural co-benefits for local communities;
- Contribute to the conservation and sustainable use of biodiversity;
- Contribute to climate change mitigation by conserving carbon stocks, reducing emissions caused by ecosystem degradation and loss and enhancing carbon stocks.

It should be noted that ecosystem-based approaches for adaptation may require managing ecosystems to provide particular services at the expense of others. Using wetlands for coastal protection, for example, could require an emphasis on silt accumulation and stabilization at the expense of wildlife values and recreation. It is important, therefore, that decisions to implement ecosystem-based approaches for adaptation be subject to risk assessment, scenario planning and adaptive management approaches that recognize and incorporate such potential trade-offs.

Impacts of adaptation activities on biodiversity

Measures to adapt to the adverse impacts of climate change can have positive, neutral and negative consequences for biodiversity and ecosystem services, depending on the way in which they are implemented. For example:

- Increasing the diversity of landscapes and interconnected agricultural ecosystems, natural floodplains, forests and other ecosystems can contribute to the climate resilience of local communities, biodiversity and ecosystem services;
- Hard infrastructure in coastal areas, such as sea walls and dykes, can adversely impact natural ecosystem processes by altering tidal current flows, disrupting or disconnecting ecologically-related coastal marine communities and disturbing sediment or nutrition flows.

It is usually possible to increase the positive and reduce the negative impacts of adaptation on biodiversity. Tools for identifying these impacts include strategic environmental assessments, environmental impact assessments and technology impact assessments, all of which facilitate the consideration of adaptation options.

The planning and implementation of effective adaptation activities that take into account the impacts on biodiversity can benefit from:



Table 1. Examples of ecosystem-based approaches to adaptation that provide co-benefits

Adaptation measure	Adaptive function	Co-benefits			
		Social and cultural	Economic	Biodiversity	Mitigation
Mangrove conservation	Protection against storm surges, sea-level rise and coastal inundation	Provision of employment options (fisheries and prawn cultivation); contribution to food security	Generation of income to local communities through marketing of mangrove products (fish, dyes, medicines)	Conservation of species that live or breed in mangroves	Conservation of carbon stocks, both above and below the ground
Forest conservation and sustainable forest management	Maintenance of nutrient and water flow; prevention of landslides	Opportunities for recreation, opportunities for culture, protection of indigenous peoples and local communities	Potential generation of income through ecotourism, recreation and sustainable logging	Conservation of habitat for forest plant and animal species	Conservation of carbon stocks; reduction of emissions from deforestation and degradation
Conservation of agricultural biodiversity	Provision of gene pools for crop and livestock adaptation to climatic variability	Enhanced food security; diversification of food products; conservation of local and traditional knowledge and practices	Possibility of agricultural income in difficult environments; environmental services such as provision of bees for pollination of cultivated crops	Conservation of genetic diversity of crop varieties and livestock breeds	Use of climatically appropriate crops, leading to the maintenance and enhanced sequestration of carbon in soil
Conservation of medicinal plants used by local and indigenous communities	Local medicines available to treat health problems resulting from or aggravated by climate change, such as malaria or diarrhoeal diseases	Independent and sustainable source of medicines for local communities; maintenance of traditional knowledge	Potential sources of income for local people	Enhanced medicinal plant conservation; recognition and protection of local and traditional knowledge	
Sustainable management of grassland	Protection against flooding; storage of nutrients; maintenance of soil structure	Recreation and tourism	Generation of income for local communities through products from grass, e.g., brooms	Forage for grazing animals; habitat for animals	Sustainable land management, leading to the maintenance and enhanced sequestration of carbon in soil

- Considering traditional knowledge and fully involving indigenous peoples and local communities;
- Defining measurable outcomes and then monitoring and evaluating them;
- Building on a scientifically credible knowledge base;
- Applying the ecosystem approach.

Looking ahead: enhancing synergies

The implementation of ecosystem-based approaches to adaptation and the integration of biodiversity considerations into relevant climate change adaptation plans and strategies require enhanced cooperation and synergies between the various biodiversity and climate change actors, especially the three Rio conventions,[2] taking into account their different mandates and composition of Parties.

The present paper is based primarily on the findings of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change.[3]

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1 P. Sukhdev et al., The Economics of Ecosystems & Biodiversity: Climate Issues Update (September 2009). Available at http://www.teebweb.org/LinkClick.aspx?fileticket=L6XLPaoaZv8%3d&tabid=1019&language=en-US.

2 The Convention on Biological Diversity, the United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa, and the United Nations Framework Convention on Climate Change.

3 Secretariat of the Convention on Biological Diversity, *Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change,* Technical Series, No. 41 (Montreal, 2009). Available at http://www.cbd.int/doc/publications/cbd-ts-41-en.pdf.

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