Biodiversity and ecosystem services: costs and benefits of adaptation

Key Messages

- There is a limited evidence base for cost and benefits analysis of adaptation options in biodiversity policy. The existing studies indicate that adaptation costs are often high including potential opportunity and policy costs.
- There is a lack of justification and data on the effectiveness of adaptation measures, therefore major assumptions have to be included in the assessments.
- The existing information is difficult to transfer between sites, geographical level, etc. due to the complexity of climate impacts and the site-specific effectiveness of measures. Furthermore, the economic valuation of benefits for ecosystems and biodiversity is still challenging and time-consuming.
- The valuation of benefits of biodiversity and ecosystems has been developed further as the ecosystem services approach becomes increasingly popular. The ecosystem services approach values the benefits of an ecosystem for human beings. Its widespread use increases the possibility of benefit valuation of adaptation measures in the biodiversity field, including ecosystem-based adaptation measures.

Context

Climate change impacts affect terrestrial, aquatic and marine ecosystems and biodiversity. Increasing average temperature, heat waves, extreme weather events and water scarcity influence biodiversity and the functioning and provisioning capacity of ecosystems. Some noted climate induced changes are, for instance, shifts in geographic ranges of species, altered seasonal activities and migration patterns, and new species interactions. The unprecedented rate at which these changes and impacts take place also increases the level of species extinction.

Potential adaptation options for biodiversity include the enlargement of protected areas, the establishment of buffer zones at rivers and the building up of ecological corridors. All of which aim to reduce habitat fragmentation. Biodiversity loss as a result of climate change is already occurring, and many adaptation options deal predominantly with existing impacts. This has led to new approaches that are designed to deal with specific species loss and include a variety of measures such as translocation and management of alien species. Underlying action-oriented adaptation options is the need for improving the overall availability of robust quality information as well as monitoring systems. These “biodiversity” ecosystem based adaptation measures (‘green’ measures) also have cross-sectoral impacts and are becoming more popular to contribute to addressing climate risks in other areas such as agriculture, coastal flooding, water management.

Policy and methodological developments

Literature is limited in relation to economic assessments of adaptation to climate change for ecosystems and biodiversity. Assessments do, however, exist at multiple scales and cover local, national and global levels. Mostly, the literature focuses on the costs of protection and restoration of habitats and species. However, the amount of literature focused on ecosystem based adaptation which is discussed in other ECONADAPT Insights is increasing.

Some **global studie**s exist, such as Berry (2007) which estimated the global costs of establishing and managing protected areas under climate change at USD 36-65 billion per year by 2030. If extended to conservation of the wider matrix of landscapes, which means areas integrating conservation measures with economic activities, the costs could reach USD 290 billion per year. Built on this study, Parry et al. (2009) estimated adaptation costs for worldwide terrestrial and marine protected areas between US$ 65 and 80 billion per year with results in a similar range to

Berry (2007).

There are a number of studies at the **national level**. Berry et al. (2006) estimated the adaptation costs for restoration and re-creation of a number of habitats in the UK. The estimation of the annual restoration costs are based on the UK Biodiversity Action Plan. The calculated annual restoration costs for 11 habitats are for 2050 in a High-Scenario: £ 2.5 mio., in a Low-Scenario: £ 1.4 mio. A 2011 UNDP report on Costa Rica estimated adaptation costs for the biodiversity sector, specifically for the conservation of terrestrial, marine and aquatic ecosystems, prevention of forest fires, and awareness raising. The UNDP estimated that costs would surmount to USD 60 million per year in 2015 and increase to USD 76 million per year in 2030 (UNDP 2011). For the Netherlands, van Ierland et al. (2006) calculated costs of establishing a national ecologic network, and additional adaptation measures under climate change at EUR 135 million per year. A Finnish study analysed the conservation of grassland butterflies under a changing climate in Finland finding that buffer zones were most cost-effective while the cost of translocation were relatively modest compared to dispersal corridors (Tainio et al. 2014).

Further examples of economic assessments for adaptation on biodiversity are available on **local and regional level**. In Honduras, for the Guacerique Watershed Ecosystem adaption-options are planned to implement a variety of measures including reforestation, transitioning to agroforestry, fire control measures and introducing soil and water conservation measures. The assessment says the options implemented would cost USD 4.2 million and net economic benefits would be between USD 23.6 and 91.5 (depending on the chosen scenario and discount rate) (Vignola et al. 2015).

Cartwright (2013) analysed adaptation measures in eThekwini, a metropolitan region in South Africa –including the City of Durban. He analysed three ecosystem-related measures: Natural capital planning and research (including system conservation planning, estuarine management plan and climate change research), Natural capital regulation and acquisition (including e.g. and use management, land acquisition) and Strategic natural capital management (including e.g. Restoration, reforestation and protected area management). The three measures have higher benefits compared to their costs and would be beneficial from an economic perspective.

In the biodiversity policy field, **methods for decision making under uncertainty** are increasingly used, but have not focused on economics to date. The only study identified for is an application of portfolio analysis to investigate genetic material that could be used for the restoration or regeneration of forests under climate change futures (Crowe and Parker 2008).

Additionally, to adaptation related assessments, the different TEEB studies can provide potential inputs for the analysis. The TEEB studies have analysed the economic value of restoration projects and assessed the benefit-cost ratio for the restoration of different biomes and ecosystems, finding high benefit-cost ratios, especially for grasslands, tropical forests, wood- and shrub-lands, and mangroves (TEEB 2009; TEEB 2010).

Main implications and recommendations

For ecosystem and biodiversity related adaptation the evidence base is still limited. The database is also benefiting from major studies, which are concentrating on economic assessment of ecosystems that are not exclusively focused on climate change with for instance the TEEB.

Methods for decision making under uncertainty are increasingly implemented. Treatment of uncertainties which are very relevant for robust decision making are included in the economic assessments for the biodiversity policy field as a variety of climate and socio-economic scenarios, e.g. in Cartwright (2013) has four scenarios.

The objectives of the economic studies are mainly to estimate financing needs for public investments in planned adaptation activities. It includes single measure assessments, but also focuses on building up a portfolio of actions, e.g. included in action plans or adaptation strategies.

Ecosystem-related adaptation measures are mainly no-regret measures which include immediate

benefits; therefore studies partially base adaptation estimates on what should theoretically be done for the conservation of ecosystems currently, the estimates already exceed a lot the current realized investments.

Timescales vary considerably. Major studies such as Berry (2007) focus on 2030 as well as the national UNDP study for Costa Rica. Berry et al. (2006) uses 2050 as a timescale. So the majority of studies focus on the short or medium term. This is likely the case because of the already existing challenges for biodiversity and the high climate uncertainties. Studies long term time scales were not found, for instance, up to 2100.

The variation between discount rates is significant and can range from 0.1 to 15%. The lowest rate of 0.1% is used for the financial and investment flow analysis of Costa Rica (UNDP 2011). Van Ierland et al. (2006) works with a discount rate of 4% and Cartwright (2013) uses rates between 1 and 15%, which vary along the four developed scenarios. Transaction costs are covered in some studies which include cost components such as the management of conservation areas.

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Further Information
Overview of costs and benefits of adaptation at the national and regional scale
Using cost and benefits to assess adaptation options [pdf]
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