Science for Environment Policy
DG Environment News Alert Service
SPECIAL ISSUE

Biodiversity

Issue 8 September 2008

Editorial

Conserving biodiversity and maintaining ecosystem services

Where would we find most of our raw materials if forests did not produce them? What would we eat if insects did not pollinate plants? Could we live without clean water? Ecosystem goods and services arising from biodiversity are critical, but they are also coming under severe threat. In this issue, we provide examples of studies that contribute to improved understanding of the current biodiversity crisis and the value of ecosystem services.

If ecosystem services are so valuable, why are they threatened? Part of the answer lies in the difficulty of measuring the value of goods and services provided by ecosystems (see: 'Understanding the economic value of biodiversity'). Another difficulty arises because the benefits of ecosystem services are often shared by society, whereas the costs of maintaining them are borne by local stakeholders. In Brazil, intergovernmental fiscal transfers have been successfully used to help local governments protect ecosystems (see: 'Supporting ecological services through fiscal transfers').

There are additional difficulties with preserving ecosystem services. For example, climate change is altering natural processes and threatening the survival of a large number of species. A promising approach to predicting these changes is to try to learn from the past (see: 'Protecting biodiversity from the effects of climate change').

Some of the most dangerous environmental changes arise from interactions between climate and other human induced changes. For example, increases in human population, together with changes in their distributions and habits, are challenging our ability to manage limited natural resources for the profit of all. In 'Preserving sandy beach ecosystems – the way forward', strategies are proposed to manage this highly threatened system. Meanwhile, seven governments in the European Alpine region are cooperating to develop sustainable land management practices to support important mountainous habitats (see: 'Networking habitats to protect and enhance biodiversity'). Effective strategies require the involvement of local communities, particularly in poorer countries where large numbers of people depend on the direct extraction of natural resources (see: 'Community involvement with forest management can boost biodiversity').

Solutions to the biodiversity crisis will not be provided by science alone. Solving environmental problems requires sound policies and these, invariably, require balancing contradictory interests for the benefit of society.

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EUROPEAN COMMISSION
environment

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Understanding the economic value of biodiversity

The economic value of biological diversity is poorly characterised. A new report highlights the key issues that need to be addressed in assigning values to ecosystems and the services they provide. The report outlines a new framework that will be developed for valuing biodiversity.

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"Ecosystem services need to be better expressed in terms of their value to the poor. Those who depend directly on subsistence farming, fishing and informal forestry, for example, are at the greatest risk from biodiversity loss."

The Convention on Biological Diversity was adopted in 1992 as an international agreement to conserve global biodiversity and share its benefits. Today, however, the value of biodiversity remains poorly understood and difficult to quantify, particularly in economic terms. This means that policymakers may lack some necessary information to make sound arguments for biodiversity conservation.

In 2007, the European Commission and German Federal Ministry for the Environment initiated a project to assess the global economic benefits of biological diversity. The aim of the project is to promote better understanding of the value of biodiversity for human health and welfare, and to give decision makers the tools to implement change. The recently published report provides an overview of progress made during the project's first phase, in assigning value to "ecosystem services", which can include everything from food and clean water to natural flood barriers and diverse plant sources for obtaining live-saving drugs.

The report highlights three key issues in giving values to these services:

- Ecosystem services need to be better expressed in terms of their value to the poor. Those who depend directly on subsistence farming, fishing and informal forestry, for example, are at the greatest risk from biodiversity loss.
- Economic models attribute a greater value to services that are available now than to the same services in the future. This creates an ethical dilemma that needs to be addressed, in that the value of ecosystems to our descendents could be grossly underestimated.
- The value of ecosystem services, and different aspects of biodiversity, must be considered in relation to the most relevant end users, who might be policy makers, commercial organisations or citizens.

A proposed valuation framework is also outlined. This focuses on "world with" and "world without" scenarios, so that comparisons can be made between, for instance, water quality with and without actions to tackle biodiversity loss. In the next phase of the project, researchers intend to develop this valuation strategy, with the long term aim of publishing a valuation toolkit for policymakers.

The key preliminary findings and issues identified by the report will be addressed during the next stage of the project, Phase II, which will run until 2010 in order to develop clear recommendations for effective policies. The authors state that large-scale policy reforms are needed to adequately protect and enhance biodiversity for future generations.

Source: European Communities report. (2008). 'The economics of ecosystems & biodiversity: An interim report'. Download from: http://ec.europa.eu/environment/nature/biodiversity/economics/index_en.htm

Supporting ecological services through fiscal transfers

Intergovernmental fiscal transfers can be an effective means of redistributing finances from central to local level to support the local provision of ecological goods and services with spillover benefits, using ecological indicators to guide distribution. A recent study has assessed the success of such a system in Brazil.

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"Decisions about where conservation areas are to be sited are frequently taken at higher levels of government, even though the costs of losing those areas for other social and income-generating developments are borne by the local governments and communities."

Local activities can have a significant impact on the success of national preservation programmes, such as biodiversity protection. However, local governments may suffer financially by having to provide ecosystem benefits that extend beyond their boundaries.

Under fiscal transfer schemes, public revenue is redistributed through transfers from national and regional governments to local governments. One purpose of such schemes is to compensate local governments for expenditure incurred in providing benefits to areas beyond their boundaries, for example for schools and hospitals.

Decisions about where conservation areas are to be sited are frequently taken at higher levels of government, even though the costs of losing those areas for other social and income-generating developments are borne by the local governments and communities. Fiscal transfers are therefore seen as an innovative instrument to provide incentives for local governments to support and maintain the quality of water and nature protection areas within their territories, but which can also provide wider ecological benefits beyond municipal boundaries.

In Brazil, a value-added tax on goods and services, the ICMS, is a major source of revenue at state level. However, thanks to a redistribution mechanism, it also benefits municipalities. In many states, a proportion of this tax is now specifically allocated to compensate local governments for providing protection areas within their boundaries. The majority of the states have successfully implemented the ecological ICMS for biodiversity conservation. For this purpose, ecological indicators based on conservation units have been introduced for the distribution of tax transfers between state and local governments. Some states have also based their indicators on water protection areas, waste disposal and sanitation systems or soil protection schemes.

Ecological fiscal transfers have been especially successful for municipalities containing large conservation areas, where the wider benefits spill over local boundaries. In addition, it has been found that it is cost-effective to include an ecological indicator to fiscal transfer systems already in place, as it does not depend upon the implementation of new authoritative bodies. A further benefit of this system is the combination of centralised incentives with decentralised decision processes. For Brazil, however, it remains a challenge to design further economic instruments that also support private land users, who are not directly rewarded for their conservation contributions within this system.

Compared with Brazil, the study suggests that countries within the European Union offer very different compensation strategies. In the EU, individual landowners, rather than local governments, predominantly receive the benefits of providing spillover ecological goods and services through a variety of agri-environmental and conservation support programmes. However, it is suggested that effective long-term conservation strategies would be best achieved by including both local private landowners and municipalities in fiscal transfer and payment schemes.

Source: Ring, I. (2008). Integrating local ecological services into intergovernmental fiscal transfers: The case of the ecological ICMS in Brazil. *Land Use Policy*. 25: 485-497.

Protecting biodiversity from the effects of climate change

Biodiversity conservation across the world is threatened by climate change, with rising temperatures potentially causing local extinctions of many vulnerable species. However, a recent study[1] suggests that lessons can be learnt from temperate mountains in parts of China which contain an unsurpassed richness of flora and fauna. They could help conservationists worldwide select protection areas which are better at withstanding the effects of climate change.

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"The ecosystems found on the Qionglai and Changbai Mountains in China are survivors from the Pleistocene Period (1.8 million – 10,000 years ago) and can provide an understanding of how certain conditions preserve such a richness of species during major climate changes."

The study defines 'species richness' as the number of species found in one place and suggests that the temperate regions generally became species poor around the Pleistocene Period (1.8 million – 10,000 years ago) because of changing climatic conditions. The ecosystems found on the Qionglai and Changbai Mountains in China are survivors from this time and can provide an understanding of how certain conditions preserve such a richness of species during major climate changes.

Changbaishan Mountain, in North-East China, is a volcano with a crater lake and is covered with a variety of distinct communities shaped by altitude, orientation, topography and water flow. Vegetation ranges from Alpine meadow and scrub at the top of the mountain, to mixed hardwood forests near the base. Although exposed to volcanic eruptions and the effects of past glaciation periods, there are more types of animals and plants found there than in any other area of similar climate and it contains greater species richness than some countries in Europe. The Qionglai Mountain ranges in the South-West of China contain even more botanical types with over 4000 species of flowering plants. Combined with the adjacent Hengduan Mountains, the area covers the richest temperate site in the world.

Reasons for the high levels of species richness in these mountains include:

- a large, well connected area, adjacent to forests on three sides allowing access for many species
- a wide variation in altitude providing numerous specialist niches and the opportunity for species to move vertically to adapt to changing conditions
- a diverse range of local habitats formed by the complex shape of the area, including peaks, hollows, lakes, valleys as well as gorges which provide shelter for species in harsher conditions
- a diversity of underlying landforms allowing a broad range of habitats
- a good summer rainfall ensures the area does not dry out
- a long north-south axis of the area includes a variety of climate states from warm temperate to cold temperate
- geological activity such as volcanic processes encourage a diverse ecology by providing new habitats for species to colonise

Identifying areas in other parts of the world which contain similar characteristics could help guide current conservation efforts. Such habitats ought to receive special protection in order to help preserve a broad array of biodiversity.

[1] This study was conducted as part of the EU-China Biodiversity Programme - a joint initiative between the European Union (EU), United Nations Development Programme (UNDP), the Chinese Ministry of Commerce (MOFCOM) and the Chinese State Environmental Protection Administration (SEPA).

Source: MacKinnon, J. (2008). Species richness and adaptive capacity in animal communities: lessons from China. *Integrative Zoology*. 3: 95-100.

Preserving sandy beach ecosystems – the way forward

The combined impacts of climate change and increasing population pressures on coastal areas for living and recreation have placed beach ecosystems under severe pressure. New research suggests efforts to preserve the biodiversity of sandy beach ecosystems should be undertaken within the framework of Integrated Coastal Management1. The aim is to integrate the physical protection of coastlines with the conservation of threatened ecosystems.

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"It is suggested that ecologists, managers and policy makers work together at all levels of decision making in implementing effective and enduring strategies to conserve coastal ecosystems."

As key recreational sites, sandy beaches are of prime social, cultural and economic importance and dominate the world's coastlines. They also provide critical and irreplaceable ecosystem services and there is a growing recognition of the ecological value of beaches. However, current beach management is largely concerned with managing sand budgets and erosion, while ecological aspects are rarely considered.

Co-operation between beach managers and ecologists is therefore important, according to the researchers. They produced 50 'key statements' summarising how essential features of sandy beach ecosystems function and are structured, which include defining the physical features of beaches, the functioning of beaches as ecosystems and incorporating the protection of beach ecosystems with wider management practices.

The researchers suggest that climate change will have a significant impact on the ecology of sandy beaches. It is anticipated that climate change will affect the following:

- Sea levels – Average sea levels have risen by 0.17 metres in the last century and there are more occurrences of damaging high seas during storms. Continued loss of beaches will severely impact on coastal habitats and communities.
- Extreme weather events – It is likely that changes in cyclone and storm behaviour will produce higher and more powerful waves, increasing beach erosion.
- Precipitation - the pattern of precipitation is changing with more incidences of floods and altered freshwater flow to the oceans and this will affect the ecology of the beaches.
- Changes in the ENSO (El-Niño-Southern Oscillation) events cause alterations to precipitation and this may affect beach ecosystems.
- Within decades, acidification of the oceans will negatively affect marine organisms that need calcium carbonate to form shells, such as urchins and snails.

Four principles have been proposed by the researchers to integrate the ecological and physical aspects of management strategies for sandy beaches, which will help beach ecosystems withstand the pressures of climate change. It is suggested that ecologists, managers and policy makers work together at all levels of decision making in implementing effective and enduring strategies to conserve coastal ecosystems. There is also a need for further development of modelling techniques to study the impacts of climate change on beach ecology and to combine this with the effects that various management strategies will have on beach systems.

Source: Schlacher, T.A., Schoeman, D.S., Dugan, J. *et al.* (2008). Sandy beach ecosystems: key features, sampling issues, management challenges and climate change impacts. *Marine Ecology*. 29(Suppl. 1): 70-90.

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Networking habitats to protect and enhance biodiversity

Biodiversity is influenced by how different habitats within a given region are connected. A new project in the Alps has made initial progress in establishing an ecological network to promote and enhance biodiversity within Alpine regions. Additionally, the project aims to raise awareness among policymakers of the importance of ecological connectivity.

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"Small, isolated populations are less able to survive because they lack the genetic variability needed to adapt to changing conditions such as climate change or disease."

The Alps are the largest natural region left in Europe and are therefore critically important to biodiversity. However, biodiversity in Alpine regions is threatened by intensive agriculture, pollution and climate change. As environmental policies affecting these regions are controlled not just by one government, but by seven, it is important for Alpine countries to work together and develop strategies for conserving biodiversity.

The project[1] has made progress in establishing a joint methodology for protecting and enhancing biodiversity. Connections between habitats, such as field ditches, rock piles, forest edges and streams are important because they allow flora and fauna to move between different spaces, promoting exchange of genetic information between different populations of the same species. Small, isolated populations are less able to survive because they lack the genetic variability needed to adapt to changing conditions such as climate change or disease. These connections all help to strengthen an ecological network, but the cooperation of local authorities and land users, such as farmers and foresters, is required to keep these connecting elements in place.

The project consortium hope to engage policymakers at local, national, regional and international levels in the importance of ecological networks for biodiversity. They are working closely with the Ecological Network Platform[2], the organisation set up under the Alpine Convention, to help achieve its goal of promoting and supporting ecological networks in Alpine regions. The platform's members include representatives from the governments of all Alpine nations.

In the first stage of the project, which has already been completed, experts assessed four different approaches to building ecological networks. The consortium plans to develop their joint methodology based on the outcomes of this assessment. During the early stages, four pilot regions were also established:

1. The Salzburg cross-boundary region on the Germany-Austria border
2. The French Departement Isère
3. The Eastern Austrian region around the Kalkalpen and Gesäuse national parks
4. The Italian Adige Valley and nearby protected areas in Switzerland and Austria.

As well as habitats that can be connected by relatively short passages, these areas cover large scale migration routes such as those for birds and bears. Pilot activities, which will begin in 2009, will involve the creation of new ecological corridors and making sustainable land use agreements with land users.

Source: Kohler, Y., Plassmann, G., Ullrich, A. *et al.* (2008). The Continuum Project: Establishing Ecological Networks throughout the European Alps. *Mountain Research and Development.* 28(2): 168-172.

[1] The Ecological Continuum Project is run by a consortium of four organisations: ALPARC (Alpine Network of Protected Areas), CIPRA (International Commission for the Protection of the Alps), ISCAR (International Scientific Committee on Research in the Alps) and the Alpine Program of WWF. See: http://econet.scnatweb.ch/index.php/initiatives/the-ecological-continuum-project-mainmenu-6

[2] See: www.alpine-ecological-network.org

Community involvement with forest management can boost biodiversity

Forests can act as carbon sinks and help counteract climate change. A study of forestry practices in India shows that involving local communities in conservation efforts can boost the biodiversity and stability of forest ecosystems. Community-based forest management policies may therefore represent valid carbon mitigation strategies.

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"Local communities should be involved in biodiversity conservation as they can provide a source of in-depth local knowledge about the habitat preferences of different species."

The EU aims to reduce its greenhouse gas emissions by more than 20 per cent of 1990 levels by 2020[1]. One way to help achieve this may be to increase the carbon storage potential of forests. However, forest ecosystems are under threat from biodiversity loss caused by climate change and deforestation. The EU's Biodiversity Action Plan[2], launched in 2006, called on member states to recognise the central role of biodiversity in reducing the impact of climate change and to develop programmes to conserve those species and habitats most at risk. Where possible, biodiversity programmes must be designed to increase community involvement in conservation.

In a recent study of forest management practices in India, it is stated that the ongoing community-based forest management (CBFM) programme could strengthen community livelihoods and avoid loss of biodiversity. They could also help to vastly increase the carbon storage potential of Indian forests. The study argues that CBFM of degraded (low carbon) forests to increase their potential carbon storage capacity should be formally recognised as a carbon mitigation strategy and accepted as a way for countries to earn carbon credits.

Conserving a diverse range of species is important because it increases the chance that enough will survive to form the basis of a stable, healthy ecosystem - meaning that, theoretically, at least some species will be able to adapt to their changing environment. Previous research has demonstrated that ecosystems containing higher numbers of different species are more resistant to extreme environmental conditions.

The study suggests that local communities should be involved in biodiversity conservation as they can provide a source of in-depth local knowledge about the habitat preferences of different species. Communities may also be keen to be involved in forest management to gain access to various non-timber products, including valuable resources such as fruits, fodder and handicraft materials which can help alleviate poverty.

CBFM could represent a viable strategy for increasing the carbon storage potential and economic value of forests, particularly in poor countries. It is predicted that emissions from rapidly developing countries such as India will soon begin to counteract the achievements of developed countries in reducing their carbon emissions. As emissions increase due to energy consumption in these countries, other strategies will need to be employed to remove carbon from the atmosphere. Forests as carbon sinks may therefore prove to be valuable resources.

Source: Singh, P.P. (2008). Exploring biodiversity and climate change benefits of community-based forest management. *Global Environmental Change*. DOI: 10.1016/j.gloenvcha.2008.04.006.

[1] See: http://ec.europa.eu/climateaction/index_en.htm
[2] See: http://ec.europa.eu/environment/nature/knowledge/rep_biodiv_ap/index_en.htm

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Recent Biodiversity articles from the *Science for Environment Policy* News Alert

The global cost of biodiversity loss: 14 trillion Euros? (4/9/08)

Although some success has been achieved in meeting the global target of reducing the rate of loss of biodiversity by 2010, a new report suggests that biodiversity will continue to decline, adversely affecting the health of associated ecosystems. By not meeting the 2010 targets, the report estimates the cumulative loss of biodiversity and associated ecosystem services between 2000 and 2050, could be equivalent to 7 per cent of the 2050 world Gross Domestic Product (GDP).

Increasing plant diversity: the answer to climate change adaptation? (4/9/08)

Extreme weather events are expected to increase in frequency and magnitude as the global climate changes. The effect of this on plant productivity in Europe is largely unknown. Researchers have recreated extreme weather conditions in isolated plots to assess the impact on plant productivity. They found that the response of plants to the conditions depended on the diversity within a plant community.

Planning for the inevitable: the impact of climate change on biodiversity (17/7/08)

Climate change is already having an impact on habitats and species in Europe, for example a decrease in plant species has been recorded in some areas. According to recent research, spatial planning is a key concept in making European ecosystems more resilient to climate change, as it takes into account all factors that affect a habitat, including economic development, transport, environmental protection, health and culture.

Motorway verges can contribute to biodiversity (9/7/08)

Motorway verges (strips of land running along the edge of the road) have been found to play a crucial role in maintaining the richness of biodiversity in intensive agricultural landscapes, according to recent research. A mixed area of both planted hedgerows and open grassland was found to provide the best habitat for encouraging biodiversity in both plants and spiders.

Reducing tourists' damage to ecosystems (5/6/08)

Large numbers of people visiting sites of special interest can potentially damage these protected places. New research suggests a method to determine the most suitable tourist routes through these areas, which preserves the biodiversity of the site by minimising the harmful impact caused by tourists.

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