International Day for Biological Diversity

Biodiversity and Climate Change

CBD
Convention on Biological Diversity

UNEP

PREFACE BY THE EXECUTIVE SECRETARY

The United Nations General Assembly proclaimed May 22 the International Day for Biological Diversity (IBD) to increase understanding and awareness of biodiversity issues. The theme for IBD 2007 is "Climate Change and Biological Diversity." The theme coincides with the fact that 2007 is the International Polar Year.

The cover image on this brochure captures the most emblematic impact of climate change and consequent biodiversity loss in the whole of Africa - the melting of the Mount Kilimanjaro glaciers on the border of Tanzania and Kenya. Although the snow and ice cover of the mountain has been shrinking for more than a hundred and fifty years, it has accelerated in recent decades due to higher temperatures and less precipitation. It is widely anticipated that the remaining glacier will disappear entirely within 20 years.

The rich variety of life on Earth has always had to deal with a changing climate. The need to adapt to new patterns of temperature and rainfall has been a major influence on evolutionary changes that produced the plant and animal species we see today. Variation in the climate is perfectly compatible with the survival of ecosystems and their functions, on which we each depend for the essentials of life. Yet, according to the Millennium Ecosystem Assessment (MA) published last year, climate change now poses one of the principal threats to the biological diversity of the planet, and is projected to become an increasingly important driver of change in the coming decades.

There are several reasons why plants and animals are less able to adapt to the current phase of global warming. One is the very rapid pace of change: it is anticipated that over the next century, the rise in average global temperatures will be faster than anything experienced by the planet for at least 10,000 years. Many species will simply be unable to adapt quickly enough to the new conditions, or to move to regions more suited to their survival.

Equally important, the massive changes humans have made to the landscape, river basins and oceans of the world have closed off survival options previously available to species under pressure from a changing climate. There are other human-induced factors as well. Pollution from nutrients such as nitrogen, the introduction of alien invasive species and the over-harvesting of wild animals through hunting or fishing can all reduce the resilience of ecosystems, and thus the likelihood that they will adapt naturally to climate change.

This has major implications not just for the variety of life on our planet, but also for the livelihoods of people around the world. As the MA showed, the rural poor are especially vulnerable to the loss of essential services when an ecosystem becomes degraded. The formation of soils suitable for crop-growing, the availability of medicinal plants, the provision of fresh water and the income gained from ecotourism, for example, are all underpinned by the web of life and the interaction of species ranging from the smallest micro-organisms to the largest predators. The loss of these services has a devastating impact for the poor, who

have no other options at their disposal. As policymakers from around the world seek ways to help the poorest to adapt to climate change priority must be given to the role of biodiversity, an element often neglected from current adaptation strategies.

Designing, funding and implementing these strategies requires cooperation and coordination at the global level. In this respect, the Convention on Biological Diversity is working closely with the United Nations Framework Convention on Climate Change and with the United Nations Convention to Combat Desertification. Such cooperation can ensure the proper design and implementation of policies aimed at improving adaptation to climate change.

The overall message for this year's celebration of the International Day for Biological Diversity is clear. If the threats of biodiversity loss and climate change are tackled together, the prospects for adapting successfully to the challenges of the coming decades will be very much improved. As we celebrate this day on 22 May, I call upon all citizens of the world to ensure that we take the necessary steps to facilitate the adaptation of biodiversity to a changing climate, and therefore ensure the livelihoods of the poorest of the poor.

In closing, I want to give my heartfelt thanks to the government of Norway, for their generous financial assistance in the preparation, translation and distribution of this brochure. Their support has made it possible for us to share this call for action to save all life on Earth.

Ahmed Djoghlaf
Executive Secretary

BIODIVERSITY,

the term given to the variety of life on Earth, provides, through its expression as ecosystems, goods and services that sustain our lives. Human pressures on ecosystems are causing changes and losses at rates not seen historically. People are changing ecosystems more rapidly and more extensively than over any other period in human history. Climate change adds yet another pressure on natural ecosystems.

According to the Millennium Ecosystem Assessment, a comprehensive assessment of the links between ecosystem health and human well-being, climate change is likely to become the dominant direct driver of biodiversity loss by the end of the century. Projected changes in climate, combined with land use change and the spread of exotic or alien species, are likely to limit the capability of some species to migrate and therefore will accelerate species loss.

The impacts of climate change on biodiversity are of major concern to the Convention on Biological Diversity (CBD). The Convention also recognizes that there are significant opportunities for mitigating climate change and adapting to it, while enhancing the conservation of biodiversity.

In an effort to draw attention to the mounting threats and opportunities, the CBD is calling on the nations of the world to celebrate the International Day for Biological Diversity on 22 May 2007 under the theme “climate change and biodiversity”.

In this booklet, we highlight some of the causes of climate change and its impacts on biodiversity, as well as the various links between biodiversity and climate change. We also present the major climate change threats that are specific to various ecosystems, as well as the opportunities for mitigation and adaptation.

Petrochemical plant, Texas, US.
Photo courtesy of Cheryl Empey

FACING CLIMATE CHANGE

In the atmosphere, gases such as water vapour, carbon dioxide, ozone, and methane act like the glass roof of a greenhouse by trapping heat and warming the planet. These gases are called greenhouse gases. The natural levels of these gases are being supplemented by emissions resulting from human activities, such as the burning of fossil fuels, farming activities and land-use changes. As a result, the Earth's surface and lower atmosphere are warming. Even small rises in temperature are accompanied by many other changes. Rising levels of greenhouse gases are already changing the climate.

Observed changes

Since the mid-1800s, the average global temperature increased by about 0.6 degrees C, impacting the entire world. For example, during the 20th century[1]:

- global mean sea level rose by 10 to 20 cm,
- the overall volume of glaciers in Switzerland decreased by two-thirds[2],
- Arctic ice thickness in late summer and early autumn decreased by about 40%, and
- Mount Kenya lost 92% of its ice mass while Mount Kilimanjaro lost 82%.

Other significant observed changes include:

- a 40-60% decrease in total available water in the large catchment basins of Niger, Lake Chad and Senegal,
- the retreat of 70% of sandy shorelines, and
- a northward movement of some 100 km of Alaska's boreal forest for every 1 degree C rise in temperature.

The recently extinct golden toad and Monteverde harlequin frog have already been labeled as the first victims of climate change[3].

Moreover, current climate change has already made "refugees" of two communities. The Lateu settlement, located in the Pacific island chain of Vanuatu, and the Shishmaref village, located on a small island in Alaska, were recently relocated—the former to escape rising sea levels, the latter degrading permafrost—as a result of current and future climate change impacts.

[1] McCarthy, J. J., O. F. Canziani, N. A. Leary, D. J. Dokken and K. S. White. 2001. Climate Change 2001: Impacts, Adaptation, and Vulnerability. IPCC, Cambridge University Press, UK.

[2] UNFCCC. Feeling the Heat, accessed online at http://unfccc.int/essential_background/feeling_the_heat/items/2918.php

[3] Pounds, J. A., Fogden, M. P. L. and Campbell, J.H. 1999. Ecology: Clouded futures. Nature 398: 611-615.

What changes might we expect in the future?

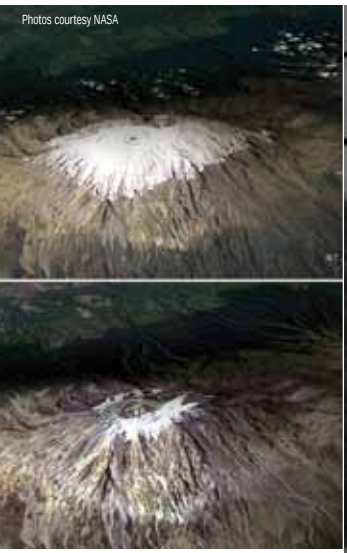
Computer models predict an average global temperature increase of 1.4 to 5.8 degrees C by the year 2100. Predicted impacts associated with such a temperature increase include[4]:

- a further rise in global mean sea level of 9 to 88 cm,
- more precipitation in temperate regions and Southeast Asia, associated with a higher probability of floods,
- less precipitation in Central Asia, the Mediterranean region, Africa, parts of Australia and New Zealand, associated with a greater probability of droughts,
- more frequent and powerful extreme climatic events, such as heat waves, storms, and hurricanes,
- an expanded range of some dangerous “vector-borne diseases”, such as malaria, and
- further warming of the Arctic and Antarctic, leading to more sea-ice disappearance.

Why act now?

Climate change is already a reality. Even if all anthropogenic emissions were to stop now, changes would continue into the future. We must, therefore, increase climate change mitigation and adaptation efforts.

[4] McCarthy, J. J., O. F. Canziani, N. A. Leary, D. J. Dokken and K. S. White. 2001. Climate Change 2001: Impacts, Adaptation, and Vulnerability. IPCC, Cambridge University Press, UK.



Mount Kilimanjaro (above) is estimated to have lost 82% of its ice mass during the 20th century. Top picture February 17,1993; bottom picture February 21, 2000.
Car emissions (right) are considered to be a major source of greenhouse gases.

Although ecosystems have adapted to changing conditions in the past, current changes are occurring at rates not seen historically. In general, the faster the climate changes, the greater the impact on people and ecosystems. Reductions in greenhouse gas emissions can lessen these pressures, giving these systems more time to adapt.

In addition to mitigation, however, there is an urgent need to develop and implement climate change adaptation plans. People and the natural environment have become particularly vulnerable to the impacts of climate change. Indeed, activities that lead to the degradation of the environment, such as deforestation and overgrazing, can exacerbate the consequences of climate change. In many countries, more people, particularly those at lower income levels, are now forced to live in exposed and marginal areas (i.e. floodplains, exposed hillsides, arid or semi-arid lands), putting them at risk to the negative impacts of climate change. For these people, even minor changes in climate can have a disastrous impact on lives and livelihoods. The same can be said of many species, which are adapted to very specific climatic conditions. A small change in these conditions could mean that we lose these species forever. While there is still more to understand about climate change, enough is known about the range of impacts, the magnitude of risks, and the potential for adaptation to act now.

Many species are uniquely adapted to very specific climatic conditions whereby small changes can mean that we lose these species forever. The golden toad has not been seen since 1989, and is believed to be extinct (UNEP-WCMC Species Sheet (February, 2002) http://www.unep-wcmc.org/species/factsheets/toad/sheet.htm)

INTER-LINKAGES BETWEEN BIODIVERSITY AND CLIMATE CHANGE

The links between biodiversity and climate change run both ways: biodiversity is threatened by climate change, but proper management of biodiversity can reduce the impacts of climate change.

In the Arctic, shorter periods of sea ice coverage endanger the polar bear's habitat and existence by giving them less time to hunt.

Climate fluctuations in North America reduce plankton populations, the main source of food of the North Atlantic right whale. Only about 300 individuals remain at present and the reduced availability of food due to climate change is becoming an increasing cause of mortality.

Warmer temperatures in the Pacific regions could reduce the number of male sea turtle offspring and threaten turtle populations. The sex of sea turtle hatchlings is dependent on temperature, with warmer temperatures increasing the number of female sea turtles.

Climate change: a threat to biodiversity

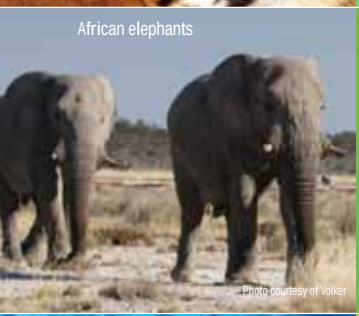
There is evidence that climate change is already affecting biodiversity and will continue to do so. The Millennium Ecosystem Assessment ranks climate change among the main direct drivers affecting ecosystems. Consequences of climate change on the species component of biodiversity include:

- changes in distribution,
- increased extinction rates,
- changes in reproduction timings, and
- changes in length of growing seasons for plants.

Some species that are already threatened are particularly vulnerable to the impacts of climate change. The following are examples of species and of their vulnerabilities[5].

Since frogs rely on water to breed, any reduction or change in rainfall could reduce frog reproduction. Moreover, rising temperatures are closely linked to outbreaks of a fungal disease that contributes to the decline of amphibian populations, especially frogs in Latin America.

Some of the largest remaining areas where tigers occur are the mangrove forests of Asia. The projected rise in sea levels could cause the disappearance of the tigers' habitat, threatening the survival of the species.



In Africa, pressures from longer dry periods and shrinking living spaces are making elephants highly vulnerable to climate change.

Australia's Great Barrier Reef could lose up to 95% of its living coral by 2050 due to changes in ocean temperature and chemistry.

[5] WWF. Climate Change. Nature at risk. Threatened species, accessed online at *http://www.panda.org/about_wwf/what_we_do/climate_change/problems/impacts/species/index.cfm*

Biodiversity: to reduce the impacts of climate change

The resilience of ecosystems can be enhanced and the risk of damage to human and natural ecosystems reduced through the adoption of biodiversity-based adaptive and mitigative strategies. Mitigation is described as a human intervention to reduce greenhouse gas sources or enhance carbon sequestration, while adaptation to climate change refers to adjustments in natural or human systems in response to climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities[7].

Examples of activities that promote mitigation of or adaptation to climate change include[8]:

- maintaining and restoring native ecosystems,
- protecting and enhancing ecosystem services,
- managing habitats for endangered species,
- creating refuges and buffer zones, and
- establishing networks of terrestrial, freshwater and marine protected areas that take into account projected changes in climate.

[6] Any process, activity or mechanism that removes a greenhouse gas, an aerosol, or a precursor of a greenhouse gas or aerosol from the atmosphere.

[7,8] Ad hoc Technical Expert Group on Biological Diversity and Climate Change. 2003. CBD Technical Series No.10, Secretariat of the Convention on Biological Diversity. Guidelines for promoting synergy among activities addressing biological diversity, desertification, land degradation and climate change. CBD Technical Series No. 25, Secretariat of the Convention on Biological Diversity.

Polar Ecosystems

Photo by istockphoto.com

Polar ecosystems are home to an array of plants and animals that survive in some of the most extreme conditions in the world. The seas surrounding the Antarctic are rich in plankton, which support a rich marine food chain, while the Arctic supports many mammals and has an important role in the annual cycle of migratory birds. The biodiversity of the Arctic is fundamental to the livelihoods of Arctic peoples.

Vulnerability to climate change

Polar regions are now experiencing some of the most rapid and severe climate change on Earth, which will contribute to environmental and socio-economic changes, many of which have already begun.

Polar regions are highly vulnerable to climate change because:

- During the 20th century, Arctic air temperatures increased by approximately 5 degrees C. This increase is ten times faster than the observed global-mean surface temperature.
- An additional warming of about 4-7 degrees C in the Arctic is predicted for the next 100 years[9].
- Polar species and societies have developed very specialized adaptations to the harsh conditions found at the poles, thus they are extremely vulnerable to dramatic changes in these conditions.
- Low resilience to changing environmental parameters, including fluctuations of air temperatures and precipitation dynamics.


Svalbard glacier, Norway.

Photo courtesy of Amanda Graham


Polar bear with cubs, Canada

About Yukon White Light / Amanda Graham/www.flickr.com

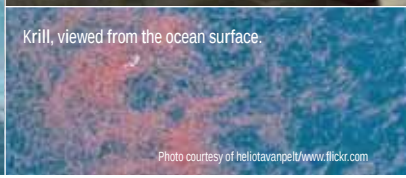

Krill, viewed from the ocean surface.

Photo courtesy of heliotavanpelt/www.flickr.com

[9] Hassol, S.J. 2004. Impacts of a warming Arctic. Arctic Climate Impact Assessment (ACIA). Cambridge University Press, UK.

Observed and projected impacts

Walruses, polar bears, seals and other marine mammals that rely on sea ice for resting, feeding and breeding are particularly threatened by climate change.

For example, studies reveal that in 1980, the average weight of female polar bears in western Hudson Bay, Canada, was 650 pounds. In 2004, their average weight was only 507 pounds. It is believed that the progressively earlier breakup of the Arctic sea ice is responsible for the fall in the polar bears' average weight[10].

Reduced sea-ice extent is also believed to have caused a 50% decline in emperor penguin populations in Terre Adélie[11].

Populations of krill and other small organisms may also decline as ice recedes. Due to the high importance of krill in food chains, the entire marine food web could be adversely affected.

The livelihood of indigenous people in the Arctic is already being affected by climate change. Losses in biodiversity affect the traditional practices of indigenous people, particularly fishing and hunting. For example, the Saami people have observed changes in reindeer grazing pastures, and the Inuit people of Canada have observed reductions in the ringed seal population, their single most important source of food.

Walrus, Alaska, US

Photo courtesy of NOAA

One of the few remaining Inuit drum dancers in Greenland.

Photo by Nick Russill

Inuit fishing for Tom Cod, Alaska.

Photo courtesy of US Fish and Wildlife Service

Emperor penguins on the Brunt Ice Shelf off the coast of Antarctica.

Photo courtesy of Bryn Jones

[10] NASA, Goddard Space Flight Center. 2006. Warming Climate May Put Chill on Arctic Polar Bear Population, accessed online at http://www.nasa.gov/centers/goddard/news/topstory/2006/polar_bears.html

[11] Ad hoc Technical Expert Group on Biological Diversity and Climate Change. 2003. CBD Technical Series No.10, Secretariat of the Convention on Biological Diversity.

Contribution to climate change

The warming of polar regions has repercussions in the rest of the world. Indeed, melting of highly reflective snow and ice uncovers darker land and ocean surfaces, increasing absorption of the sun's heat and further warming the planet. Moreover, snow and ice melt raises global sea level. The melting of ice sheets in Antarctica and Greenland is estimated to account for one third of the sea level rise[12]. This addition of fresh water in the ocean is also slowing ocean circulation, affecting global and regional climate.

Adaptation options

The reduction of other stressors, such as permafrost degradation, chemical pollution, overfishing, land-use changes, and habitat fragmentation could improve polar ecosystems' resilience to climate change.

Adaptation activities can make use of local and indigenous knowledge and participation. Indeed, indigenous people can contribute to the understanding of changes in the Arctic through their observations and perspectives on changes in biodiversity and ecosystem functioning.

For example, the Inuvialuit Hunters and Trappers in Canada's High Arctic, along with the International Institute for Sustainable Development (IISD), initiated a year-long project to document Arctic climate change and communicate it to Canadian and international audiences. During the initiative, a video and several scientific journal articles were produced to communicate the negative impacts of climate change observed in the Arctic and to understand the adaptive strategies that local people are using in response[13].

Brunt Ice Shelf, Antarctica.

Photo courtesy of Bryn Jones

Geddes and Lena Wolki explain how the lack of sea-ice in the summer is making it difficult for the community to hunt seals for food. Terry Woolf and Lawrence Rogers capture the interview on video.

Photo courtesy of Neil Ford/ IISD

[12] British Antarctic Survey. Natural Environment Survey. The Antarctic ice sheet and rising sea levels-Is Antarctica melting due to global warming?, accessed online at http://www.antarctica.ac.uk/Key_Topics/IceSheet_SeaLevel/index.html

[13] International Institute for Sustainable Development (IISD). Inuit Observations on Climate Change, accessed online at http://www.iisd.org/casl/projects/inuitobs.htm

Agricultural Ecosystems

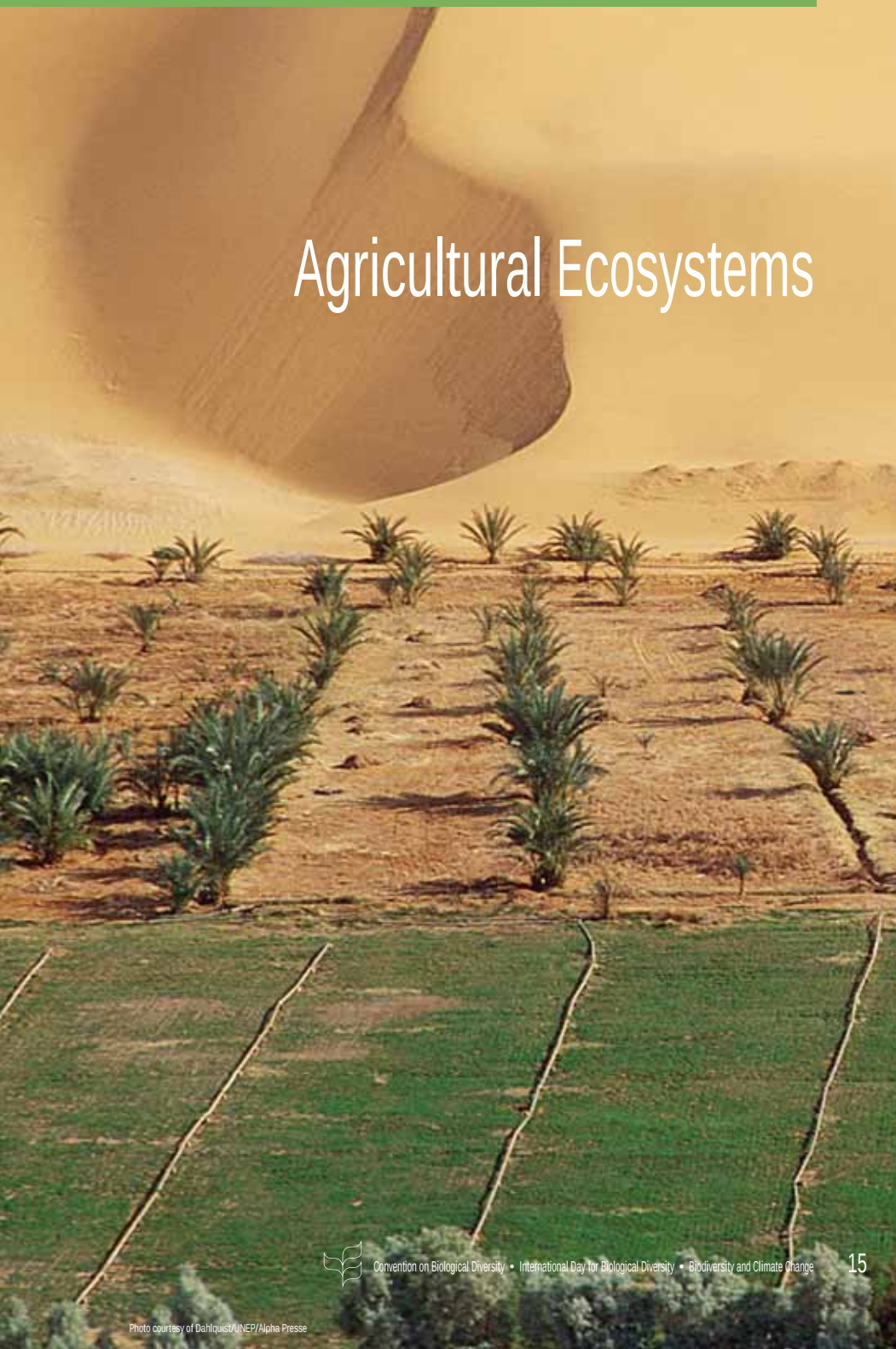


Photo courtesy of Dahlquist/UNEP/Alpha Presse

One third of the world's land area is used for food production and agricultural ecosystems can be found in almost every part of the world. As such, the impacts of climate change on agricultural biodiversity will be extensive and varied.

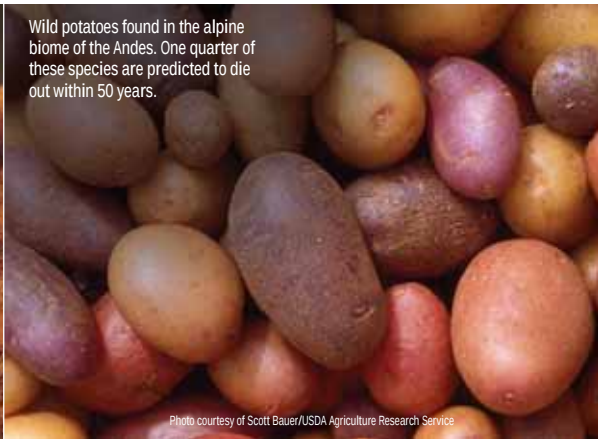
Vulnerability to climate change

Rapid population growth has led to a change from traditional to intensive agricultural systems. About 7,000 plant species have been cultivated for food since agriculture began about 12,000 years ago. Today, however, only about 15 plant species and eight animal species supply 90% of our food. Many traits incorporated into these modern crop varieties were introduced from wild relatives, improving their productivity and tolerance to pests, disease and difficult growing conditions. Wild relatives of food crops are considered an insurance policy for the future, as they can be used to breed new varieties that can cope with the changing conditions.

Unfortunately, many wild races of staple food crops are endangered. For example, one quarter of all wild potato species are predicted to die out within 50 years, which could make it difficult for future plant breeders to ensure that commercial varieties can cope with a changing climate.

Wheat field, Canada

Photo courtesy of Cameron/UNEP/Alpha Presse



Wild potatoes found in the alpine biome of the Andes. One quarter of these species are predicted to die out within 50 years.

Photo courtesy of Scott Bauer/USDA Agriculture Research Service

Observed and projected impacts

Climate change may affect plant growth and production by promoting the spread of pests and diseases. Other expected impacts include:

- increased exposure to heat stress,
- changes in rainfall patterns,
- greater leaching of nutrients from the soil during intense rains,
- greater erosion due to stronger winds, and
- more wildfires in drier regions.

The added heat stress and drier soils may reduce yields by as much as one third in the tropics and subtropics, where crops are already near their maximum heat tolerance[14].

Contribution to climate change and mitigation options

Agriculture also contributes to climate change. Indeed, land-use changes, flooding areas for rice and sugarcane production, burning crop residues, raising ruminant animals, and using nitrogen fertilizers are all activities that release greenhouse gases into the atmosphere.

Global agriculture is now estimated to account for about 20% of total anthropogenic emissions of greenhouse gases[15]. Therefore, activities should be undertaken to reduce emissions of greenhouse gases. Examples of such activities include:

Pivot irrigation on cotton field, US.

Photo courtesy of USDA

Rice paddies, Bali, Indonesia.

Photo courtesy of Peter Garnhum/www.flickr.com

[14, 15] UNEP. Climate Change Information Sheets, accessed online at http://www.unep.org/dec/docs/info/ccinfokit/infokit-2001.pdf

- better management of agricultural soils,
- improving efficiency of fertilizer use,
- restoring degraded agricultural lands, and
- improving rice farming to reduce methane emissions.

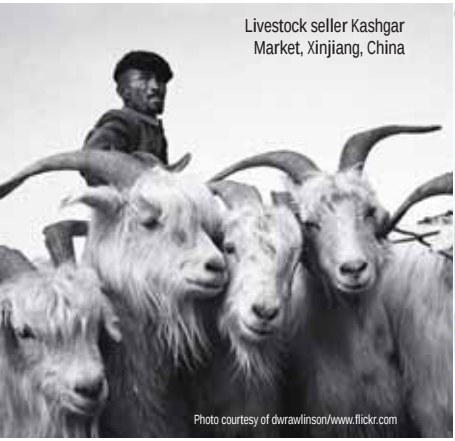
Agricultural soils also have a potential for sequestering carbon. Improved management practices could enable agricultural soils to absorb and hold more carbon. Suggested strategies include the use of crop residues and low- or no-tillage practices.

Adaptation options

The *in situ* and *ex situ* conservation of crop and livestock genetic resources is important for maintaining options for future agriculture needs.

In situ conservation of agricultural biodiversity is defined as the management of a diverse set of crop populations by the farmers in the ecosystem where the crop evolved. It allows the maintenance of the processes of evolution and adaptation of crops to their environment. *Ex situ* conservation involves the conservation of species outside their natural habitat, such as in seed banks and greenhouses.

The conservation of the components of agricultural ecosystems that provide goods and services, such as natural pest control, pollination, and seed dispersal, should also be promoted. Indeed, 35% of the world's crop production is dependent on pollinators such as bees, birds and bats.



Livestock seller Kashgar Market, Xinjiang, China

Photo courtesy of dwrawlinson/www.flickr.com

35% of the world's crop production is dependent on pollinators such as bees, birds and bats.

Photo courtesy of Rodolfo Clix

Dry and Sub-humid Lands Ecosystems

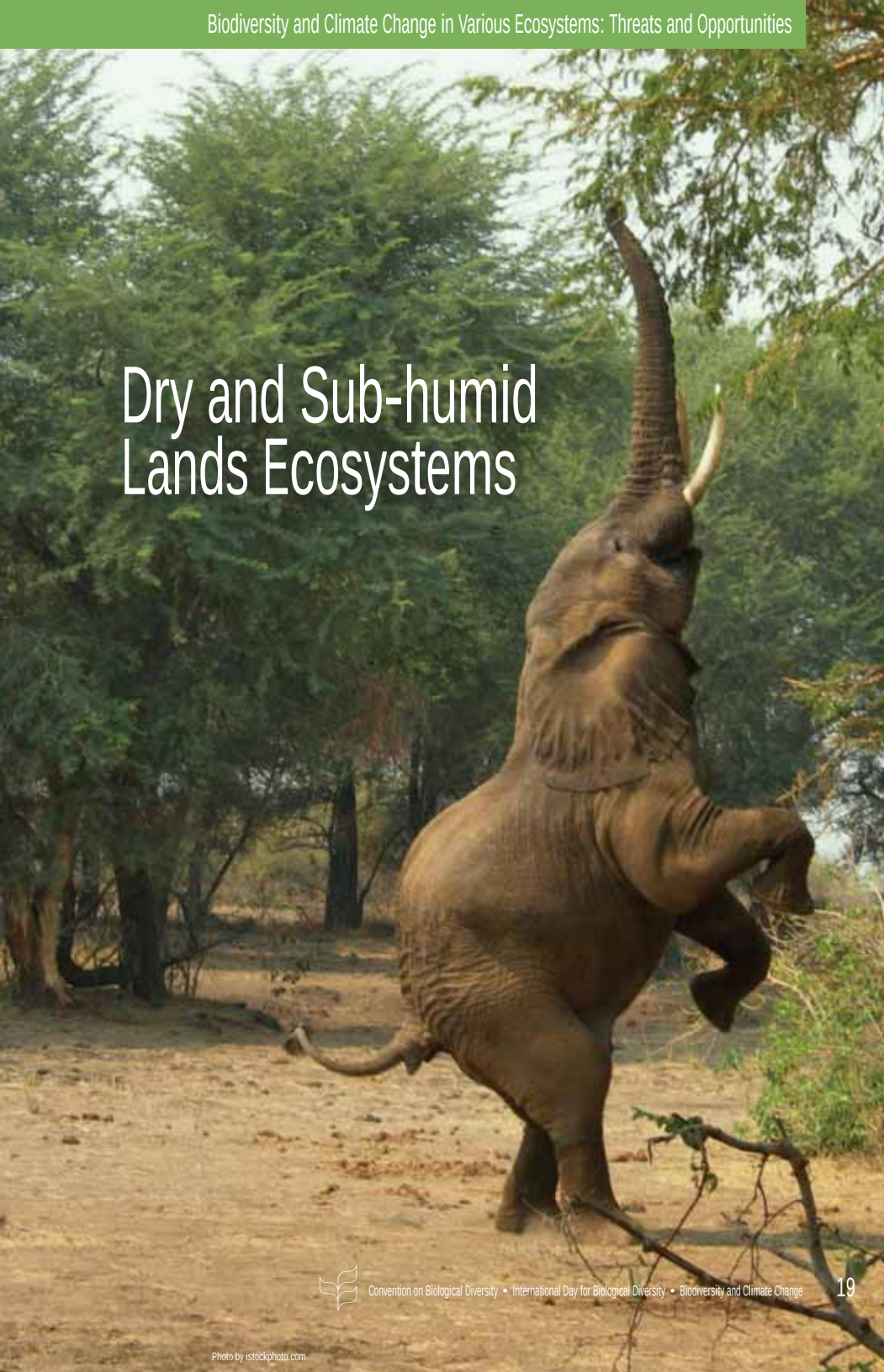


Photo by istockphoto.com

Dry and sub-humid lands, including arid and semi-arid areas, grasslands, savannahs, and Mediterranean landscapes, are home to 2 billion people (35% of the global population). These lands have great biological value and are home to many of the world's food crops and livestock.

Vulnerability to climate change

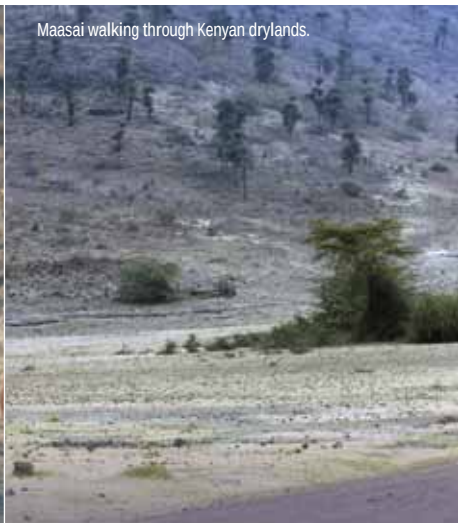
Drylands are particularly vulnerable to climate change because:

- Small changes in temperature and rainfall patterns can have serious impacts on the biodiversity of dry and sub-humid lands.
- Drylands are already under stress from various activities, including conversion to agriculture, the introduction of invasive species, alterations to fire regimes, and pollution.

The impacts of climate change on drylands may have significant repercussions on populations and economies. Many people are highly dependent on drylands biodiversity. For example, about 70% of Africans depend directly on dry and sub-humid lands for their daily livelihoods.

Women with water, Rajasthan, India. Balancing human and wildlife needs for fresh water is essential to dry and sub-humid lands adaptation to climate change.

Photo courtesy of Michael Martin, Germany



Maasai walking through Kenyan drylands.

Observed and projected impacts

Deserts are projected to become hotter and drier. Higher temperatures could threaten organisms that are already near their heat-tolerance limits. For example, climate change is likely to have serious impacts on the Succulent Karoo, the world's richest arid hotspot, located in the southwestern part of South Africa and southern Namibia. This very sensitive region is highly affected by climate.

Changes in rainfall patterns could also have serious impacts on drylands biodiversity. Climate change could increase the risk of wildfires, which could change the species composition and decrease biodiversity.

Adaptation options

Water is a limiting factor in drylands, and changes in water availability can have disproportionate effects on biodiversity. Hence, balancing human and wildlife needs for fresh water is essential to dry and sub-humid lands adaptation to climate change. This can be achieved through sustainable and efficient management of water resources. Another adaptation strategy consists of restoring degraded lands.

Photo by istockphoto.com

Lace Cactus, Mexico.

Photo courtesy of Franz Dejo/CBD

Forest Ecosystems

Forests cover a third of the Earth's surface, and are estimated to contain as much as two thirds of all known terrestrial species[16]. Forest ecosystems also provide a wide array of goods and services.

In the last 8,000 years, about 45% of the Earth's original forest cover has been converted. Most of it was cleared during the past century.

Vulnerability to climate change

Forests are particularly vulnerable to climate change because:

- Even small changes in temperature and precipitation can have significant effects on forest growth. It has been shown that an increase of 1 degree C in the temperature can modify the functioning and composition of forests[17].
- Many forest-dwelling large animals, half of the large primates, and nearly 9% of all known tree species are already at some risk of extinction[18].
- Woody tree species are less able to shift poleward with changing climatic conditions.

Observed and projected impacts

Growth in some forests may initially increase as carbon dioxide concentrations rise. However, climate change may force species to migrate or shift their ranges far faster than they are able to. Some species may die off as a result. For example, in Canada, it is unlikely that white spruce populations will be able to migrate at a rate matching the pace of climate change.

Moreover, forests could become increasingly threatened by pests and fires, making them more vulnerable to invasive species. For example, in England,

A US forest in autumn. Even small changes in temperature and precipitation can have significant effects on forest growth and survival.

Photo courtesy of UNEP/Alpha Presse

[16] FAO (Food and Agriculture Organization of the United Nations). 2000. State of the World's forests 1997. FAO, Rome, Italy.
[17] UNEP. Climate Change Information Sheets, accessed online at http://www.unep.org/dec/docs/info/ccinfokit/infokit-2001.pdf
[18] World Resources Institute (WRI). 2000. World Resources 2000-2001- People and ecosystems: The fraying web of life.

insect pests that were previously unknown to the region because they would not have survived the winter frosts have been observed.

Contribution to climate change and mitigation options

The conservation of forests is particularly important since they contain 80% of all the carbon stored in terrestrial vegetation. Deforestation and land-clearing activities emit about 1.7 billion metric tons of carbon per year into the atmosphere. Hence, the conservation of forests offers important opportunities to protect biodiversity and slow climate change.

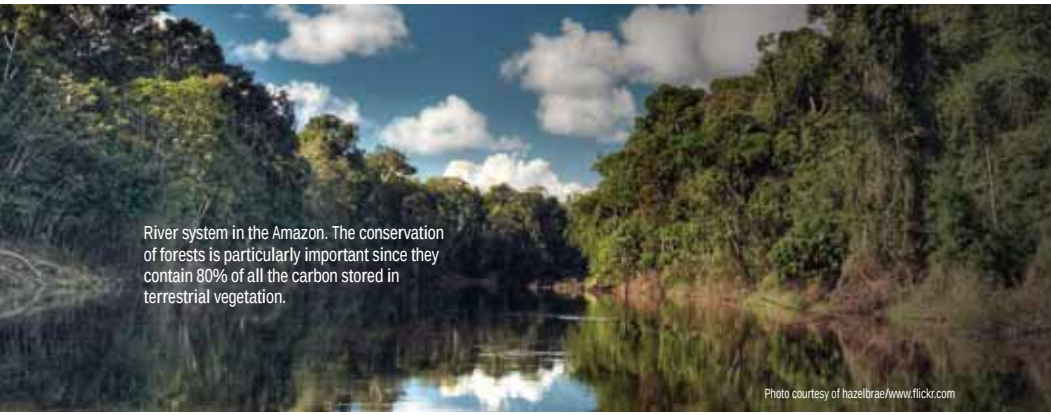
In addition, afforestation and reforestation can be used to enhance carbon sinks and reservoirs. Afforestation is defined as the direct human-induced conversion of land that either has not been forested for a period of at least 50 years or that has never been forested to forested land through planting, seeding, and/or the human-induced promotion of natural seed sources. Reforestation refers to the replanting, seeding and/or the human-induced promotion of natural seed sources on land that was forested within the past 50 years.

Adaptation options

Reducing the vulnerabilities forests currently face can help build resilience against climate change impacts.

Other activities that can increase resilience to climate change include:

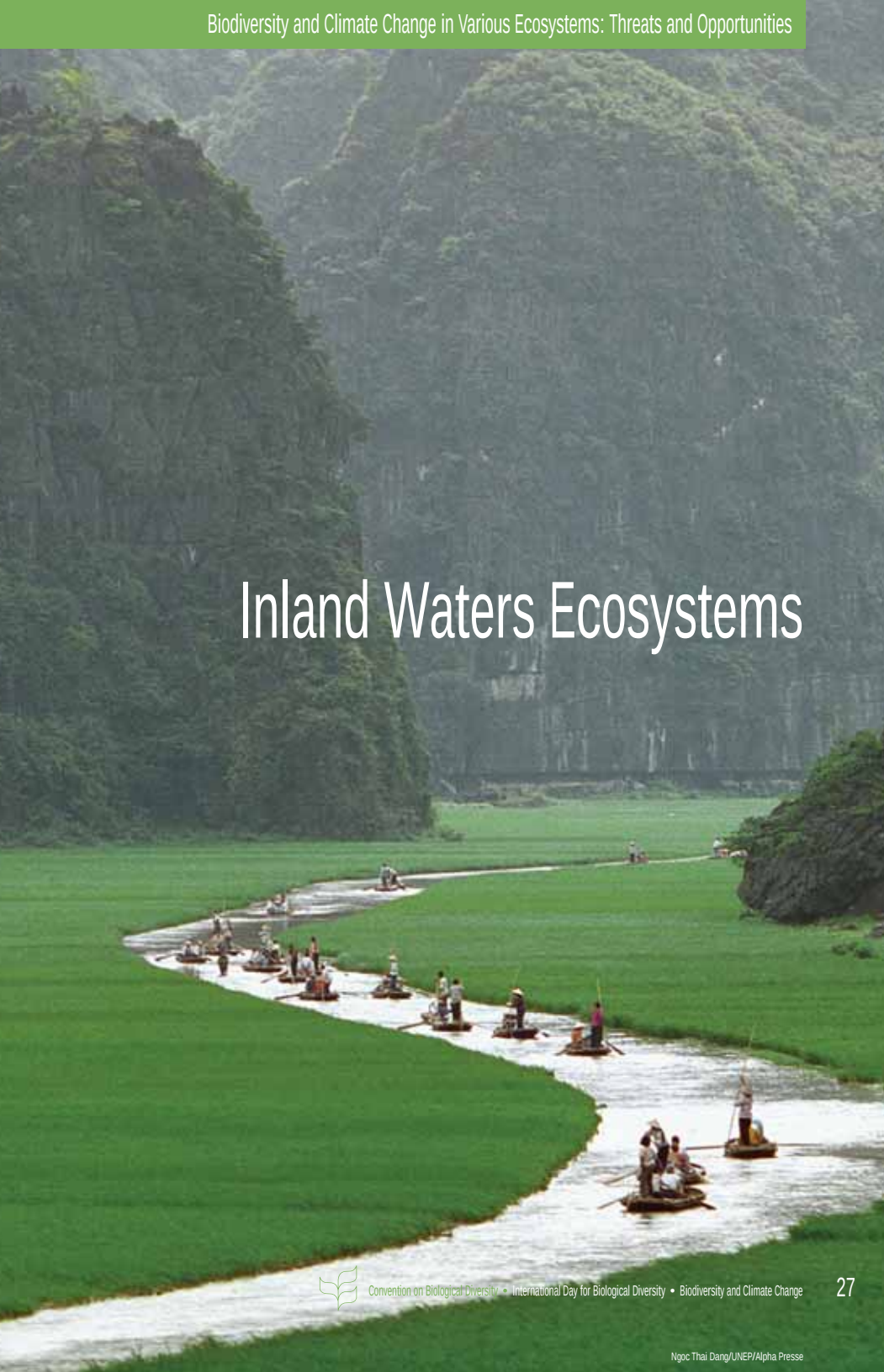
- avoiding habitat fragmentation,
- preventing conversion to plantations, and
- practicing low-intensity forestry.



River system in the Amazon. The conservation of forests is particularly important since they contain 80% of all the carbon stored in terrestrial vegetation.

Photo courtesy of hazelbrae/www.flickr.com

Inland Waters Ecosystems



Ngoc Thai Dang/UNEP/Alpha Presse

Inland water systems can be fresh or saline within continental and island boundaries. Inland waters are rich ecosystems. For example, fresh water makes up only 0.01% of the world's water and approximately 0.8% of the Earth's surface, yet it supports at least 100,000 species (almost 6% of all described species)[19].

Biodiversity of inland waters is an important source of food, income and livelihood. Other values of these ecosystems include: maintenance of hydrological balance, retention of nutrients and sediments, and provision of habitats for various flora and fauna.

Vulnerability to climate change

Inland water ecosystems are likely to be negatively affected by climate change because:

- More than 20% of the world's freshwater fish species have become extinct, threatened or endangered in recent decades. Freshwater species are experiencing declines in biodiversity far greater than those in most terrestrial ecosystems.
- Changing rainfall and melt patterns will result in changing flow regimes in many rivers and lakes. This will affect the spawning and feeding habits of many species.
- Human responses to climate change could exacerbate the negative impacts on many wetlands. For example, human responses to a warmer climate are likely to increase demand of fresh water to meet urban and agricultural needs. Likely results will be decreased flow in rivers and streams, causing a loss of ecosystem services.

Observed and projected impacts

Climate-related changes in the hydrological regime will affect inland water ecosystems. Responses of lakes and streams to climate change include:

Men fishing with nets, Asia. Changing rainfall and melt patterns will result in changing flow regimes in many rivers and lakes, affecting the spawning and feeding habits of many species.

Photo courtesy of UNEP/Alpha Presse

[19] Dudgeon, D. et al. 2006. Freshwater biodiversity: importance, threats, status and conservation challenges. Biological Research 81 pp. 163-182

- warming of rivers,
- reductions in ice cover,
- altered mixing regimes,
- alterations in flow regimes, and
- greater frequencies of extreme events, including flood and drought.

These responses are likely to lead to:

- changes in growth, reproduction, and distribution of lake and stream biodiversity,
- the poleward movement of some organisms, and
- changes in the reproduction of migratory birds that depend on lakes and streams for their breeding cycle.

Contribution to climate change and mitigation options

Wetlands are the world's primary carbon sequestration mechanism, especially in the peatlands of the boreal regions, and tropical peat swamps and forests. Draining and drying these can release both carbon dioxide and methane, adding to the level of greenhouse gases[20].Actions that avoid degradation of these wetlands, and thus the potential release of greenhouse gases, are beneficial mitigation options.

Adaptation options

Specific wetland management can help reduce non-climate pressures on wetlands (e.g, reduction of fragmentation of inland water habitats, reduction of land-based pollution). Wetlands can also be restored or created.


Uros Boatman, Lake Titicaca, Peru

Photo courtesy of Gaethlich/ UNEP/Alpha Presse


Flamingos in Lake Nakuru, Kenya.

Photo courtesy of Joe Barbosa/www.flickr.com

[19] Dudgeon, D. et al. 2006. Freshwater biodiversity: importance, threats, status and conservation challenges. Biological Research 81 pp. 163-182

Island Ecosystems

Islands are often characterized by a very rich biodiversity, upon which local people rely economically. Island ecosystems are also very fragile. An estimated 75% of animal species and 90% of bird species that have become extinct since the 17th century are insular. Furthermore, 23% of island species are at present considered endangered, whereas the corresponding figure for the rest of the world is 11%[21].

Vulnerability to climate change

Island ecosystems are especially vulnerable to climate change because:

- Island species populations tend to be small, localized, and highly specialized, and thus can easily be driven to extinction[22].
- Coral reefs, which provide a number of services to island people, are highly sensitive to temperature and chemical changes in seawater.

In addition, small island developing States are particularly vulnerable to climate change because of their physical, socio-political and economic characteristics. For example, in the Maldives, 50 to 80% of the land area is less than 1 metre above sea level[23]. Any storm or rise in sea level has direct negative impacts on the population and ecosystems of such islands.

Yasawa Islands, Fiji. The main threat to island ecosystems is the observed and projected rise in sea level.

Photo courtesy of David Solis Matus

[21] INSULA, International Journal of Island Affairs. 2004. Island Biodiversity: Sustaining life in vulnerable ecosystems.

[22] UNESCO. Sustainable Living in Small Island Developing States. Biological Diversity, accessed online at http://portal.unesco.org/en/ev.php-URL_ID=11735&URL_DO=DO_TOPIC&URL_SECTION=201.html

[23] UNFCCC. 2005. Climate Change, small island developing States. Bonn, Germany.

Observed and projected impacts

The main threat to island ecosystems is the observed and projected rise in sea level. Other risks to island ecosystems include an increased frequency and/or intensity of storms, reductions in rainfall in some regions, and intolerably high temperatures.

Increases in sea surface temperatures and changes in water chemistry can cause large-scale coral bleaching, increasing the probability of coral death.

The tourism sector, which is an important source of employment and economic growth for many islands, will likely be affected through loss of beaches, flooding, and associated damage to critical infrastructures.

Adaptation options

Many island species provide vital goods and services, such as protection against extreme climatic events. For example, coral reefs act as natural breakwaters along the coast, and they provide habitat for marine animals and reef fish, generating revenues from tourists who engage in scuba diving. The conservation of the various island ecosystems represents a cost-effective and practical way for islands to build resilience to climate change.

Funafuti conservation area Fualopa, Tuvalu. Other risks to island ecosystems include an increased frequency and/or intensity of storms, reductions in rainfall in some regions, and intolerably high temperatures.

Photo courtesy of Semese Alefaio

Marine and Coastal Ecosystems

Oceans cover 70% of the Earth's surface area, forming the largest habitat on Earth, while coastal areas contain some of the world's most diverse and productive ecosystems, including mangroves, coral reefs, and sea grass beds.

Coral reefs, sometimes called the "tropical rainforests of the ocean", are estimated to provide about US$ 30 billion worth of benefits in goods and services. Although reefs cover only 0.2% of the world's sea floor, they contain about 25% of marine species[24].

Vulnerability to climate change

Marine ecosystems are vulnerable to the impacts of climate change since they already face myriad stresses, including overharvesting and habitat destruction from commercial fisheries, coastal development, and pollution.

Observed and projected impacts

Potential impacts of climate change and sea level rise on marine and coastal ecosystems include:

- increased coastal erosion,
- more extensive coastal flooding,
- higher storm surge flooding,
- landward intrusion of seawater in estuaries and aquifers,
- higher sea-surface temperatures, and
- reduced sea-ice cover.

These changes are likely to affect species' composition and distribution.

Great Barrier Reef. Coral reefs, sometimes called the "tropical rainforests of the ocean", are estimated to provide about US$ 30 billion worth of benefits in goods and services.

Photo courtesy of Celeste Gouldin

An orca spyhopping in region of Antarctic Peninsula

Photo courtesy of image-oasis/www.flickr.com

[24] IUCN. New strategy to help corals and mangroves survive climate change, accessed online at http://www.iucn.org/en/news/archive/2006/10/31_climate.htm

Adaptation options

Many coastal ecosystems, such as coral reefs, sea grass beds, salt marshes, and mangroves, provide significant coastal protection and thus contribute substantially to the resilience of coastal systems. However, many of them are also sensitive to accelerated sea-level rise. For example, mangroves provide protection against cyclones, storms, and tides. Unfortunately, many mangroves are already under stress from excessive exploitation, reducing resilience to the projected sea-level rise. Therefore, adaptation strategies should focus on the reduction of these external stresses.

The Great Barrier Reef Marine Park Authority (GBRMPA) has established a comprehensive Coral Bleaching Response Program (2003) that aims to increase the coral reefs' chances of survival under future climate change scenarios by minimizing the occurrence of chronic stresses on the reefs[25].

Coral formations off Port Douglas in the Great Barrier Reef, Australia. Many coastal ecosystems, such as coral reefs, beaches, salt marshes, and mangroves, provide significant coastal protection and thus contribute substantially to the resilience of coastal systems.

Photo courtesy of Bill Adler/www.flickr.com

[25] Natural Resource Management Ministerial Council, Australia Government. 2004. National Biodiversity and Climate Change Action Plan (2004-2007).

Mountain Ecosystems

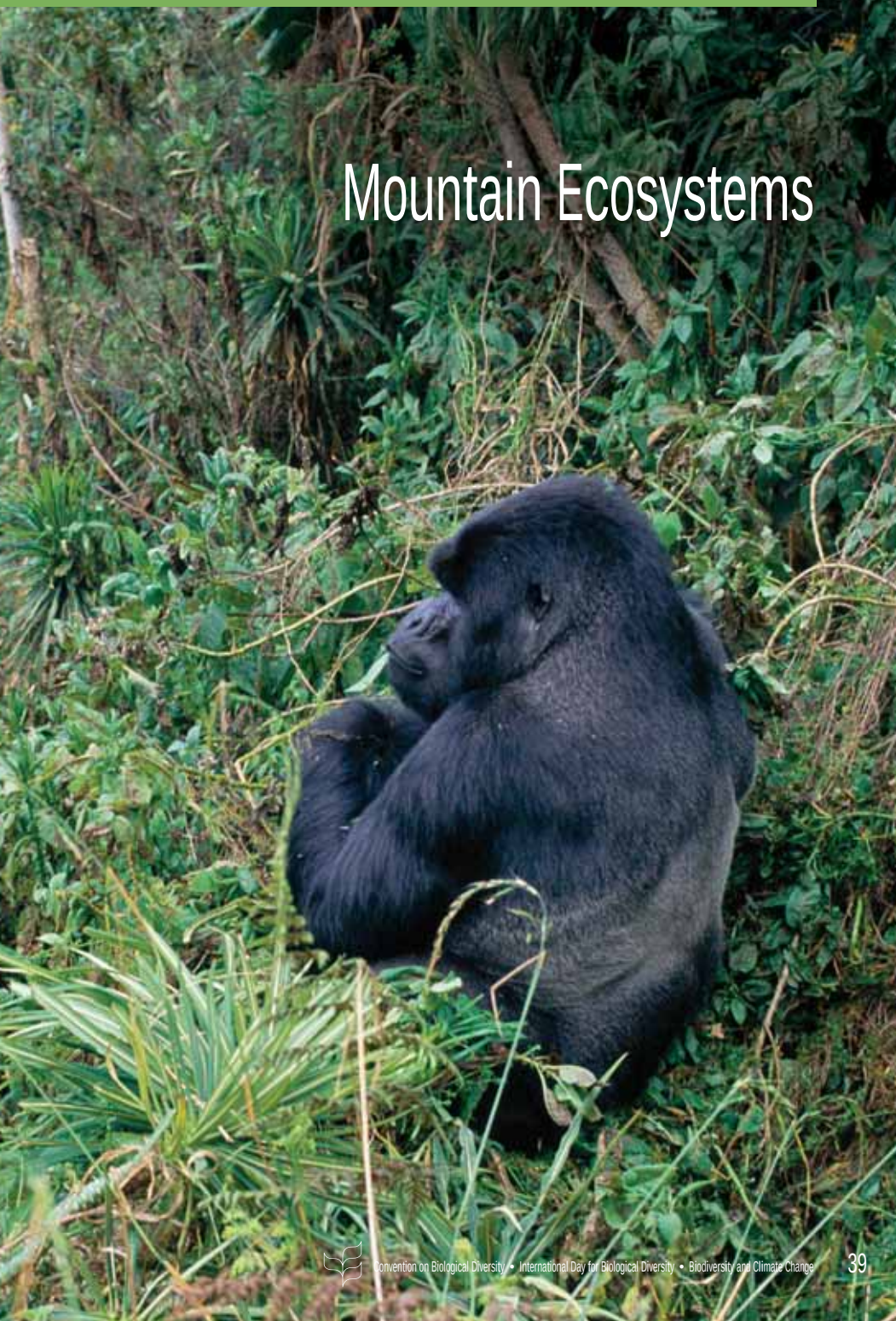


Photo courtesy Anup Shah/www.naturepl.com

Mountain environments cover about 27% of the Earth's surface and support 22% of the world's people. Many species adapt and specialize in these ecosystems, providing essential goods and services to people living in mountain regions.

Vulnerability to climate change

Mountain regions are already under stress from various human activities, such as overgrazing, abandonment or inappropriate land management, reducing their natural resilience to climate change.

Mountain species also have a very limited capacity to move to higher altitudes in response to warming temperatures. This is especially true of "mountain islands", which are often dominated by endemic species.

Observed and projected impacts

Climate change has serious impacts on mountain ecosystems as it causes the retreat and sometimes disappearance of alpine species that become trapped on mountain summits. For example, in the Alps, some plant species have been migrating upward by one to four metres per decade, and some plants previously found only on mountaintops have disappeared[26].

Moreover, the shrinking of glaciers modifies the water-holding capacities of mountains, thus affecting downstream ecosystems.

Adaptation options

Activities that link upland and lowland management strategies can provide adaptation benefits. These include mountain watershed management and the establishment of migration corridors, both horizontal and vertical.

Other adaptive activities include rehabilitating damaged ecosystems, reducing pressures on biodiversity, and avoiding deforestation.


Photo courtesy Anup Shah/www.naturepl.com

Nilgiri tahr resting on rock in mountain habitat.


Mountain village, Peru.

Photo courtesy of Karen Alvareng

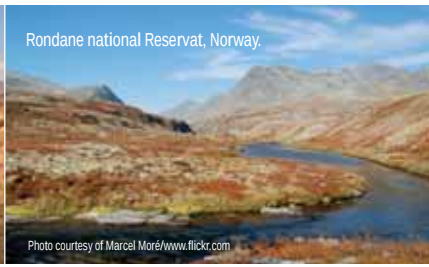

Rondane national Reservat, Norway.

Photo courtesy of Marcel Moré/www.flickr.com

[26] UNFCCC. Feeling the Heat, accessed online at http://unfccc.int/essential_background/feeling_the_heat/items/2918.php

CLIMATE CHANGE AND BIODIVERSITY-RELATED CONVENTIONS

In recent years, many climate change considerations have been included in the programmes, decisions, and recommendations of various conventions.

Here is how some conventions are considering the links between climate change and biodiversity:

- At its eighth meeting, the Conference of the Parties to the Convention on Biological Diversity (CBD) highlighted the importance of integrating biodiversity considerations into all relevant national policies, programmes and plans, in response to climate change, and to rapidly develop tools for the implementation of biodiversity conservation activities that contribute to climate change adaptation. The Conference of the Parties also noted the need to identify mutually supportive activities to be conducted by the secretariats of the Rio conventions, Parties, and relevant organizations (decision VIII/30).

- The United Nations Framework Convention on Climate Change (UNFCCC) has been signed by 191 Parties, which recognize the need to tackle climate change. The Convention's objective is to achieve stabilization of greenhouse gas concentrations at a level preventing dangerous anthropogenic interference with the climate system. It calls upon Parties to achieve that level in a time frame that allows ecosystems to adapt to climate change.

- The United Nations Convention to Combat Desertification (UNCCD) emphasizes the need to coordinate desertification-related activities with the research efforts on climate change in order to find solutions to both problems.

- In March 2006, the World Heritage Committee organized a meeting of experts at the UNESCO headquarters in Paris. An outcome of this meeting was the elaboration of a strategy to assist States Parties to implement appropriate management responses to climate change. At its 30th session, held in Vilnius (Lithuania) in July 2006, the World Heritage Committee requested "States Parties and all partners concerned to implement this strategy to protect the Outstanding Universal Value, integrity and authenticity of World Heritage sites from the adverse effects of Climate Change, to the extent possible and within the available resources" (Decision 30 COM7.1/8).

(continued)

- At its eighth meeting, the Conference of the Parties to the Convention on the Conservation of Migratory Species (CMS) requested their scientific council to afford climate change high priority in its future programme of activities and called on Parties to implement, as appropriate, adaptation measures.

- The Conference of the Contracting Parties of the Ramsar Convention on Wetlands, at its eighth meeting, called upon Contracting Parties to manage wetlands so as to increase their resilience to climate change by promoting wetland and watershed protection and restoration (Resolution VIII.3). Its science and technical review Panel is reviewing the potential impacts of climate change on wetland ecosystems' ability to deliver services, and the role of wetlands in ameliorating the effects of climate change. The 10th COP to be held in 2008 will have a consideration of the linkages between climate change and wetlands.

FOOTNOTES

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