Climate change adaptation

According to the Fourth Assessment Report Panel on Climate Change (IPCC),

IN 2007, INCREASED GLOBAL WARMING WILL LEAD TO MORE EVAPOTRANSPIRATION, ENHANCE THE ATMOSPHERE'S CAPACITY TO HOLD MOISTURE, AND PROVOKE MORE EXTREME WEATHER EVENTS, SUCH AS FLOODS. CONSEQUENTLY, THERE WILL BE LESS PRECIPITATION, PARTICULARLY IN THE TROPICAL AND SUB-TROPICAL DRYLANDS.

Not only will droughts be longer and more intense in such regions, but new areas will also suffer from drought. The IPCC also reports that drying is evident in new regions, such as the sub-humid areas of Southern Africa. It suggests a 90 percent probability these developments will take place, implying a need for effective adaptation measures in dryland communities.

Over the years, communities living in drylands affected by desertification and land degradation have learned to live with more predictable weather events. In the absence of adequate financial and technical assistance, however, these communities are unlikely to cope when new hazards strike. Unless rapid response and adaptation measures are in place, past experience with these kinds of disasters suggests the human and economic consequences will be tragic.

Adaptation measures in the drylands must consider three dynamics: adaptation can lag due to the learning curve; some but not all predictable risks may be averted; and some risks cannot be anticipated. To minimize the learning curve and ensure sustainability, technologies must build on and strengthen existing knowledge in communities, specifically their current coping mechanisms. Since yesterday's technologies cannot solve today's problems, traditional mechanisms must be modified. In preparing for unpredictable risks, adaptation measures must provide for rapid responses, as well as long-term solutions, that cut across the livelihoods, ecosystems, and social aspects of these communities.

The impacts of climate change pose new challenges to the sustainability of existing land-use systems in production landscapes, making adaptation critical. By improving risk management, SLM can help reduce vulnerability and thus increase adaptability and the coping range of the poor. In particular, SLM can help restore soil fertility, improve water availability, and increase livestock productivity, which all ultimately improve conditions of the natural resource base and enhance food security.

Strong evidence suggests that diversity of land-use systems and cultivated crops that support local livelihoods increases resilience to climate change; builds potential for development, scaling-up, and transfer; and provides a foundation for viable innovative economic activities. Lack of diversity, in turn, reduces resilience: intensifying livestock in dryland areas at the expense of diverse agropastural and silvopastural systems, for example, may add to the carbon footprint. The anticipated nature of drought, particularly in the sub-tropics and Southern Africa, underlines the need to protect livestock corridors and water points. Existing SLM practices, such as the use of wildlife corridors in Eastern and Southern Africa, and transboundary water management approaches in different regions, have important adaptation benefits in these regions.

Communities dependent on rainfed agricultural and pastoral systems for their livelihoods—including subsistence and livestock farmers—are particularly vulnerable to the effects of climate change and drought. The same is true for vulnerable ecosystems suffering from water stress such as small-island and mountain ecosystems. Improving the productive capacity of such communities strengthens their ability to generate income and diversify crops. Conserving and establishing forests with varying canopy-levels, for example, can check moisture and soil loss, enhance crop and fodder availability, and improve soil quality.

Cultivated crops that support local livelihoods build resilience to climate change.

Rural family life in Albay, a province in the Philippines.

Access to knowledge about natural and socioeconomic systems (both past and potential), enabling policies, and supporting institutions are critical to develop viable strategies for adaptation to climate change. Information on cultural and political contexts is also important to ensure these strategies are acceptable and realistic. Finally, the implementation of adaptation strategies requires resources, including financial capital, social capital (e.g., strong institutions, transparent decision-making systems, formal and informal networks that promote collective action), human resources (e.g., labor, skills, knowledge, expertise) and natural resources (e.g., land, water, raw materials, biodiversity).

The stories that follow include a range of options for addressing climate change adaptation through SLM—from catchment management in a transboundary area (*Niger and Nigeria*), restoration of rangeland (*Syria*), and retention of soil and water on steep slopes (*Bhutan*) to regional-scale integration of interventions across island states (*Pacific Islands*) and empowerment of farmers as land stewards (*Italy*). The stories demonstrate how SLM can increase the resilience of vulnerable communities (*development benefit*) and promote sustained productivity of agricultural and rangeland systems (*environmental benefit*) across multiple scales.

SLM is creating alternative livelihoods in poppy-ridden areas.

Making a fishing net with branches in Lagos, Nigeria.

Catchment management for ecosystem resilience across borders

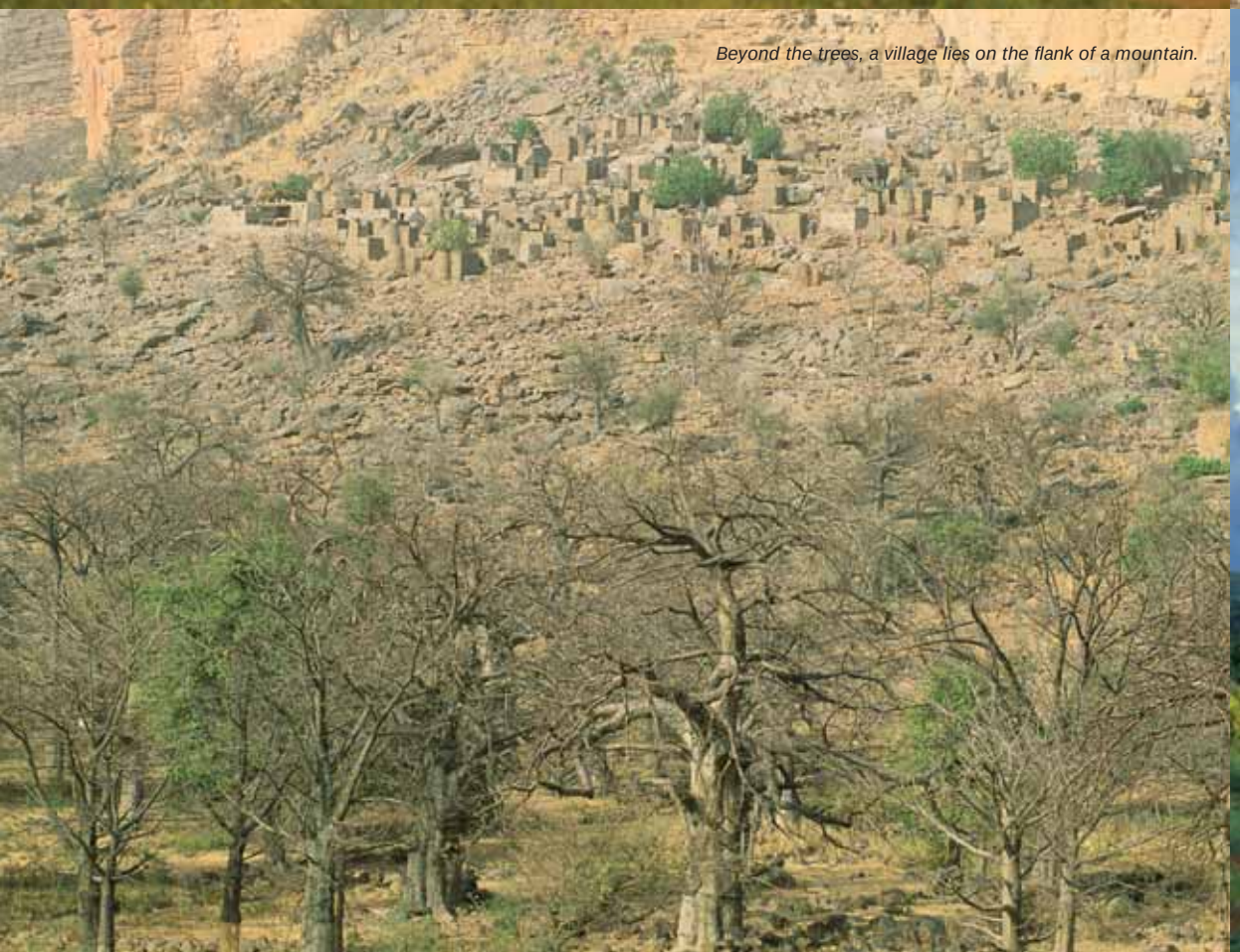
The four catchments (Maggia-Lamido, Gada-Gulbin Maradi, Tagwai-El Fadama, and Komadugu Yobe) in the transboundary areas between Nigeria and Niger offer a wealth and diversity of land, biological, and water resources. These resources have long been the main source of livelihoods for 15 million people living in the catchment areas, but land degradation and desertification are putting the environmentally sensitive ecosystems at risk. The catchment areas suffer from loss of soil nutrients and organic matter, reduced or degraded natural woodland, fewer surface-water resources, lower groundwater tables, and less biodiversity. Rapid population growth is also increasing pressure on natural resources, causing livelihood vulnerability, and increasing risk of migration and conflicts.

In response, through a UNDP/GEF integrated ecosystem management (IEM) project implemented between 2006 and 2010, the two countries embarked on a strategic approach in the four shared catchment areas. The goal: to ensure the sustainable use of the catchment resources, as well as equitable sharing of development benefits. In addition to a bilateral agreement and strengthening capacity of the Nigeria-Niger Joint Commission (NNJC), the project set up a network of pilot demonstration sites that includes 24 community-based development plans, 11 of which are already in place. Key interventions include demonstrations on community woodlots, tree nurseries, and agroforestry/eco-farms; rehabilitation of degraded lands; sand dune repair in degraded areas; and improved cooking stove technologies and practices. Though small in scope and capital intensive, these pilots are demonstrating that SLM technologies work under the prevailing socioeconomic and environmental conditions. The two governments plan to scale-up SLM interventions, enhancing resilience and functioning of the ecosystem for improved rural livelihoods.

A communal tree nursery in the Inner Niger Delta, Mali.

A dirt road passes through the grasslands in Nigeria.

Traditional technologies must be modified to help cope with climate change.



Beyond the trees, a village lies on the flank of a mountain.

A lush field in nigeria.

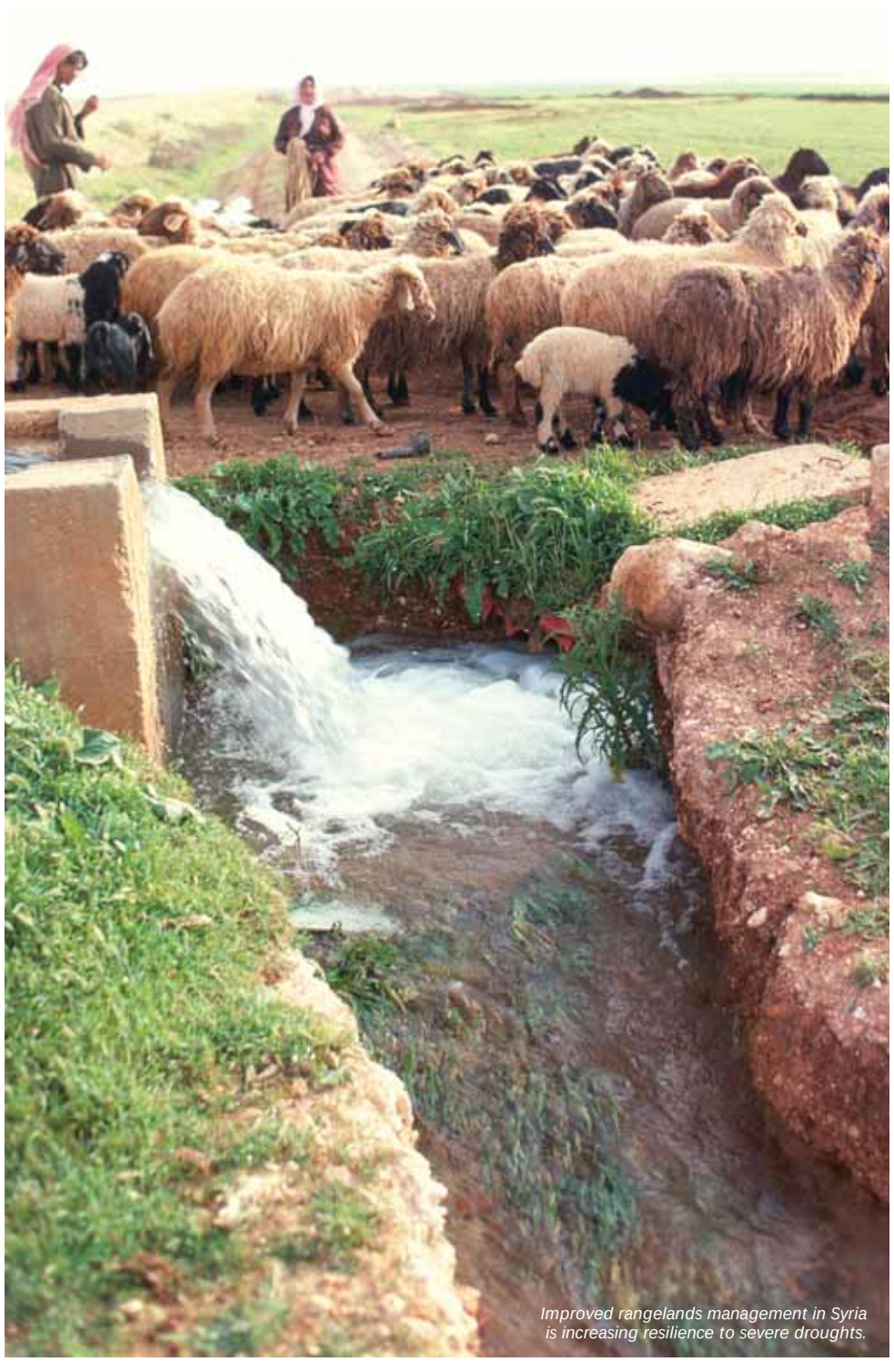
Harvesting cotton on the banks of the Euphrates River, Syria.

Enhancing resilience of the Badia Rangelands

Years of relentless drought and intensive grazing severely degraded rangelands in the Syrian steppe (or Badia). In response, the Government of Syria worked with IFAD, as well as with local communities, on the Badia Rangelands Development Project. The project, which sought to reduce vulnerability to climate change and restore the long-term productivity of rangelands, reintroduced native plants to help increase fodder, fixed the soil, stopped sand encroachment, restored ecosystems, and reduced the local population's vulnerability to the effects of climate change. All told, the project restored three million hectares of rangelands. After two years of resting, reseeding, and planting shrubs on 1.4 million hectares, for example, birds, insects, and animals returned to the area.

As truffles grow in some areas of the Badia, rehabilitated ecosystems offered further ways for women to boost family incomes. In 2010, a community with a 100,000-hectare grazing area could earn up to US$1 million by selling truffles. Higher household incomes enabled the community to offer women literacy classes and training courses in new skills such as first aid, food processing, and sewing, all of which could help further diversify incomes. As women gain more economic autonomy, gender relations are shifting; with households better off, for example, young girls feel less pressure to marry early. More availability of grazing feed and a strong participatory approach to rangeland management also significantly increased the resilience of herder communities to severe droughts.

Rural landscape around Qal'at al-Hisn, Syria.



Improved rangelands management in Syria is increasing resilience to severe droughts.

On the Syrian steppe, more economic autonomy for women has reduced pressure on young girls to marry early.

The Badia Rangelands Project has rested, reseeded, and replanted shrubs on 1.4 million hectares.

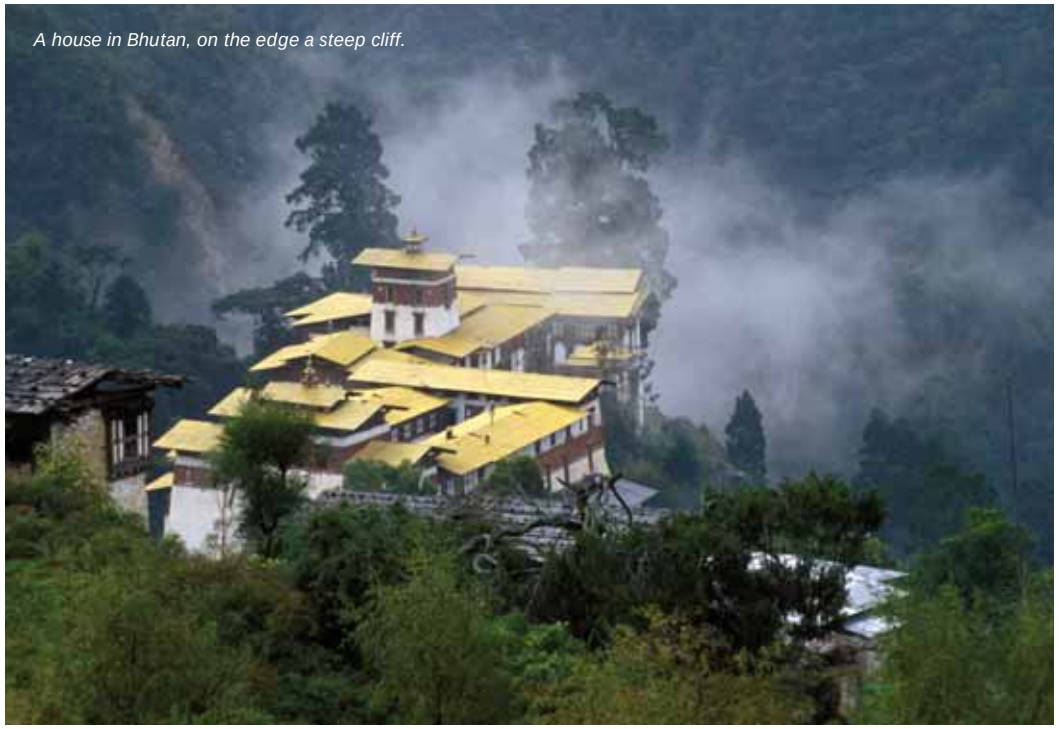
Rice fields in the south of Pokhara, Pahar region, Nepal.

Holding back soil and water on steep slopes

In Bhutan, 69 percent of the population depends on subsistence and mixed farming performed largely on steep to very steep slopes. Small-scale farmers are thus highly vulnerable to the adverse effects of more frequent climate extremes in the Bhutan Himalayas. Both anthropogenic and natural factors coupled with projected climate extremes may well accelerate land degradation, undermining both the environment and farmers' livelihoods. In participatory fashion, 130 villages in Bhutan identified land-based problems, causal chains, and priorities for targeted SLM. Drawing on the villages' analysis, the Government of Bhutan is promoting SLM practices to reduce vulnerability and help rural households adapt better to climate variability and change through the World Bank/ GEF Sustainable Land Management Project. Applied practices include hedgerows, check dams, stone bunds, terraces, bamboo, and planted trees to retain soil and water. Even if the impact of projected climate extremes is less than forecast, these SLM interventions will still enhance farmers' livelihoods by conserving soil and moisture (which makes agricultural production less variable) and diversifying agricultural income. The multiple benefits offered by SLM on steep cropping and degraded lands are central to decreasing on-site vulnerability and off-site dampening of peak flows and sediment loads. As a result, SLM represents a preventive and cost-effective approach to climate change with a positive long-term impact on rural landscape and farmers' livelihoods.

SLM is helping rural households in Bhutan adapt to climate change.

In Bhutan, most people depend on subsistance and mixed farming carried out on steep to very steep slopes.



A house in Bhutan, on the edge a steep cliff.

Two boys in Bhutan sell produce at a market.

Panoramic view of the landscape in Bhutan.

Climate change is already a reality for many island countries, including those in the Pacific.

COUNTRIES:
COOK ISLANDS, FEDERAL STATES OF MICRONESIA, FIJI, NAURU, NIUE, PAPUA NEW GUINEA, SAMOA, SOLOMON ISLANDS, TONGA, TUVALU, AND VANUATU

Climate change adaptation through SLM in the Pacific Islands

Pacific Island Countries (PICs) are characterized by extremely small land area and limited land resources, such as soil and forest. These factors make many terrestrial and near-shore resources sensitive to overexploitation and pollution from poorly planned waste disposal, and are one reason why PICs are so vulnerable to climate change. Indeed, many anticipated impacts of climate change are already an unfortunate reality for Pacific Islanders. These include extensive coastal erosion; coral bleaching; persistent alternation of weather patterns; less productivity in fisheries and agriculture; more erosion of coastal roads, bridges, foreshores, and plantations; devastating droughts that hit export crops; serious water shortages; and more widespread and frequent occurrence of mosquito-borne diseases.

A coastal road in Tuvalu.

In response to these challenges, the UNDP/GEF Pacific Adaptation to Climate Change Project has been building resilience to climate change in all 11 countries since 2009. Through its focus on food production and food security, coastal management, and water resource management, the project is helping each country diversify agricultural practices and upgrade irrigation systems to handle longer dry periods and stronger rainfall. The demonstration projects will integrate climate change risk reduction into drains and drainage networks; harvest rainwater to counter the effects of increasing salinity in coastal freshwater resources; develop an alternative water supply system to enhance resilience to drought; and support community-based management of climate change in agriculture. Lessons learned are feeding back into policy processes, ensuring national strategies for agriculture, water, and coastal zone management explicitly address climate risk.

Many near-shore resources in Pacific Island Countries are sensitive to overexploitation.

Coastal erosion is one of many anticipated impacts of climate change for Pacific Island Countries.

Capo di Milazzo, a peninsula on the Island of Sicily, Italy.

Farmers as land stewards on the Island of Sicily

The Macalube d'Aragona, a 256-hectare protected area of extensive mud volcanoes on the Italian island of Sicily, has a semi-arid and dry sub-humid climate. Between 1921 and 2002, the region's temperature increased by 1.5 degrees Celsius, while average annual rainfall declined by 158 millimeters. Farming is the dominant agricultural land-use practice for its 1,000 inhabitants, but there are also large tracks of unproductive land. Intensive wheat cropping has curved out slopes in the landscape, causing frequent soil erosion from water runoff. Natural habitats surrounding the volcanoes are under threat. In addition, drainage of wetlands, soil manipulation, and the burning of crop residuals have led to soil sealing and the depletion of organic matter. When the regional government—with an eye on tourism—designated Macalube d'Aragona as a protected area, conflict erupted among farmers, environmentalists, and the government. Researchers at the University of Palermo, environmental nongovernmental organizations, and the local farmers' cooperative began searching for a suitable ecological restoration system.

The initiative, known as the European Union Macalife Project, ensures endemic plant species such as *Lygeum spartum* maintain local biodiversity, and protects the primary grassland varieties. University researchers developed a protocol for collecting, multiplying, and installing different species in nurseries, as well as planting them. Using conventional practices such as monocropping, local farmers put the research into practice at relatively low cost; environmentalists subsequently encouraged farmers to adopt more diversified cropping practices that included legumes and cereals, as well as livestock management. The project set up a new cooperative enterprise to maintain habitats and generate income from tourism. In this way, farmers became managers of the protected area, ultimately helping develop and transform the entire rural landscape. Rehabilitation of the degraded habitats has increased tourist flow significantly, and increased prospects of adaptation to climate change.

The Calascibette Highway in Sicily, Italy.

Springbok roam a dry riverbed in Namibia.

Conservation of biodiversity

In many areas of the world, land degradation and biodiversity loss are intertwined as the two most visible impacts of human occupation.

If not managed well, clearing native vegetation for agriculture and livestock can accelerate both soil erosion and the loss of soil carbon and biota. Without adequate vegetative cover, production systems can quickly deteriorate, increasing poverty and adding pressure to migrate from rural landscapes. With the loss of soil fertility, including micro-organisms and all other fauna and flora that sustain above-ground biomass, agricultural and pastoral lands can sink into a downward spiral of environmental degradation. Hence, it's critical to balance agricultural fields and natural habitats to sustain human livelihoods in rural environments.

In the drylands of the world where cattle ranching and pastoralism are widely practiced, poor grazing is a major factor in land degradation and threat to native biodiversity. From the vast plains of Eastern and Southern Africa to the steep slopes of the Himalayas and the high Andes, livestock management is often traditionally integrated with wildlife populations. Disrupting the delicate balance in how livestock and wildlife use these systems can lead to land degradation and biodiversity loss, which in turn, undermines the livelihood of indigenous communities. The need to sustain traditional grazing practices is a major priority of most dryland countries with pastoral- and livestock-dependent populations, especially in the context of changing environmental conditions globally. SLM can play an important role in addressing this need, offering ways to maximize access to pasture and water resources for both livestock and wildlife while enhancing ecosystem resilience.

Land degradation and biodiversity loss threaten the supply of numerous ecosystem services—such as the prevention of floods and severe droughts—which are vital for healthy and productive agricultural systems. In arid, semi-arid, and sub-humid regions, the loss may occur particularly fast with long-lasting impacts for human occupation; areas with compromised soils and biodiversity are less resilient to new environmental conditions. It's critically important to arrest, and eventually, reverse these trends to reduce poverty and achieve environmental sustainability. Fortunately, reforestation, restoration, and changes in land-use practices in various ecological and cultural settings are showing it is possible to safeguard biodiversity through SLM.

Projects around the world are facilitating the delivery of environmental services in production systems. Many countries have adopted Payment for Ecosystem Services (PES), including Costa Rica where crop and livestock production have been major drivers of deforestation.[33] In addition, smallholder farmers and poor land-users have used PES schemes as incentives to generate environmental benefits in production landscapes.[34] Since they are self-contained units, with land occupation and environmental services easily measured and monitored, watersheds have become common settings for PES schemes. Investing in PES through SLM enhances benefits such as carbon sequestration in production landscapes and reduction of sediment load in streams, rivers, and lakes. With increased understanding of policy options and the dynamics of "buyers" and "sellers" of ecosystem goods and services, PES offers a major opportunity to align SLM with biodiversity conservation in highly threatened ecosystems.

A gemsbok casts a long shadow in the Namib Desert, Namibia.

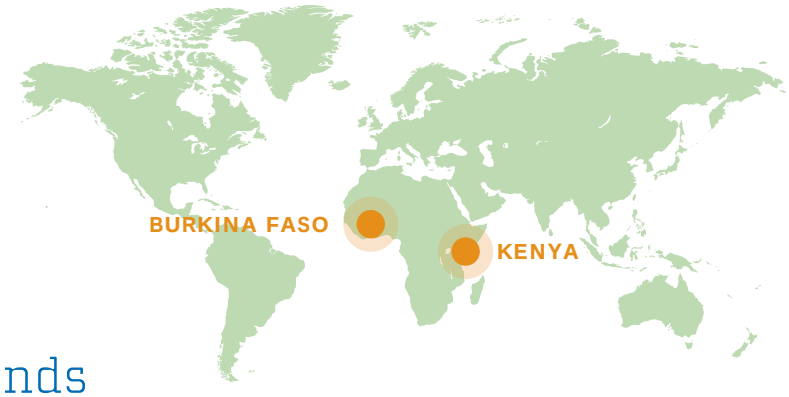
The loss of biological diversity threatens both the supply of basic environmental services and the genetic make-up of species. Agrobiodiversity, or the resources directly related to agriculture, encompasses the gene pool of wild crop relatives of domesticated plant species, including grains, vegetables, fruits, spices, and medicinal plants. These wild relatives and their indigenous landraces are all highly prized for their potential to improve crop management. The loss of these biological resources is permanent. Not only would the loss impede improvement of existing domesticated species, it would also undercut development of entirely new productive systems needed to sustain growing populations around the world. Driven largely by traditional knowledge, farmers are maintaining genetic resources through SLM, in addition to conserving them in protected areas. Such traditional practices are now seen as a smart and valuable insurance policy against unknown future environmental conditions.

By reducing the diversity and population size of many wild species associated with productive systems, important and costly ecosystem services like pollination and pest control may be lost. The disappearance of natural habitats associated with agricultural fields and the widespread use of pesticides, for example, have been major factors in reported declines of important pollinators of crop plants, especially bees[35] and bats.[36] Excessive pesticide use also threatens biological control of pests, including insects, weeds, and plant diseases, in crop production systems. Sustainable land management plays an important role in maintaining these species and their services over the long term, and includes a range of agroecological practices that enhance integrated management of production systems and natural habitats.[37]

Mutually dependent, SLM and biodiversity conservation must be considered together while developing strategies to address environmental degradation. As shown in the stories that follow, SLM offers opportunities for successful conservation of species and habitats (*environmental benefit*) that in turn generate multiple benefits for humans (*development benefit*). From integrating wildlife and livestock management (*Burkina Faso and Kenya*), and safeguarding desert oases and genetic resources (*Algeria and Tunisia*), to protecting indigenous lands (*Central America*), safeguarding hydrological services (*Andes Region*), and enhancing pollinator functions, the stories are evidence that SLM offers an important pathway for mainstreaming biodiversity in agricultural systems. Through a combination of appropriate policy and management options, including the use of biological resources, local and global environmental benefits can be increasingly harnessed with measurable improvements for millions of people making a living in the wider agricultural landscape.

A tree nursery in Tambacounda, Senegal, receives a welcome shot of rain.

A lone acacia tree in Tsavo-East National Park in Kenya.



Integrated wildlife and livestock management in African drylands

The increasing presence of humans coupled with weakening traditions to control and regulate access to grazing resources and wildlife protection have led to overexploitation of natural resources, threatening the co-existence of livestock and wildlife in the savanna landscape. Through the UNEP/GEF Dryland Livestock Wildlife Environment Interface Project, the Governments of Kenya and Burkina Faso sought to keep mixed production systems sustainable. They focused on savanna agroecosystems that are rapidly changing due to modernization of agriculture and other emerging land-use practices such as community management of natural resources conservation. The project chose two pilot sites for their different regional contexts: the Arly region in southeast Burkina Faso, which is part of a dryland system with transhumance and the largest elephant population remaining in West Africa; and the Greater Ewaso Nyiro ecosystem in Kenya, which has the largest number of wildlife outside protected areas and the largest number of elephants in the country.

By engaging stakeholders that included target communities, nongovernmental organizations, private sector players, and various government entities, the project promoted community conservation and land rehabilitation, built community capacity, stimulated income-generating activities (alternative livelihoods), and established mechanisms to manage and resolve community conflict. In particular, the project strengthened the management team of conservancies in Kenya and *Zones Villageoise d'Intervention Cyn*égétique or "ZOVICs" in Burkina Faso to implement SLM. In Kenya, since several sedentary pastoralists in the conservancies are attempting to replicate activities at the household level, the rehabilitation of degraded rangeland ultimately generated income. Defining "resource tenure" under group-ranch bylaws ensures that household investors will receive all the benefits. Moreover, the project could be replicated and expanded over 1.5 million hectares of drylands in the Greater Ewaso Nyiro ecosystem. In Burkina Faso, the project is expected to cover the Arly National Park (119,500 hectares) and its adjacent areas under agropastoral production.

Kenyan women load up precious water for the journey home.

White rhinoceros graze at Lake Baringo in Kenya.

Vegetation in the dunes near El Oued, Algeria.

Safeguarding cultural patrimony in oases of the Maghreb

The oases of the Maghreb region are green islands flourishing in a constraining and harsh environment, home to a diversified, highly intensive, and productive system developed over millennia. Old but sophisticated irrigation architectures, supported by local custodians, are a crucial element of the oasis systems, ensuring the fair distribution of water. Not only do agricultural products from the oasis systems provide an important source of nutrition and income for inhabitants, they often provide a primary or secondary source of livelihood as well. Oases, however, are threatened: modern irrigation has depleted aquifers; and local customs for water management have been disrupted, rupturing transfers of specialized traditional knowledge.

Oases are an important source of nutrition, income, and livelihood.

Through the FAO-led Globally Important Agricultural Heritage Systems (GIAHS) Partnership Initiative, the Governments of Tunisia and Algeria embarked on a participatory process to assess the needs, aspirations, and priorities of oases communities—a process that identified ways to safeguard and add economic value to the oases' agricultural biodiversity. The project regularly trains farmers, youth, and women from Gafsa (Tunisia) and El Oued (Algeria), and uses different media to raise awareness about agricultural patrimony. Such efforts have made these target groups, along with civil society generally, more engaged in agricultural activities. Ultimately, the project has enabled local communities to adopt policies and strategies that ensure sustainable livelihoods, safeguard the cultural patrimony of oases, and revitalize traditional practices and local institutions that maintain diversity in the oases.

Working on an oasis garden in Algeria.

A wine farm north of Capetown, Republic of South Africa.

Harnessing SLM best practices to safeguard pollinators

Two-thirds of all food crops depend on insect pollinators for maximum production. With managed honeybee populations rapidly declining and more crops being grown under intensive systems, multiple agroecosystems and ecologies need to identify practices to prevent the loss of pollination services. Unfortunately, the level of capacity to manage these services, and public awareness of their importance, is very low, both in traditional and modern societies. Several highly localized crop pollination failures, however, have brought the issues to the forefront of global debate on agricultural land use and conservation.

As part of the UNEP/FAO/GEF project—Conservation and Management of Pollinators for Sustainable Agriculture through an Ecosystem Approach—seven countries joined forces to enhance management of pollination services for the benefit of human livelihoods and sustainable agriculture. In Ghana, for example, partners found that spraying insecticides decreases populations of midges by one-third to one-half: without these pollinators, yields of cocoa may drop by 90 percent. In farms that grow bananas or plantains near cocoa trees, however, leaf litter from the trees provides a microhabitat for midges, enabling populations to recover faster. The project will establish SLM best practices to conserve pollinators over the long term, enabling farmers, extension agents, land managers, policy-makers, and the general public to support pollinator conservation efforts worldwide.

Two-thirds of all food crops depend on insect pollinators.

A young woman harvests cooca beans in Bolivia.

The mangrove-fringed lagoon of Los Micos in Honduras.

Integrated management of indigenous lands in Central America

The Central American section of the Mesoamerican Biological Corridor is well known as one of the richest areas in the world, both for its traditions and cultures, as well as its high-valued biodiversity. Home to at least 14 diverse ethnic groups of indigenous peoples speaking 39 languages, the section is prized for its large numbers of endemic species. The section has also gained attention for the tremendous pressure from expanding agriculture that threatens its biodiversity.

An IDB/World Bank/GEF project, Integrated Ecosystem Management in Indigenous Communities, is responding to the challenges. Through this IEM project, an emerging network of indigenous communities is recovering land management traditional knowledge (LMTK) as stated in the Convention on Biodiversity (Article 8j), and using it to protect biodiversity. By sharing best practices and fostering environmental sustainability, the project strengthened community networks across the region. In one of its most relevant activities, the project used a participatory approach to map cultural uses of these lands based on beliefs and needs. In total, the communities designed, implemented, and executed 15 community development plans. As a result of this empowering process for indigenous peoples, the project has protected about 135,000 hectares of community lands and preserved 45,000 hectares of land for cultural use.

Expanding agriculture in Central America threatens biodiversity.

Indigenous communities in Central America are using traditional knowledge to protect endemic species.

A farm valley in Ecuador.

Protection and sustainable use of the Andean Paramo

Above the treeline, on the upper part of the Northern Andes, the Paramo forms a discontinuous belt between the Cordillera de Merida in Venezuela and the Cajamarca area in Peru. A critical regulator of watershed hydrology, it is an important source of biodiversity. Nearly 5,000 plant species, half of them endemic to this environment, live here alongside large mammals such as the Andean spectacled bear, the mountain tapir, and the emblematic Andean condor. The Paramo, however, is threatened by a variety of factors, including livestock farming and global warming.

The UNEP/GEF project, Conservation of the Biodiversity of the Paramo in the Northern and Central Andes, is tackling the problems. Andean Paramo countries and a range of partners, including advanced research institutions, and nongovernmental- and community-based organizations, are developing policies and incentives to support conservation and sustainable use in 14 different sites. Lobbying efforts have already borne fruit. Ecuador mentions Paramo in its new Constitution as a fragile ecosystem that requires special treatment, while Colombia now prohibits mining in all Paramo areas. Integrating these protection efforts with sustainable agriculture and livestock management practices, and sustainable use of the Paramo, is helping strengthen local and national economies. A regional workshop opened dialogue on how huge quantities of carbon stored in the Paramo soils could benefit the ecosystem. As a result, an international monitoring network now facilitates research and extension, and helps resolve key conflicts and policy issues associated with the Paramo's delicate and complex environment.

A plantation of palm trees stretches to the horizon.

A tropical forest in the Bijagos Archipelago, Guinea Bissau.

Avoided deforestation

Forests have become central to the international debate about reducing greenhouse gas (GHG) emissions.

ACCORDING TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC), DEFORESTATION CONTRIBUTES ABOUT 15-17 PERCENT OF GLOBAL GHG EMISSIONS—MORE THAN THE ENTIRE TRANSPORT SECTOR.

Of particular concern is the conversion and degradation of tropical forests, which account for approximately 90 percent of total GHG emissions from deforestation. According to the Food and Agriculture Organization (FAO), rapid population growth and the associated need for farming and grazing land pose the main threat to forests. Although overall deforestation has declined globally, it persists in Africa and South America where, the FAO recently reported, forests support the livelihoods of a large proportion of the two billion people who live in the drylands. The pressure on arid-zone forests, and the rangelands that protect them, might thus increase, especially in the tropical and sub-tropical regions.

The importance of forests in the global carbon equation has prompted significant policy discussions on the newly renamed REDD-plus (REDD+) framework, which expands the Framework of Reducing Emissions from Deforestation and Degradation to include forest restoration, rehabilitation, sustainable forest management, afforestation, and reforestation. Throughout the world, integrated pilot efforts are combating deforestation and forest degradation, including approaches for monitoring, reporting, and verification (MRV) systems for carbon stocks. What's more, the idea of using REDD+ to increase carbon stocks through SLM in a landscape approach is gaining momentum around the world.

Debate about deforestation has tended to focus on tropical forests, such as those in Indonesia and Brazil that experience the greatest rate of decline. Substantially less attention gets paid to dryland forests and woodlands where per unit area of carbon stocks is lower than in tropical forests. Noting the large areas covered by dryland forest, however, a recent study suggests these forests offer potential carbon benefits and socioeconomic side-benefits by improving livelihoods for the poor.[38] One area with high potential for REDD+ is the *miombo* woodlands that cover between 2.7 and 3.6 million square kilometers in Eastern and Southern Africa, extending into 11 countries. Most people in these countries are poor, and about three-quarters of them live in rural areas. Typically, they are small-scale farmers who use goods and services produced by *miombo* woodlands.

The contribution of forest production landscapes to mitigating climate change can link directly to livelihood improvement and rural energy, generating long-lasting economic, ecological, and social benefits, as well as direct and indirect carbon benefits. Beyond their role in mitigating land-based emissions, forests harbor a significant amount of the world's biodiversity wealth. They also provide key ecosystem services, acting as carbon sinks and storehouses, and buffers against soil degradation and desertification, as well as sustaining the livelihoods of hundreds of millions of rural people everywhere. These linkages imply that, if different objectives can be pursued synergistically, forests can be conserved and managed for multiple benefits.

REDD+ and activities in agriculture, forestry, and other land uses (AFOLU) offer significant mitigation opportunities. In the same breath, they can provide substantial livelihood and sustainable development benefits, which can improve several dimensions of livelihoods. These factors make AFOLU suitable to pioneer a sectoral approach to quantified emission reductions in willing developing nations, with possible scope for national accounting of emission reductions. Moreover, given the means to act, farmers can respond quickly to REDD+ opportunities. For example, through conservation

Fog covers the mountains in a New Zealand rainforest.

tillage or mixed cropping, they can combine food crops with cover crop legumes and/or tree and shrub species.

In general, production landscapes often provide a favorable enabling environment through tenure security, competing land use, and regulations on access and control. Well-constructed carbon markets offer an alternative income to landholders determined to clear old growth and regrowth forests for cattle ranching and soybeans. Developing diverse and sustainable grazing systems could increase the resilience of landscape to the impacts of climate change, realizing a multitude of environmental benefits: the integration of grazing systems with other income sources such as carbon credits; agroforestry; bioprospecting; biodiversity credits and steward payments; and production of agricultural commodities for direct human consumption. Such schemes would allow beef producers to diversify their income sources, while protecting forests and maintaining some cattle.

As shown in the stories that follow, SLM practices that emphasize integrated management of production landscapes can greatly reduce deforestation. The stories include efforts to protect forests for carbon benefits (*Madagascar*), manage fire risks to mitigate deforestation (*Guatemala*), expand a protected area to minimize "leakage" (*Bolivia*), and empower communities to secure ecosystem services in production landscapes (*Albania*). By building on specific activities to secure forests and restore degraded forest landscapes, SLM practices can support REDD+ by enhancing productivity of existing agriculture and livestock systems. Improved breeds and varieties of animals, crops, and trees, alongside enhanced management, can also significantly increase efficiency of resources in agroecosystems and plantations, and reduce pressure on intact ecosystems such as primary and healthy secondary forests.

A larch and conifer forest in spring.

Betsiboka River Delta near Mahajanga, Madagascar.

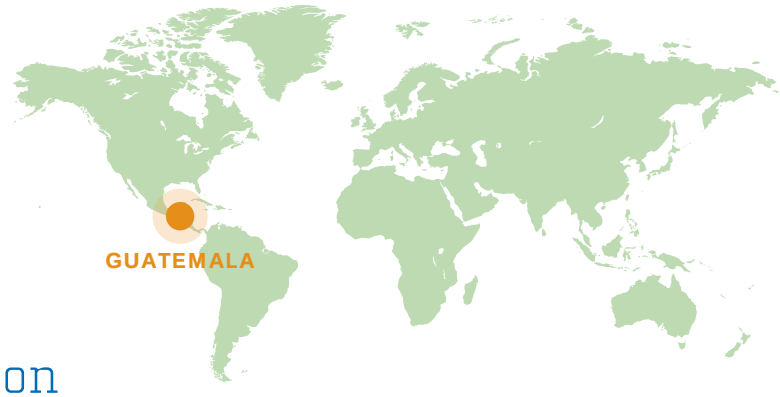
Enhancing forest protection for carbon benefits

In 2001, the Government of Madagascar and various partners began creating the 372,470-hectare Makira Forest Protected Area, the largest remaining contiguous tract of low- and mid-altitude rainforest in Madagascar—ecologically and biologically important because of its high biodiversity value. The Makira project takes an integrated approach to reduce human threats to the region's forests, while engaging local communities in the management of the protected area. The project combats the principal cause of deforestation in the area—swidden agriculture or "tavy," which is driven by both subsistence and economic pressures. It also tackles threats to forests from bush meat-hunting, collection/exploitation of timber and non-timber forest products, burning of forest land for cattle grazing, illegal commercial exploitation of the forests' hardwood species, and illicit commercial mining of quartz and precious stones.

The project involves zoning the Makira forests and surrounding areas into three parts: Strict Protection, Multiple Use, and Community Management. It covers an area of 697,827 hectares—which includes a 372,470-hectare protected area and a 325,357-hectare buffer zone of community-managed land. Of the total area, 522,750 hectares are forested and eligible for carbon crediting. This REDD project is expected to avoid an estimated 9.5 million metric tons of carbon dioxide equivalent emissions over its 30-year lifetime. The project addresses permanence and leakage through a legally protected area, community-based sustainable land management and legal property rights, a project endowment, credit buffers and discounts, and monitoring of adjacent areas/activities via satellite and surveys. The Voluntary Carbon Standard (VCS) is currently validating the project.

Baobab trees, majestic sentinels in Madagascar.

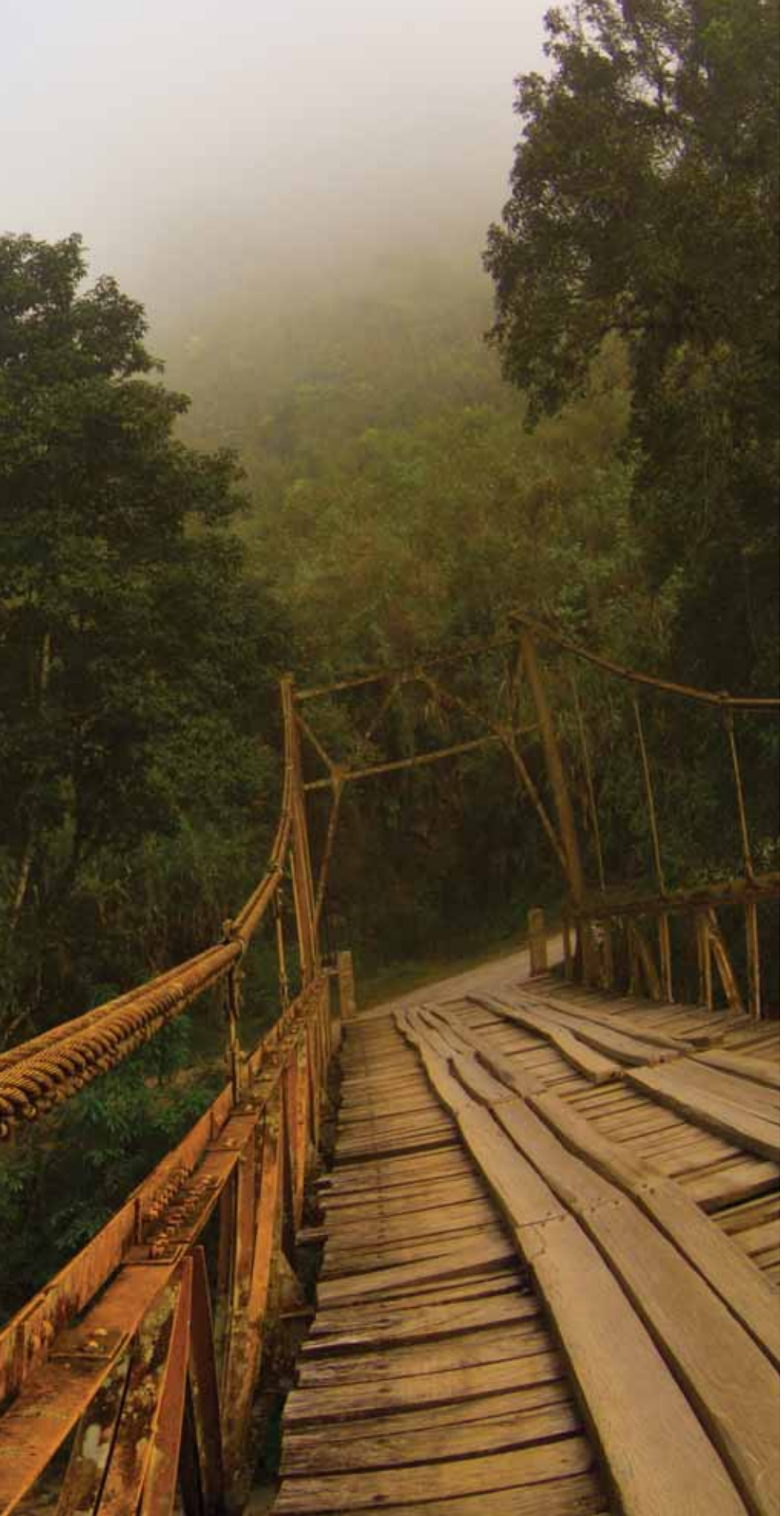
Below the clouds, the Orinico River flows through the Amazon rainforest in Venezuela.



Integrated management of fire risk to mitigate forest degradation

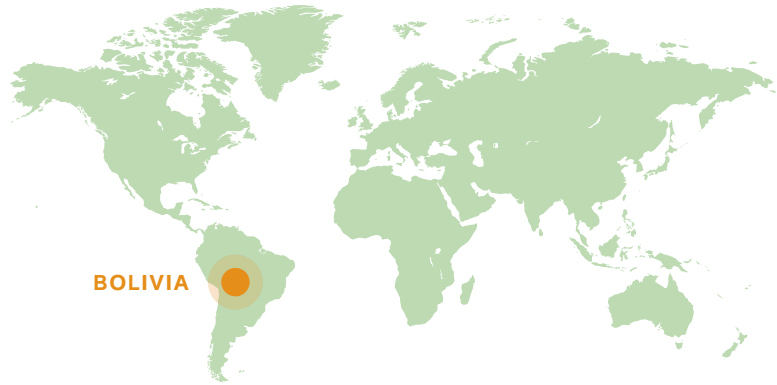
The Maya Biosphere Reserve, home to a complex system of natural forests, magnificent archeological sites, and unique biodiversity, has come under pressure from a proliferation of illegal settlements and economic activities. These range from smuggling of rare woods and wildlife to the exploration of oil fields to unsustainable farming, ranching, and logging. The reserve has three main zones: a protected core zone, a buffer zone, and a multiple-use zone that allows certain regulated economic activities, including sustainable harvesting of wood, and traditional forest products and agriculture. Since it is often used to clear the forest, fire caused by agriculture and ranching expansion is the single biggest threat to the biosphere.

The IDB/GEF Improvement of Management Effectiveness in the Maya Biosphere Reserve Project seeks to slow down the number of fires in the biosphere reserve, which covers 20 percent of the country's territory, while improving the local population's economic and social conditions. In the multiple-use zone, the project has been teaching rural communities and farmers how to clean the land without fire and to use forest resources in a sustainable way. These education campaigns, coupled with control and prevention activities by national institutions, have helped avoid deforestation by mitigating the risk of fire spread from agricultural areas. During 2010, for example, the project reported a 66 percent decrease in the number of hot spots compared to the average during 2007 and 2009.



A suspension bridge offers a gateway to the jungle in Guatemala.

The Amazon rainforest in Brazil, a natural treasure.



Noel Kempff Mercado Climate Action Project

The Noel Kempff Mercado Climate Action Project began in 1996, before modern REDD standards existed under the Clean Development Mechanism of the Kyoto Protocol. It was designed as a comprehensive 10-year community development project to alleviate the threat of deforestation from local agricultural expansion. Most significantly, it helped indigenous communities living adjacent to the Noel Kempff Mercado National Park to gain legal recognition as an indigenous organization and tenure over ancestral lands bordering the project area. The project also enabled the Government of Bolivia to cancel the rights to commercial harvest in the target area, compensate the owners of area timber-concessions for lost income, and expand a pre-existing national park to encompass these former concessions, effectively stopping degradation from timber harvesting.

The project used a novel economic model of the national Bolivian timber market to calculate leakage from its activities, and carbon benefits are discounted accordingly. Initial investments have enabled a local partner (FAN) to monitor the project, while a permanent endowment will fund monitoring after the 30-year project crediting period ends. The Noel Kempff project is essentially a demonstration of REDD, addressing emissions from both deforestation and forest degradation on 642,184 hectares of forested land. To date, a third party has verified more than one million metric tons of carbon dioxide equivalent (tCO_2e) through 2005. Over the project's lifetime, nearly six million tCO_2e will be avoided.

Indigenous women near Lake Titicaca, Bolivia.

On the Choro Trail, Bolivia.

The fertile Salonica region in Macedonia, Greece, where wheat mingles with fruit trees.

Securing ecosystem services in production landscapes

Forest and pasture resources produce numerous benefits such as controlling erosion, stabilizing water supply, improving water quality, restoring landscape, and enhancing biodiversity, as well as offering opportunities for cultural and environmental tourism. In Albania, however, soil degradation and weak watershed management are threatening these benefits. During 1996 and 2003, the World Bank/GEF Albanian Forestry Project piloted a forest and pasture management project in 30 communes. Following the positive outcome and wide community support, the project was extended under the Natural Resources Development Project (financed by IDA, GEF and the Swedish International Development Cooperation Agency) to 240 communes. In June 2008, the Government of Albania transferred forest land-rights to 345 communes used by almost 1 million people.

The World Bank/GEF Natural Resources Development Project addressed soil degradation and improved watershed management in a variety of ways, including participatory forest-management planning; micro-catchment planning to integrate agriculture, forest, and pasture management; and carbon sequestration. Since the project's inception, for example, small-scale investments in planting of forests and orchards in degraded lands, thinning and cleaning of degraded forests and pastures, and erosion and grazing control measures have helped achieve these results: 25 percent and 50 percent increases in income earned respectively from forest activities, and forest and agriculture activities in micro-catchments; increased natural forest habitats and improvement of scrub forest; and a 200,000-ton reduction in erosion. The project is now seeking alternative revenue sources to provide environmental services from sustainable land management undertaken by upland communities.

Women work in a tobacco field.

The long journey home.

The day ends in Burkina Faso.

Looking Ahead

Looking Ahead

SLM as a pathway to climate-smart agriculture

The themes covered in this book and accompanying stories offer only a glimpse of what is happening globally. Countries such as Australia, Brazil, Canada, China, Ethiopia, India, Indonesia, South Africa, and the United States all have numerous documented cases of successful transformations in production landscapes through SLM that have generated development and environment benefits. In Australia, for example, the grassroots movement known as "Landcare" is mobilizing individuals and groups to improve agricultural productivity through SLM practices.[39] The movement has now extended to more than a dozen countries where government agencies and rural communities are collectively embracing a similar ethic of caring for the land.[40] In the late 1990s, China put in place one of the world's most successful efforts to improve land and water management, focusing on small tributary watersheds of the Loess Plateau in the arid northwest region. With support from the World Bank, the project pursued an integrated catchment management approach to increase on-farm agricultural productivity, convert marginal lands to agriculture, improve rural water supply, and reduce severe erosion and sediment loss into the Yellow River system affecting downstream communities.[41]

The potential to leverage these successful efforts is now greater than ever, especially since sustainable agriculture is increasingly recognized as a contributing factor toward a "Green Economy" around the world.[42] As shown through this book, the triple-win of increased productivity, enhanced climate resilience, and greenhouse mitigation underpins the need for SLM in production systems, especially in the developing world. Indeed, achieving the triple-win through SLM is now touted as part of "climate-smart agriculture," which the Food and Agricultural Organization (FAO) defines as "….*agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation), and enhances achievement of national food security and development goals.*"[43] Clearly, as defined here, "adaptation" and "mitigation" directly benefit from practices that integrate land, water, biodiversity, and environmental management into agricultural landscapes. Indeed, land-use practices contribute to both the emission and sequestration of greenhouse gases. Land is where the struggle to adapt to climate change will be won or lost by the poorest of the poor, reinforcing the importance of SLM for countries' implementation of the Global Environmental Conventions.

While the global environmental benefit of mitigating greenhouse gas emissions is a priority of the United Nations Framework Convention on Climate Change (UNFCCC), SLM is about combating land degradation in production systems—*agricultural, rangelands, and forest landscapes*. SLM therefore underpins implementation of the United Nations Convention to Combat Desertification (UNCCD), to which 194 Parties are now signatories. From dryland regions prone to frequent droughts to the humid tropics with rampant deforestation, combating land degradation through SLM is a global priority that paves the way for constructive implementation of the UNCCD by all countries. Furthermore, biodiversity benefits that result from SLM, such as reduced pressure on natural habitats, maintenance of agrobiodiversity, and diversification of production landscapes, are important priorities for the Convention on Biological Diversity (CBD). Embracing SLM

as a practical option for climate-smart agriculture, therefore, offers countries a unique opportunity to mainstream a wide range of successful interventions that can maximize impact at scale. This is particularly crucial in light of growing demands for efficiency and intensification of agricultural production as a response to the recent global food crisis.[44]

Policy options for harnessing SLM in agricultural intensification

Agricultural intensification, through fostering traditional and cash crops, livestock, forestry, and aquaculture, is a key and desirable way to increase the productivity of existing land and water resources in food production.[45] Generally associated with increased use of external inputs, sustainable intensification also involves the more efficient use of production inputs. Increased productivity comes from improved varieties and breeds, more efficient use of labor, and better farm management. In accordance with its 10-Year Strategic Plan, UNCCD is mandated to improve living conditions of affected populations as one of its four strategic objectives. Therefore, policy for agricultural intensification must recognize the need to act in a water-efficient manner and boost productive safety nets with concrete action that diversifies income and improves livelihoods of farmers and pastoralists in drylands, focusing particularly on women. Some good examples include agroforestry, fruit trees, nurseries, homestead gardens, and other activities to create community and household assets, often in combination with micro-credit and local empowerment of women and men.

Generating knowledge—traditional and new—is also expected to foster intensification, and mobilize networks that disseminate such knowledge effectively. Intensification allows for making the best use of scarce resources for investment in agriculture; this is especially true in drylands where the UNCCD can facilitate transfer and uptake of SLM innovations to help reduce transaction costs. Therefore, while intensification of production systems is important in light of global food security needs, land management systems must avoid compromising the ability of future generations to meet their needs. In this regard, important policy options for sustainable intensification include the following:

- Agricultural diversification must be pursued where existing farming systems are not environmentally sustainable or economically viable. Diversification into high-value, nontraditional crop and livestock systems (e.g. horticulture), is attractive because of the growing market demand for these products, their high labor intensity, and the high returns to labor and management. In contrast to other low-input strategies for sustainable intensification, diversification to high-value products frequently requires the use of relatively high levels of inputs, which must be monitored and managed carefully.

- Tree crops, including fruit, beverage, timber, and specialty crops, maintain vegetative cover and can reduce soil erosion, offering opportunities for environmentally sound production systems. Tree crops, especially when multiple species are planted, help maintain a relatively high level of biodiversity. They are important for export earnings in many countries and, although often suited to large-scale plantations, are also valuable to smallholders with mixed cropping systems.

- Protection and management of natural regeneration is a low-cost form of agricultural intensification that produces multiple benefits, including more complex and productive farming systems, increased resilience to drought, improved soil fertility, increased biodiversity, increased availability of firewood, and enhanced capacity of farmers to adapt to climate change. It also produces a win-win: since trees are capital assets, natural generation reduces rural poverty (by increasing agricultural production), and improves environment and livelihoods.

Both public and private investments are needed to support the transition to more profitable and sustainable farming systems. Sustainable intensification will often require activities that provide an enabling environment and support services for the market-led changes or component technologies, including management practices. Much investment will come from market supply-chains based in the private sector, including input supply, output marketing, processing enterprises, and farmers. Public investment will need to focus on (a) new knowledge and information services, (b) public policy and regulatory systems, and (c) market and private sector development.

A key investment area is in technology associated with management innovations to improve overall productivity and sustainability of agricultural systems. Much research will focus on improving management systems, with an emphasis on understanding agricultural ecology, farm management, and social systems. Biotechnology also offers opportunities to diversify and intensify agricultural production systems, especially based on the potential to close yield gaps for food crops.

Enhancing synergy for implementation of the Conventions at the national level

The CBD, UNCCD, and UNFCCC have overlapping concerns regarding biodiversity loss, land degradation, and deforestation, including implications for livelihoods and food security. As a result, there is considerable interest and opportunity to enhance synergies among the Conventions through countries' SLM practices. SLM increases storage of carbon in soils and in vegetation, helping respond to global warming. At the same time, it enhances crop yields and farm incomes, helping the poor adapt to climate change. SLM practices harness and help maintain vital services provided by biodiversity (genes, species, and ecosystems). For all these reasons, SLM represents a major opportunity for countries to implement the Conventions in a collaborative and coordinated manner based on linkages manifested on land, including the following:[46]

- Addressing climate change can affect rates of desertification and biodiversity loss, for which climate is a key factor;
- Introducing renewable energy technologies for the reduction of greenhouse gas emissions can also reduce pressure on land and forest biodiversity by providing an alternative to unsustainable biomass fuels; and
- Combating deforestation reduces net carbon-dioxide emissions, land degradation, and the loss of biodiversity.

These opportunities can be greatly enhanced by targeting SLM as an investment priority in three areas: mainstreaming into national socioeconomic development plans, formulation and implementation of integrated strategies and policies, and enhancement of capacity for coordination and support mechanisms at national and local levels. Synergy can be further reinforced through common policies and strategies, common thematic areas for SLM implementation, and institutional linkages across sectors. Drawing on resources such as the TerrAfrica Country Support Tool[47] and the Integrated Financing Strategy of the UNCCD's Global Mechanism,[48] many UNCCD-affected Parties are developing strategic investment frameworks for SLM that enhance opportunities for achieving synergy in implementation of all three Conventions. By directing national-level resources toward SLM through mainstreaming across relevant sectors, these Parties will be best placed to leverage GEF resources for incremental financing.

The GEF and SLM Financing

As demonstrated through this book, SLM's value-added lies in its potential to enhance sustainability and resilience of ecosystem service flows in production systems, especially drylands prone to persistent risks of degradation. Investing in SLM is, therefore, a pathway to climate-smart agriculture, which holds great promise for the 2.6 billion people (including about 70 percent of the world's poorest farmers) who depend directly on land resources for their livelihood. As financial mechanism for the global Conventions, the GEF makes harnessing this opportunity a priority. Indeed, the GEF's role needs to be further enhanced to foster SLM as a means of stabilizing ecosystem services and reducing the vulnerability of rural populations. This will involve increased support to building effective enabling environments in countries for the implementation and scaling-up of SLM. The GEF investment also needs to be scaled-up through comprehensive and integrated approaches that cover more territory. Improved management of agroecosystems and forest landscapes over larger geographical areas will safeguard soil and water resources, increase carbon stocks,[49] reduce emissions, and protect biodiversity.

The GEF is the largest financer to developing countries and countries with economies in transition for projects related to both mitigating climate change and combating land degradation (desertification and deforestation). Although the GEF invests in SLM primarily through the designated Land Degradation Focal Area, demands from GEF-eligible countries have helped leverage resources from other GEF focal areas (Climate Change, Biodiversity, and International Waters), and from the climate change adaptation funds (the Least Developed Countries Fund [LDCF] and Special Climate Change Fund [SCCF]). The GEF mandate to address land degradation enables countries to pursue holistic and synergistic options for generating multiple development and environmental benefits. Moreover, the incremental nature of GEF financing enables countries to hone in on development priorities with the greatest leverage potential for global environmental benefits. The GEF Land Degradation Focal Area offers a unique financing opportunity for countries to leverage investments across multiple sectors in meeting their obligations to all major Conventions. Furthermore, it allows those investments to reach the billions of land users who stand to gain directly from SLM innovations that generate global environmental benefits, while ensuring sustainability of production systems.

With the new System for a Transparent Allocation of Resources during the GEF Fifth Replenishment Phase (2010 - 2014), $324 million has been allocated to 143 countries for investment in SLM. This amount will undoubtedly leverage significant co-financing as countries seek to achieve the triple-win and meet their obligations under the Conventions. For many of the countries, the GEF allocation plays a crucial catalytic role to engage stakeholders in SLM at all levels.

Investing in SLM is, therefore, a way to transform the hope and aspirations of millions of poor farmers into reality, with an opportunity to benefit billions and ensure a sustainable planet for future generations. This is the pathway to climate-smart agriculture, but it requires a strategic alignment of priorities under the UNFCCC and the UNCCD, and this in the context of evolving policy discourse on agricultural land use and climate change mitigation. In drylands, where SLM interventions are crucial for improved livelihoods, the large surface area also makes an important target for carbon storage[50] and sequestration. Demonstrating reduced carbon emissions through SLM projects will help position GEF for an influential role in future financing options for climate change mitigation in agriculture. The GEF will harness these opportunities to help countries mainstream SLM as a fundamental aspect of sustainable development.

An inland mountain desert in South Africa, owned and managed by the local community.

A mosaic of terraced fields in the Sultanate of Oman.

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