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Convenient Solutions to an Inconvenient Truth

E N V I R O N M E N T
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D E V E L O P M E N T

[illegible] 2007 [illegible]

Ti les in his series:

Convenient Solutions to an Inconvenient Truth: Ecosystem-Based Approaches to Climate Change

Environmental Flows in Water Resources Policies, Plans, and Projects: Findings and Recommendations

Environmental Health and Child Survival: Epidemiology, Economics, and Experiences

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Ecosystem-Based Approaches to Climate Change

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CONTENTS

Acknowledgments

Abbreviations and Glossary

ACG [illegible]

AFEP [illegible]

AHTEG [illegible]

ARPA [illegible]

CARICOM [illegible]

CBD [illegible]

CDM [illegible]

CEPF [illegible]

CER [illegible]

CFR [illegible]

CIFs [illegible]

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FUNBIO [illegible]

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GISP [illegible]

GtC [illegible]

IBA [illegible]

IPCC [illegible]

IUCN [illegible]

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MABC [illegible]

Mt CO_2e [illegible]

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PSA [illegible]

REDD [illegible]

SCF [illegible]

SFCCD [illegible]

tC [illegible]

UNESCO [illegible]

UNFCCC [illegible]

UN-REDD [illegible]

WWF [illegible]

[illegible]

THE WORLD BANK'S MISSION

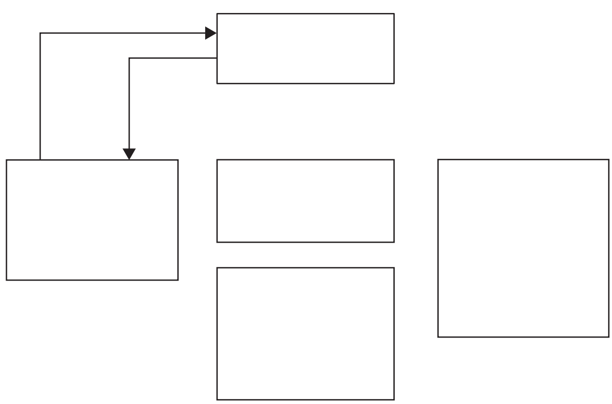
Ecosystem-Based Mitigation

[illegible] 50 [illegible] 2020. [illegible] 7.3 [illegible] ([illegible]), [illegible] 57 [illegible]

CLIMATE CHANGE IS A SERIOUS ENVIRONMENTAL CHALLENGE

[illegible]

FIGURE 1.1
Approximate Stores (Gigatons) and Fluxes (Gigatons per Year) of Carbon



Impacts of Climate Change on Ecosystems and Biodiversity

BOX 1.1

Monitoring the Impact of Climate Change in a Biodiversity Hot Spot

The Succulent Karoo biome, which covers 116,000 square kilometers of desert along the Atlantic coast of South Africa and southern Namibia, supports the world's richest succulent flora. It is one of the world's 34 biodiversity hot spots, regions that are the richest in endemic species and also the most threatened on Earth. Together these hot spots harbor more than 75 percent of the most threatened mammals, birds, and amphibians, yet they have already lost more than 85 percent of their original habitat cover. These critical areas for biodiversity are also home to millions of people who are highly dependent on healthy ecosystems for their livelihoods and well-being.

This transboundary area—comprising the Richtersveld, Gariep River, Ais-Ais, and the Fish River Canyon—has a staggering 2,700 plant species, of which 560 are endemic. Compared with vegetation in other hot spots, vegetation in the Richtersveld remains relatively intact in spite of pressures from overgrazing and diamond mining. In recognition of these values, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) has put the Richtersveld cultural and botanical landscape on its World Heritage List.

The area is globally recognized as an example of a biodiversity hot spot under apparent and imminent threat from climate change. Projected time [illegible] (... 1.2). [illegible]

BOX 1.2

Climate Change and Biodiversity Loss in Hövsgöl National Park, Mongolia

Hövsgöl National Park is centered on Lake Hövsgöl, lying at 1,700 meters above sea level in the mountains of northern Mongolia. Here the winters are long and vicious, with temperatures dropping to below –40° C. The Lake Hövsgöl area lies at the southern edge of the taiga forest and is underlain by permafrost (la-scTc0.ll2a 8(00 me)gf fro°cCdcs333 TcDl 1.° C. The1(gadatand 126t1(scause[(

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Impacts on Human Communities and Livelihoods

[illegible] 30 [illegible] 1980 [illegible] ([illegible]) [illegible] ([illegible] 1.3). [illegible] 1.1 [illegible]

BOX 1.3

Likely Regional Impacts on Human Communities and Livelihoods

The fourth assessment of the IPCC studied and reported on the likely regional impacts. The magnitude and timing of impacts will vary with the amount and rate of climate change.

In *Africa*, by 2020, between 75 million and 250 million people are projected to be exposed to increased water stress due to climate change, and, in some countries, yields from rain-fed agriculture could be reduced up to 50 percent. Toward the end of the century, the projected rise in sea level will affect low-lying coastal areas with large populations. The cost of adaptation could amount to at least 5–10 percent of gross domestic product (GDP). By 2080, arid and semiarid land is projected to increase 5–8 percent.

In *Asia*, by the 2050s, the availability of freshwater in Central, South, East, and Southeast Asia, particularly in large river basins, is projected to decrease. Coastal areas, especially heavily populated delta regions in South, East, and Southeast Asia, will be at greatest risk due to increased flooding from the sea and, in some mega-deltas, from the rivers. Climate change is projected to compound the pressures on natural resources and the

[illegible]

environment associated with rapid urbanization, industrialization, and economic development. Endemic morbidity and mortality due to diarrheal disease, primarily associated with floods and droughts, are expected to rise in East, South, and Southeast Asia.

In *Latin America*, by mid-century, increases in temperature and associated decreases in soil water are projected to lead to the gradual replacement of tropical forest by savanna in eastern Amazonia. Similarly, areas of semiarid vegetation will tend to be replaced by dryland vegetation. Significant biodiversity will be lost as a result of species extinction in many areas of tropical Latin America. Changes in rainfall patterns and the disappearance of glaciers are projected to reduce the availability of water for human consumption, agriculture, and energy generation.

In *small islands*, sea-level rise is expected to exacerbate inundation, storm surge, erosion, and other coastal hazards. By 2050, climate change is expected to reduce water resources in many small islands, such as in the Caribbean and Pacific, to the point where they become insufficient to meet demand during periods of low rainfall. With higher temperatures, increased invasion by non-native species is expected to occur, particularly on mid- and high-latitude islands.

[illegible]

[illegible]

TABLE 1.2

Total Biodiversity Investments, by Year and Source of Funding

US$ millions

	World Bank Group							
Fiscal Year	GEF	IBRD	IDA	Trust Funds	Carbon Finance	Total	Co-financing	Total Biodiversity Funding
19	0.00	3. 9	2.	0.00	0.00	.	.9	1 . 0
19 9	0.00	3.1	3.9 3	0.00	0.00	.09	.21	12.30
199 0	0.00	129 .2	14.22	0.00	0.00	143.4	9 1.00	234.4
199 1	0.00	9 .1	3 .4	0.00	0.00	132.	129 .9 4	2 2. 9
199 2	23.20	9 1.21	12 .9	0.00	0.00	240.3	130.1	3 0.
199 3	29 . 9	1 .13	2 .3	0.00	0.00	.29	43.	11 .9
199 4	1.2	2 .9 4	4.01	0.00	0.00	133.21	3.9	19 .1
199	44.0	. 1	34. 0	3 .	0.00	1 1.33	1 .0	34 .40
199	4.23	40. 9	.0	0.30	0.00	120.4	0.4	19 0.9
199	9 .9 0	39 .29	103.	2.00	0.00	240.9	1 .4	399 .43
199	.2	9 . 4	122.	0.20	0.00	2 0.9	2 2.	13. 4
1999	4 .12	1 .	40.1	3.23	0.00	104.3	101.9	20 .34
2000	2.0	49 . 9	14.0	.3	0.00	123.0	0. 4	1 3. 0
2001	1 .	49 . 4	29 .41	2 .9 0	0.00	2 3. 9	2 .	42.2
2002	1 4.9 2	1 .10	.49	.	0.00	241.1	20 .21	44 .39
2003	1.31	33.33	2.29	0.00	0.00	1 .9 2	110.	2 . 0
2004	103.4	3 .9	. 0	4.42	0.44	213.	2 4.9	4 . 4
200	11 . 3	. 4	3.20	14.4	0.00	29 4.9 3	1 4.3	449 .31
200	1 .02	.	2 .39	1 . 0	19 .20	29 .9	1 2.33	4 9 .29
200	0. 1	3 . 4	2 . 2	3.02	1.04	13 . 3	.	19 3. 1
200	4 .3	33.3	0. 0	1.10	0.00	3. 4	1 .11	2 1.
Total	1,403.9	1,003.	9 2 .23	124.00	20.	3,4 . 2	[redacted]	,19 2.1

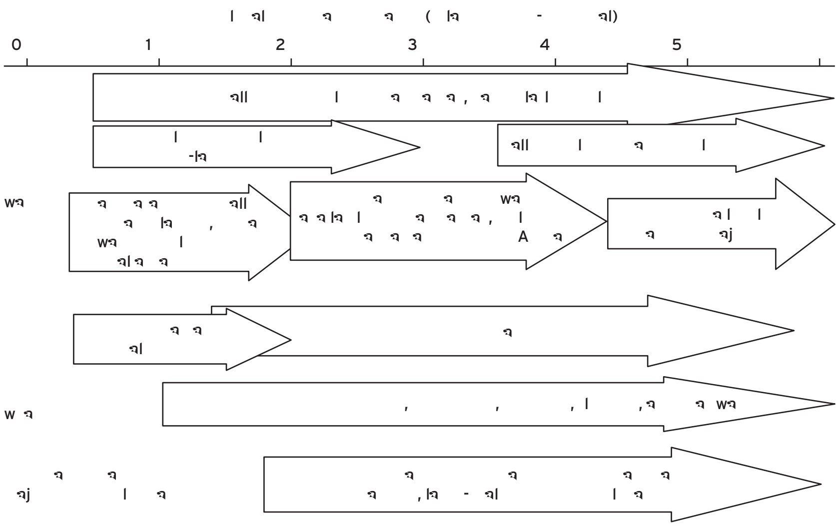
S : World Bank 33 gs1239our1313725 0./GS2 gs1Tf8 0 0 8 60 188.3152 Tm0.13725 0.1 184.6.90196 0.90588 0.

CHAPTER 2

Natural Ecosystems and Mitigation

CLIMATE CHANGE IS ALREADY AFFECTING NATURAL SYSTEMS, [illegible]

FIGURE 2.1
Likely Changes to Earth Systems Depending on Mitigation Activities Undertaken



S   *:* Stern 2007.

Afforestation and Reforestation

[illegible] ([illegible] 2.1). [illegible] 23,000 [illegible] *Acacia senegalensis,* [illegible]

BOX 2.1

Reforestation under the BioCarbon Fund

Brazil: Reforestation around hydro reservoirs

Natural forests will be restored on approximately 5,576 hectares of land around four reservoirs created by hydroelectric plants in the state of São Paulo. Planting a mix of at least 80 native species will regenerate forested areas, protect the recreational use of the area, and improve the value of the lands for tourism. Many of the targeted sites are connected to existing forested areas and linked to riverine habitats. Restoration of forest is expected to sequester 0.67 Mt CO_2e by 2012 and 1.66 Mt CO_2e by 2017, increasing critical habitats, creating vital wildlife corridors, and connecting the newly forested lands with existing conservation areas.

China: Pearl River watershed management

This project is reforesting 4,000 hectares in the Guangxi Zhuang Autonomous Region, which includes half of the Pearl River basin and is an area of high biodiversity value. The sites selected for planting are shrubland, grassland, and areas with less than 30 percent tree cover; 75 percent of the species planted will be native. ***Eucalyptus***, grown in China for a century, will make up most of the exotics. The restoration of forests along the middle and upper reaches of the Pearl River will serve as a demonstration model for watershed management. Carbon sequestered by a plantation will be used as a cash crop and will generate income for local communities. As the first life-size Land Use, Land Use Change, and Forestry (LULUCF) project in China, it

BOX 2.2

Building Resilience by Promoting Native Vegetation in Mali

For the past 30 years, the Nara area of northern Mali has suffered decreases in rainfall and water levels, land degradation, loss of forest canopy, and change in plant species composition. Tree cutting for firewood, charcoal, and shifting agriculture has been a leading cause of deforestation in the area.

Securing Carbon Stores through Protection and Restoration of Natural Ecosystems

[illegible]

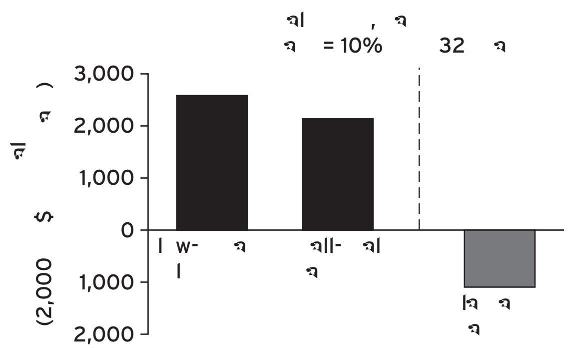
[illegible]

BOX 2.3

Economic Arguments for Sustainable Forest Management

A study from Mount Cameroon comparing low-impact logging with more extreme uses of land found that private benefits favor the conversion of forests to small-scale agriculture. Conversion to oil palm and rubber plantations, however, yielded negative private benefits once the effect of market distortions was removed. Social benefits from nontimber forest products, sedimentation control, and flood prevention were highest under sustainable forestry, as were global benefits from carbon storage. This was true for a range of option, bequest, and existence values. Overall, the total economic value of sustainable forestry was 18 percent greater than that of small-scale farming ($2,570 compared with $2,110 per hectare).

Net Present Value of Various Uses of Tropical Forest in Cameroon



BOX 2.4

Carbon and Conservation in the Forests of Indonesia

In December 2004 a tsunami struck Aceh, Indonesia, causing a large-scale humanitarian crisis, especially along the west coast. In this narrow coastal belt, communities and agricultural lands border directly on protected forests and the karst mountain ranges of the Gunung Leuser National Park and ecosystem in the south and the Ulu Masen Forest Complex in the north. More than two-thirds of the province remains under forests. Even within Indonesia, a mega-diversity country, this area is unique, comprising the largest remaining contiguous forested area (3.3 million hectares) with the richest assemblage of wildlife in Southeast Asia, including tigers, elephants, rhinos, and orangutans. These areas also provide valuable ecosystem services

Wetlands

[illegible] 20 [illegible] 25 [illegible] 550 ([illegible] 2008). [illegible] 0.3 [illegible] ( ) [illegible] ([illegible] 2009). [illegible]

[illegible]

Grasslands

[illegible]

Afforestation and reforestation activities on 1,200 hectares of the wetlands is expected to generate carbon credits for approximately 193,000 tons of CO_2e up to 2017, which will be purchased by the BioCarbon Fund. This investment will fund the restoration work, including the following activities:

- Restoration of natural hydrology will help to restore Nariva's ecological functions, including active management of the landscape to ensure the survival of the existing forest as well as reforested areas.
- Between 1,000 and 1,500 hectares are being reforested with native terrestrial and aquatic species. Mechanical and chemical treatment of invasive species may be required to open areas for more natural plant communities.
- A fire management program will protect the newly restored vegetation.
- A monitoring plan will record the impact of reforestation activities and monitor biodiversity, including key species.

[illegible]

Protected Areas: A Convenient Solution to Protect Carbon Sinks and Ecosystem Services

BOX 2.7

Amazon Region Protected Areas Program: A Storehouse for Carbon and Biodiversity

The Amazon Region Protected Areas (ARPA) Program is an initiative of the Brazilian government to support biodiversity conservation in the Brazilian Amazon, one of the world's largest remaining wilderness areas and an important carbon store. Under the ARPA Program, Brazil has created 22.28 million hectares of protected areas since 2000, surpassing its first-phase target of 18 million hectares. With government support and additional grant funding from the GEF, Kreditanstalt für Wiederaufbau (KfW), and World Wide Fund for Nature (WWF), ARPA has strengthened the management of an additional 8.65 million hectares of existing protected areas. With these 30.93 million hectares of biodiversity-rich forests—a mosaic of state, provincial, private, and indigenous reserves—ARPA is the world's largest protected area program. Plans for the future are even more ambitious: to create a system of well-managed parks and other protected areas, including extractive and indigenous reserves, that encompasses some 50 million hectares, an area larger than the entire U.S. system of national parks.

ARPA was established to protect the rich biodiversity of the Amazon basin, but the mosaic of protected areas contributes to both Brazilian and global efforts to fight climate change through avoided deforestation. The carbon stock in ARPA reserves is estimated at 4.5 billion tC, with potential reductions in emissions estimated at 1.8 billion tC. This role is recognized in the *Stern Review on the Economics of Climate Change* (Stern 2007).

The ARPA Program has tested and demonstrated the value of public-private partnerships and different institutional models, both in implementation of the overall program and in management of individual forest sites. The program funding is disbursed through an NGO—the Brazilian Biodiversity Fund, FUNBIO—which allows greater flexibility and innovation to improve operational effectiveness and create accounts that are co-managed by

[illegible] ([illegible] 2.9). [illegible]

BOX 2.11 *(continued)*

magnitude greater than the total presently allocated from the central budget to the rest of the Lao protected areas system. The Bank is therefore establishing another fund for other local conservation areas to provide modest, demand-driven funding at a level appropriate to existing local capacity. Sustained support for the fund will also come from the revenues generated by natural resource industries. Through direct financing and the promotion of integrated development models, the Bank is providing long-term biodiversity funding for conservation efforts in Lao PDR.

TABLE 2.2
Known Invasive Species Proposed as Suitable for Biofuel Production

Species Name	Common Name	Native Range	Invasive Status
Artocarpus communis, A. altilis	Breadfruit	Pacific Islands, Southeast Asia	Fiji, Kiribati, Line Islands
Arundo dona	Giant reed	Eurasia	Australia, the Caribbean, Hawaii, Mexico, New Zealand, South Africa, Southern Europe, Thailand, United States
A adirachta indica	Neem	Bangladesh, India, Myanmar, Sri Lanka,	Australia, Fiji, Mauritius, West Africa
Brassica napus	Rapeseed, canola	Eurasia	Australia, Ecuador, Fiji, Hawaii, New Caledonia
Camelina sativa	False flax	Eastern Europe and Southwest Asia	Australia, Central America, Japan, North America, South America, Western Europe
Elaeis guineensis	African oil palm	Madagascar, West Africa	Brazil, Florida, Federated States of Micronesia
Gleditsia triacanthos	Honey locust	Eastern North America	Australia, Central Argentina, New Zealand, South Africa, United States
Jatropha curcas	Jatropha, physic nut	Tropical America	Australia, Pacific Islands, Puerto Rico, South Africa, United States
Maclura pomifera	Osage orange	Central United States	Australia, Europe, South Africa, United States
Morus alba	Mulberry	Asia	Brazil, Ecuador, United States
Olea europaea	Olive tree	Mediterranean Europe	Australia, Hawaii, New Zealand
Phalaris arundinacea	Reed canary grass	Asia, Europe, North America	Australia, Chile, New Zealand, South Africa, United States, most temperate countries

(*continued*)

Prosopis spp.	Mesquite	North America	Australia, Eastern Africa (Djibouti, Eritrea, Ethiopia, Sudan), Southern Africa, India
Ricinus communis	Castor bean	East Africa	

2006.

Jatropha curcas,

BOX 2.12

Biofuels: Too Much of a Good Thing?

With oil prices at record highs and with few alternative fuels for transport, several countries are actively supporting the production of liquid biofuels from agriculture—usually maize or sugarcane for ethanol and various oil crops for biodiesel. The economic, environmental, and social effects of biofuels need to be assessed carefully before extending public support to

B a . Biofuels can benefit smallholder farmers by generating employment and increasing rural incomes, but the scope of those benefits is likely to remain limited given current technologies. Ethanol production requires fairly large economies of scale and vertical integration because of the complexity of the production process in the distilleries. Small-scale production of biodiesel could meet local demand for energy, but rising prices for food and feedstock could negate any gains in cheaper energy.

S : World Bank 2008b.

CHAPTER 3

Ecosystem-Based Adaptation: Reducing Vulnerability

DURING THE COURSE OF HUMAN HISTORY,

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[illegible]
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[illegible]
[illegible]
[illegible]
[illegible]

BOX 3.5

Measures to Address Climate Change in the Salinas and Aguada Blanca National Reserve in Peru

Since 2005 the GEF has supported the Participatory Management of Protected Areas Project in Peru, including the Salinas and Aguada Blanca National Reserve. Located north of the city of Arequipa, at an altitude between 3,600 and 6,000 meters, the Salinas and Aguada Blanca National Reserve is home to wild cameloids, such as vicuña and guanaco, as well as many migratory and resident birds that breed around the mountain lakes, dams, and rivers. Created in 1979 to conserve the endangered flora and

BOX 3.6

Investing in Mangroves

The destruction of mangroves has a strong economic impact on local fisheries and fishing communities. Maintenance or restoration of mangroves can, however, reduce vulnerability of coastal areas to sea-level rise and extreme weather events, while also contributing to food security. Often such ecosystem-based approaches are highly cost-effective.

Restoring and protecting mangroves can reduce vulnerability in various ways:

- Mangrove forests have an estimated economic value of $300,000 per kilometer as coastal defenses in Malaysia (Ramsar Convention on Wetlands 2005).
- Since 1994, communities have been planting and protecting mangrove forests in Vietnam as a way to buffer against storms. An initial investment of $1.1 million saved an estimated $7.3 million a year in sea dike maintenance and significantly reduced the loss of life and property from Typhoon Wukong in 2000 in comparison with other areas (IFRC 2002).
- Loss of mangrove area has been estimated to increase storm damage on the coast of Thailand by $585,000 or $187,898 per square kilometer (in 1996 U.S. dollars), based on data from 1979–96 and 1996–2004, respectively (Stolton, Dudley, and Randall 2008).
- Recent studies in the Gulf of Mexico suggest that mangrove-related fish and crab species account for 32 percent of the small-scale fisheries in the region and that mangrove zones can be valued at $37,500 per hectare annually (Aburto-Oropeza and others 2008).
- In Surat Thani, Thailand, the sum of all measured goods and services of intact mangroves ($60,400) exceeds that of shrimp farming from aquaculture by around 70 percent Balmford and others 2002).

[illegible] ([illegible]) [illegible]
$1.4 [illegible] $9 [illegible]
[illegible] (2005), [illegible]
[illegible] (15220 [illegible]), [illegible] (7211 [illegible]).
[illegible]

- [illegible] 20230 [illegible]
- [illegible]
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[illegible] ([illegible]) [illegible] ([illegible] 3.8). [illegible]

( ). [illegible] (3.9). [illegible]

Investing in Ecosystems versus Infrastructure

[illegible]

(2009). (3.10).

BOX 3.10

Protecting Natural Forests for Flood Control

The irregular rainfall patterns prevailing in Argentina cause floods and droughts. Under all climate change scenarios, these boom-and-bust cycles will be exaggerated. Currently, about one-fourth of the country is repeatedly flooded. This is particularly true for northeastern Argentina, which has three major rivers—the Paraná, the Paraguay, and the Uruguay—and extensive, low-lying plains. The seven provinces of this area (Entre Ríos, Formosa, Chaco, Corrientes, Misiones, Buenos Aires, and Santa Fe) make up almost 30 percent of the country and include more than half of Argentina's population.

Flooding is the major force regulating the ecosystems around these rivers; virtually all ecological events in the floodplains are related to the extent and regularity of flooding. Typical habitats include the Pampas grasslands, Mesopotamia savanna, Paraná forests, Chaco estuaries and forests, and the Paraná River islands and delta. The Paraná forests in the province of Misiones have the highest level of faunal biodiversity, followed by the Chaco estuaries and forests. Overall, 60 percent of Argentina's birds and more than 50 percent of its amphibians, reptiles, and mammals are found in the floodplains.

The first phase of a two-stage flood protection program provided cost-effective flood protection for the most important economic and ecological areas and developed a strategy to cope with recurrent floods. Activities included the development and enforcement of flood defense strategies, the maintenance of flood defense installations, early flood warning systems, environmental guidelines for flood-prone areas, and flood emergency plans. Extensive areas of natural forest were protected as part of the flood defense system. This incorporation of natural habitats into flood defenses provided a low-cost alternative to costly infrastructure, with the added benefit of high biodiversity gains. As changing climate makes extreme weather events and flooding more likely, the experience of Argentina provides some useful lessons on how best to harness natural habitats to reduce the vulnerability of downstream communities.

[illegible] $100 [illegible] $170,000 [illegible] (… 2008). [illegible] (… 3.1).

[illegible] (… 3.2).

TABLE 3.1
Ecosystem-Based Approaches to Defend against Natural Disasters

Natural Hazard	Types of Ecological Protection	Examples
Landslide		

FOR SOME YEARS, THE WORLD BANK HAS RECOGNIZED THE THREAT

2050, 40 (2008).

( ),

( ),

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-
-
-
-
-
-

BOX 4.1

Insects and Orange Juice: Paying for Ecosystem Services in Costa Rica

In Costa Rica, the Del Oro Company, a large producer of citrus juices, is leading the way in maintaining a balance between agriculture and nature. Its collaboration with the government of Costa Rica in conserving tropical forests in the Guanacaste National Park ensures the provision of essential ecosystem services to the plantations.

The Area de Conservación Guanacaste (ACG) encompasses a range of tropical forest habitats including a belt of transition forests between the dry forests of Guanacaste and the wetter Caribbean rain forests. Approximately 1,200 hectares of the dry-wet transition forests form a wide peninsula extending into the Del Oro plantations and adjoining the ACG forests at the southern boundary of Del Oro lands. Del Oro recognizes that the ACG provides essential ecosystem services, in the form of pollination and pest control, to the citrus plantations and juice production industry. Through an agreement with the Ministry of Environment and Energy signed in August 1998, Del Oro agreed to pay for such services:

- Biological control agents, primarily parasitic wasps and flies of importance to integrated pest control, were valued at $1 per hectare per year for the 1,685 hectares of Del Oro orange plantations adjacent to the AGA, for a total of $1,685 a year.
- Water from the Upper Río Mena Basin, in the ACG, services Del Oro farms and was valued at $5 per hectare per year for the 1,169 hectares, totaling $5,885 a year.
- Biodegradation of the orange peels from Del Oro on ACG lands was valued at $11.93 per truckload, for a minimum payment of 1,000 truckloads per year, for a total of $11,930 a year.

3

BOX 4.2

Water Tanks for Irrigation in Andhra Pradesh, India

In the Godavari River Basin in India, home to 63 million people, nearly all rain falls in the monsoon from June to October, making storage essential for year-round access to water. Poverty, limited water supplies, drought, costs of seeds and farm chemicals, and iniquitous financing by suppliers jeopardize the lives of many farmers and have resulted in a wave of farmer suicides. Climate change adds uncertainty to the frequency and rate of precipitation in the region, putting an additional burden on these farmers.

Ancient village earth dams (1–10 hectares in size), which used to function as storage tanks, have deteriorated due to mismanagement and full diversion of river water. Loss of surface waters has driven the overexploitation of groundwater, further threatening security of supply. To meet the growing demand for irrigation water, the Andhra Pradesh government proposed building a $4 billion Polavaram Dam on the Lower Godavari River, which would displace 250,000 people and inundate key habitats, including 60,000 hectares of forest.

A World Wide Fund for Nature (WWF) pilot project developed in 2004 in collaboration with a local NGO and villages assessed the costs and benefits of restoring the old water tanks. Between 2005 and 2006, in Sali Vagu subcatchment, on a tributary of the Godavari, 12 tanks with an area of 11 hectares and serving 42,000 people were restored through de-silting to capture and store more monsoon runoff. The $103,000 intervention was undertaken with funding of $28,000 in cash from WWF and $75,000 from farmers in cash inputs and labor. The increased water supply and groundwater recharge resulted in less groundwater pumping. Water tables rose, reactivating some dry wells worth an average value of $2,330 each. An additional 900 hectares were irrigated, and the nutrient-rich silt was spread over 602 hectares. Crop yields rose significantly, increasing total production by Rs 5.8 million ($69,600) per year. Irrigation of additional lands reduced the need for electricity to pump groundwater, and wages paid for de-silting the tanks supplemented farmers' incomes. In addition, use of some ponds for fish production provided a further net profit of Rs 160,000 ($3,700). The project also created artificial habitats for migratory and water birds.

The pilot project demonstrated the potential for tank restoration to meet India's soaring demand for water, in place of proposals for large-scale water infrastructure developments. In the Maner River Basin, 6,234 water tanks covering 588 square kilometers could be de-silted at an estimated cost of Rs 25.5 billion ($635 million). These could store an extra 1.9 billion cubic meters of water (compared to estimated water use in the basin today of 2 billion cubic meters per year) at a cost of $0.32 per cubic meter. Further, this water would be stored widely across the basin where more people could access it. In contrast, the government's proposed $4 billion Polavaram Dam would store 2.1 billion cubic meters of irrigation water at a cost of $1.88 per cubic meter.

S   : WWF 2008.

BOX 4.3
Adaptation to Climate Change: Exploiting Agrobiodiversity in the Rain-fed Highlands of the Republic of Yemen

Communities in the highlands of the Republic of Yemen retain old crop varieties and traditional knowledge related to the use of these agrobiodiversity resources. Knowledge and practice have evolved over more than 2,000 years to increase agricultural productivity in areas of limited rainfall. The construction and management of terraces, for instance, help to improve the

Sustainable Land Management

complement a loan through the Rain-fed Agriculture and Livestock Project. Since women do much of the farm work in the Republic of Yemen, the project will have a strong gender emphasis. The project will have four components:

- ***Agrobiodiversity and local knowledge assessment.*** Document farmers knowledge on (adaptive) characteristics of local landraces and their wild relatives in relation to environmental parameters to develop vulnerability profiles for the crops.
- ***Climate modeling assessment.***

BOX 4.4

Conservation Farming in Practice in South Africa

A GEF-funded medium-size project showed that conservation farming on some South African farms can reduce input costs, increase profits, and improve sustainability. These farming practices also conserve biodiversity, contribute to carbon sequestration, and improve the quantity and quality of water flow.

Farming for Flowers on the Bokkeveld Plateau

From the western rim to the eastern margin of the Bokkeveld plateau, rainfall declines from 500 millimeters to 200 millimeters per year over a distance of 15 kilometers. Over this transition, the vegetation changes from fynbos on infertile sandy soils to renosterveld to Succulent Karoo. The area supports about 1,350 plant species, 97 of which are endangered. The small village of Nieuwoudtville on the Bokkeveld plateau is the “bulb capital of the world,” with a staggering 241 bulb species. The richest concentration of bulbs, both in terms of species and individuals, occurs on the highly fertile clays. Unfortunately, large areas of bulb-rich veld have been ploughed up and replaced with cereals and pasture crops.

About 30 years ago, one farmer—Neil McGregor, on the farm Glen Lyon—decided that this form of agriculture was not sustainable. Instead, he began to nurture the indigenous veld to provide better plant cover. With the diversity of indigenous plants, McGregor was able to maintain productivity for much longer through the dry summer season than his neighbors did with their planted crops. By using biodiversity-friendly practices and refraining from the use of pesticides, he boosted sheep productivity and reduced the use of inputs. Moreover, he found that aardvark and porcupine, which are considered troublesome on crop farms, promoted the proliferation of bulbs and hence forage for his livestock. He abandoned attempts to control these so-called problem animals. One consequence of this conservation farming was unparalleled displays of

30

(

4.5).

wildflowers with a profusion of bulb species flowering from mid-winter through to late spring. These displays draw tourists to Namaqualand, bringing additional tourist income to the farm and district. Glen Lyon has become a role model in the region, and many farmers are now using conservation farming practices. Recently, Glen Lyon was declared a national botanical garden in recognition of its biodiversity values.

Getting the Most Out of the Veld

The semiarid area of South Africa known as the Nama Karoo is characterized by highly variable rainfall from year to year. The natural veld comprises a very diverse flora of palatable shrubs and grasses, interspersed with unpalatable shrubs. This area also supports an important livestock industry, based mainly on wool and mutton production. Over the past century, the condition of ranch land over much of the Nama Karoo has deteriorated, with the proliferation of a few unpalatable species replacing more palatable plants.

One farm in Elandsfontein in the Beaufort West district instituted a grazing regime that simulated natural conditions before farming, when the veld was grazed by migrating herds of ungulates. Livestock were separated into small units and kept in one area until that area was well grazed before being moved on. The condition of the veld improved. Livestock were forced to eat both palatable and unpalatable plant species. Since the unpalatable plants were not adapted to being grazed, they lost their competitive edge, became weakened, and declined in number. The higher number of small management areas ensured a longer period between grazing, thereby enabling much of the rangeland to recover. Studies show that implementation of this system raised productivity in the district, created an ecological buffer, and increased the resilience of the veld against drought, with benefits for both biodiversity and production.

S ***:*** Pierce and others 2002.

BOX 4.5

Payments for Environmental Services to Protect Biodiversity and Carbon in Agricultural Landscapes

$140

Protecting Natural Ecosystems for Water Services

from four major floods between 1991 and 1998 resulted in thousands of deaths and billions of dollars in damages.

To ameliorate these conditions, government agencies and NGOs have been restoring the wetlands in the basin, reconnecting the flows between the lakes and the Yangtze River. Since 2005, the sluice gates at lakes Zhangdu, Hong, and Tien'e zhou have been seasonally reopened, and illegal and uneconomic aquaculture facilities and other infrastructure have been removed or modified. Now these 448 square kilometers of wetlands can store up to 285 million cubic meters of floodwaters, reducing vulnerability to flooding in the central Yangtze region. Cessation of unsustainable aquaculture, better agricultural practices, and reconnection to the Yangtze River have reduced pollution levels in these lakes. Pollution fell at Lake Hong from national pollution level IV (fit for agricultural use only) to level II (drinkable) on China's five-point scale.

Healthy wetlands naturally remove organic and inorganic pollutants and supply clean water. Restoration of these wetlands provided more services than constructing wastewater treatment plants and at a considerably cheaper cost. Rehabilitation of these wetlands has also considerably enhanced the biodiversity of the lakes, bringing back 12 migratory fish species. Hong Lake supported only 100 herons and egrets when polluted; after restoration, the lake supported 45,000 wintering water birds and 20,000 breeding birds, including the endangered Oriental White Stork. Similar positive results were seen in Tian'e zhou and Zhangdu lakes as well.

S: WWF 2008.

[illegible]

Natural Water Towers

[illegible]

CHAPTER 5

Implementing Ecosystem-Based Approaches to Climate Change

CLIMATE CHANGE HAS BECOME THE KEY ENVIRONMENTAL CONCERN [illegible]

Looking Forward: The Strategic Framework for Climate Change and Development

Growing Forest Partnerships

[illegible] 17 [illegible]

Climate Investment Funds

[illegible] 2012, [illegible] 2008. [illegible]

[illegible] ([illegible] 5.1).

Reducing Emissions from Deforestation and Degradation

[illegible] 45 [illegible]

$1.2

$695

$3.9

2006.

2008).

5.6

BOX 5.1

Principles for Leveraging Benefits from REDD for the Poor

1. ***P a .*** Basic details of how REDD mechanisms work, realistic expectations of benefits, and possible implications of different approaches are required.
2. ***P - a a a .*** Provision of up-front finance would significantly improve the equitable distribution of benefits; for example, at community levels, some options for self-financing could be explored, such as improved agricultural production, nonfarm employment, and revolving credit programs.
3. ***U a a .*** "Hard" enforcement measures such as financial penalties are likely to affect the poor disproportionately. Instead, "soft" measures such as nonbinding commitments to emissions reduction should be applied where possible.
4. ***P - REDD a a a .*** Stable and predictable benefits would provide increased security to the poor.
5. ***P a a a a a .*** To ensure "voice and choice," improved access to appropriate legal support is crucial for poor people.
6. ***Ma a REDD a .*** Flexibility is crucial in order to minimize risks such as communities being locked into inappropriate long-term commitments.
7. ***C a a a a a a .*** Rights to own and transfer carbon are essential, and such rights are likely to govern land management over long time scales.
8. ***D a a a .*** Social standards would improve benefits for the

[illegible] , 25 [illegible]
[illegible]
[illegible]

BOX 5.2

Can Carbon Markets Save Sumatran Tigers and Elephants?

Riau Province in central Sumatra harbors populations of the critically endangered Sumatran tiger and the endangered Sumatran elephant within a high-priority Tiger Conservation Landscape. Riau has lost 65 percent of its original forest cover and has one of the highest rates of deforestation in the world, due to loss and conversion of forest for agriculture, for pulpwood plantations, and for expanding industrial oil palm plantations to serve the surging biofuels market. If the current rate of deforestation continues, estimates suggest that Riau's natural forests will decline from 27 percent today to only 6 percent by 2015. All of this comes at a global cost. The average annual carbon dioxide (CO_2) emissions from deforestation in Riau exceed the emissions of the Netherlands by 122 percent and are about 58 percent of Australia's annual emissions. Between 1990 and 2007, Riau alone produced the equivalent of 24 percent of the targeted reduction in collective annual GHG emissions set by the Kyoto Protocol Annex I countries for the first commitment period of 2008–12.

Can carbon trading provide a new economic incentive to protect Riau's forests, especially the carbon-rich peat swamp forests? At present, countries are not rewarded for retaining forest canopy (avoided deforestation); instead, the emphasis is on afforestation. Second, although new programs are under consideration to provide incentives for conserving forests, the prevailing price of carbon may be too low to shift incentives from forest clearance for biofuels or pulp to conservation. Third, even if the price of carbon rises sufficiently, Riau's forests may not be given priority over other forests with higher carbon sequestration potential because the proposed new systems pay only for carbon, giving little attention to the biodiversity value of forests.

Yet carbon markets may have potential to promote conservation in less productive lands. In parts of South Asia, the returns (present value) of arable land are often as low as $100 to $150 per hectare. Clearing a hectare of tropical forest could release 500 tons of CO_2. At an extraordinarily low carbon price of even $10 per ton of CO_2, an asset worth $5,000 per hectare is being destroyed for a less valuable use. A modest payment through avoided deforestation schemes could be sufficient to shift incentives in some of the unproductive arable land in South Asia.

S ***:*** Damania and others 2008.

Type of Project

- [illegible]
- [illegible]

- [illegible]
- [illegible]

Competent Project Participants and Clear Institutional Arrangements

- [illegible]
- [illegible]

Viable Business and Operation Model That Helps to Reduce Transaction Costs

- [illegible]
- [illegible]

Ratification of Kyoto Protocol by the Host Country

- [illegible]
- [illegible]

Financing Sought

- [illegible]
- [illegible]

Sound Financing Structure

- [illegible]
- [illegible]

Technical Summary of Project

- [illegible]
- [illegible]
- [illegible]

E pected Environmental Benefits

- [illegible]

Safeguard Policies of the World Bank Group

- [illegible]

Contribution to Sustainable Development

- [illegible]

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ECO-AUDIT

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Saved:

- 19 trees
- 6 million British thermal units of total energy
- 1,8455 pounds of net greenhouse gases
- 8,885 gallons of waste water
- 539 pounds of solid waste