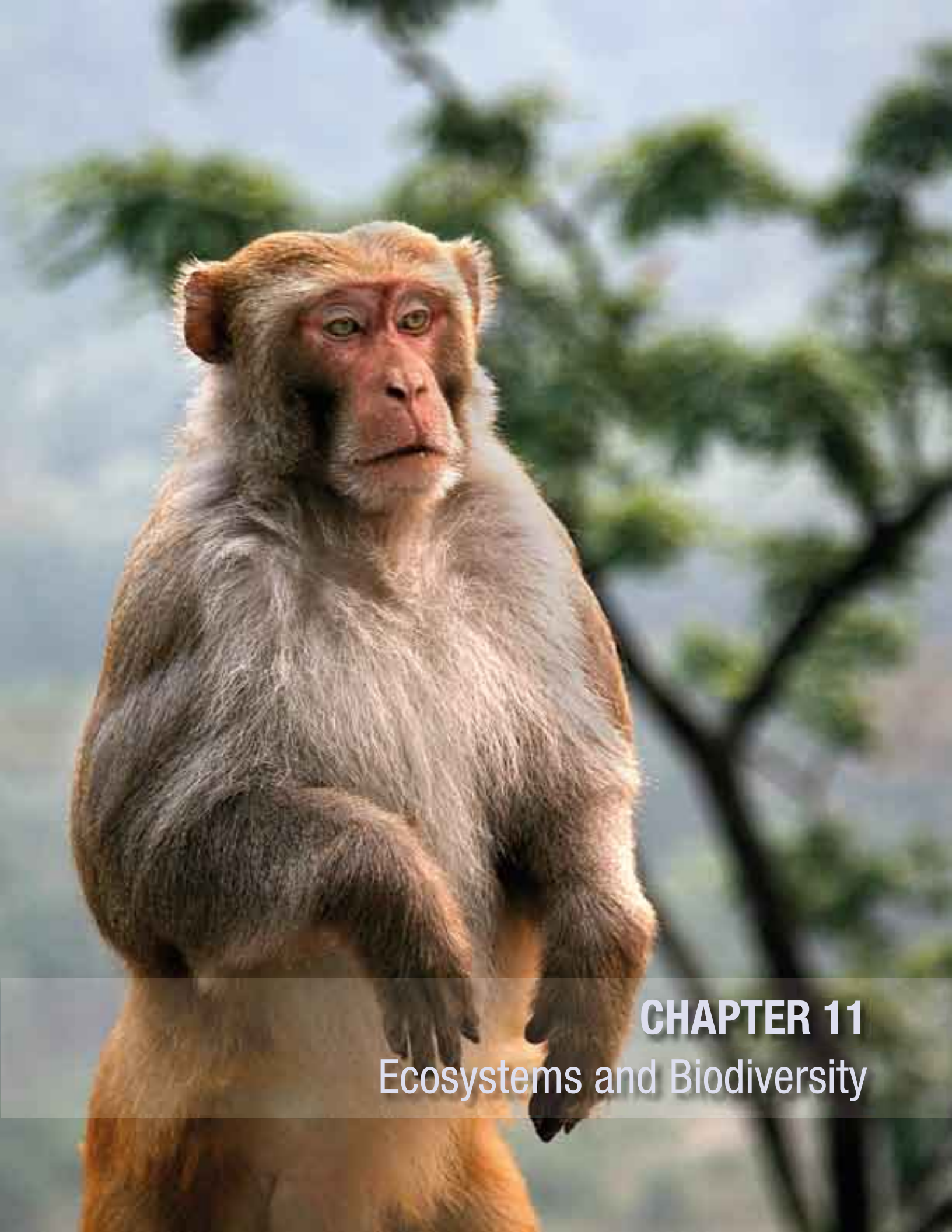

CHAPTER 11
Ecosystems and Biodiversity

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Ecosystems and Biodiversity[70]

South Asia's Rich Biodiversity under Stress

South Asia is endowed with an exceptional array of biodiversity. The region's biodiversity is reflected in varied biomes and the wide range of habitats within its ecosystems. Its geographical expanse includes several diverse ecosystems, such as the mountains of the Himalayan Hindu Kush, the rangelands of Bhutan, the Thar Desert, the high-altitude freshwater lakes of Nepal, the Deosai plains in Kashmir, the extended contiguous mangrove swamps of India and Bangladesh, and the coral reefs and atolls of Maldives. Forests range from tropical, subtropical, and coastal to temperate, and the deserts range from hot to cold. Bengal tigers, snow leopards, sloth bears, rhinos, elephants, red panda, wild boar, hoofed animals, birds, and reptiles dwell in these forests, savannas, and deserts. The unique topography and climate has shaped the remarkable variation within the forests, rangelands, deserts, wetlands, freshwater areas, and coasts of South Asia. These ecosystems occupy about 3.6 percent of the world's area but contain 16 percent of floral and 12 percent of faunal species found in the world (UNEP 2001).

This rich ecological landscape has been integral to the lives, well-being, and livelihoods of millions of people. The ecosystems and their diversity have sustained the supply of food, water, fodder, fuel wood, clothing, shelter, medicine, and energy. Biodiversity is the foundation of agriculture and rural livelihoods. The region's livelihoods are derived in large part from forestry, fishery, and tourism, and the services performed by its ecosystems support life (through soil formation, nutrient cycling, primary production, oxygen production, and habitats) and regulate processes crucial to well-being (air quality, climate, water flow, soil retention, water purification, and biological and disease control). Biodiversity has thus been crucial to ensuring food security, income, nutrition, access to improved water, good health, safety, and the environmental sustainability of the region. The ability to adapt to changes in the environment is also determined in great part by the variation and resilience of species and ecosystems. In addition, ecosystems play a crucial role in absorbing greenhouse gas emissions.[71] Appropriate management of natural systems can therefore play a critical role in contributing to cost-effective adaptation as well as reducing greenhouse gas emissions.

[70] Authors in alphabetical order: Rahimaisa Abdula and Anupam Joshi.

[71] About 3 gigatons of CO_2 are absorbed by terrestrial ecosystems, which is about half the amount released by fossil fuel combustion.

South Asia's natural resources face tremendous pressure from rapid population growth. Economic expansion and a burgeoning population have led to unsustainable extraction of natural resources and accelerating levels of air and water pollution. Poverty, high resource dependence, and policy failures have lowered resource productivity with negative implications for development. About 10–30 percent of the region's faunal species are currently under threat of extinction. Of concern is the unsustainable resource extraction and pollution in previously remote areas with relatively large numbers of endemic species. Three global biodiversity hot spots have been identified in the region: the Western Ghats of India and Sri Lanka and the Eastern Himalayas. Table 11.1 gives a profile of the rich biodiversity of SAR countries.

Threats of Climate Change to Ecosystems and Biodiversity in South Asia

Climate change will increase the damage from current risks and present new challenges to the sustainability of ecosystems and their services. The increased precipitation (predicted for many areas) and incidence of extreme events under future climate change will magnify existing vulnerabilities. Increased incidence of rapid-onset disasters will threaten vulnerable species, while slow-onset one will prolong existing stress. Sea-level rise will induce greater flooding and exacerbate the damage to coastal ecosystems. The extent of damage from sea-level rise will span the coastal wetlands, aquifers, freshwater systems, forests, and low-lying plains, while the costs of reduced glacial cover include biodiversity loss in the mountain and low-lying ecosystems of the Hindu Kush Himalayan range. New issues will also arise from expected changes in seawater chemistry. For example, the increased acidity levels in the oceans due to warmer sea temperature will slow coral reef formation, disturb the marine food chain, and adversely affect fisheries.

Climate change will affect all ecosystems and intensify many existing stresses caused by unsustainable resource use. The changes in precipitation, sea level, seawater chemistry, incidence of extreme events, and rate of deglaciation will modify the conditions that shape ecosystems and biodiversity. These climatic changes can disrupt ecosystem functions and distort the growth, size, composition, and roles of species (IPCC 2002). The most vulnerable ecosystems are the mountain biota, rangelands, and coastal and marine ecosystems. Endemic mountain species, biota restricted to islands or coastal areas, and species with small populations, limited climatic ranges, and restricted habitat requirements are most in danger of extinction. There are more subtle impacts, too, such as the reduced capacity of ecosystems to perform sequestration that could aggravate the impacts of climate change (IPCC 2007c). There are significant knowledge gaps and a limited understanding of the impacts. Accordingly, the following sections provide an overview based largely on global assessments.

Risks to Terrestrial Ecosystems

The biodiverse forests, rangelands, and deserts of South Asia support basic human needs and

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livelihoods. Forest accounts for about 20–30 percent of the total land area of India, Nepal, and Sri Lanka and about 68 percent in Bhutan (Table 11.1). These are important to energy, housing, and the livelihoods of many people in rural South Asia. Savannas and dry forests are grazing areas for the region's large population of livestock, which is essential to food security and agricultural draught.

Climate change will affect the vegetation, productivity, and biodiversity of these ecosystems. Forests and rangelands that

Table 11.1 Biodiversity Profile of SAR Countries

	Afghanistan	Bangladesh	Bhutan	India	Maldives	Nepal	Pakistan	Sri Lanka
Forest Area (% of land area)	1.3	6.7	68.0	22.8	3.3	25.4	2.5	29.9
Deforestation (average annual %, 1990–2005)	2.7	0.1	-0.3	-0.4	0	1.9	1.9	1.3
Conservation Status								
% Threatened Animal Species	5.71	12.11	5.72	19.54	7.73	15.82	9.51	35.12
Critically Endangered (all species)	3	10	3	72	1	4	8	129
Endangered (all species)	5	28	12	161	3	18	16	127
Vulnerable (all species)	22	51	32	240	7	52	50	159
Endemic (all species)	1	1	3	276	0	2	3	361
Globally Threatened Species Present in the Country								
Mammals	14	23	22	86	0	31	18	21
Birds	12	23	16	73	0	27	25	15
Reptiles	1	21	0	25	2	6	9	8
Amphibians	1	1	1	66	0	3	0	52
Fish	0	11	0	35	9	0	20	29
Invertebrates	1	0	1	22	0	0	0	52
Plants	1	10	7	166	0	7	2	238
Protected Areas								
Nationally Protected Area (% of land area)	0.3	0.5	25.6	5.3	0	18.6	9.5	27.3
Total Protected Areas[a] (number)	9	26	9	718	25	30	234	278

[a] Includes all IUCN category reserves (IA, IB, II, III, IV, V and VI), Ramsar Wetlands, UNESCO-MAB Reserves, World Heritage Sites, and sites that are protected but do not fall in any IUCN categories.

Sources: World Bank, *The Little Green Data Book 2008;* 2008 International Union for Conservation of Nature (IUCN), Red List of Threatened Species (www.iucnredlist.org), accessed on January 27, 2009; World Biodiversity Database (WBDB) 2008, joint project of BirdLife International and Conservation International; and World Database on Protected Areas (WDPA) 2007, joint project of UNEP and IUCN 2007, managed by UNEP World Conservation Monitoring Centre (UNEP-WCMC) and IUCN World Commission on Protected Areas (WCPA)

receive increased precipitation relative to evapotranspiration will experience primary productivity gains. But in the long run, as critical thresholds are reached, productivity losses could ensue. Biodiversity loss occurs during the transition over the medium term and during the long-term collapse of forest types. The critical impacts on South Asia's terrestrial ecosystems include transformations in the areas supporting large habitats, such as the savanna of India, the highly endemic areas of the Hindu Kush, and the drylands at threat of desertification.

Vegetation Shifts and Loss of Biodiversity in Mountain and Forest Ecosystems

While climate change could improve forest productivity in the short to medium term, the resulting transformation of vegetation systems is likely to result in a loss of biodiversity and productivity as critical thresholds are reached. The IPCC projects that carbon fertilization will lead to net primary productivity gains in the medium term (IPCC 2007c), with the gains experienced in some forest types outweighing the losses in others.[72] Vegetation types will shift to higher elevations as a result of global warming, and some vegetation types may disappear in the process, together with dependent species and ecosystems with strict climate niches (CBD 2003; IPCC 2007c).

In India, climate change is projected to lead to loss of savanna cover. Vegetation is expected to shift toward wetter types in the northeast and to drier types in the northwest of India by 2085. This will transform the currently dominant land cover into tropical dry forest. Wildlife adapted only to the savanna landscape could be threatened by loss of habitat. Net primary productivity gains are expected for many vegetation types, but reduction in population in several species, and extinction of some species, will inevitably occur. The highly endemic areas of the Western Ghats and central Himalayas are projected to experience forest dieback and loss of biodiversity in the long run (Ravindranath et al. 2006).

In the high altitude Himalayan Hindu Kush, climate change will transform vegetation and reduce biodiversity of the mountain ranges. Climate change is expected to lead to a northward shift of vegetation and to the reduction and loss of alpine tundra cover in the dry temperate and temperate mountains of the region. The changes in precipitation in the dry temperate mountains of Pakistan are expected to expand conifer coverage at the expense of alpine vegetation even before mid-century (Ministry of Environment 2003). The upward migration of plants in the Himalayas could lead to similar reduction in alpine meadows, thus impacting the habitats of several high altitude mammals including wild sheep, goat, antelope and cattle (Garg 2005).

Changes in forest composition and density will inevitably alter the carbon budget with uncertain feedback effects on the regional climate. Shifts in and losses of vegetation cover can distort the carbon uptake of terrestrial ecosystems (IPCC 2007c). The growth in tropical forest predicted in some areas in India is expected to increase carbon sequestration in the medium run (White et al. 1999). In areas where forests shift to drier types, such as in Sri Lanka, carbon uptake could decline. The modification in carbon budget in turn transforms the feedbacks to regional and global climate (CBD 2003). Increased temperature will also raise the risks from fire outbreaks that could destroy many forest species and alter the carbon budget (IPCC 2007c). Forest fire is one of the biggest threats to the forests of Bhutan. There are on average 50 forest fires reported every year in the country. About 40 percent of its forest area has been identified as susceptible to frequent fire. Forest fires also degrade the soil, release stored carbon and emit other greenhouse gases (IPCC 1998).

[72] IPCC (2007c) predicts some reversal of forest productivity in the later part of the century.

Threat of Desertification in Rangelands and Semi-deserts

Climate change poses a threat of desertification in drylands expected to undergo increased aridity. South Asia's arid and semi-arid rangelands provide livelihood for millions of herders and pastoralists in Afghanistan, India, and Pakistan (Ministry of Environment 2003). The deserts of the Indus Valley and Thar support population densities of about 150 per square kilometer—almost five times the global average for desert areas. Though projections of the impacts of climate change on the arid areas are uncertain, there is growing consensus that El Niño southern oscillation events in the Pacific Basin are likely to increase the incidence and duration of droughts in drylands and deserts. In most deserts and rangelands, the combined effects of higher evapotranspiration, lower precipitation, and more intense and protracted droughts will reduce soil moisture and promote desertification. Fewer flood events with greater intensity will also induce aridity as less moisture is infiltrated into soils (UNEP 2006).

Future changes will likely be most severe in desert margins and desert montane areas where the principal arid rangelands are located (UNEP 2006). The rangelands and semi-deserts of Afghanistan, India, and Pakistan are vulnerable due to the projected increase in the intensity and frequency of drought in the future. Projections suggest that the Thar Desert will expand over the coming century due to local shortfall in precipitation and increased aridity in its northeast and eastern neighboring areas (Goswamy and Ramesh 2007). Desertification has also been identified as a major threat to Pakistan's biodiversity (IUCN 2002). Deserts and rangelands fed by melting snow or ice, such as those in India and Pakistan, will be susceptible to future desiccation of rivers. As the volume of snowpack diminishes, rivers will shift from glacial fed to pluvial.

The changes in desert, rangelands, and savanna cover brought about by climate change will feed back to regional and global climate. On balance, savannas and grasslands are likely to show reduced carbon sequestration capacity given the greater loss in soil respiration induced by warming, fire regime changes, and rainfall variability. Shifts of rangelands to deserts could release stored carbon but will have uncertain effects upon regional and global climate (MEA 2005). There are, however, potential gains that may arise from enhanced woody coverage resulting from carbon fertilization. Desert albedo in areas projected to undergo greater aridity and loss of vegetation will also enhance global cooling effect (UNEP 2006). However, there are uncertainties in the feedback of desert dusts upon global climate.

Challenges Facing Freshwater and Marine Ecosystems

Freshwater and marine ecosystems are crucial to the well-being and survival of the region's population and are under threat from multiple stressors due to climate change. The water resources of South Asia are the most important economic asset threatened by climate change. They supply water to millions of people and remain an important input to economic survival and prosperity. The wetlands of South

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Asia provide food, livestock grazing, fodder, fuel wood, timber, medicine, transport, energy, and outdoor recreation. Coral reefs on the other hand match tropical rainforests in biodiversity and are important sources of revenue from tourism. Coral reefs and mangroves also protect hinterlands against coastal erosion, sedimentation, floods, and storm surges. Climate change will alter these ecosystems through changes in hydrology, sea level, sea temperature, and water chemistry.

Multiple Stresses Threatening Freshwater,[73] Wetlands, and Coastal Resources

Freshwater and inland wetlands will be affected by the likely impacts of sea-level rise, glacial melt, and extreme weather events. Of all ecosystems, freshwater aquatic resources appear to have the highest proportion of species threatened with extinction by climate change (MEA 2005). Freshwater resources and species in low-lying plains can be affected by sea-level rise through saltwater intrusion and by flood through inundation. In semi-arid areas, lower seasonal stream flow and drying up of lakes can have profound effects upon biodiversity and ecosystem services (IPCC 2007c). The drying of stream beds and lakes for extended periods could reduce ecosystem productivity due to the impacts of lower oxygen levels on aquatic habitats and water quality. The endorheic lakes in arid and semi-arid areas, such as those in the deserts of Afghanistan, could disappear as a result of climate change (IPCC 2008).

Among the multiple stresses, drought presents the major challenge to the sustainability of freshwater and inland wetlands services (CBD 2003). Most delta regions in India and Pakistan, where shortfalls in precipitation and drought have already led to parchedness and degradation of wetlands, are projected to face further evapotranspiration. Climate change could erode their ability to regulate water quality and quantity (Ramsar Convention and UNFCCC 1999). The magnitude and possible timing of these impacts is unknown and suggests the need for greater research into the likely consequences of climate change on wetlands. This is of particular significance in Pakistan, where wetlands extend over 7.8 million hectares, covering about 9.7 percent of the country. The wetlands are being rapidly degraded by a host of anthropogenic pressures. Climate change can be expected to add to these.

Coastal ecosystems are vulnerable to the myriad impacts of sea-level rise. The effects of expanding sea levels are multiple and include inundation of wetlands and lowlands, erosion of shorelines, coastal flooding, increased salinity of estuaries and aquifers, changes in tidal ranges in rivers and bays, and increase in the heights of waves. High levels of global warming are expected to lead to

Box 11.1 Sea-level Rise and the Biodiversity of the Bangladesh Coastal Area

Bangladesh is particularly at risk from sea-level rise, given that its coastal zone, comprising intertidal mudflats, mangroves, and tidal creeks, covers about 30 percent of its area. These coastal ecosystems are habitat for many species, sources of livelihood for many communities, and a natural defense against storms and floods. The coastline mangroves of the Sundarbans will be threatened by the increase in inundated areas and salinity of water.

The Sundarbans supports a diversity of wildlife: Bengal tigers, Indian otters, spotted deer, wild boars, some of the largest estuarine reptiles, and endangered turtles. Moderate increases in sea level could disturb its exotic wildlife and spur conflict between human and animal. A one-meter rise in sea level, which is likely to occur by the end of the century, will lead to the disappearance of the Sundarbans and its biodiversity (IPCC 2001).

[73] Refer to chapter 6 on climate change and the water sector.

Box 11.2 Ocean Acidification and the Protective Services of Coral Reefs

Ocean acidification is another consequence of climate change that would slow coral reef formation and reduce its capacity to protect the coast against damage from sea-level rise and wave surges. The combination of ocean and atmospheric warming changes seawater chemistry and slows the calcification of corals, which could stunt the formation of the reef framework and the vertical growth of coral reefs (CBD 2003; UNEP 2008a). This would reduce the ability of the reef to prevent coastal erosion and flooding. The future degradation of coral reefs due to combined human and natural pressures is predicted to lead to the disappearance of reef-building corals as the rate of erosion exceeds the rate of calcification (CBD 2003; UNEP 2008a).

an average sea-level rise of up to 88 centimeters over the next century. This would contaminate surface and groundwater resources (Ramsar and UNFCC 1999; IPCC 2007c) and could exacerbate the damage caused by tsunamis, storms, and flooding. The low-elevation small island state of Maldives, the mangroves of the Sundarbans, and the coastal ecosystems of Sri Lanka are particularly vulnerable to these impacts (Box 11.1). Sea-level rise could also displace low-lying floodplain and swamps, submerge intertidal areas such as mudflats, and eliminate the wetland plants and animals sensitive to salinity (CBD 2003).

Coral Bleaching, Ocean Acidification and the Impacts on Marine Ecosystems

Coral reefs are exceptionally rich in marine biodiversity and play a crucial role in sustaining fisheries and low-lying coastal areas. Coral reefs, like rainforests, support complex habitat niches that host a wide diversity of species. Corals are formed through the action of living organisms, called polyps, which secrete an external limestone skeleton that constitutes the reef framework. These coral reef builders serve as the sturdy base that dissipate tidal and storm wave velocity and provide natural protection to low-lying areas. Indeed, the existence of the Maldivian islands is largely dependent on the integrity of the ring of corals that protect them from erosion and inundation.

Climate change will increase the incidence of coral bleaching. Tropical corals survive within a narrow range of water temperatures and nutrient loads (UNEP 2008a). Even an ocean warming of 1°C to 2°C can cause bleaching of coral reefs,[74] weakening the health and services of corals and dependent species and distorting the dynamics within the ecosystem (UNEP 2008a). Sustained ocean warming of 3°C to 4°C would cause large-scale coral mortality. The reestablishment of coral reefs takes centuries, and the consequences for coral reefs of climate change may be irreversible. According to the IPCC (2007d), the projected temperature rise will exceed current tolerance levels of corals in major coral biomes in the coming 20 to 50 years.

The irreversible losses to biodiversity, and the impact upon food security and livelihood, would adversely impact economic opportunities in coastal communities. Coral coverage in the Indian Ocean islands and South Asia combined has declined from more than 40 percent in 1997 to slightly above 20 percent in 2002. In areas where coral reefs have functional linkages with other ecosystems, including deep-sea fisheries, mangroves, and seabed grasses, the impact of coral bleaching will be wide ranging. The loss of biodiversity from coral bleaching and ocean acidification could translate to losses in revenue from fisheries, mangrove ecosystem productivity, and tourism.

[74] Coral bleaching occurs when the symbiotic algae in coral tissues separate from their hosts due to sustained stress. Coral can survive this condition for a short period and even restore its symbiotic algae, but prolonged stress can cause its mortality.

Glacial Melt[75] and the Biodiversity of the Himalayas

The rapid retreat of some glaciers in the Himalayas will significantly impact freshwater resources and the vast ecosystems fed by them. At the other end of the altitudinal spectrum, climate change is affecting the Himalayan ecosystem. Glacial melt will have a wide range of impacts on river systems and the biodiversity they host (WHO 2006). The effects of the drying of rivers will extend to terrestrial systems, from mountain forest ecosystem, rangelands, and low-lying wetland and other ecosystems. Glaciers supplying the river Indus and its tributaries are predicted to be particularly susceptible to climatic warming, with a rise in temperature of 3°C reducing river flow by 40 percent and seriously affecting the riverine forests, wetlands, lakes, and mangrove forests and dependent species in Pakistan. In the short run, earlier thaw in the mountains feeding the system will reduce freshwater runoff in the summer months, placing forests and other vegetation at risk from drought. The magnitude and duration of these impacts is, however, largely unknown.

Recommended Next Steps

The impact of climate change upon ecosystems and biodiversity is a key development concern that needs to be integrated in development programs and responses to climate change. Many facets of the impacts of climate change upon biodiversity and species are still unknown, and implementation of informed programs of action requires a considerable investment in knowledge building. The existing engagement on natural resource management and biodiversity conservation must be scaled up or reconfigured to take account of the many risks from climate change. Further action must revolve around the following areas:

a. **Knowledge building:** The generation of knowledge must be directed toward reducing the information gaps and uncertainties regarding the effects of climate change upon ecosystems and biodiversity and identifying national priorities for conservation. Reducing the uncertainties requires an assessment of the status and vulnerabilities of species and biodiversity to socioeconomic drivers and climate change, and the possible impediments to their adaptive migration. Knowledge management should also take stock of local knowledge of ecosystems and best practices in management. Increased scientific knowledge is also needed to better understand the ecological responses to climate change (time lag, nonlinearity in reaction, natural adaptation mechanisms, and threshold limits). Valuation of the environmental damages of climate change must be incorporated in the assessment of the cost of climate change and benefits of adaptation strategies. Efforts should also be directed toward model development and coupling to better predict the impacts of climate change upon biodiversity and its feedbacks.

b. **Management of ecosystems and biodiversity:** New approaches to the management of ecosystems and biodiversity are required to respond to the emerging threats of climate change. Ecosystem and biodiversity considerations must be integrated into climate mitigation, adaptation, and risk-management approaches. Shift from a piecemeal to an ecosystem-based approach to management and conservation of biodiversity must be considered, particularly for interdependent and complex ecosystems such as coastal ecosystems (including coral seascapes) and the Himalayan Hindu Kush, and the conservation of endangered species. Protected area networks would need to be expanded to prevent further habitat fragmentation that could hinder adaptive migration of species. Table 11.3 presents a detailed approach to protecting, upgrading, restoring, sustaining, and

[75] Refer to chapter 6.

expanding ecosystems to develop a climate-resilient economy based on sustainable use of the natural resource capital.

c. **Integration in national and sectoral development:** Ecosystem and biodiversity concerns must also be reflected in national and sectoral development. Environmentally sensitive development and poverty reduction should integrate ecosystem and biodiversity consideration in development strategies in a wide range of sectors, including agricultural and rural development, forestry, fisheries, tourism, energy, and infrastructural development. Spatial planning and coastal and upland development, in particular, must carry safeguards to maintain ecosystem connectivity and enhance climate resilience of rural communities.

d. **Financing of biodiversity conservation:** Financing is a key challenge to biodiversity conservation. Achieving sustainable finance for biodiversity conservation will involve the creation of appropriate conditions through the removal of perverse subsidies, building capacity to design and manage biodiversity-based revenue-generating activities, and expanding the funding base through a wide range of instruments, including grants from donors, debt relief, and equity and market-based instruments.

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Table 11.2 Climate-change Impacts and Vulnerability Index

Ecosystems	Threats	Afghanistan	Bangladesh	Bhutan	India	Maldives	Nepal	Pakistan	Sri Lanka
Coastal (mangroves, mudflats, estuaries)	Inundation, salination, storms, species loss		■		■	■			
Coral reefs	Bleaching, acidification, loss of ecological and protective services, reduction in species diversity				■	■			■
Inland wetlands	Desiccation, drainage and diversion, degradation and service loss	■			■			■	■
Forests	Loss of forest cover and species, altered composition and structure, enhanced evapotranspiration			■	■		■		■
Mountain (subtemperate, temperate)	Altitudinal shifts in vegetation disrupting species types			■			■		
Mountain (subalpine, alpine)	Loss of vegetation cover	■		■	■		■	■	
Glaciers	Loss of coverage	■		■	■		■	■	
Desert	Expansion	■			■			■	
Rangelands & Grasslands	Regime shift, degradation due to overgrazing and increased incidence of fire	■			■			■	
Freshwater (rivers, lakes)	Desiccation, increased salinity at coast, degradation due to increased demand	■	■		■	■	■	■	
Species diversity (floral & faunal)	Loss of diversity and habitat, changes in species composition and food web		■		■		■		■
Key: ■	Locations particularly vulnerable to impacts of climate change.								

Table 11.3 Climate-change Approach for Ecosystems and Biodiversity in the South Asia Region: The PURSE Approach

Approach	Investments required in:	Gaps	Investment support for:	
Protect	Existing public awareness network Community reserves Remaining wilderness and catchment areas Unpolluted water bodies	Lack of training on participatory resource management approaches Inadequate use of conservation planning tools, e.g., GIS Limited livelihood opportunities No long-term engagement, only project-based approaches Old staff, poor work conditions, no incentives	Improved public awareness and management skills	
			Rural livelihoods support	
			Landscape-based conservation approach	
Upgrade	Existing reserves and protected forests Community forests Fodder banks Social forestry plots Canal-side plantations	Old efforts lying in neglect—dilapidated reserves and protected forests No coordinated effort to deal with exotics and biological invasions Nontransparent resource-sharing mechanisms	Awareness generation at state level	
			Supporting local-level civil society and NGOs	
			Generating scientific knowledge and research	
Restore	Mined-out areas Degraded ecosystems (forests, wetlands, rivers, grasslands, etc.) Overgrazed pastures Wastelands Alkaline and saline soils	No regional or sector focus on restoration, poor investment support Limited knowledge base and availability of technologies International technologies not tried under regional conditions Limited or no phytoremediation	New national-level project on restoration	
			Help create database and GIS maps	
			Help develop biotechnologies	
Sustain	Existing watersheds Remaining natural habitats (mangroves, corals, homesteads, private forests, etc.) Undisturbed ecosystems	Poor PRI capacities in resource sharing Inadequate conflict resolution system and rights settlement incomplete Encroachment on natural ecosystems not addressed politically Alternate livelihoods, technological options not fully introduced	Building community ownership	
			Livelihood support in ecosystem fringe areas	
			Settlements of rights	
Expand	Forest ecosystems Wetlands (create new) Watersheds, catchments Other natural resource base	No innovative thinking for expanding ecological resource base (create forest ecosystems instead of plantations) Wetlands considered as wastelands Poor budgetary support and investments for developing ecosystem resilience	Planning Commission (India) target of 5 percent increase in forest cover (XI Plan)	
			New approaches for habitat creation	
			Mapping and database	
	Short-term		Medium-term	Long-term

Source: Developed by Anupam Joshi, World Bank staff in 2009