The massive acceleration in the rate and scale of environmental change exemplified in this chapter is characteristic of the last decades.

**Anthropogenic disturbance and rate of change**

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**CITIES OF LATIN AMERICA AND THE CARIBBEAN**

The massive acceleration in the rate and scale of environmental change exemplified in this chapter is characteristic of the last decades.
Urban development »

As described in Chapter 1, LAC is a highly urbanized region with a particularly high concentration of urban centers close to coastal areas (Table 2.1). The original location of native populations and different colonization methods determined patterns of urban concentration and growth. Figure 2.3 shows the successive colonization “waves,” entry routes and urban settlements.

Although urbanization continues space in LAC, the growth rate slowed from 2.8 per cent to 1.9 per cent annually from 1985 to 1990 and 2000 to 2005, respectively (Figure 2.4), see also Chapter 1, Urbanization patterns. Rural poverty, displacement, insecurity and the search for jobs and services continues to drive rural migrants to cities. Although they seek better living conditions in urban centers, a large proportion of rural immigrants to large cities live in poverty in (Mexico City, for example, the proportion is 40 per cent and in São Paulo it is 20 per cent) (UNEP 2010). Population growth is less concentrated in megapolises than in medium and large cities, which have the highest growth rates since their tourism and manufacturing jobs attract migrants.

Access to improved water and sanitation sources is significantly higher in urban than in rural areas and has been increasing since about 1990 (Figure 2.5a and b).

As LAC’s urban populations have grown, cities have expanded. Some examples of this expansion (São Paulo, Lima, Mexico City, San Salvador, São Paulo and Santiago de Chile, among others) are shown in Chapter 3. This extensive growth is particularly acute in LAC because of the lack of adequate urban planning. Latin American cities are also the world’s most compact and have the densest urban cores (Shang and others 2007). Buenos Aires, shown in Figure 2.6, is an example. This increases pressure on natural ecosystems by causing water, soil and air pollution problems and restricting the amount of green space available for urban inhabitants and biodiversity. A partial analysis (Figure 2.7) of cities of different size in LAC shows that large agglomerations do not necessarily suffer the most from lack of green space. In analyzing urban green space, it is important to consider its location within the urban matrix and access to it.

Waste management remains one of the main challenges for urban areas in LAC. Most countries in the region lack adequate hazardous waste facilities and dispose of household and industrial waste into unsuitable dumps and have very low levels of recycling. Treatment of both industrial and household sewage is also a critical environmental issue in urban areas. Less than 15 per cent of sewage is treated in LAC and the situation is particularly serious in the Caribbean (see the case of Saint John’s in Antigua and Barbuda in Chapter 3) where relatively little water is available and the health of coastal areas is vital for the economy.

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Grasslands and other fire-dependent ecosystems were formed long before hominids started altering landscapes by using fire. Natural and anthropogenic fire events have shaped the region, altering vegetation distribution. Every year, millions of hectares are burnt in the region (Figure 2.8). Between 2000 and 2004, LAC lost approximately 3.3 million hectares to fire. Using multitemporal MODIS satellite images, 14,446 burnt areas were detected in 2004, for a total of slightly more than 15,300 ha (UNEP 2010). Whether deliberate or not, humans have been lighting fires for more than a million years and fire has been used in the region for as long as it has been inhabited. Non-fires are also part of disturbance regimes. When fires are lit, their frequency and distribution depend on meteorological, vegetation and other natural conditions (Di Bella and others 2006). Estimates place the percentage of anthropogenic fires in South America at 85 per cent (FAO 2007).

Climatic water balance and land use have the highest correlation with fire density in LAC. In areas with no or little agriculture, fire events are related to water deficit. In humid environments such as tropical rain forests, areas with high agricultural use are correlated with fire occurrences. In grasslands, high agricultural use reduces fire density (Di Bella and others 2006). Illegal roads and logging reduce the upper canopy and generate fuel, increasing the risk of fire (Barreto and others 2006). Studies conducted in the Brazilian Amazon show a correlation between fire outbreaks and international meat and soybean prices (Arima and others 2007). The economic cost of fires has been estimated at between US$10-15 000 million per year (UNEP 2003).

Fires are also a significant source of air pollution, possibly with regional repercussions. Fires in the Amazon can sometimes lead to the closure of international airports, and in 2009 a grassland fire in the Buenos Aires province had a negative effect on air quality in Buenos Aires city and along the Uruguayan coast, including the capital city Montevideo, located hundreds of kilometres away from the fire.

To illustrate air pollution originating in megacities and emissions from fires, Figure 2.9a shows near-surface CO concentrations. Figure 2.9b shows pollution originating in megacities. The location of most megacities near the coastal area, as seen in Chapter 1, lessens the burden on the inland population and allows pollution to be transported over the ocean for long distances. Pollution caused by fires (Figure 2.9a) is concentrated inland and affects large areas of Argentina, Paraguay, Brazil, Bolivia, northern Peru, Venezuela and Colombia (Teichmann 2009).
Land degradation

The LAC region is usually perceived as a green paradise. Although it still has areas of exuberant vegetation and is in fact one of the world’s “reservoirs” in terms of biocapacity (Figure 2.10), land degradation, including desertification, soil erosion and coastal erosion, are evident throughout the continent. These processes could be exacerbated by increased pressure on land resources and more intense climate events.

Agriculture and overgrazing cause the most extensive soil erosion, but other activities such as mining, forest clearance, fires and road building also have direct and indirect effects on erosion rates. Soil erosion not only seriously affects productivity, it also has off-site consequences, particularly over water courses. Sediment deposition in rivers and lakes can affect navigation and habitat with significant adverse consequences on biodiversity, society and the economy.

Land is increasingly being degraded in LAC and desertification currently affects more than 600 million hectares in arid, semi-arid and sub-humid biomes (UNEP 2010). The consequences of soil erosion and degradation are sometimes temporarily obscured by the positive impacts of increased fertilizer or irrigation use, but unless sustainable practices are expanded, social and economic losses are inevitable in the long run. It is estimated that land degradation and related water losses to the region up to US$27 000 million per year (CEPAL 2007a).

Agriculture

Many of the currently most important and widely cultivated crops, such as potato, tomato, corn and maize, are native to LAC, where they were domesticated by native Americans. After the Conquest, maize was taken from Central America to Europe and later introduced to the rest of the world (Figure 2.11). Until the 21st century, maize was the most extensive crop in the region, with almost 30 million hectares or a quarter of cultivated land. Despite its new uses as a biofuel, soybeans have recently replaced it as LAC’s most cultivated crop (CEPAL 2005). In the first 80 years of the 20th century, more than 90 per cent of maize varieties were lost (Kimbrell 2002). This is not only a loss in terms of beauty and taste, but also in opportunities to discover varieties with a potential for increased yields and more resistance to disease, drought and humidity.
As ever more land is converted to agriculture—at the rate of 0.13 per cent annually between 2003 and 2005—so forests and other habitats are lost.

Figure 2.13 Structure of cultivated areas by main agricultural product

<table>
<thead>
<tr>
<th>Year</th>
<th>Soy</th>
<th>Maize</th>
<th>Wheat</th>
<th>Legumes</th>
<th>Rice</th>
<th>Roots &amp; tubers</th>
<th>Vegetables</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1990</td>
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<tr>
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<td></td>
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</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

As illustrated in the previous section, agricultural increase has had a significant cost in terms of land degradation. To preserve biodiversity and water resources, it is vital to base the growth of agricultural production on increased yields and soil conservation, rather than on merely cultivating new land areas. However, intensifying agriculture has other environmental risks: associated massive fertilizer and pesticide applications have had an impact on soil and water quality. Land-based sources of pollution can affect water resources such as rivers, lakes and oceans too, for example, the cases of Lake Maracaibo in Venezuela and Atitlan in Guatemala in Chapter 3. In turn, groundwater pollution affects fish and marine diversity. At the same time, extensive monoculture has devastating impacts on wildlife by destroying natural habitats and displacing species that have adapted to certain agricultural production methods.

A profound change is currently occurring in the region’s agriculture. Acro ever more land is converted to agriculture—at the rate of 0.13 per cent annually between 2003 and 2005 (Figure 2.13)—so forests and other habitats are lost. Yet another more profound and new transformation is taking place in the agricultural sector: main food crops such as potato, yuca, rice and wheat are decreasing in per capita terms, while industrial, fuel, and animal feed crops are increasing (Figure 2.13) (UNEP 2010). This conversion is associated with mechanized intensive agriculture, and is particularly the case in the expansion of soybean cultivation.

Figure 2.14a shows LAC’s outstanding potential for cropland expansion. Figure 2.14b shows the areas within the region with most agricultural potential. Agricultural potential is depicted in terms of potential agricultural outputs from cereals under rain-fed and irrigated multiple cropping with high agrochemical input levels.

Despite the massive land-use change in the region since 1700, LAC remains the world’s region with most land suitable for rain-fed crops—with over 1,000 million hectares. Whether this potential productivity will be a blessing or a curse in terms of environmental impacts will depend to a great extent on the importance given to sustainable ecosystem management.

As ever more land is converted to agriculture—at the rate of 0.13 per cent annually between 2003 and 2005—so forests and other habitats are lost.
Mining

The geological processes described in Chapter 1 explain the region’s wealth of mineral resources. Discovering, exploiting and exporting mineral resources drove European exploration on the continent. Mining, for example, played a significant role in establishing urban centres in the Andean highlands. Despite its isolation, the silver deposits of Cerro Rico led to the city of Potosí, with more than 100,000 inhabitants, to remain one of the largest cities in the Andes for almost 100 years (Kest 2006). Today, the bulk of mineral and oil exploitation remains largely in the hands of foreign companies.

Latin America is the world’s region with the highest share (23 per cent) of exploration budgets from the top mining industry companies (Figure 2.15a). More than US$10 million are invested in the region every year, with around 20 per cent going to Chile (PricewaterhouseCoopers 2009). This exploration spending in the region has been decreasing due to a perceived political risk by the companies. The industry news Venezuela, Bolivia and Peru as riskier countries than Chile, Brazil and Argentina (Figure 2.15b). The mining industry also perceives the latter countries to have more lax or less persuasive environmental regulations (McDonnell and Cost 2006).

The income earned from mineral exploitation in LAC does not always reach communities located close to mineral wealth. Local and poor communities living near these springs of相动水和资源 have also experienced disproportional suffering from displacement and environmental and health problems (see the cases of mining activities in La Bambú, Chili, Cerro de Pasco, Peru, and Moengo, Suriname, among others, in Chapter 3).

Small-scale mining can also have devastating environmental impacts. Gold miners that use mercury techniques or cyanide solutions to extract the metal have affected aquatic organisms and the impact increases when these chemicals become concentrated as they move up through the food chain. In the Amazon basin, there is mercury contamination in the upper basins of the rivers Madre de Dios, Tahuántes and Xingó. Some communities have already suffered from its effects, such as the fishing village of Pauhatú in the Tahuántes river upstream of Bautisla, where mercury level measurements in the population have been over the maximum of 6 ppm accepted by the World Health Organization. Similar levels were encountered in the Kayapo fishing communities of the Madeira River. Mercury levels in human tissues have been increasing in the Amazon basin not only as a consequence of mining but also of deforestation and erosion, which release mercury contained in soils into aquatic ecosystems (Paxson and others 2007).

![Image](image-url)
LAC holds more than 30 per cent of all the planet’s available freshwater and almost 40 per cent of its Total Renewable Water Resources (TRWR) (UNEP 2010). Water is not equally distributed throughout the region, however, and some locations and sub-regions such as the Caribbean have less freshwater than others.

Water quantity and quality are a cause of particular concern in the Caribbean. The sub-region has less than one-third the amount of water per capita than the global average and the situation is made worse by water pollution. A review of data from published Global Environment Outlook (GEO) reports on the sub-region shows that the main pressures on water quality are domestic and industrial effluents. In other parts of LAC (Peru, Brazil and Guatemala, for example), resource extraction (such as mining), agro-industrial activities and river regulation are the most significant pressures.

River channeling moderately or strongly affects the largest basins. Some of LAC’s most affected and fragmented rivers are located in southern South America (Figure 2.17). Among these, the Paraná basin can be considered to be the most intensively developed, with around 20 dams already affecting at least 60 per cent of its mean annual flow (Dunne and Mertes 2007). Dredging projects proposed to improve navigation have a negative effect on wetlands and also have an impact on aquatic and riparian ecosystems (Dunne and Mertes 2007). Although fisheries in the Paraguay-Parana-Rio de la Plata complex are less exploited than fisheries in other subtropical or tropical systems, small hydro-projects, sedimentation from agriculture and pollution have adversely affected fish habitats and reduced fish diversity (Suire and others 2007).

Water use also varies in the region. In almost all countries, agriculture is either the dominant water user or is equally important as the domestic or industrial sector. Pressure from agricultural use has been growing steadily since the mid-1990s. The total irrigated surface doubled between 1961 and 1990. These pressures on freshwater resources have affected inland fisheries that supply the local population with much needed protein. Catches by inland fisheries have been decreasing in most of LAC (Figure 2.18). Almost a quarter of the world’s fish species are found in LAC, with South America accounting for about 90 per cent. Despite the importance of these resources, much more needs to be known in terms of fish distribution and fish diversity (Junk 2007).

Another threat to freshwater resources is the problem of how to manage water resources in basins that are shared by two or more riparian countries. Problems can arise, for example, when upstream uses have significant downstream effects, as illustrated in the following instances: water evaporating in the Pantanal is prevented from reaching Asunción; water pumped from the Uruguay River into the rice fields of Uruguaiana does not feed the Salto Grande reservoir; polluted water in the upper Tietê will be unusable or of poor quality in the lower Tietê; and in the upper Paraná, a dam that may improve land transport and increase energy production may become an obstacle to navigation or fish migration. To prepare comprehensive management plans on communications, farming, urban development and energy production, water basins need to be managed as units. Incipient steps are being taken towards this goal in bi-national efforts related to transboundary waters.
Coastal urbanization

A large percentage of the population and activities are concentrated in coastal areas, with higher concentrations in southeastern South America, the La Plata basin, western and northern South America along the Andes, and in the centre of Central America. As seen in Figures 2.19 and 2.20, most urban centres, particularly the larger ones, are concentrated near the coast or on main rivers. This has placed a particular burden on coastal and river ecosystems.

Population concentration along the coastline varies among countries. In all countries, however, with the exception of Mexico, Colombia and the two landlocked countries in South America (Bolivia and Paraguay), more than 30 per cent of the population lives within 100 km of the coast (UNEPA 2007). Within the Amazon basin, population centres are still distributed along river ways.

The resulting coastal degradation threatens the very resources that have directly or indirectly attracted people to coastal regions. Figure 2.19 shows that the eastern Atlantic coast of South America, the western coast of Central America, the Gulf of Mexico and the Caribbean coasts are the most affected shorelines in LAC.

Figure 2.19
Population living within 100 km of the coast and coastal alteration

Figure 2.20
Urban population concentrations alongside rivers in the Amazon basin

Threatened glaciers

According to the International Panel on Climate Change (IPCC), most tropical glaciers in LAC will melt by 2030. South American glaciers are of vital importance as water resources for domestic, agricultural and industrial uses. Moreover, melting glaciers can increase geological hazards such as avalanches and floods (Cassasa and others 2007).

As the regional and global warming trend and changes in humidity continue, glaciers in the region have been experiencing a generalized and strong retreat and thinning (with a few exceptions in Patagonia and Tierra del Fuego) that has accelerated in the recent past (see the cases of glaciers O’Higgins in Chile, Upsala in Argentina and Copacabana in Ecuador in Chapter 3). This retreat is unequivocal but not continuous, with periods of stagnation and even advance that are partly related to El Niño and La Niña events (Vallés and others 2007, 2008) as described in Chapter 5, Box 1. According to the IPCC’s forth assessment report, this retreat is particularly critical in Bolivia, Peru, Colombia and Ecuador.

Not enough studies have been done on the social impacts of glacial melt. It is expected that many vulnerable communities across LAC will suffer from changes that lead to water shortages (Comunidad Andina de Naciones 2008). “Enhanced melt is likely to result in short-term increase of runoff, but in the long-term changes in runoff may occur, which could seriously affect the availability of water resources, particularly during dry periods. Glacier hazards such as avalanches of ice and moraine-dammed lakes will certainly change and possibly increase” (Cassasa and others 2007, 7). Shrinkage or loss of some glaciers will also cause water shortages and reduce hydroelectric power generation capacity (ECLAC 2006b).

The expected decrease in water resources is likely to increase conflict over the distribution of these resources between such varied consumer sectors as urban, rural, commercial, hydropower and mining (Painter 2007). Peru and Bolivia are already vulnerable to water shortages and there has been political confrontation about access to water among urban consumers and between the mining and rural sectors, for example. A study by the World Bank estimated the cost of providing Lima with freshwater after the glacial melt at US$116 million per year (Painter 2007).

The poor are usually the most vulnerable to environmental risks and such will be the case with water shortages and risks associated with glacier retreat. Rapid retreat increases river flow outbursts and ice precipitation or landslides into lakes can lead to dramatic flooding events. Thousands of people have died in the past and warming systems need to be improved. In 1941, one event of a flood outburst from a lake destroyed a third of the city of Huancayo in Peru, and killed 1 000 people (Cassasa 2005).
Since the turn of the century, the waters around the LAC region have provided between 15 and 30 per cent of global fish supply. Between 2002 and 2006, the region’s main producers were Peru with 6 to almost 10 million tons, Chile with 4 to 5 million tons and Argentina with 0.9 to 1.2 million tons (UNEP 2010). Figure 2.20 shows the trend in small pelagic fish catches between 1970 and 2007.

There are three areas of high and very high catch abundance in LAC: in the western coast of Central America, the western Atlantic coast of South America and the western coast of South America. Of these, only the latter is not experiencing decreased biomass yields. This reality is reflected in national state of the environment reports (such as DIO reports). DIO Brazil (2002) reports that 80 per cent of the country’s fisheries are over the maximum sustainable yield exploitation and the rest have entered a phase of either recovery or deprestation as a result of fishing measures. DIO Barbados (2000) reports that all fisheries whose status is known are being over-exploited. According to DIO Uruguay (2008), in 30 years, 92 per cent of fisheries were from being under-exploited or virgin to being over-exploited or at maximum capacity. Similarly, in the Pacific Central America-Coastal Large Marine Ecosystems, shared by Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Panama, Colombia and Ecuador, an increasing percentage of some over-exploited and collapsed fisheries (Sherman and Hempel 2009). Figure 2.22 shows the trend in the number of fish stocks that are being depleted to varying degrees from 1950-2004 and Figure 2.23 shows catch abundance in large marine ecosystems.

The main pressures on fisheries come from over-exploitation and habitat degradation. Habitat degradation is mainly a result of coastal activities, as shown in Figure 2.19. Attempts to protect coastal and marine areas with protected areas are still very modest. Only 0.1 per cent of Exclusive Economic Zones (EEZ) of LAC countries is under some sort of protection (Figure 2.24).

Small-scale fisheries are a source of food and livelihood income for more than two million people in the region.
Some of the most degraded coastal ecosystems are mangroves, wetlands and coral reefs. The main pressure are tourism and unplanned urban expansion, urban and industrial effluents and aquiculture. The degradation of these ecosystems has resulted in the loss of ecosystem services: regulating services have been lost in the case of Belize City where mangrove–wetland systems have been used for sewage treatment (UNEP 2010); in the case of fisheries decline, provisioning services have decreased; and cultural services directly related to tourism that is essential for many Caribbean economies have suffered. Some of the most degraded coastal ecosystems are mangroves, wetlands and coral reefs. The main pressure are tourism and unplanned urban expansion, urban and industrial effluents and aquiculture. The degradation of these ecosystems has resulted in the loss of ecosystem services: regulating services have been lost in the case of Belize City where mangrove–wetland systems have been used for sewage treatment (UNEP 2010); in the case of fisheries decline, provisioning services have decreased; and cultural services directly related to tourism that is essential for many Caribbean economies have suffered.
In the Caribbean region, 30 per cent of reefs have either been wiped out or are under serious risk from anthropogenic sources. In a business-as-usual scenario, it is expected that 20 per cent more will be lost in the next 10 to 30 years.
Forests

389 Figure 2.28 shows the variety of forest types and their distribution in LAC. LAC has 47 per cent of the Earth’s tropical forests, mainly in the Amazon basin, which is still the largest expanse of rainforest in the world. This tropical forest hosts some of the world’s biodiversity hotspots and thousands of unregistered species, and sequesters hundreds of millions of tonnes of carbon.

Deforestation is widespread and in some places rampant. Figure 2.29 shows original and current tropical, temperate and boreal forest cover. According to the Food and Agriculture Organization of the United Nations (FAO), between 2000 and 2005 LAC lost approximately 43.500 km² of forest per year. This represents the yearly loss of an area more than the size of Switzerland. The biggest share of deforestation is in South America, particularly in the Brazilian Amazon. In this sub-region, deforestation accounts for almost half of global CO₂ emissions from land-use change (UNEP 2010). Many Caribbean countries have preserved or expanded their forested areas, sometimes with plantation. In the Caribbean or elsewhere in the region, plantations can contribute to carbon storage and soil coverage but cannot replace many of the other ecosystem services and biodiversity values provided by native forests. In fact, they often alter them.

Cattle ranching, agriculture and infrastructure remain the most widespread pressures on LAC’s forests. A study by ECLAC (CEPAL, 2007a) indicates that between 1990 and 2005, an increase in cattle ranching coincided with a rise in deforestation in many countries in LAC, and as shown in Figure 2.30, between 1997 and 2000, cattle numbers increased at the expense of forest cover. A study carried out in 36 municipalities in the Brazilian Amazon region (Barreto and others 2009) found a high correlation between deforestation and deforested and area and soy (Figure 2.35).

Large-scale and highly mechanized agriculture is responsible for most agricultural expansion into forests in LAC, particularly in northern Argentina, Bolivia, Paraguay and Brazil (Figure 2.32a and b). Since the turn of the 20th century, soybean production has accounted for the main crop expansion in those areas, representing about 40 million hectares in the region. More than 50 per cent of LAC’s total cropland is deforested and harvested in soy and cattle, mainly in soy and cattle, mainly in the Amazon basin.

The building of infrastructure, particularly roads, is an important factor in the rate of deforestation, mainly in Central and South America. Roads open up forests for the agricultural frontier to expand, but also for the spread of illegal logging. Eighty per cent of Amazonian deforestation takes place less than 30 km away from an official road. As Figure 2.33 shows, paving is also a major contributing factor (Barreto and others, 2008). The characteristic Amazonian deforestation image (see the cases of Rondonia, Brazil and Pucallpa, Peru in Chapter 3) is a result of exploitation through roads, and early in the 20th century, through river networks, a practice that remains common in isolated areas of the Colombian and Venezuelan Amazon (Figure 2.34).

Figure 2.28 Forest extension and distribution


Figure 2.29 Original and current forest

Source: (2.21) CEPAL 2007, UN-FAO, UNEP.

Figure 2.30 and 2.31 Correlation between cattle numbers and deforestation 1961-2000. (a) Livestock category; (b) cropland

Figure 2.32 Proportion of forest area converted by various agricultural production systems in Africa, Latin America and Asia (percentage)

Figure 2.33 Correlation between deforestation rates and price of fattened cattle and soy, 1995-2007 (thousands of US dollars)

Figure 2.34 Proportion of forest area converted by crops and pasture in LAC countries, 2000-2010 (percentage)
### Biodiversity

**Anthropogenic disturbances** and the rates of habitat alteration described above are putting unprecedented pressure on biodiversity. Amphibians are particularly sensitive to habitat degradation, particularly in humid habitats, so they are good indicator species of what is happening in the ecosystems they inhabit and what will happen to other species that share those ecosystems. Figure 2.35 illustrates the amphibians at risk of local extinction. Territory size indicates the proportion of species at risk found in each country.

LAC as a whole, but particularly South America, has an important proportion of global species at risk locally (Figure 2.36).

Ecoregions can also be classified by their conservation vulnerability or threat status. Figure 2.37 shows the conservation status of the region according to Dinerstein and others (1995). The transformation of these ecoregions reduces viable habitat for many species, resulting in their endangerment as shown above, or their outright extinction.

As described above, the LAC region has been undergoing constant human activities, which are a direct cause of habitat alteration and transformation, and are driving the current biodiversity-extinction crisis. Figure 2.36 shows the enormous acceleration rate since 2000 and the extent of human impact on biodiversity over three centuries and five decades. Protected areas alone will not suffice to mitigate the consequences of this massive change. Political and market systems need to properly recognize and value biodiversity to reverse this trend. At the same time, existing and new sustainable practices need to be applied to producing goods and services. The area devoted to protection varies among LAC’s sub-regions: the Caribbean has set aside more than 16 per

### Table 2.1

<table>
<thead>
<tr>
<th>Region</th>
<th>Percentage of Forest Area</th>
<th>Ecoregion Status</th>
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</thead>
<tbody>
<tr>
<td>Latin America</td>
<td>Relatively Intact</td>
<td>Critical</td>
</tr>
<tr>
<td>Caribbean</td>
<td>Relatively Intact</td>
<td>Endangered</td>
</tr>
<tr>
<td>South America</td>
<td>Relatively Stable</td>
<td>Vulnerable</td>
</tr>
<tr>
<td>Central America</td>
<td>Vulnerable</td>
<td>Relatively Safe</td>
</tr>
<tr>
<td>South America</td>
<td>Relatively Stable</td>
<td>Unclassified</td>
</tr>
<tr>
<td>Central America</td>
<td>Vulnerable</td>
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</tr>
<tr>
<td>Central America</td>
<td>Vulnerable</td>
<td>Relatively Safe</td>
</tr>
</tbody>
</table>

### Figure 2.33

Deforestation along paved and unpaved highways

### Figure 2.34

Highways and urban settlements in the Amazon

### Figure 2.35

Histogram of amphibians at risk at global scale. The larger the size of the country or region, the higher the proportion of amphibian species at risk.

### Figure 2.36

Species locally at risk by region (Thousands of species)

### Figure 2.37

Conservation status of ecoregions

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*Source: CEPALSTAT*
Figure 2.38
Biodiversity as ratio of species abundance before and since human impact

Source: UNEP 2009a

Figure 2.39
Size and distribution of protected areas (IUCN and not IUCN categories)

Source: prepared from data by WDPA 2010

Figure 2.40
Percentage of total area protected, by biome

Source: prepared from data by Dinerstein and others 1995 and WDPA 2010

Protected areas alone will not suffice to mitigate the consequences of massive environmental change.

Although LAC has many “paper parks” (areas that are legally protected but that lack effective conservation action), protected areas have proven to be effective in preserving habitats and biodiversity. Appropriate land use planning has also worked in Brazil and Peru (Silveira and others 2007), and indigenous lands have been effective deterrents of illegal logging and fires. Different options exist for forest management and conservation, including protected areas where activities are regulated and restricted, although this may become a source of conflict over use by the communities living in them, certified forest production, which is a step forward in solving socio-environmental conflicts and may also help reduce the migration of local populations, although certification does not always provide economic benefits that can compensate producers for the cost of certification; and community forest management, a development strategy based on community management of natural resources (forest resources, in particular) that has been promoted as a viable strategy for reconciling conservation objectives with local practices and lifestyles. Such collective action has the potential to further long-term conservation goals by establishing rules for managing and accessing forest resources, and by establishing control mechanisms and forms of organization (UNEP 2010).

Compared to tropical forests, which have the largest percentage of area under protection, grasslands remain the least protected biome in LAC (Figure 2.40).
Interlinkages

The physical and cultural changes underscored in Chapter 1 and the changes described earlier in this chapter are keys to understanding the current well-being of LAC societies. The physical geography explains the variety of ecosystems and the location of human settlements and activities. In turn, these activities are reshaping the region.

Natural disasters

The number of people affected by floods, droughts and other hydro-meteorological events has grown in the region since 2000. Between 1995 and 2006, some 20 million people were affected by these events, especially weather events such as hurricanes, which were the principal cause of natural disasters in the Caribbean, and droughts and floods, which affected in Latin America in particular (CEPAL 2007b). Figure 2.41 illustrates the damage produced by one single hazardous event—Hurricane Mitch, which occurred in 1998.

Figure 2.41
Damage due to Hurricane Mitch per country and sector

Source: Torres and Castro 2007

Extreme natural events are hard to predict and are usually inevitable. Their consequences for the human population, however, can be mitigated with proper planning. Coastal communities, the poor and especially women and children, are the most vulnerable to natural disasters. A previous section described the vulnerability of Andean populations to glacier retreat. Caribbean SIDS are particularly vulnerable to extreme weather events, and if climate change projections hold, they will become even more vulnerable. As shown in Figure 2.42, people from the Caribbean region are particularly vulnerable to hydro-meteorological events.

Figure 2.42
People affected and killed by natural disasters in the Caribbean, 1950-2007

As described earlier in this chapter, a large percentage of LAC’s population is concentrated in urban areas close to the coast, which makes them vulnerable to changes in sea level. Figure 2.43 illustrates the location of populations living in low elevation coastal zones in Guyana and Suriname. Large areas with dense populations in both countries are within the 20 m low-elevation coastal zone, making them at risk to the effect of sea level rise due to climate change.
Energy demand and supply

LAC has 12 per cent of global oil reserves, 8 per cent of gas reserves and less than 2 per cent of coal reserves. Current energy consumption in LAC from renewable sources is slightly higher than the world average. Excluding hydroelectric energy, the growth of renewable energy in the region is likely to remain below the growth rate of other energy sources.

Energy consumption and supply have been growing in LAC over recent decades. Since 2000, the rate of variation in energy supply has slowed in comparison to the rate of variation in energy demand. This has slightly narrowed the yearly gap between total energy consumption and energy supply in the region as shown in Figures 2.44 and 2.46.

Mexico, the Andean region, central Argentina and eastern Brazil have strong potentials for solar energy development. Direct-normal solar radiation maps are used to identify the most economically suitable lands available for placing solar power plants. The abundant solar radiation received by the region (Figure 2.46) offers huge potential for extensive use of solar energy through photovoltaic or solar thermal converters (Krauter and Kissel 2005).

A 2009 global study of wind power potential shows that the greatest potential for the construction of aeolian energy supply plants in LAC is in the southern tip of South America (Figure 2.47) (Archer and Jacobson 2009).

Environmental conflicts

Competition over resources use or conflicting views regarding the appropriate use or non-use of certain geographic areas has led to local, regional and international environmental conflicts. The Amazon basin has sometimes been described as an area where “survival of the fittest” rules. As Figures 2.48 shows, the number of rural assassinations in the area is concentrated and higher than in any other region in Brazil, with 71 per cent occurring in the Amazon region. In addition to those killed, hundreds of people live under threat of being murdered and in 2008 alone, almost 100 were threatened because of their ideas of how to manage the region’s resources and their struggle against loggers, farmers and cattle ranchers (EPT 2008).
Other areas and sectors are also a source of environmental conflicts. Extractive industries and infrastructure have been the cause of some of the most longstanding conflicts in the region. According to the Peoples Ombudsman of Peru, the majority of social conflicts in the country originate in environmental problems related to the mining sector (Bamossy 2007). In Bolivia and Chile there have been conflicts between small farmers and mining industries over water use and pollution. In Argentina, a provincial law against open-pit mining led to a political standoff with the federal government. Cellulosic and paper-mill industries have also been a source of conflicts both nationally, as in the case of the Mapuche in the X region of Chile, and internationally, as in the case of the Fray Bentos (Uruguay) and Guayaquil (Ecuador), two riverside communities on opposite banks of the Uruguay river.

These are not the only cases of international environmental conflicts in LAC region and Figure 2.49 shows the recent conflicts that have taken place there. Some of these cases go through phases of problem-tension-conflict, but on many occasions they also provide an opportunity for (and can become an example of) transboundary cooperation to improve internal or internal relations. Cases of transboundary cooperation are also illustrated. Sometimes these phases and states coexist in time between the same countries (Gudynas 2007).  

### Fumigation in Ecuador

Fumigations by the Colombian government on the border with Ecuador to combat drug trafficking have caused several reactions on the part of the Ecuadorian government. The main issues in particular are destruction of flora, biodiversity, crops and impacts to human health in the area.

### Apa River, Brazil-Paraguay

The Apa River basin is the setting of agricultural, timber and fish smuggling operations between these two countries. To improve enforcement and foster cooperation, a sustainable and integrated management of the basin in 2006 Brazil and Paraguay signed a cooperation agreement and created a Mixed Commission.

### San Juan river basin

The San Juan river basin is emblematic of transboundary cooperation issues in the international basins of Central America. The International Court of Justice recently ruled on the river’s sovereignty and navigation rights. Other issues—contaminated water sources, agriculture and gold mining, for example—have raised tensions but do not come under the Court’s ruling.

### Panama and Colombia border

Exploitation and movement of natural resources and illegal drugs and weapons are not only political issues, but affect the environment and native installations in El Darién (Panama and Colombia border) and El Peñón in the Mayajigua Biosphere Reserve (Guatemala and Mexico).

### International parks

Tension is not all that occurs in environmental relations between states. Examples still of international protected areas: the international park La Amistad between Costa Rica and Panama, the transboundary park Bosawas y la Mosquitia between Nicaragua and Honduras, and the transnational park El Triângulo between Honduras, El Salvador and Guatemala—examples of cooperation among Central American countries.

### Pascua Lama, Chile-Argentina

Pascua Lama is a longstanding project to extract gold and silver on the border of the Andes in Chile and San Juan province in Argentina. Public opposition relates to the potential impacts of the project on glaciers and water quality due to the use of cyanide and mercury. The company contends the project complies with environmental standards and will bring needed jobs to the region.

### Madeira River Brazil-Bolivia

The Madeira River is complex part of the IIRSA (Iniciativa para la Integración de la Infraestructura Regional Suramericana) and includes the construction of hydroelectric dams and a transportation corridor. Building this complex will increase air and water quality, while Argentinian authorities affirm monitoring has shown mill discharges are below set standards. The International Court of Justice decided in April 2006 that Uruguay had violated the procedural system of consultations established by the Statute of the Rio Uruguay. At the same time, it decided that there was no evidence of environmental damage due to the pulp mill activity.
Human-induced changes in the environment, such as reduced vegetation cover or altered water cycles, can have a negative effect on human health.»
While the ozone-hole problem is worse in polar areas, the ozone layer is thinning everywhere else outside the tropics. Many adverse health effects can result from exposure to high UV levels. Sunburn, skin damage and cancer are the most widely recognized. Other damage can include weakening of the immune system and cataracts that can cause blindness. According to the World Health Organization (WHO), up to 20 per cent of cataracts may be caused by overexposure to UV (UNEP/GRID-Arendal). “Models predict that a 10 per cent decrease in the ozone in the stratosphere could cause an additional 300,000 non-melanoma and 4,500 (more dangerous) melanoma skin cancer cases worldwide annually” (UNEP GRID). Figure 2.54 shows the number of extra skin cancer cases by 2020 as a result of exposure to UV radiation. A substantial part of the increase will be in the southern cone of South America.

Overall, WHO estimates that approximately a quarter of all diseases are related to environmental exposure. In LAC, the burden of disease due to environmental conditions is between 12 and 25 per cent, with Bolivia, Nicaragua, Guatemala and Haiti sharing the highest burden (20-25 per cent).

Deforestation has been found to increase cases of leishmaniasis in Paraguay and of malaria in Peru. Water pollution can lead to cholera outbreaks and water sources can be contaminated with cyanobacteria as a result of agricultural or cattle ranching activities. In addition, forest fires are known to increase respiratory diseases in Brazil (UNEP 2010).

Environmental change can also have indirect effects on health. Increased drought and floods can have a detrimental effect on food production, making less nutrition available to vulnerable communities. Climate change can be a major negative factor for food production in the region (see below). Environmental degradation can also lead to the displacement or extinction of local languages, cultures and traditions. This can affect health in two ways, either by the loss of knowledge about medicinal plants and traditional medicines on which local populations depend, or by the loss of such plants in the natural environment.

Climate change is also likely to have an effect on health in LAC. Limited to the Caribbean and northern South America in the 1970s, the Aedes aegypti mosquito (dengue vector) had spread to almost the entire region by the beginning of the 21st century (Figure 2.50). This expansion is thought to be related to climate change (UNEP 2007). The vector’s spread has lead to a significant increase in the number of dengue hemorrhagic fever cases in the region. Between 1995 and 1997, there were peaks in some countries with more than 100 per cent increases in Trinidad and Tobago and Cuba and of around 70 per cent in Venezuela (Torres and Castro 2007).

Figure 2.53 shows the Global Solar UV index, the measurement of ultra-violet (UV) radiation levels at the earth’s surface. The index serves as an indicator of potential adverse health effects. While the ozone-hole problem is worse in polar areas, the ozone layer is thinning everywhere else outside the tropics.

Many adverse health effects can result from exposure to high UV levels. Sunburn, skin damage and cancer are the most widely recognized. Other damage can include weakening of the immune system and cataracts that can cause blindness. According to the World Health Organization (WHO), up to 20 per cent of cataracts may be caused by overexposure to UV (UNEP/GRID-Arendal). “Models predict that a 10 per cent decrease in the ozone in the stratosphere could cause an additional 300,000 non-melanoma and 4,500 (more dangerous) melanoma skin cancer cases worldwide annually” (UNEP GRID). Figure 2.54 shows the number of extra skin cancer cases by 2020 as a result of exposure to UV radiation. A substantial part of the increase will be in the southern cone of South America.

Overall, WHO estimates that approximately a quarter of all diseases are related to environmental exposure. In LAC, the burden of disease due to environmental conditions is between 12 and 25 per cent, with Bolivia, Nicaragua, Guatemala and Haiti sharing the highest burden (20-25 per cent).