The Physical Context
Latin America and the Caribbean (LAC) constitutes a large geographic region with similar socio-economic, cultural and historical characteristics.”

This macro-region covers approximately 20,808,000 km², representing almost half of the total area of the Americas (42,330,000 km²).

It includes the large South American landmass, with a surface area of 17,819,000 km²; Mexico, in the southern part of the North American continent, with an area of 1,972,550 km²; Central America (522,000 km²); and the Caribbean islands (240,000 km²).

Physical geography

LAC is a highly diverse geographic expanse (Figure 1.1). It includes long and soaring mountain ranges, towering volcanoes, immense plains, a wide variety of climates and some of the Earth’s longest rivers. There are snow-capped peaks and glaciers, immense lakes, extensive salt marshes and plains, vast rain forests, deserts and broad, open grassland environments. The coasts also represent a wide range of geographies. All three major coastal groups—the Pacific, Atlantic and Caribbean—are extremely varied, with sandy beaches, coral reefs and mangroves, all in different states of conservation.

Physical geography

The physical geography of Latin America and the Caribbean is very complex (Figure 1.2). The western Pacific strip of Latin America is composed of the Central American and Mexican sierras and their long mountain extension to South America (the Andes), with intercalated or associated plateaus (Bolivian altiplano, Peruvian highlands, Cundinamarca plateau in Colombia and Mexican mesas) and active volcanic zones (the transverse volcanic belt in Mexico, the Central American volcanic belt and Andean effusive focal points in western South America).

A complex island arch and related continental reliefs (the Caribbean islands, the Caribbean coast of South America and associated Central American terrain) developed in the marine region between the South American and North American continents. A large stable portion of the continental crust (shield) extends along the eastern portion of South America, consisting mainly of the Brazilian and Guyana shields with their associated palaeovolcanic and sedimentary basins.

In the centre of the South American continent lies a very large flat area extending for about 90° of latitude; it includes the Colombian-Venezuelan Llanos, the Amazonean and Guaco plains and the grassland Pampas in the south. A sedimentary platform (Patagonia) extends under the ocean to the marine Antarctic platform at the southern tip of South America.
The tectonic context

Mountains, shields and plains

There are numerous valleys throughout the Andes and the Caribbean. Some are wide, others are narrow, and even include lake systems; in some cases, they rise to high altitudes.

Figure 1.4 PHYSICAL GEOGRAPHY OF LATIN AMERICA AND THE CARIBBEAN

South America, Central America, and the Caribbean are divided by the drainage of two major river systems, Brazil's, with its drainage basin in the Amazonas, and the Andes, with its drainage basin in the Orinoco. This division has created the Andes, a mountain range that runs from northern Mexico (where it continues further north along the west coast of the United States and Canada to Alaska) to southern Argentina (Uruguay), still in Mexico, and further south in Central America.

The Andes chain is more than 7,000 km long, extending in a north-south direction along the western coast of the South American continent. It has been shaped by the processes of tectonic activity, erosion, and weathering, which have created a range of spectacular landscapes with steep slopes and unstable soils.

Towards the south, they become narrower, particularly in northern Mexico and Bolivia, where internal basins and plateaus have been formed.

The structure of the region's geology is based on the arrangement of the Andes, the Central American and Patagonian Ranges, and the Patagonian Shelf. The Andes are the result of the subduction of the Nazca Plate below the South American Plate, creating the Andean orogeny. The Central American Range is a result of the subduction of the Cocos Plate below the North American Plate, and the Patagonian Shelf is a result of the subduction of the Scotia Plate below the Antarctic Plate.

The Andes are composed of two main parts: the Western Andes, which are higher and more rugged, and the Eastern Andes, which are lower and more gentle. The Western Andes are made up of the Cordillera Blanca, the Cordillera Negra, and the Cordillera Occidental, while the Eastern Andes are made up of the Cordillera Oriental and the Cordillera Oriental Serrana.

There are numerous valleys throughout the Andes and the Central American Range. Some are wide, others are narrow, and even include lake systems; in some cases, they rise to high altitudes.

Figure 1.3

Source: courtesy by Dr. William A. Bowen, California Geographical Survey, California State University

Satellite view of the three separate mountain chains in northern South America.
Many of the Andean range’s highest elevations are volcanoes, some of which are still active. Active and potentially active volcanoes are found throughout the whole Andean range. Some of the main volcanoes include active Nevado del Ruiz and Sabancaya in Colombia; Chimborazo, Tungurahua and Cotopaxi in Ecuador; Misti, Huaynaputina and Ubinas in Peru; and Chachón and Villarrica in Chile.

During the formation of the Andes, continuous effusive processes took place and many volcanoes were built. Volcanic ashes were transported by wind and water forming an important part of the accumulations making up the mountain valleys and foothills and resulting in the formation of mainly narrow alluvial plains throughout the region. These events, which occurred millions of years ago, not only shaped the continent’s topography, but also its current productive and social activities, since most of the valley cities were settled on soils that developed from particularly fertile volcanic materials.

The Andes range is one of the richest orogenic belts in the world because of its oil resources and metallic ores. Ninety per cent of LAC’s known petroleum and natural gas reserves occur in the Andean foreland basins located from the Caribbean coast to southern Venezuela and including eastern Colombia, Ecuador and northern Peru (Orme 2007).

The South American continent was formed on and to the west of a large cratonic shield that fragmented into pieces of unequal size over geologic time spans. The Brazilian Shield in the central-eastern part of South America is the largest nucleus (more than 6 million km²) and represents almost one third of the continent. Another large shield section, situated further north, is the Guyana Shield. There are other shield “islands” to the south, including the Uruguay-Rio Grande Crystalline Island in Southern Brazil and Uruguay, and the Sierras de Cordoba and Sierras Pampeanas in Argentina.

Several rivers that drain the hinterland into the Atlantic Ocean formed dissected fluvial valleys in the Guyanese crystalline reliefs and end in alluvial deltas, fan deltas, lagoons and bars along the Atlantic seaboard. These accumulations formed a relatively narrow and low-lying coastal plain where most of the populations of Guyana, Suriname and French Guiana are located.

The large South American plains extend between the crystalline shields of Guyana and Brazil and the long Andean range, from the Venezuelan-Colombian Llanos to the Pampean and through the Amazonian and Chaco plains (Figure 1.4). There are also important plains in Central America and on the Caribbean coast, and some often quite narrow coastal plains along South America’s Atlantic and Caribbean coast.

On the western façade of the Latin America supra-continent there are several plateaus related to the uplift of pre-existing terrains, including the Bolivian-Peruvian Altiplano, the Mexican and Central-American plateaus and the Cundinamarquense plateau in Colombia, among others. Plateaus of various sizes also developed on some sedimentary landmasses on the periphery of the Brazilian and Guyana Shields (chapadas). There are extensive semiarid and periglacial landscapes associated with the Patagonian sedimentary platform on the southern tip of the continent.

Figure 1.4
Partial view of the Andes and plains

Many of the Andes range’s highest elevations are volcanoes, some of which are still active. Active and potentially active volcanoes are found throughout the whole Andean range. Some of the main volcanoes include active Nevado del Ruiz and Sabancaya in Colombia; Chimborazo, Tungurahua and Cotopaxi in Ecuador; Misti, Huaynaputina and Ubinas in Peru; and Chachón and Villarrica in Chile.

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The South American Atlantic coast

The adjacent shield geologically influenced the South American Atlantic coast. Granitic rocks that eroded over geological ages (an age is formed by two or more eras) produced large quantities of sand (mainly quartz) that formed thick sandstone accumulations (particularly during the late Paleozoic and Mesozoic ages, but also in the Cenozoic era). In turn, they were eroded and rivers transported their sediments onto Atlantic shores, explaining the dominance of sandy beaches on South America’s Atlantic coast. Another feature of this coast is the presence of coastal plains that appear as narrow flat strips along the Brazilian Shield (often interrupted by hills or escarpments that reach the sea) or wider plains near river mouths. In several places the coast is also characterized by many rocky points (often also granitic) and, to a lesser degree, by rocky sea cliffs.

Near large rivers, such as the Amazon, the Paraná and the Orinoco, there are sedimentary deltas with many islands, some of which are large (such as the Marajo island at the mouth of the Amazon). Tidal flats and mangroves may also be found in calm bays, inlets or coastal depressions.

The Caribbean coast

The Caribbean Sea is a very large sea in the Atlantic Ocean limited by the South American and Central American sub-continents, the Yucatan peninsula and the Caribbean island arch. It covers 2,754,000 km². The coasts of this extensive sea are very diverse due to the large variety of adjacent continental and insular terrains.

To the south, the South American Caribbean coast is somewhat similar to the Pacific Coast. It has a very long coastline exceeding 60,000 km. Pacific Ocean tropical coast because of the high elevations approaching the shoreline (Figure 1.5). An outstanding example of the steep regional relief slope is the Sierra Nevada de Santa Maria, which reaches 5,778 m at about 30 km from the seashore. Most rivers in this area are short with rapid flows. The plains of Uribia in northeastern Colombia, the Magdalena river delta, its associated plain and the large Maracaibo estuarine lake are exceptions to these steep sloping reliefs.

In Central America, the Caribbean coasts are mainly low-lying plains, particularly in Costa Rica, Nicaragua and Honduras. They are often composed of long sandy and coraline beaches associated with lagoons and swamps. Two distinct geological features are characteristic of the Caribbean Islands coast: volcanic terrains and coraline reefs. These volcanic coastal areas tend to be rocky and more abrupt while the coraline islands are more commonly flat with white calcareous beaches. Quartzic sandy beaches with rocky crystalline points and cliffs can be found in some of the largest islands with granitic cores (such as Cuba).

The Gulf of Mexico coast

The adjacent coastal region of the Gulf of Mexico is mainly composed of low-lying plains, including extensive sandy beaches, coastal lagoons and bays with tidal flats and wetlands. The width of the plain varies from more than 100 km in Northern Tamaulipas, Tabasco and Campeche to a few kilometres in Veracruz, to the east of Xalapa and near San Andres Tuxtla (where the volcanic reliefs reach the seashore).

The Pacific coast

The Latin American Pacific coast is heavily influenced by the proximity of mountain chains. The coast’s geological evolution is relatively recent, so there was less time to produce assorted sand deposits from granitic sources. The coastal chains also include numerous volcanic deposits and volcanic geomorphological features, which were deposited on the shores when they eroded. As a result, the Latin American Pacific coast is rich in non-quartzic sands (volcanic detrital sediments) and abrupt rocky cliffs. It is a coast with strong relief energy, short water-courses flowing from the mountains, numerous cliffs and steep slopes near the coastline. Typically, Pacific coastal plains and beaches are not fully developed, although there are some small plains in places like the Balsas and Papagayo river basins in Mexico, the Cocibolca lake basin in Nicaragua and the Guayas plains in Ecuador.

Unlike the Atlantic, the Pacific coast lacks a stable continental shelf, so the deep abyssal domain is much closer to the shorelines than on the Atlantic. This configuration allows cooler currents to upwell very near the coast, which in turn, affects ocean productivity and fisheries.

The Caribbean Sea

The Caribbean Sea has a very long coastline exceeding 60,000 km.
The climate

The tectonic forces described above have shaped climate patterns at several scales. Major reliefs, such as the Andes or the closure of the Central American Isthmus, affect climate forces on a continental scale. The uplift of the Andes represents a climate wall that influences weather systems, while the closure of the Central American Isthmus alters ocean currents (Gems 2007). These climate and tectonic contexts in turn set the stage for the movement, evolution and the drama of the extinction of plants and animals throughout the LAC region.

Most parts of Latin America and the Caribbean are located in the inter-tropical and subtropical zone extending for 8°04’ (approximately 9 900 km) from the northernmost point of Mexico (32°32’ N) to the islands contiguous to the southern tip of South America (56°32’ S at the Diego Ramírez islands in Chile). Consequently, for most of its latitudinal length the climate is tropical and subtropical, with relatively high temperatures in inter-tropical and low altitude zones. The 20° isotherms both north and south of the Equator embrace about two-thirds of the whole region’s area. Valleys and peaks can be defined as cold or cold only in the far south and the highest plateaus.

According to the Köppen classification system, the main climatic zones of Latin America and the Caribbean are as follows (Figure 1.6):

- **Tropical rain forest climates (Af)**
  - In these areas, there is little annual rainfall variability. There are two peak precipitation periods but no dry season.

- **Tropical savannah climates with dry season (Aw)**
  - In these areas, the dry season may last up to 8 or 9 months.

- **Dry climates—arid and semi-arid (Group B)**
  - Here, annual rainfall may be extremely low (often less than 100 mm).

- **Humid subtropical and temperate climates (Cf)**
  - This region has no dry season and rainfall is quite uniform all year round.

- **Temperate climates with dry winters, mostly in highland environments (Cwb)**
  - As a result of subtropical high-pressure systems, winters are dry while summers are rainy due to tropical air masses.

- **Sub-polar oceanic climates (ET)**
  - The mean temperature is 0°C. In the warmest month, the temperature can vary between 0° and 10°C.

The tropical (A zones) dominate the region’s climate, affecting more than 60 per cent of the land area, followed by temperate (C zones) covering approximately 24 per cent and arid (B zones) with less than 15 per cent (Peel and others 2007).
El Niño (ENSO)

Warming of the central and eastern Pacific Ocean surface temperature anomaly determines the El Niño–Southern Oscillation (ENSO). Anomalous warming in the eastern Pacific is often accompanied by anomalous cooling in the western Pacific, resulting in a change in the trade winds and atmospheric circulation patterns, with subsequent changes in the weather and climate of Pacific basin countries. An El Niño event is defined as a period of three months or longer during which the sea surface temperature anomaly in the eastern equatorial Pacific Ocean exceeds 0.5 °C for at least 12 months. The El Niño phenomenon has been observed for centuries and is known to affect weather patterns globally, including the frequency and intensity of droughts, floods, and storms. El Niño events have significant economic and social impacts, affecting agriculture, fisheries, water resources, and public health systems.
**Tropical and Subtropical Moist Broadleaf Forests (TSMBF)**

This terrestrial biome is the most extensive in the LAC region, comprising 48 per cent of its surface and extending over eastern Brazil, northern South America, large tracts of Central America and a few of the Caribbean islands. LAC holds 47 per cent of the world’s TSMBF. These forests are dominated by semi-evergreen and evergreen deciduous trees, have the highest levels of biodiversity and include the largest number of ecoregions (64) within a single biome. The Southwest Amazon moist forest and the Madeira Tapajós moist forests are among the biome’s largest ecoregions. The nature of threats to the ecoregions vary among them, but logging, fire and deforestation to expand grasslands and agriculture, hunting, and pollution related to mining are the most common threats in many of the biome’s critical/endangered ecoregions. Although several of its ecoregions are in a critical or endangered state, this is the most undisturbed biome in LAC (National Geographic and WWF 2001).

**Tropical and Subtropical Dry Broadleaf Forests (TDBF)**

These tropical and subtropical forests have lower rainfall than moist tropical and subtropical broadleaf forests. LAC holds 40 per cent of the world’s TDBF, which cover six per cent of the region. The largest tract of this biome is located in central South America (Chaco and Chapadmalal ecoregions); other significant areas are in eastern Brazil, coastal Ecuador and Peru, Venezuela and Colombia, parts of the Pacific Central American coast and most of Cuba. These are the world’s most endangered tropical and subtropical forests. Habitat destruction is the main threat and the main causes vary by sub-region. In central South America, where only 30 per cent or less of the original cover of the Atlantic Dry Forests remains, the main threat is agricultural expansion and deforestation for farmland. The Chaco ecoregion is threatened by grazing activities. In Peru and Ecuador, the Tambopata Madre Valley Dry Forests are also threatened by agriculture, logging and overgrazing; in Central America, wildlife exploitation, and infrastructure for tourism and urbanization represent serious threats (National Geographic and WWF 2001).

**Tropical and Subtropical Coniferous Forests (TSCF)**

Critically endangered worldwide, these forests in the LAC region are located in Mesoamerica—Mexico and Guatemala—and in the Caribbean—Haiti and Dominican Republic, Bahamas and northwestern Cuba. The largest tracts are the Sierra Madre del Sur Pine-Oak ecoregion, the Trans-Mexican Volcanic Belt pine-oak forests and the Central American pine-oak forest ecosystem. The Mixteca pine forests ecoregion is the largest remaining l.cuviend tropical pine savanna in LAC and, though vulnerable, has tracts in a relatively good conservation state. The Trans-Mexican pine forest ecoregion holds more pine species than any other ecoregion in the world. In the Caribbean, this biome has been heavily altered and areas with well-conserved tracts are highly vulnerable, as is the Mixteca pine forest, which is being threatened by banana monocultures. Other serious threats are logging, agriculture and road openings. TSCF cover 2 per cent of the region, which represents 85 per cent of this biome worldwide (National Geographic and WWF 2001).

**Temperate Broadleaf and Mixed Forests (TBMF)**

Located at the southern tip of South America and in central Chile, this biome has four recognized ecoregions—two of which are islands off the coast of Chile—covering two per cent of LAC. The most extensive ecoregions are the Valdivian Temperate Forests and the Magellanic Subpolar Forests. Although the Valdivian Temperate Forest is the world’s second-largest temperate rainforest, it holds only 40 per cent of its original cover in a good state of conservation and is critically endangered. The conservation status of the Magellanic Subpolar Forests ecoregion is relatively stable/ intact and it has outstanding conservation areas and some of the oldest trees in the world, with Horchellas (larches) more than 3,000 years old. The main threats to this biome come from timber extraction, logging, deforestation of forest ecosystems with monoculture plantations and the introduction of exotic species (National Geographic and WWF 2001).

**Temperate Grasslands, Savannas, and Shrublands (TGSS)**

This biome spreads through vast areas of southern Brazil including the Coroado ecoregion (the largest ecoregion in LAC), extends into central Paraguay and northern Argentina and covers all of Uruguay—the Uruguay-Paraná savanna ecoregion, which extends into the state of Rio Grande do Sul in southern Brazil. The Bonaire savanna is located in northern-central Bolivia. The Llanos ecoregion in Colombia and Venezuela contains other very large tracts of this biome. The Guianan savanna ecoregion is an area surrounded by a TBMF biome in southern Venezuela, northern Brazil and part of southeastern Guyana. The total area covered by this biome represents 19 per cent of LAC, and it is the second-largest biome. The main threats and conservation status in this biome vary by ecoregion. In the southern section, the major disturbance comes from cattle ranching, but agriculture and deforestation with exotic species are of growing concern (National Geographic and WWF 2001).

**Temperate grasslands** differ from tropical and subtropical grasslands in temperature and annual rainfall and as a consequence, in tree cover. In LAC, this biome is mostly located in Argentina. Three of the five ecoregions within this biome are in a critical/endangered conservation status and they represent more than 70 per cent of the biome’s extension. Since the foundation of Buenos Aires and other urban areas located in this biome, its southern section has been used for cattle ranching and in under increasing agricultural pressure. Overgrazing and the introduction of exotic species are the most serious threats to the southern ecoregions of the Patagonian Steppe and Grasslands and the Argentinean Montes (National Geographic and WWF 2001).
Ecoregions within this biome are scattered around LAC and host numerous plant and animal species, including high migratory-waterbirds biodiversity. The Pantanal is located in central South America and is one of the planet’s largest wetlands, expanding over more than 170,000 km²—more than half of this entire biome in LAC. Other significant areas in southern South America are the Southern Cone Mesopotamian Savannah and the Pampa Flooded Savannah, both within Argentina. The Guayacán flooded grasslands and the Grinccio wetlands are located in eastern and northern South America, respectively. In the Caribbean, Cuban wetlands are home to swamps and marshes with significant biodiversity. The modification of hydrologic integrity by building dams and waterways and through pollution is the main threat to this biome. In southern ecoregions, agriculture and cattle ranching are increasing pressures (National Geographic and WWF 2001).4

Montane Grasslands and Shrublands (MGs) »

With the exception of a very small area of Zacatonal in southern Mexico, the rest of the ecoregions within this biome are located in the South American Andean region. This biome extends over four per cent of LAC and has many ecoregions with a relatively stable/intact conservation status. The Central Andean and wet and dry Puna occupy more than 70 per cent of this biome in LAC. The ecoregions are contiguous and run parallel to the Pacific Ocean from central Chile to northern Peru; interspaced with the Montane Grasslands are the Andean—Montane Grasslands—for over 2,500 km of extremely dry conditions in Chile and Peru. The Cantas, on the eastern tip of Brazil, is the largest dry forest in South America and one of the world’s richest. It includes several distinct vegetation types covering around 60 per cent of LAC’s deserts and Xeric Shrublands. The northern parts of Colombia and Venezuela contain another large tract of this biome, consisting of Paragua, Guajira-Barranquita and La Costa xeric scrub. Although interrupted by spots of dry and most broadleaf forests, it expands over almost 2,000 km of coast. In Cuba, the Cuban-cactus scrub covers the southeastern and a small part of the north-central coast. Threats are as varied as the ecoregions within this biome. Grazing and agriculture are of great concern on its fragile soils. In some of the most arid regions, hunting and the introduction of exotic species are major threats. Likewise, timber extraction, fire and cultivation are serious threats in the Caatinga ecoregion (National Geographic and WWF 2001).4

Mediterranean Forests, Woodlands and Shrublands (MFWS) »

This biome is found in a small area in northern California, Mexico, and in the Chilenian Matorral ecoregion in central Chile. It represents two per cent of the total worldwide biome. The Chilenian Matorral’s isolation—situated between the ocean and the very distinct biomes of forest and desert—favours the abundance of endemic species within this biome. Chile’s capital city, Santiago, and some of the largest urban areas in Chile are located in this ecoregion. The main threats come from expanding urban areas, agriculture, exotic species and fire (National Geographic and WWF 2001).4

LAC has more than 30 distinct mangrove ecoregions that are unique and highly diverse ecosystems located in the continental-marine transition zone.

Deserts and Xeric Shrublands (DXS) »

This biome is spread throughout LAC, with distinct ecoregions in eastern, western and northern South America, many of the Caribbean Islands, Guatemala and western Mexico. The Atacama and Sechura deserts in western South America extend between the Pacific Ocean and the Andes—Montana Grasslands—for over 2,500 km of extremely dry conditions in Chile and Peru. The Cantas, on the eastern tip of Brazil, is the largest dry forest in South America and one of the world’s richest. It includes several distinct vegetation types covering around 60 per cent of LAC’s deserts and Xeric Shrublands. The northern parts of Colombia and Venezuela contain another large tract of this biome, consisting of Paragua, Guajira-Barranquita and La Costa xeric scrub. Although interrupted by spots of dry and most broadleaf forests, it expands over almost 2,000 km of coast. In Cuba, the Cuban-cactus scrub covers the southeastern and a small part of the north-central coast. Threats are as varied as the ecoregions within this biome. Grazing and agriculture are of great concern on its fragile soils. In some of the most arid regions, hunting and the introduction of exotic species are major threats. Likewise, timber extraction, fire and cultivation are serious threats in the Caatinga ecoregion (National Geographic and WWF 2001).4

Mangroves »

This biome covers extended coastal areas of Central America and the Caribbean and in South America it extends up to Ecuador on the Pacific coast and to southern Brazil on the Atlantic coast. LAC has more than 30 distinct mangrove ecoregions that are unique and highly diverse ecosystems located in the continental-marine transition zone, generally related to lagoon, estuarine or deltaic environments. The Guianan mangroves in northeastern South America are the most extensive in LAC, followed by the Greater Antilles mangroves in Cuba, Hispaniola, Jamaica and Puerto Rico. A variety of pressures are affecting these highly productive ecosystems. Logging for charcoal and construction material is widespread; pollution from urban, industrial and agricultural activities is affecting the habitat, which in many ecoregions is being destroyed by increased tourism infrastructure, salt flats, and shrimp farms and in some areas, agriculture and cattle ranching; and finally, the increased number and severity of storms is also affecting some mangrove ecosystems (National Geographic and WWF 2001).4
The humid tropical forest systems of Latin America are generally very stable and have the greatest biological diversity. It is very difficult to quantify the number of species in tropical rain forests, particularly when considering smaller vertebrates and invertebrates; according to conservative estimates, however, the number of vertebrate species may exceed 200,000–500,000 and there are certainly more than several million invertebrates (perhaps 10–20 million or more). Latin America’s most highly biodiverse tropical rain forests are in the Amazon basin, the Atlantic Humid Forest (Mata Atlantica of Brazil) and on the Central American Caribbean coast and nearby plains.

Common in some LAC regions, coral reefs are highly stable systems and are rich in biodiversity. They are located mainly in the Caribbean Sea, but there are also important coral reefs on the Bahama archipelago and nearby islands and on the northern and northeastern Atlantic coast of South America. Although very little is known about the identity and number of species in coral reefs, it is estimated that there are several hundred thousand invertebrate species and several tens of thousands of vertebrate species (mainly fish, but also aquatic reptiles, mammals and birds, among others).

There are other important biodiverse aquatic ecosystems associated with different coastal regions throughout the continent. They include littoral and neritic bio-environments in tropical seas, such as sandy beaches, lagoons, tidal flats and shallow sea bottoms. Temperate and cool water systems also have considerable biodiversity. Although there are fewer species than in tropical seas, there is very high biomass productivity due to the abundance of nutrients and dissolved oxygen in the water. For this reason, most fisheries are located in the cooler waters of the Peru (Humboldt) Current on the Pacific Coast of South America, the Falkland Current on the Atlantic Coast of South America and further south in the Antarctic Sea.
The Sao Francisco basin

With more than 2,800 km in length, the Sao Francisco is the largest entirely Brazilian river. It runs through five states, starting approximately 150 km north of the city of Belo Horizonte. Several tributaries flow towards the Sao Francisco, which in certain sections of its course is a crucial source of freshwater. More than 13 million people live in a basin of over 600,000 km². Several dams have been built along the river, the first one being the hydroelectric dam of Paulo Afonso, built in 1955. In 1977, the Sobradinho dam was finished, forming one of the largest artificial lakes in the world, covering an area of over 4,000 km².

LAC is estimated to contain 31 per cent of the planet’s 35 million km³ of freshwater resources.
The Plata-Paraná basin

The Rio de la Plata (Paraná hydrographic system) is a large (3.8 million km²) transboundary basin shared by five countries: Brazil, Paraguay, Argentina, Bolivia and Uruguay. The basin comprises the Rio de la Plata and the main tributaries, the Paraná and the Uruguay rivers. The average flow in the river reaches of the Paraná River is about 20,000 m³/second. This hydrologic network serves a population of about 70 million people, of whom about 67 million are in Brazil, 15 million in Argentina, and the rest in Paraguay (4 million), Uruguay (2.5 million) and Bolivia (1.5 million). The Rio de la Plata basin provides the following ecosystem services:

- Water supply for many cities (São Paulo, Asunción, Rosario, Santa Fe, Parana, Posadas, Corrientes, Cúcuta and many others) and hundreds of thousands of farms.
- Irrigation water for crops (sugarcane, rice and fruit trees) in five countries;
- Energy, through large hydroelectric dams (Itaipú, Salto Grande and Itaipú, the largest in the world), the Paraná and the Uruguay rivers. The average flow in the lower reaches of the Paraná River is about 20,000 m³/second. Like the Río de la Plata basin, the Magdalena basin serves many purposes and is used extremely. Bogotá, Cali, Bucaramanga and Cartagena all take water from the system. Hydroelectric power generation is important. Fluvial navigation, and fisheries are less significant than they were in the past, but with adequate planning and implementation, there is still a potential for these activities.

On the other hand, the Magdalena River and its tributaries are the main “drains” for the sewage systems of most Colombian cities. The Bogotá River causes the worst problem, receiving all the effluent from the Bogotá metropolitan area (over 4 million people) and joins the Magdalena near the city of Girardot. Downstream from Girardot, the quality of the river water becomes so poor that it is hazardous to human health.

Caribbean Islands hydrologic basins

Because of their insular nature, the rivers of the Caribbean islands do not have large basins and they are relatively short. In Cuba, the main hydrologic basin is the Caño river basin covering 9,640 km². The Caño River itself is 343 km long. The Zaza river basin is the second largest at 2,413 km². The Zaza River is 145 km long.

In the Haiti-Dominican Republic island of Hispaniola, the longest water course is the Artibonite River with a length of 320 km. The headwaters are in the highlands of the Cordillera Central in the Dominican Republic and the river ends in the Gulf of Gonâve, in Haiti. It is used for irrigation and to generate hydroelectricity for Haiti (at the Peligre Hydroelectric Dam). The Yaque del Norte River, at 326 km long with a basin area of 7,044 km², is another important river on the island.

The hydrologic basins on the other major islands (mainly Jamaica and Puerto Rico) are significantly smaller. While the Rio Minho is the longest river in Jamaica (approximately 95 km), the Black River Watershed is the largest basin in Jamaica covering 1,681 km². The Rio Grande de Arecibo in Puerto Rico has a length of 605 km and a basin covering 650 km².

Orinoco basin

The Orinoco river basin is the third-largest in South America. It extends for about 1 million km² and the river’s length is approximately 2,500 km.

The Orinoco basin is not heavily populated. In the southern part there are some important native nations including the Panamés, Yekuana, Guajibo and Piaroa, among others, and population density is low. Further north, a number of urban centres have been built. The most important are Puerto Ayacucho (population of 40,000 and capital of the State of Amazonas), Ciudad Bolívar (population of 300,000 and capital of the State of Bolívar) and Ciudad Guayana (population 1 million, in the State of Bolívar). This Orinoco delta, consisting of islands and swamps that are regularly flooded during the rainy season.

Magdalena basin

The Magdalena River basin is entirely in Colombia, descending 1,550 km from the highlands of the Andes ranges towards the Caribbean with a flow in excess of 2,000 m³/second in its lower reaches. Like the Rio de la Plata basin, the Magda- lena basin serves many purposes and is used extensively. Bogotá, Cali, Bucaramanga and Cartagena all take water from the system. Hydroelectric power generation is important. Fluvial navigation, and fisheries are less significant than they were in the past, but with adequate planning and implementation, there is still a potential for these activities.

Lerma-Santiago basin

The Lerma river is the longest river in México with a length of 965 km. The headwaters are located at nearly 3,000 masl in the springs of Almoloya del Río in the State of México, and the river flows into the densely populated Valley of Toluca where it forms swamps and lakes. In recent times, most of these lakes and swamps were drained due to over-pumping, inter-basin water transfer and ditching. The river flows out of the Toluca Valley and finally reaches the large Chapala Lake after crossing the States of Morelos and Jalisco. The outflow from the Chapala Lake enters the Pacific Ocean through the Santiago River.

The overuse of the river Lerma for irrigation and urban water supply has reduced its flow volumes significantly. In many stretches the river, they are very small or nonexistent due to unsustainable extraction that threatens the survival of the ecosystems and communities on its margins.
Lake Titicaca and associated Salinas

Lake Titicaca is located on a plateau, which was elevated to a considerable height mainly in the Cenozoic era. With an area of 8,372 km² and a catchment basin of 58,000 km², Lake Titicaca is the largest high-altitude freshwater lake of the world. It drains its excess water southwards into an Altiplano internal depression where water evaporates, forming brackish and salty lakes (Uru Uru and Poopó lakes), huge salty marshes and salinas or salt flats (such as Salares de Coipasa and Uyuni). Uru Uru is a relatively small and shallow lake with brackish water, Poopó is a 1,000 km² salty lake (1-2 g/litre of salts), Coipasa is made of extensive salty marshes (2,000 km²) and Salar de Uyuni is the largest salt flat on the planet with more than 10,000 km² of salty crusts and brine ponds (Risach and Fritz 1991).

Mexican lakes

Mexico has many lakes and marshes, mainly related to volcanic obstructions of hydrologic networks or to coastal geomorphic systems. The bottom of the Ana- huac geological depression (Valley of Mexico) was covered by a chain of seven lakes of which only a few remnants still exist. These lakes are Chalco (a freshwater lake that has almost been totally drained), Xochimilco (a freshwater lake, now partially drained); lake Mexico (brackish water, totally drained); the large Texcoco (brackish water, mostly drained); and Zumpango (salty water, partially drained). There are also lakes in the region of Michoacán and Jalisco (Cuitzeo, Pátzcuaro and Chapala—the latter is the largest in Mexico; see Chapter 3). These lakes are under intense pressure and human activities have affected their size, depths and water quality. There are also lakes and marshes along the Pacific coast and adjacent to the Gulf of Mexico: they are also being degraded as a result of urban and industrial development.

Lake Maracaibo

Lake Maracaibo is an extensive brackish water body (at 13,210 km², it is the largest lake in Latin America). It is located in the Gulf of Venezuela and is connected to the Caribbean Sea by the Tablazo Strait; it is fed by numerous rivers of which the largest is the Caura. It was formed in a sinking basin, mainly filled with sandy sediments derived from the nearby sandstone hills. The Pantanal system extends for about 160 km along the east bank of the upper Paraguay River; it resembles an interior delta with annual flooding feeding its many rivers and swampy areas.

Streams descending from the north and east arrive at the plain and produce enormous alluvial fans that obstruct the development of river valleys. This causes the formation of a characteristic meandering pattern as the riverbeds frequently change direction, leaving abandoned crescent-shaped lakes. The landscape is dotted with hundreds of lakes where aquatic organisms, waterfowl and many other species flourish. There are also lakes in the region of Michoacán and Jalisco (Cuitzeo, Pátzcuaro and Chapala—the latter is the largest in Mexico; see Chapter 3). These lakes are under intense pressure and human activities have affected their size, depths and water quality. There are also lakes and marshes along the Pacific coast and adjacent to the Gulf of Mexico: they are also being degraded as a result of urban and industrial development.

Lakes and marshes in Latin America and the Caribbean have many lakes, marshes and salt plains representing a very important part of its biodiversity and natural resources. Many of the lakes and marshes are related to volcanic obstructions of river flow (mainly from lava downing onto river valleys that dam their courses), others are located in undrained zones on the large plains, while still others are found in coastal regions. In some other cases, the lakes are the result of tectonic events, such as subsidence (sinking) of crust compartments forming local sedimentary basins.

Gran Pantanal

The Gran Pantanal is a large wetland of swamp and marsh land overlying older sedimentary formations in southwestern Mato Grosso, Brazil, west of the Brazilian shield (Figure 1.11). It was formed in a sinking basin, mainly filled with sandy sediments derived from the nearby sandstone hills. The Pantanal system extends for about 160 km along the east bank of the upper Paraguay River; it resembles an interior delta with annual flooding feeding its many rivers and swampy areas.

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Lake Titicaca is the largest high-altitude freshwater lake of the world, with an area of 8,372 km² and a catchment basin of 58,000 km².
Cambios en un glaciar

Puede estar a pocos metros de profundidad o a más de mil metros.

Fuente: Museo de Naturaleza y Ciencia de Denver

variables dependiendo del subsuelo a velocidades moderadas.

El agua fluye en las rocas del subsuelo.

El agua de la lluvia se incorpora en el subsuelo.

El agua se almacena en los Áreas de almacenamiento.

Nieve

Icebergs

Solares, dificultando la fusión del hielo que la nieve absorbe.

La acumulación de nieve en los lugares donde se funde más nieve.

El hielo del glaciar queda expuesto a manantiales naturales.

Icebergs

El agua de los manantiales y las nubes se convierte en nieve en áreas de presión ascendente.

Se obtienen perforando el terreno (pozos artesianos).

Artificial upwelling

Natural upwelling

volcanic origin.

Rock of volcanic origin.

Ice

Snow

Water table

Napa de agua

Transboundary aquifers

THE PHYSICAL CONTEXT

Water in an aquifer

Importance of glaciers and snow fields

Snowfields are important hydrological reservoirs and their melting water feeds many rivers along the mountain ranges. Melting increases considerably in the warmer seasons on the upper field edges and at the end of the glacier valleys that supply water to many urban centres and farming areas in the valleys and foothills. In some cases, melting takes place during the dry season and provides precious water in times of scarcity (for example, the Rimac River in La Punta supplies water in the dry season). Another socio-economic role played by snowfields in some places is the potential to attract tourists. Some communities in Argentina and Chile depend on this system for their livelihoods.

Glaciers

Several factors determine the existence, volume and altitude of glaciers—the frequency and constancy of below-freezing temperatures, the amount of snow and related icy precipitation, the configuration of the relief that allows snow to accumulate over long periods and the presence of slopes and valleys allowing the gradual down-slope movement of ice masses.

Low temperatures are found in high latitudes (polar and sub-polar climate) and for this reason the snowline varies from very low elevations near sea level in polar or sub-polar areas to more than 6 000 m in arid tropical regions.

Because Latin America has high mountains and is mainly tropical region, the snowline is usually found in the upper part of the ranges and chains. However, in the south, glaciers may occur at elevations of a few hundred metres or even at sea level.

Many tropical glaciers can be found throughout Latin America, from the high peaks of the Trans-Mexican Volcanic Belt in Central Mexico to the snowfields of Bolivia and Northern Chile. In Mexico, glaciers occur in association with the highest volcanoes, such as Pico de Orizaba, Popocatepetl, Iztaccíhuatl, Nevado de Toluca and Nevado de Colima.

In South America, tropical glaciers occur at low latitudes in the Andes ranges, mainly in Peru and Bolivia and to a lesser extent in Ecuador and Colombia. Most Peruvian glaciers are located in the Cordillera Blanca and some are found in other smaller ranges such as the Cordillera Vilcanota in Ecuador and the Cordillera Darwin in Peru. Tropical glaciers in Bolivia are also related to volcanic mountains (the Nevado de Illimani close to the city of La Paz, for example) where measured water deficits indicate that some glaciers may disappear in the near future, as has been the case with the Charahuayla glacier.

Most snowfields in medium and high latitude Andean glaciers are located along the Chiloé-Argentino foreland. In Northern Chile the arid region of Tarapacá and Antofagasta the snowline is located at about 6 000–6 500 m above sea level; here they are covered by less than 100 m of snow and there are no glaciers.

In Southern Argentina, every four years an ice dam appears that separates arroyo glacial waters from the main portion of Lake Río. This lake is small but drains into the larger Lake Argentino. It is caused by the drowning of Las Perito Moreno glacier into Lake Río, whose water gradually rises 30–40 m or more above the level of Lake Argentino, putting pressures on the ice dam. Finally, after two to four days, the ice wall crumbles, falls into Lake Argentino and forms large impact waves along its shores. This spectacular natural event can be observed along the coast of Lake Argentino and especially in El Calafate city, which has become a major tourist attraction in the south of the continent.
The human journey leading to distribution and density started at least 10,000 years ago. This journey is a story of changing landscapes, adaptation, diversity, disease, the growth and collapse of populations and cultures.»

**Human geography**

The human journey leading to the Americas occurred in stages. Figure 1.3 shows that the Americas were inhabited by numerous human populations that speak, to a large extent, different languages.

**Population**

The first humans to populate the Americas moved at different times and in different ways. Some populations survived longer than others, depending on their cultural strategies, geographical factors, or other conditions. The population density varied throughout the Americas, with some areas inhabited by a larger number of people than others.

**Tools of the first Americans**

The remains of a camp of 12 people, dated to 12,400 years ago, was found in Monteverde I, a site located in Costa Rica. This site is one of the earliest evidence of human occupation in the Americas.

**Cultural diversity**

The cultural diversity of the Americas is evident in the variety of tools and artifacts found in different sites. The earliest cultural remains found in the Americas are the Clovis culture, which dates back to around 13,000 years ago.

**Migration routes through the Americas**

The migration routes through the Americas are depicted in Figure 1.4. The routes include the coastal route and the land route, as well as the oceanic route and the coastal route.

**Advancing across the Americas**

The corridor, formed by the Cordilleran Ice Sheet and the confluence of rivers, was a critical route for human migration. It allowed human populations to move across the Americas, adapting to different environments and cultures.

**Demographic changes**

The lack of reliable data makes it very difficult to determine the demographic changes that took place during the migration of human populations to the Americas. Nevertheless, it is estimated that the first populations to inhabit the Americas were small and scattered. Over time, the population grew, reaching its peak around 14,000 years ago.

**The human journey**

The journey of human populations to the Americas is a story of adaptation to different environments and cultures. The growth and collapse of populations and cultures are evident in the archaeological record.
The vast occupation of the Americas modified the pristine landscapes and ecosystems to a degree that is still being discovered. Even areas in the Amazon forest, until recently considered “pristine”, are now known to be secondary forests with traces of urban centres with significant exchange floors between them (Manin 2000, 2008; Heckenberger and others 2003, 2006).

The Conquest (Conquista) was a catastrophic event for Native Americans, who saw their populations decimated, their resources depleted and their cultures destroyed. New societies continue shaping, evolving and collapsing in the territories first occupied by humans many millennia ago.

There are four distinct periods of population change in LAC (Figure 1.15). The first period is one of rapid population decline (1492-1850) as a consequence of the Conquest as described above. The population fell from around 50 million to 5 million. Others of slower (1850-1890), moderate (1890-1950) and accelerated (1950-2000) growth followed this period (Breu 2003). From the 1995-2000 period to the 2015-2020 period, the population growth rate is expected to decrease from 1.56 to 0.98 (CEPAL 2008a).

There are sub-regional variations in the figures described above. For example, in Latin America, infant mortality will decrease from the current 25·4 in the 1995-2000 period to 18.5 by 2010-2015. Although it is a shared trend, the figures are significantly higher in the Caribbean—39·4 for 1995-2000 and 25·4 for 2010-2015. There are also extreme differences among countries. For instance, at current rates of population growth, it will take only 20-25 years for Nicaragua to double its population, while it would take almost a century for Uruguay to do so. Figure 1.16 and 1.17 show infant mortality rates and poverty in LAC, respectively.

Since 1990, the percentage of poor and extremely poor people has been constantly decreasing. Despite this, LAC continues to be the world’s most uneven region in terms of equality. A group of countries (Venezuela, Bolivia, Brazil and Nicaragua) have seen the inequality gap decline significantly over the past five years, while others (Honduras and Dominican Repub. have experienced an increase in inequality, and Uruguay, Costa Rica, Mexico and Peru have seen virtually no change. Uruguay remains among the most equal societies in LAC. The opposite is true of Bolivia, despite the progress being made. Figures 1.18 and 1.19 show trends in the proportion of people below poverty lines and the Gini Index, respectively.
The contribution of natural resources to the economy

The present contribution of the 10 leading products in the percentage share of exports has changed since the 1970s (CEPAL 2008a). However, in LAC, exports of primary products continue to be around 50 per cent of total exports. Tourism, which in the Caribbean in particular depends on nature conservation, represents 7 per cent of GDP and 17.3 per cent of the export of goods and services. It is estimated that Guatemala receives US$50 million annually from tourism, timber and non-timber forest products, while Ecuador receives US$100 million from nature-based tourism alone (CIEP 2010).

The volume of exports directly dependent on highly polluting industries tripled in the 1980s and 1990s. Despite improvements in technology, the natural resource base is suffering from centuries of economic development that depends on exporting natural resources. The rate of growth slowed in 1980-1999 and 1990-2000 in the following sectors: arable land surface; cattle stock; wood production; mining production; and without petroleum; and agricultural production due to a dramatic increase in the use of herbicides are the only sectors that increased (CEPAL 2008a). However, investment in LAC, particularly in mining, increased in the 1980s and 1990s. Despite large concentrations of minerals in Central America and the Caribbean, recent examples being many Mexican towns near the U.S. border; Mineral deposits explain the settlements and expansion in northern Mexico, the Andes (Peru), for example, and eastern Brazil (such as Recife, Salvador).

Population, economy and natural resources

Remittances and Foreign Direct Investment

After the migration flows from LAC in the 1980s and 1990s, remittances began to have an increasing impact on LAC’s national economies. The International Fund for Agricultural Development (IFAD) estimates that total remittances to the region in 2007 were US$67 905 million, distributed among sub-regions as shown below (Mexico is listed individually due to its high proportion of the total in Mesoamerica):

- Caribbean: US$8 370 million
- Central America: US$11 031 million
- Mexico: US$8 254 million
- South America: US$24 250 million

Remittances represent 3 per cent of regional GDP, and 11 per cent of exports. Intradation, according to the Economic Commission for Latin America (ECLAC), remittances are more stable than capital flows. In Haiti, Nicaragua, and Jamaica remittances represent more than 20 per cent of GDP –33, 29 and 23 per cent, respectively. Figure 1.20 shows the trend in remittances and Foreign Direct Investment.

Trend in remittances and in Foreign Direct Investment, 1993-2007

Urbanization patterns

Population distribution in LAC (as shown in Figure 1.21) is affected by at least four factors that also explain urbanization patterns during different periods as described below (Blouet and Blouet 2006; see also the figure on “Cities of Latin America and the Caribbean” in Chapter 2):

In 1492, indigenous populations were mainly concentrated in the central valley of Mexico, in the highlands of Central America and in the Andes, with linear concentrations along the Amazon River. Some of these concentrations still remain, others were short lived, like the logging communities that developed on the Caribbean coast; in some areas, such as the Iberians of the Andes, the Orientals in Bolivia and the Gulf coast of Mexico, populations continue to increase.

Linking the LAC region to the rest of the world was the main focus during colonialism, as resources were extracted to meet European demand. This explains the existence of many port towns such as Lima-Calle, Veracruz, Santo Domingo, Montevideo and Buenos Aires. The emergence of North American markets explains the expansion of urban areas in Central America and the Caribbean, recent examples being many Mexican towns such as Tijuana near the U.S. border. Minera deposits explain the settlements and expansion in northern Mexico, the Andes (Peru), for example, and eastern Brazil (such as Recife, Salvador).
Transportation facilities are closely related to the previous two points and have transformed areas like the Pampas and its port cities (of Buenos Aires, for example) into channels for production outside LAC. The location of Amazon towns used to be close to the river networks such as Manaus. Today, roads entering Amazonia support the extraction of resources and allow new towns to be built.

Spanish and Portuguese colonization differed in the location, establishment, and use of urban areas. Urban centres were a key element in the Spanish conquest and settlement, and land grants were distributed among officers and soldiers and provided the bases for colonial authority. In Portuguese America, settlements were limited to coastal areas; cities functioning as ports and forts and were mercantile and administrative centres were dominated by more powerful rural-based elites (Kent 2006).

The percentage of urban population in LAC is similar to proportions in Europe, but LAC is far more urbanized than the world’s other developing regions. There are striking contrasts in urbanization rates and characteristics in LAC (Figure 1.22). South America, with 83 per cent of its population in urban areas, is the most urbanized region in the world, while Uruguay, with 92 per cent, is the most urbanized country in LAC. The urban population in the Caribbean represents over 60 per cent of its total population, and in Mesoamerica, it is over 70 per cent (UNEP 2010). Sub-regions are not homogeneous: in Central America, Guatemala has an urban population of around 40 per cent while in Costa Rica it is over 80 per cent. Contrasts are striking in the urban centres of the world’s most socially unequal region, where affluent cosmopolitan European or North American-style societies coexist with poor rural migrants. It is estimated that about 27 per cent of the urban population in LAC lives in slums (UN-HABITAT 2008) and in some cities (such as Mexico City and Caracas) estimates are as high as 60 per cent (Kent 2006).

The number of megalopolises continues to increase in LAC. However, it is in medium, and to some extent, large (around a million inhabitable cities where the bulk of urban growth in LAC is taking place. Currently, 80 per cent of the urban population in the region lives in cities with fewer than a million people. A

![Figure 1.23](image)

Endangered languages and most endangered ecoregions

- **South America**, with 83 per cent of its population in urban areas, is the most urbanized region in the world, while Uruguay, with 92 per cent, is the most urbanized country in LAC.
More than 600 indigenous groups are recognized by independent states of LAC. These groups have a total population of 40-50 million people. Overall, the indigenous peoples of LAC have higher poverty and child mortality rates as well as lower income, formal education, life expectancy and access to drinking water and sanitation than the general population. They face exclusion and discrimination that contradict many of the rights recognized by international conventions (Popolo and Oyarce 2006).

An increasing percentage of the indigenous populations live in urban areas. Despite the higher cost of living and increased marginalization, indigenous people move to urban centres close to their communities (Popolo and Oyarce 2007), where they face discrimination. “Ethnic inequities persist in cities and in some cases are intensified, reflecting the discrimination and social exclusion that affect indigenous peoples who live in cities” (Popolo and others 2007: 5).

Many of these indigenous nations are in danger of disappearing (Figure 1.23). The number of languages at risk of disappearing continues to grow, and some of the languages with the greatest risk of extinction are in central South America. Likewise, there is an important link between cultural and biological diversity, with many of the biodiversity hotspots found in areas of high cultural diversity.

Increased pressure on natural resources is recognized as the heaviest pressure facing the indigenous communities in the LAC region and the world (IWGIA 2006). Hydroelectric projects have led to displacement and conflict affecting indigenous communities throughout LAC. The Balco hydrological project in Chile, for example, flooded 3,500 ha of Pehuenche land and led to the forced relocation of 500 inhabitants. At least five indigenous communities in Suriname are currently endangered by the construction of a hydroelectric project in the western part of the country. In Mexico, the potential construction of the La Parota dam threatens to displace between 25,000 and 72,000 people when 17,000 hectares will be flooded in the state of Guerrero (IWGIA 2006).

Conflicts related to mining, petroleum and gas are even more widespread in LAC. Rising mineral prices since 2007 have led to the opening of new mining areas. In Central America this has been accompanied by an increase in social-environmental conflicts. For example, among the 138 conflicts linked to hydroelectric mining or prospecting projects and registered in the database of the Observatory of Mining Conflicts in Latin America, at least 150 indigenous and peasant communities are known to have been affected. Of the total, the 21 events recorded in Central America and Mexico are recent examples of episodes that began in the late 1990s and intensified during the first decade of the 2000s (UNEP 2010).

Indigenous knowledge and the relationship with the local environment is embedded in social and spiritual systems (Gadgil and others 1993, Berkes and others 1995). The main difference with western knowledge is that indigenous knowledge cannot be preserved without the social and spiritual systems of which it is a part. In turn, many of these social and spiritual systems are highly interrelated to the land where they developed and to which they belong. Thus, displacing indigenous communities from their territories threatens their entire culture. Conflict over natural resources between “mainstream” society and indigenous peoples sometimes arises from different ways of perceiving nature, natural resources and the services they provide.

Indigenous peoples generally see themselves as stewards of their surrounding environment that is central to their spirituality (UNEP 1999). Their cosmology and relationship with nature are closely interwoven and throughout centuries of interaction, both their natural surroundings and culture have evolved by being influenced by each other. The demands of the indigenous and still predominantly rural populations have changed significantly from those related to social and economic rights; they are now more political and associated with their self-identification as distinct cultures and peoples who want to exercise their rights to access to their original lands and the natural resources they have traditionally used, their right to manage them, their practices and customs, their spiritual systems are highly interrelated to the land where they developed and to which they belong. Thus, displacing indigenous communities from their territories threatens their entire culture. Conflict over natural resources between “mainstream” society and indigenous peoples sometimes arises from different ways of perceiving nature, natural resources and the services they provide.

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