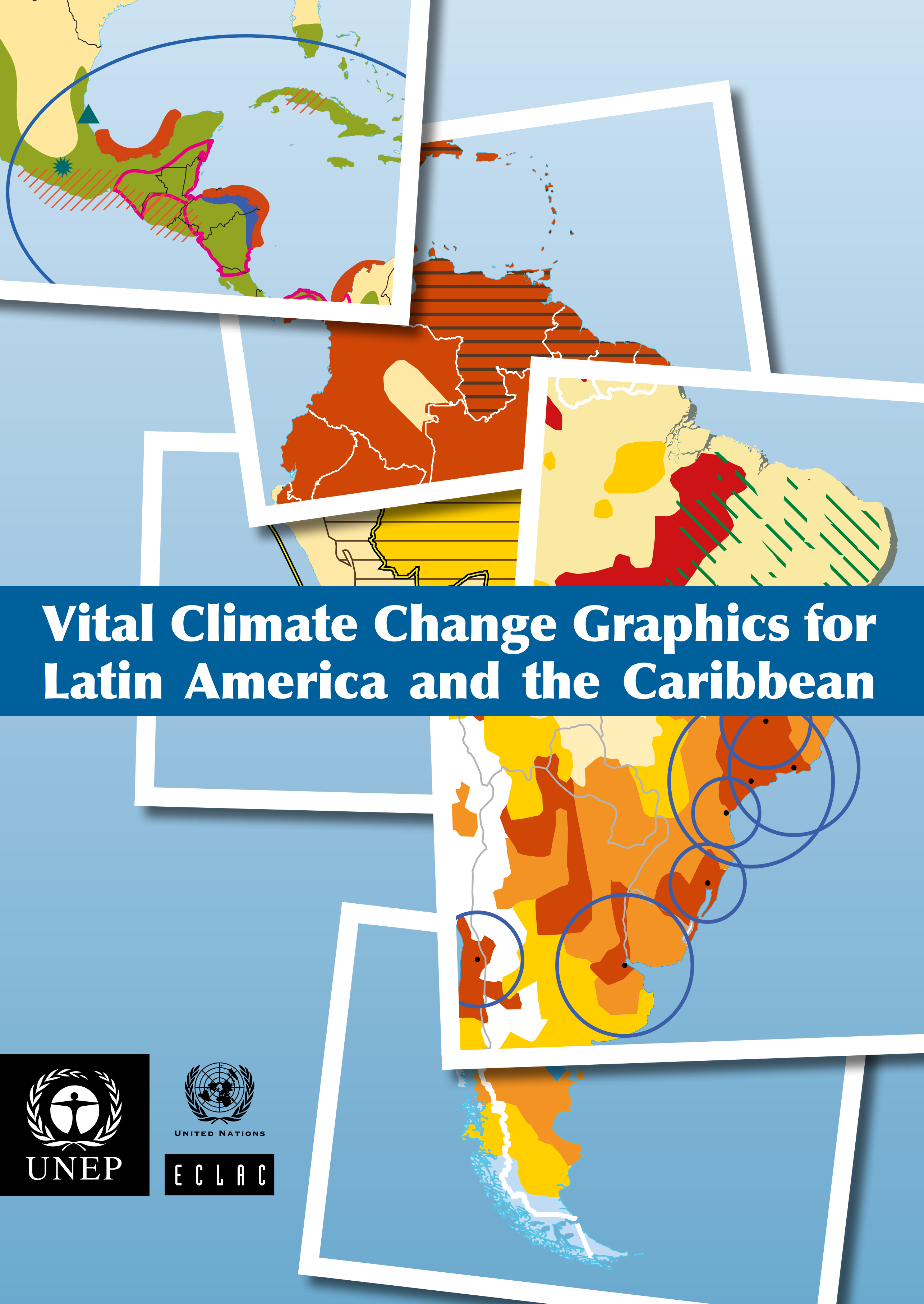
Vital Climate Change Graphics for Latin America and the Caribbean



UNEP

United Nations

ECLAC

The United Nations Environment Programme, as the world's leading intergovernmental environmental organization, is the authoritative source of knowledge on the current state of, and trends shaping the global environment. The mission of UNEP is to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.

The Economic Commission for Latin America and the Caribbean (ECLAC), through the Sustainable Development and Human Settlements Division assists on specific chapters of Agenda 21 such as those referring to promoting the development of human settlements, changing consumption patterns, integrating environment and development in decision-making through analysis of environmental economics and environmental impact assessments, environmentally sound management of hazardous products and wastes, protection of the atmosphere and conservation of biological diversity, oceans, fresh water and desertification.

UNEP/GRID-Arendal is an official United Nations Environment Programme (UNEP) centre located in Southern Norway. Established in 1989, UNEP/GRID-Arendal's mission is to provide environmental information, communications and capacity building services for information management and assessment. Together with partners in different countries and regions, UNEP/GRID-Arendal's core focus is to facilitate the free access and exchange of information to support decision making and secure a sustainable future (www.grida.no)

For further information:

United Nations Environment Programme (UNEP)
Regional Office for Latin America and the Caribbean
Avenida Morse, Edificio 103. Clayton, Ciudad del Saber, corregimiento de Ancón
Panama city, Panama
P.O. Box 03590
http://www.pnuma.org
Email: enlace@pnuma.org

Director, Division of Sustainable Development and Human Settlements
Economic Commission for Latin America and the Caribbean
Casilla179-D
Santiago, Chile
Ph: (56-2) 2102295 Fax (56-2) 2080484
Email: DDSAH@cepal.org
Web: www.cepal.org

Job Number: DEW/1325/PA
ISBN: 978-92-807-3120-0

Disclaimer

UNEP and ECLAC promote environmentally sound practices globally and in their own activities. This publication is printed on ecological paper. Our distribution policies aim to reduce our carbon footprint.

Vital Climate Change Graphics for Latin America and the Caribbean

Special edition for the COP 16/CMP 6, Mexico

Production Equipment

Graciela Metternicht (UNEP Regional Office for Latin America and the Caribbean)

Jan Kappen (UNEP Regional Office for Latin America and the Caribbean)

Ieva Rucevska (UNEP/GRID Arendal)

José Luis Samaniego (ECLAC, Santiago, Chile)

Luis Miguel Galindo (ECLAC, Santiago, Chile)

Authors and Contributors:

Luis Miguel Galindo (ECLAC, Santiago, Chile)

Carlos de Miguel (ECLAC, Santiago, Chile)

Jimy Ferrer (ECLAC, Santiago, Chile)

Layout:

Petter Sevaldsen & Robert Barnes (UNEP/GRID Arendal)

Cartographic Production

Cartographer Nieves López Izquierdo (Associate Consultant UNEP/GRID-Arendal) with specific contributions Pravettoni Riccardo (UNEP/GRID-Arendal)

Expert Reviewers Panel

Mara Murillo Correa (Regional Office for Latin America and the Caribbean)

Jan Kappen (UNEP Regional Office for Latin America and the Caribbean)

Miguel Naranjo (UNEP Regional Office for Latin America and the Caribbean)

Seraphine Haeussling (UNEP Division of Technology, Economy and Industry)

Kaveh Zahedi (UNEP Division of Technology, Economy and Industry)

Emil Cherrington - Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC), Panama

Africa Flores - Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC), Panama

Emilio Sempris - Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC), Panama

Eric Anderson, Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC), Panamá

José Eduardo Alatorre, CEPAL, Santiago, Chile

Julie Lennox, ECLAC, Mexico

Karina Martinez, CEPAL, Santiago, Chile.

Preface

Climate change – its causes, its global consequences and the magnitude of its expected effects on both ecosystems and human activities – will be one of the greatest challenges of this century. It will significantly alter current patterns of production, distribution and consumption, as well as the overall lifestyles of modern societies.

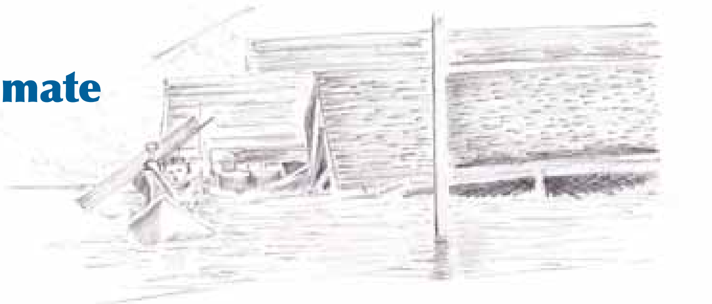
During the present century, countries will be compelled to deal with two simultaneous challenges: adapting to the new climate conditions and working to mitigate them. This will require an international agreement that recognizes historical, but differentiated, responsibilities. The Latin American and the Caribbean region is not immune to this challenge – one of the most difficult confronting modern economies – and will have to transition to a sustainable development strategy that pursues a low-carbon path and promotes equity and social inclusion.

The United Nations Development Programme (UNEP), the Economic Commission for Latin America and the Caribbean (ECLAC) – through its Sustainable Development and Human Settlements Division – and GRID-Arendal hereby present Vital Climate Change Graphics for Latin America and the Caribbean. The objective of this work is to show, in a clear and articulate way, through charts, maps and detailed analyses, the status of climate change and its implications for the region. This document, in addition to contributing to the study and debate on the phenomenon of global climate change and its effects on the region, also provides a reference source for decision makers in both the public and private spheres.

Alicia Bárcena
Executive Secretary
Economic Commission for Latin America
and the Caribbean (ECLAC)

Margarita Astrálaga
Regional Director
United Nations Environment Programme
(UNEP)

Table of contents



Introduction

The phenomenon of climate change – its global causes and origins, and the magnitude of its environmental, economic and social effects – constitutes one of the highest-priority issues on the public and private agendas of both the developed and developing countries.

Available scientific evidence shows that climate change manifests itself primarily in a gradual but continuous increase in temperature, changes in precipitation patterns, a rise in sea levels, a reduction of the cryosphere, and shifts in the patterns of extreme events. This phenomenon is the result of a variety of anthropogenic activities, associated primarily with the burning of fossil fuels, changes in land use and, in particular, deforestation and the generation of solid waste.

For the countries of Latin America and the Caribbean, the effects of climate change projected for the present century will be significant – this despite the fact that the region's emissions of greenhouse gases represent only a small proportion of total global emissions.

The Vital Graphics series provides a clear, direct, visual presentation of issues relevant to the global environment, based on a scientific analysis of currently available information. Vital Climate Change Graphics for Latin America and the Caribbean outlines for decision makers, academics and the general public the status of the climate change phenomenon in the region, focusing on its effects and its causes. The document describes the ways in which climate change manifests itself, drawing on historical analysis of variables such as temperature, precipitation and sea levels. In addition, it details the effects of climate change on ecosystem services, human health and the region's vulnerability to extreme events. Lastly, it provides an analysis of global and regional greenhouse gas emissions and identifies possible options in the region for mitigating the impact of climate change.

Key Messages

- Available international scientific evidence (IPCC, 2007a) points to the existence of the phenomenon of climate change, which is caused primarily by specific anthropogenic activities.

- Climate change manifests itself in an increase in the temperature of the earth's surface and of the oceans, shifts in precipitation patterns, changes in the frequency and intensity of extreme climate events, reduction of the cryosphere and a rise in sea levels.

- The consequences of climate change – in terms of economic activities, people and ecosystems – are significant and will most likely increase unless there is a change in the current baseline, or inertial, trajectory.

- Significant effects from climate change are expected to be felt in Latin America and the Caribbean. It is therefore essential to advance attempts to find ways to adapt to the changes, in order to reduce risks to the populations most exposed to these impacts, while at the same time aiding efforts to reduce poverty levels and inequality in the region.

- Any solution to climate change, as a global problem, must be based on the participation of all countries, with a recognition of historical, but differentiated, responsibilities.

- Climate projections under the different emissions scenarios indicate that forms of production, distribution and consumption must be profoundly altered, in order to move towards economies with lower levels of CO_2 emissions and greater social inclusion.

- In the coming decades, Latin America and the Caribbean will face two simultaneous challenges: adapting to the new climate conditions and working to mitigate their effects through a global agreement that is just and inclusive.

- The Latin American and the Caribbean region is not immune to this challenge – one of the most difficult confronting modern economies – and must transition to a sustainable development strategy that pursues a low-carbon path and promotes social inclusion.

1. Manifestations of climate change

Climate change manifests itself primarily through a gradual increase in the average temperatures of the earth's surface, alterations in precipitation patterns, changes in the intensity and/or frequency of extreme climatic events, a slow but significant reduction in the cryosphere (including glaciers) and a rise in sea levels (IPCC, 2007a).

Available scientific evidence associates the phenomenon of climate change with increased concentrations of anthropogenic greenhouse gases (GHG) in the atmosphere resulting principally from greater use of fossil fuels, changes in land use, agricultural activities, and solid waste disposal methods.

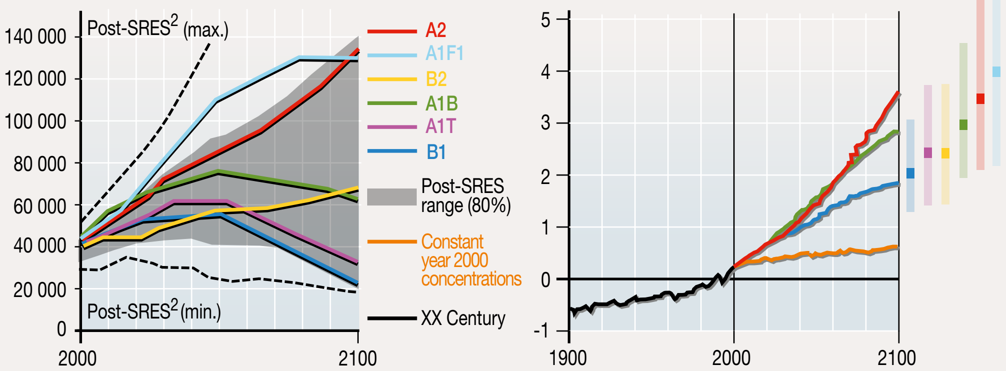
Greenhouse gas emissions scenarios[1] and surface temperature projections

Global greenhouse gas emissions

Millions of metric tons of CO_2 equivalent per year

Global surface warming

Degrees centigrade



A1 Very rapid economic growth and global population, and introduction of new and more efficient technologies:

A1F1 Fossil intensive

A1T Non-fossil energy sources

A1B Balance across all energy sources.

A2 Economic growth and technological change are more fragmented and slower than in other storylines.Continuously increasing global population.

B1 Rapid changes in economic structures toward a service and information economy, with reductions in material intensity, and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social, and environmental sustainability, including improved equity, but without additional climate initiatives.

B2 Emphasis is on local solutions to economic, social, and environmental sustainability.

Note: 1. In the absence of additional climate policies, from 2000 to 2100; 2. IPCC Special Report on Emission Scenarios.

Source: Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the IPCC, Cambridge University Press, 2007.

Figure 1.1

Socioeconomic and demographic changes, and their effects on emissions, are shaping projected climate scenarios. However, given the long time period and feedback processes involved, along with the potential for extreme climate events, there is a high level of uncertainty regarding the precise reactions of the principal climate variables in each of the GHG emissions scenarios (A1B, B1, A2, A1F1, A1T and B2).[1] For this reason, temperature change projections (in degrees centigrade, comparing 2090-2099 to 1980-1999), based on multiple climate models for different emissions scenarios, show increases of between 0.6℃ and slightly over 6℃ (figure 1.1), with effects varying from one region to another. These projections, however, are subject to a considerable degree of uncertainty.

Climate projections for Latin America and the Caribbean (LAC) indicate that temperature increases will vary, according to the particular emissions scenario and country or region concerned. Based on the various climate models, it is projected that towards the end of the century (2090-2099), Latin America will experience an increase of between 1℃ and 4℃ under scenario B2 and between 2℃ and 6℃ under scenario A2 (IPCC, 2007a). In the specific case of scenario A1B, regional increases this century are projected to be between 1℃ and 4℃ compared to 1980-1999, with variances from one country to another (figure 1.2).

Projections for changes in precipitation patterns are extremely complex, involving a high degree of uncertainty and large heterogeneity . Thus, the predictions presented here, based on multiple general circulation models (GCMs) and on the principal emissions scenarios, also show rainfall regimes varying from one part of the region to another (IPCC, 2007a). For Central America and tropical South America, predictions range from a 20% to 40% decrease in precipitation to a 5% to 10% increase by 2080. For the southern portion of South America, it is predicted that changes in precipitation will be plus or minus 12% in winter, and plus or minus 10% in summer.

Summer climate projections under scenario A1B show a reduction in precipitation of between 5% and 10% by the end of the century (2090-2099) in Central America as compared to 1980-1999 (figure 1.3), while for much of Mexico, southern Chile and the northeastern portion of the Bolivarian Republic of Venezuela, the decrease is projected to be between 10% and 20%. Projections call for a summer-time increase in the rainfall regime of between 5% and 10% in Ecuador, central and southern Colombia, eastern Argentina and much of Peru. For the winter season, the

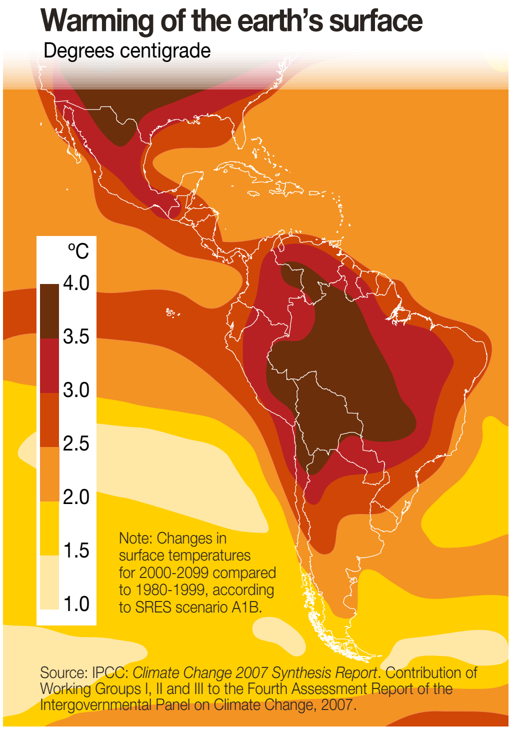
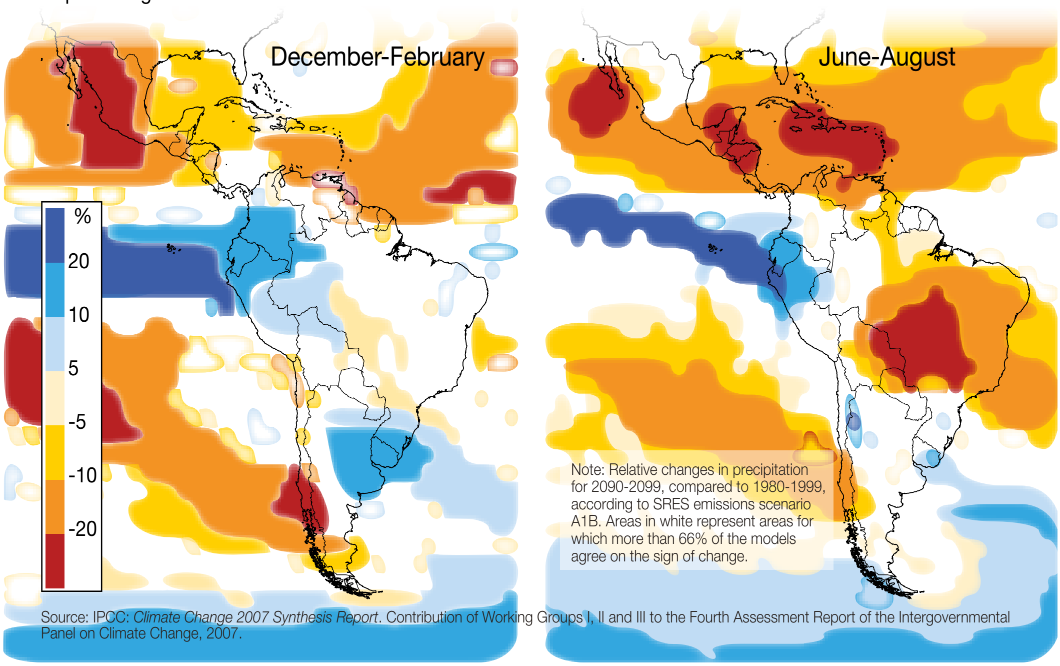


Figure 1.2

1 Scenario A1 assumes rapid demographic and economic growth, accompanied by the introduction of new and more efficient technologies; A1F1 is based on intensive use of fossil fuels; A1T presupposes that non-fossil-fuel energy will predominate; A1B assumes a balanced use of all types of energy sources; and A2 envisages lower economic growth, less globalization, and high and sustained demographic growth. Scenarios B1 and B2, for their part, include some mitigation of emissions through more efficient use of energy and improved technologies (B1), and more localized solutions (B2).

Relative changes in precipitation

In percentages



Source: IPCC: *Climate Change 2007 Synthesis Report*. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007.

Figure 1.3

greatest changes in precipitation are expected to occur in Central America, southern Mexico, the northern portion of the Bolivarian Republic of Venezuela and the eastern portion of Brazil, with reductions of between 10% and 20%. These changes in precipitation are important primarily because of their impact on water availability, re-supply of aquifers, maintenance of plant cover and agricultural yields in the region.

With regard to changes in sea levels resulting exclusively from changes in ocean density and circulation patterns, results of atmosphere-ocean general circulation models (AOGCM) for scenario A1B show that there will be significant spatial variability, i.e., changes in sea levels will not be uniform. Thus, it is expected that by the end of the century (2090-2099) there will be major rises in sea levels in the Caribbean and the Atlantic compared to 1980-1999 levels – attributable to the change in density and ocean circulation patterns – which (except for the southeastern coast of Argentina and the eastern coast of Brazil) are expected to be as much as 5 cm greater than the projected world average of between 0.21 meters and 0.48 meters. Indeed, these same models predict that increases in Pacific sea levels will be less than the world average of 5 cm (figure 1.4). This rise in sea levels is associated, in part, with the melting of glaciers (Church and Gregory, 2001, Dyugerov, 2002, 2003 and Ringot, 2003).

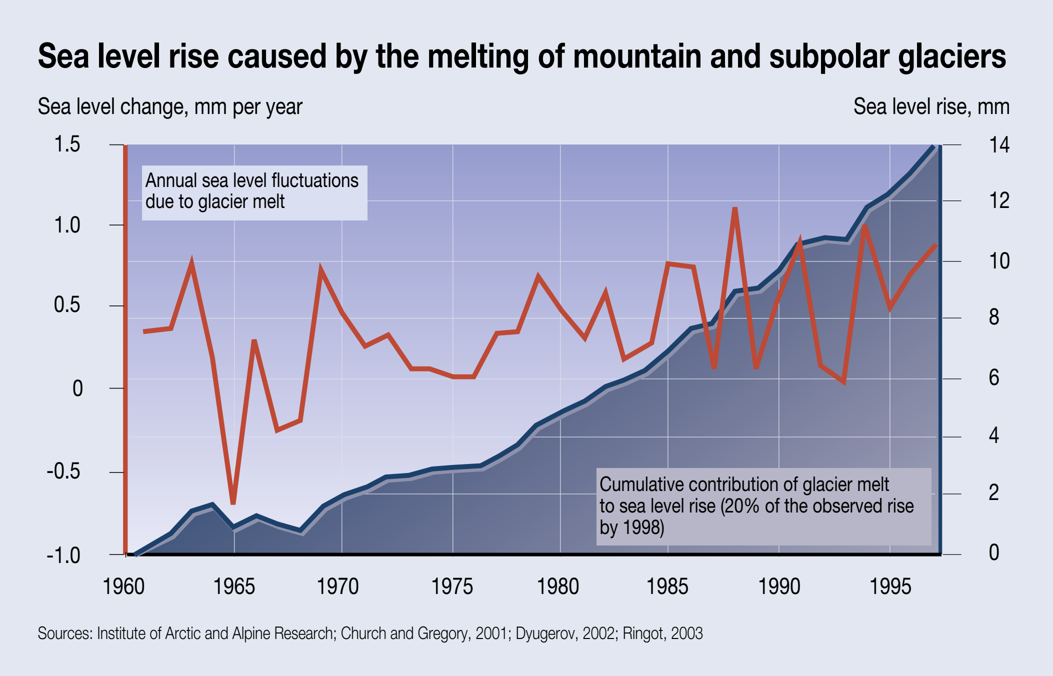


Figure 1.4a

Changes in precipitation and temperature influence changes in runoff and in the availability of water (IPCC, 2007b). Results from models of changes in runoff are consistent with predictions for precipitation: for 2090-2099, in areas for which increases in the rainfall regimen are expected, increases in runoff are also projected. The anticipated changes in runoff, as with changes in temperature and precipitation, vary from one country to another within the region. The greatest changes projected (between 10% and 30%) will occur in eastern Argentina and southern Brazil, while the most significant decreases (between 10% and 30%) are predicted for Mexico, Central America and Chile (figure 1.5). Declines in runoff could even accelerate in dry regions, owing to the lower levels of rainfall, and as a result of higher rates of evapotranspiration brought on by the rise in temperature (IPCC, 2007b).

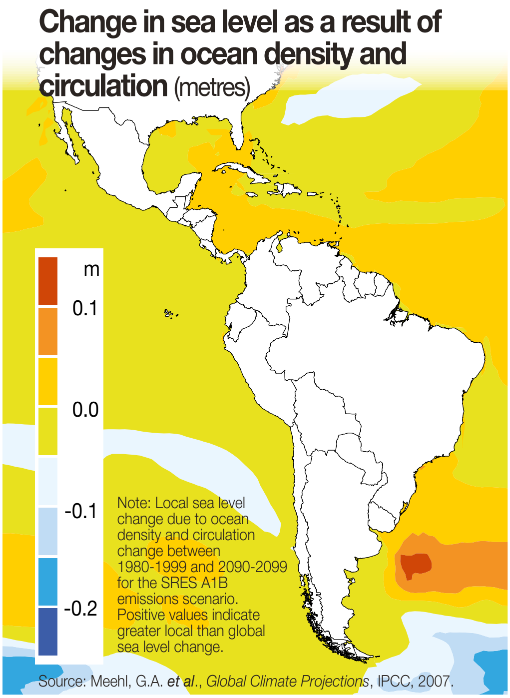


Figure 1.4b

The retreat of the glaciers is another manifestation of climate change affecting the region. Thus, the Bolivarian Republic of Venezuela, Colombia, Ecuador and Chile show evidence of reductions in the size of their glaciers; in Peru and the Plurinational State of Bolivia, the shrinkage of the glaciers, compared to 1970 and 1975, is even more striking (figure

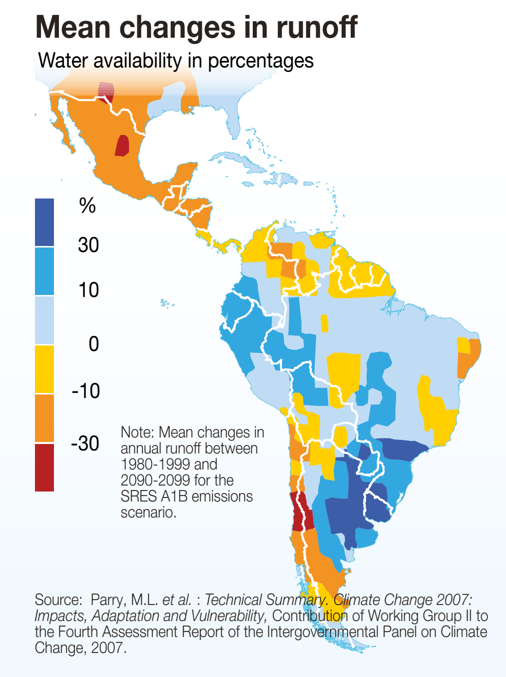


Figure 1.5

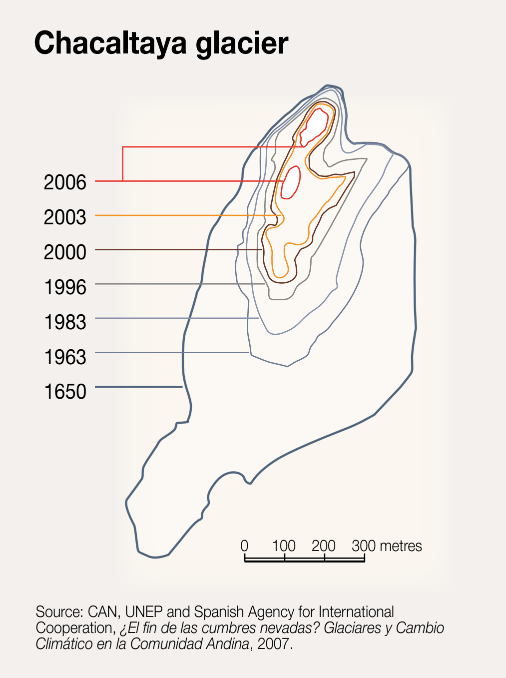


Figure 1.6a

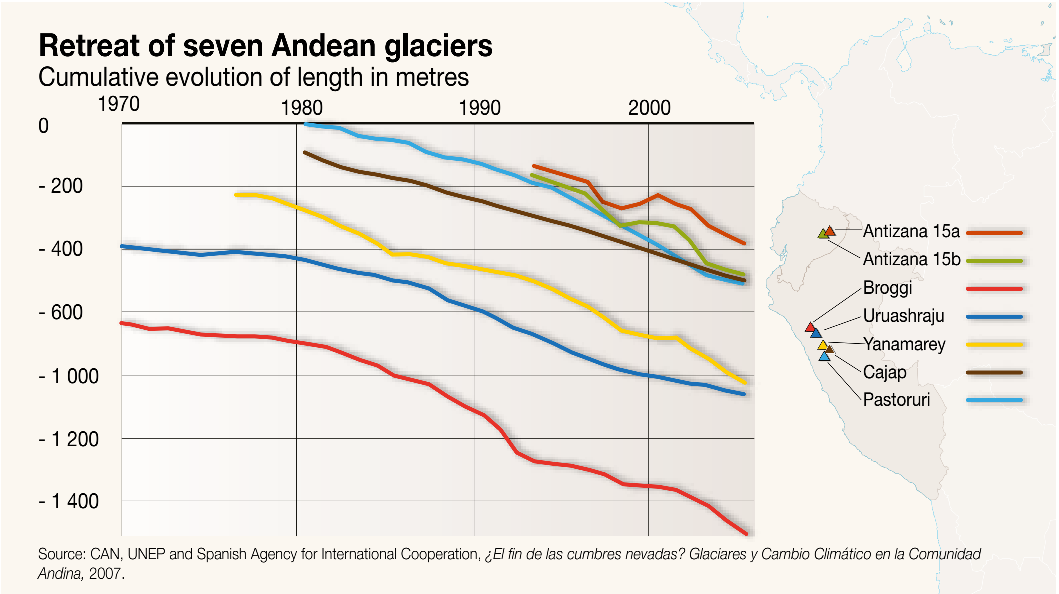


Figure 1.6b

1.6). In Peru, since 1970, there has been a substantial reduction in the surface area of the smaller glaciers, along with a significant loss in water reserves during the last 50 years (NC-Peru, 2001). Since the mid-1990s, the Chacaltaya glacier in the Plurinational State of Bolivia has lost half of its surface area and two thirds of its volume, endangering its long-term sustainability (Francou *et al.*, 2003).

Likewise, the San Quintín glacier in North Patagonia, in addition to rapidly decreasing in size, has also been exhibiting cracks and fractures in recent years (figure 1.7). In Colombia, between 1959 and 1996, the snowcapped volcano of Santa Isabel showed a 44% decrease in its ice-covered peak, and this process has continued, causing it to lose its attraction as a tourist site, with significant economic consequences (figure 1.8).

Retreat of tropical glaciers

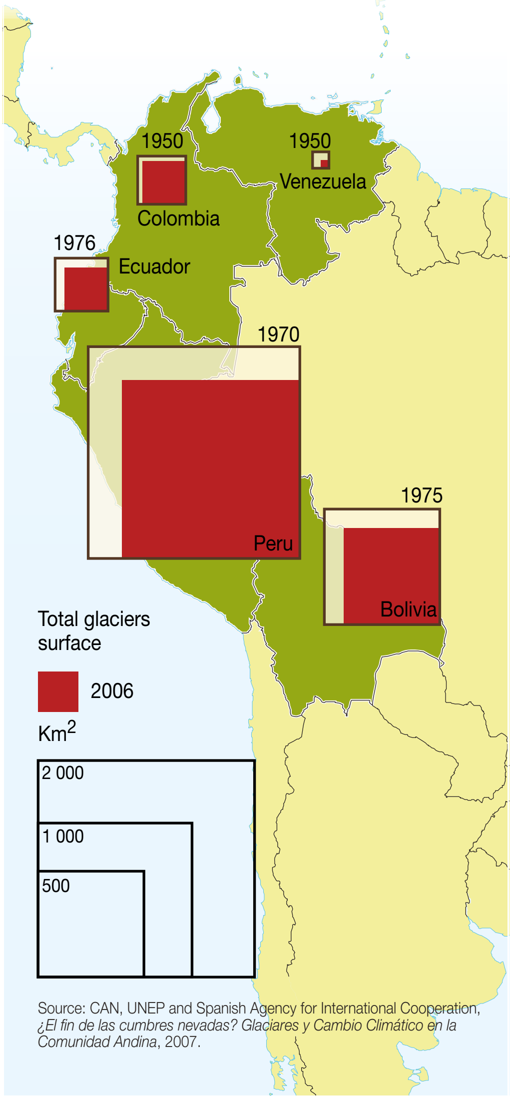


Figure 1.6c

Rapid decline of the San Quintin glacier, Northern Patagonia

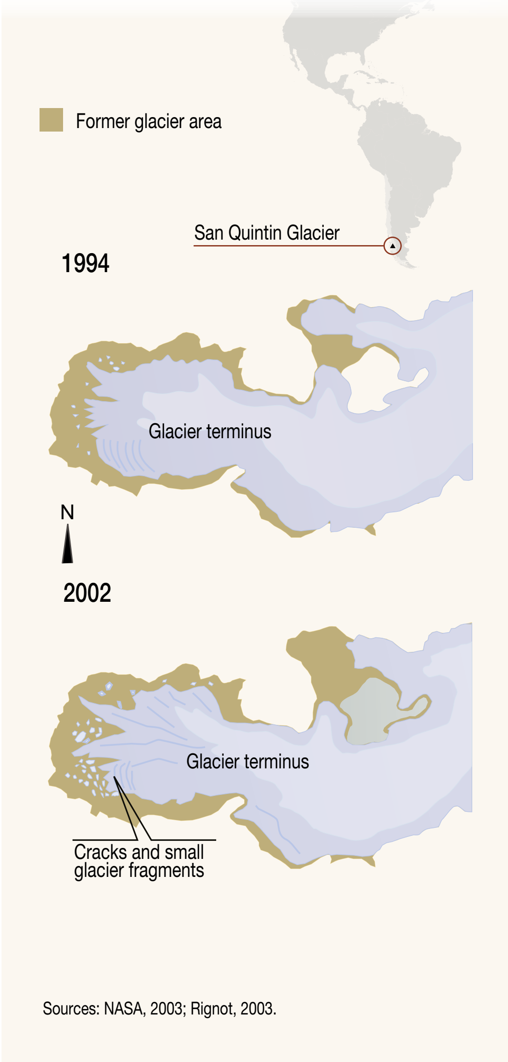
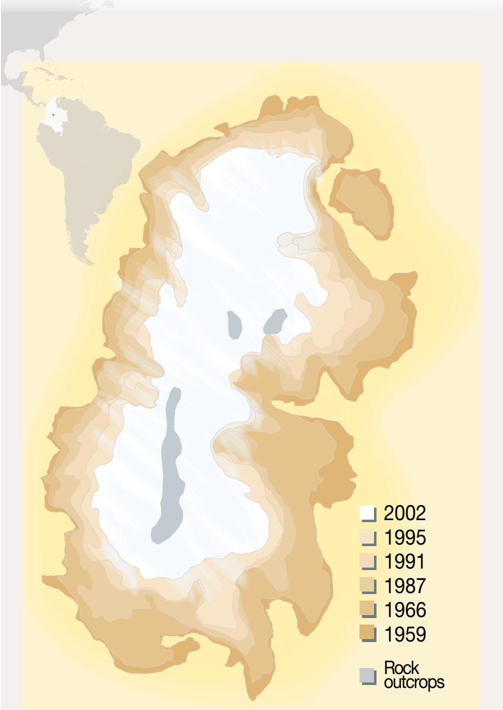


Figure 1.7

Retreat of the snowcapped volcano of Santa Isabel, Colombia



Source: Ceballo, J. L., *et al.*, *Fast shrinkage of tropical glaciers in Colombia*, 2006.

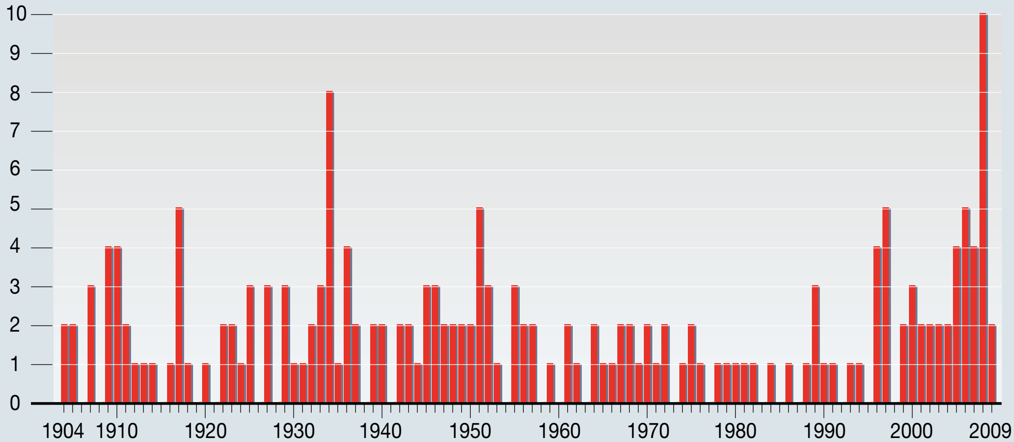
Figure 1.8

The extreme climate events show that there is a strong correlation (most likely non-linear) between greenhouse gas emissions, temperature increases, increased intensity of hurricanes and the rise in sea levels (IPCC, 2007a and Stern, 2007). For example, in Mesoamerica and the Caribbean sub-region, there were 36 hurricanes between 2000 and 2009, as against 15 and 9 per year in the 1980s and 1990s, respectively (figure 1.9). Moreover, during the last 100 years, 4 of the 12 years with the highest number of hurricanes making landfall occurred in the last decade. Nevertheless, the long-term pattern is a fluctuating one, suggesting that there is a major element of uncertainty involved.

Latin America and the Caribbean, in particular, has seen a recent increase in extreme climatic events, and with it a rise in the number of people affected. The number of storms between 2000 and 2009 increased by 12 compared to the period between 1970 and 1979. In this same time period, floods quadrupled. The number of people affected by extreme temperatures, forest fires, droughts, storms and floods grew from 5 million in the 1970s to more than 40 million in the most recent decade, both as a result of increased human settlement in the region and due to the increased vulnerability of costal zones

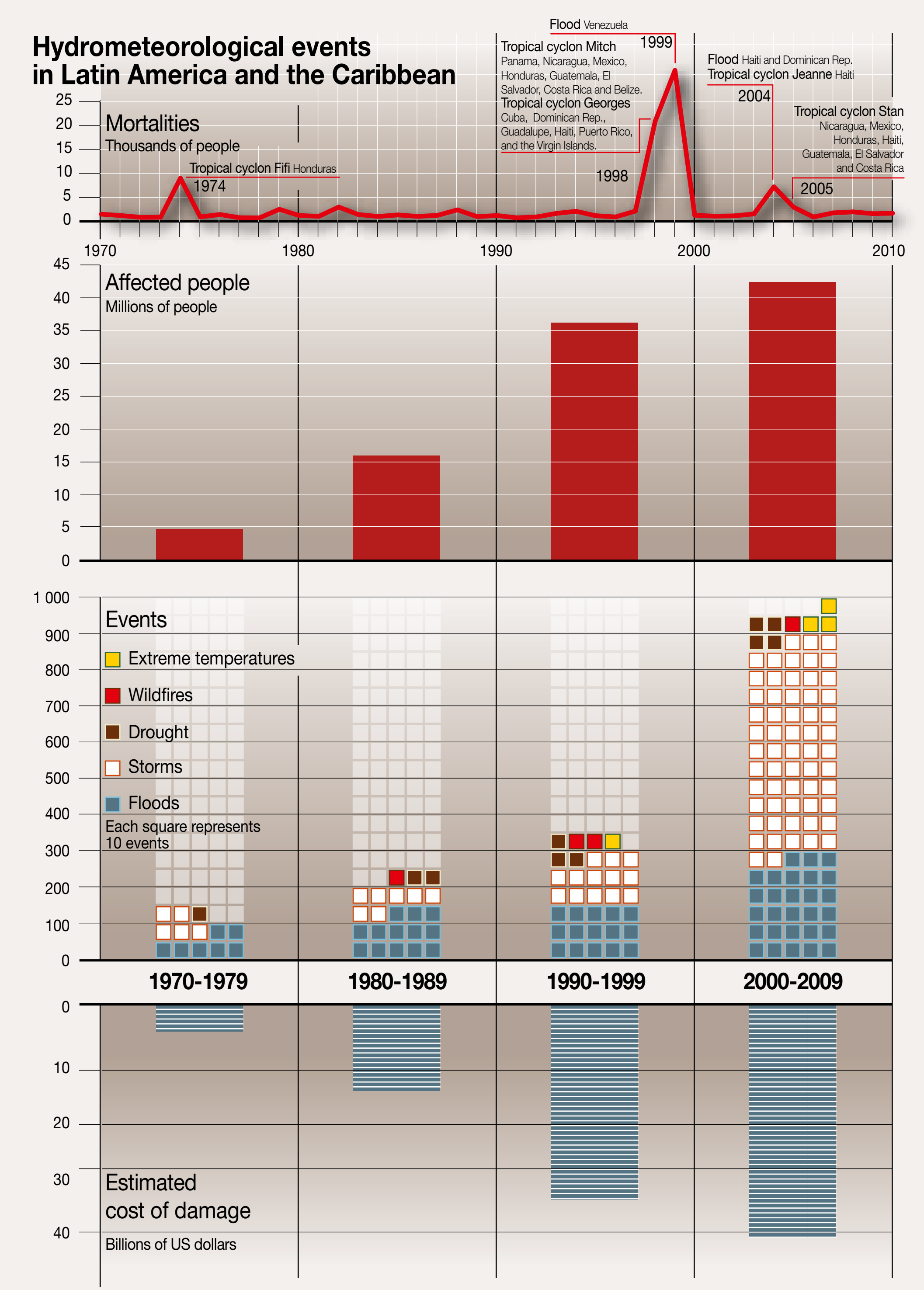
Hurricanes in Mesoamerica and the Caribbean, 1904-2009

Annual total number



Source: National Hurricane Center, NOAA, online database, accessed October 2010.

Figure 1.9



Source: *The International Disasters Database*, accessed in August 2010.

Figure 1.10

to these events. The estimated cost of damage from these extreme climate events in the last ten years exceeds US$40 billion (figure 1.10).

Regional climate change patterns projected for the end of the century indicate that the Central American and Caribbean sub-regions will experience an increase in the intensity of hurricanes, along with a reduction in precipitation and a corresponding series of droughts (figure 1.11). In Mexico, higher temperatures, a greater number of heat waves, fewer days of frost and an increased number of droughts are expected. In Colombia, Ecuador, Peru, the Plurinational State of Bolivia, Chile and Argentina, glaciers will continue to shrink, while countries with coasts on the Pacific and Atlantic Oceans will see increased precipitation.

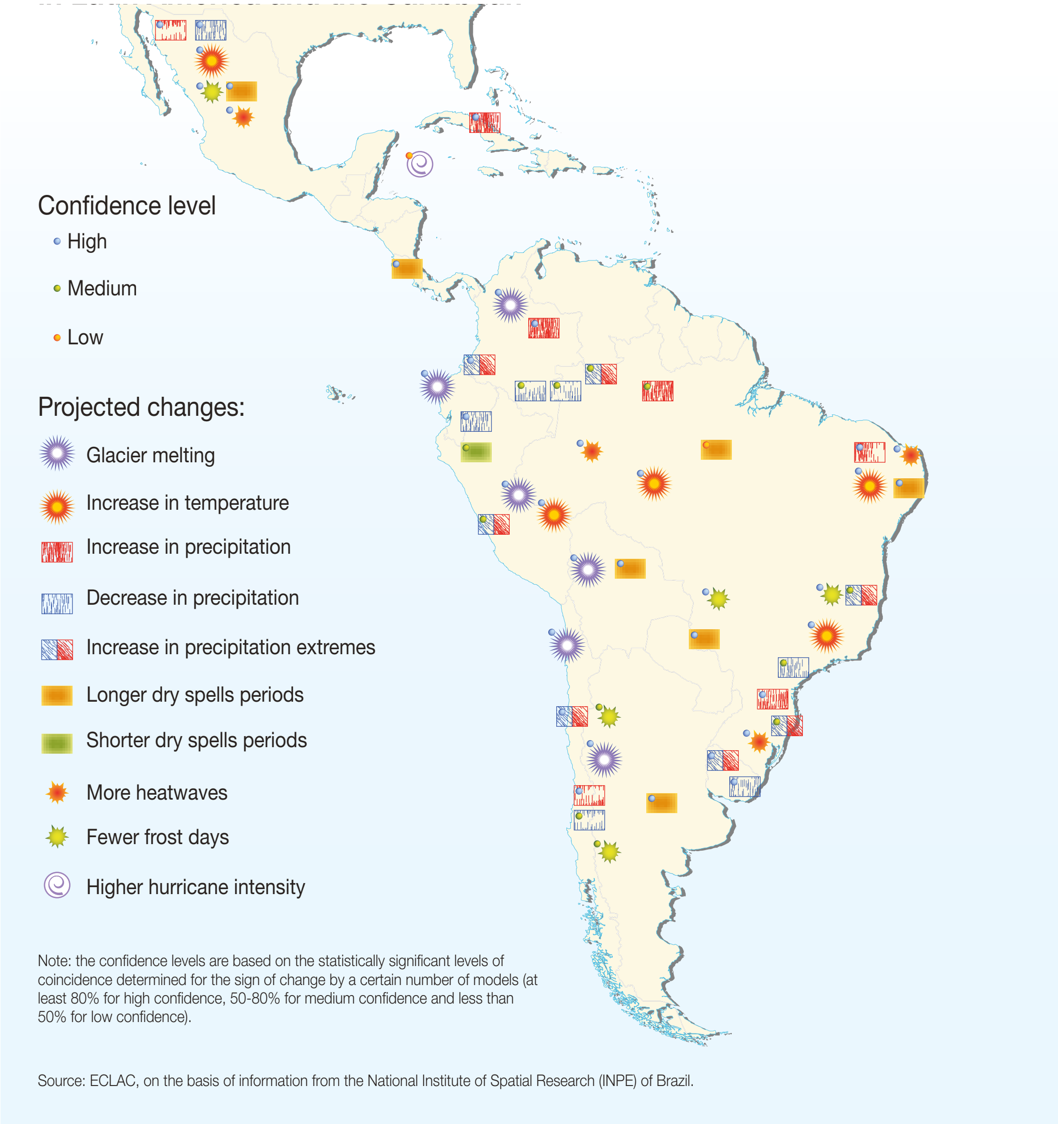
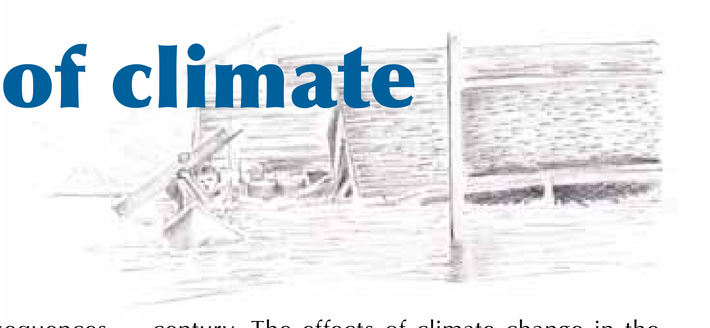


Figure 1.11

2. Effects of climate change



Dealing with the causes and consequences of climate change will be one of the main challenges facing humanity in the present century. The effects of climate change in the region are already significant (albeit with differences from one country to another),

Expected impacts of climate change in 2050

Sources: R. Landa *et al.*, *Cambio climático y desarrollo sustentable*, 2010; ECLAC, *Climate Change. A regional perspective*, 2010.

Figure 2.1

particularly in terms of the agricultural sector, the health of the population, the availability of water, tourism, urban infrastructure, and biodiversity and ecosystems (Magrin *et al.*, 2007). These effects could intensify in the future unless the necessary initiatives are taken at the global level to mitigate greenhouse gas emissions and the appropriate measures and investments are undertaken to adjust to the new climate conditions.

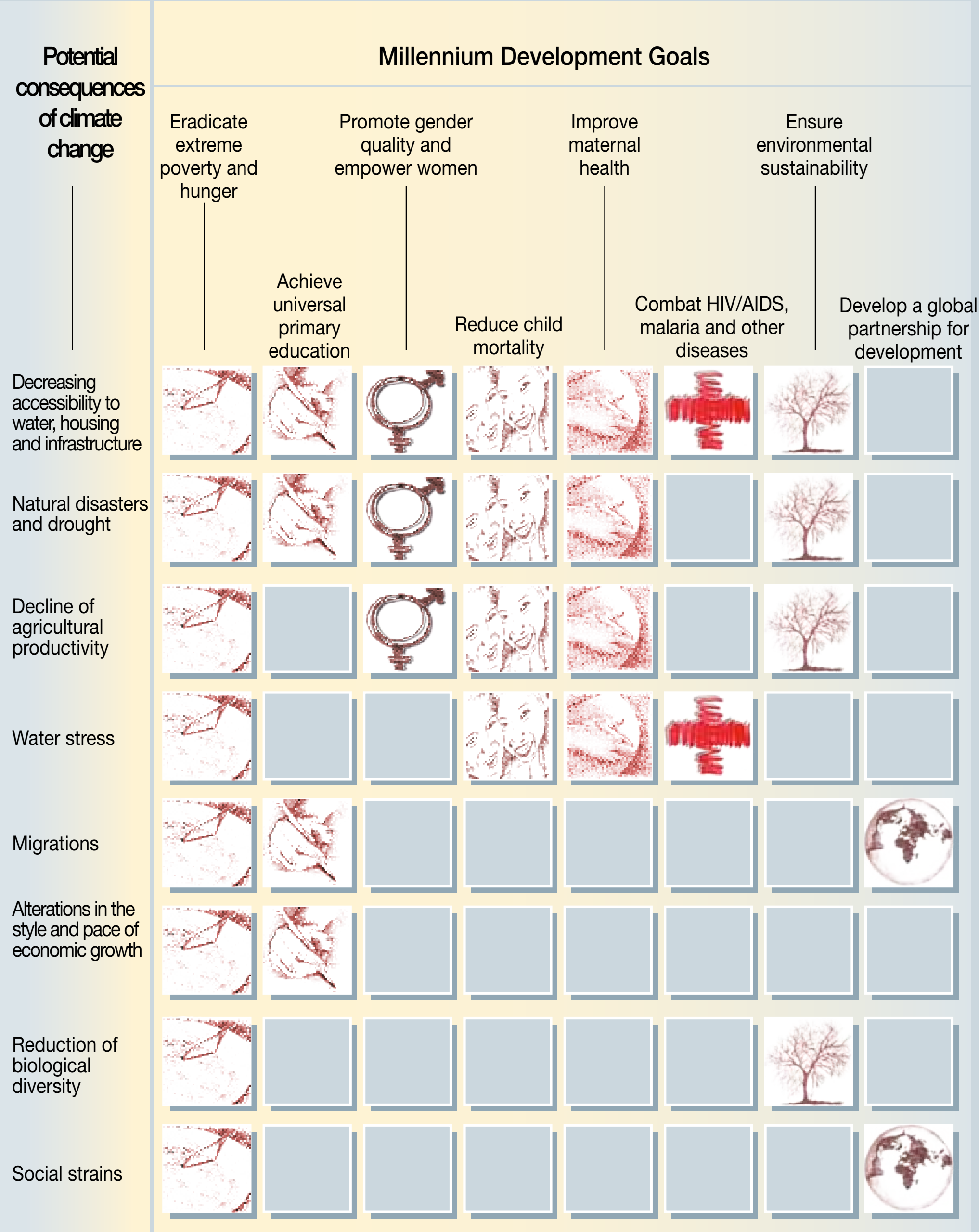
It is expected that, by 2050, there will be threats to ecosystem services in the Andes and in Mexico, in the Central American and Caribbean sub-regions, and in southeastern Brazil, while there will be negative effects on fishing in the Pacific coastal areas of Peru and Chile. The decrease in precipitation will have adverse effects on agricultural yields in several regions and countries on the continent. Particularly noteworthy within LAC as a whole is the high degree of vulnerability that will be seen in the Central American and Caribbean sub-regions as a result of the increased frequency of extreme events expected to occur in the wake of climate change (figure 2.1). Moreover, the rises in the temperature of ocean surfaces will make for more frequent bleaching of coral reefs, with a negative impact on fishing and tourism. Likewise, under the scenario with the greatest rise in sea levels (A1F1), there will be a serious threat to the continued existence of mangroves in the low coastal areas, with serious implications for biological diversity (birds, fish, crustaceans, molluscs) in those locations.

Several studies examining both global and regional conditions, using different techniques and methods, point to significant economic costs associated with climate change. The total costs of failing to take action would amount to an ongoing annual cost of at least 5% of the world's GDP (Stern, 2007). For Central America, estimates of the economic costs of climate change, up to the year 2100, using a discount rate of 0.5% – based on the impact on the agricultural sector, biodiversity, water resources, and the damage from hurricanes, storms and floods – are equivalent to approximately 54% of the 2008 GDP of the Central American sub-region under scenario A2, and 32% of its 2008 GDP under scenario B2 (ELCAC/CCAD/DFID, 2010).

For Uruguay, using a discount rate of 4%, accumulated losses, up to the year 2100, are estimated at 50% of 2008 GDP under scenario A2 and 0.3% of 2008 GDP under the B2 scenario (ECLAC, 2010). In Chile, applying a discount rate of 4%, the accumulated economic costs due to climate change, up until 2100, are estimated at 0.82% of annual GDP under scenario A2 and 0.23% of annual GDP under scenario B2 (ECLAC/IDB/Government of Chile, 2009). For Mexico, estimates show that the economic costs of climate effects, up to 2100, using an annual discount rate of 4%, will reach an average of 6.22% of current GDP (Galindo, 2009). These costs, associated with climate change, thus act as a brake, intensifying budget constraints in the region's countries as they continue attempts to reduce poverty and work towards meeting the Millennium Development Goals (MDGs) (figure 2.2).

The effects of climate change on different countries are not proportional to their respective contributions to GHG emissions. Rather, they vary; in some cases, for certain time periods, the effects may even be positive in specific regions. This presents a general paradox: the countries that are the highest emitters suffer less impact, while those that are lower emitters experience the greatest impact. Metropolitan areas in the region are experiencing different levels of risk as a result of extreme events such as cyclones, floods and droughts. Owing to their location, the cities of Central America, the Caribbean and Mexico, as well as those in central and western Colombia and the coast areas of eastern Argentina and Brazil, are at the highest risk (high and very high) (figure 2.3).

Climate change impacts that could affect attainment of the Millennium Development Goals



Note: Based on national communications from non-Annex I countries and the *Sixth Compilation and Synthesis of Initial National Communications from Parties Not Included in Annex 1 to the United Nations Framework Convention on Climate Change*.

Source: ECLAC, *Climate change and development in Latin America and the Caribbean. Overview 2009.*

Figure 2.2

Vulnerability of large cities to climate hazards

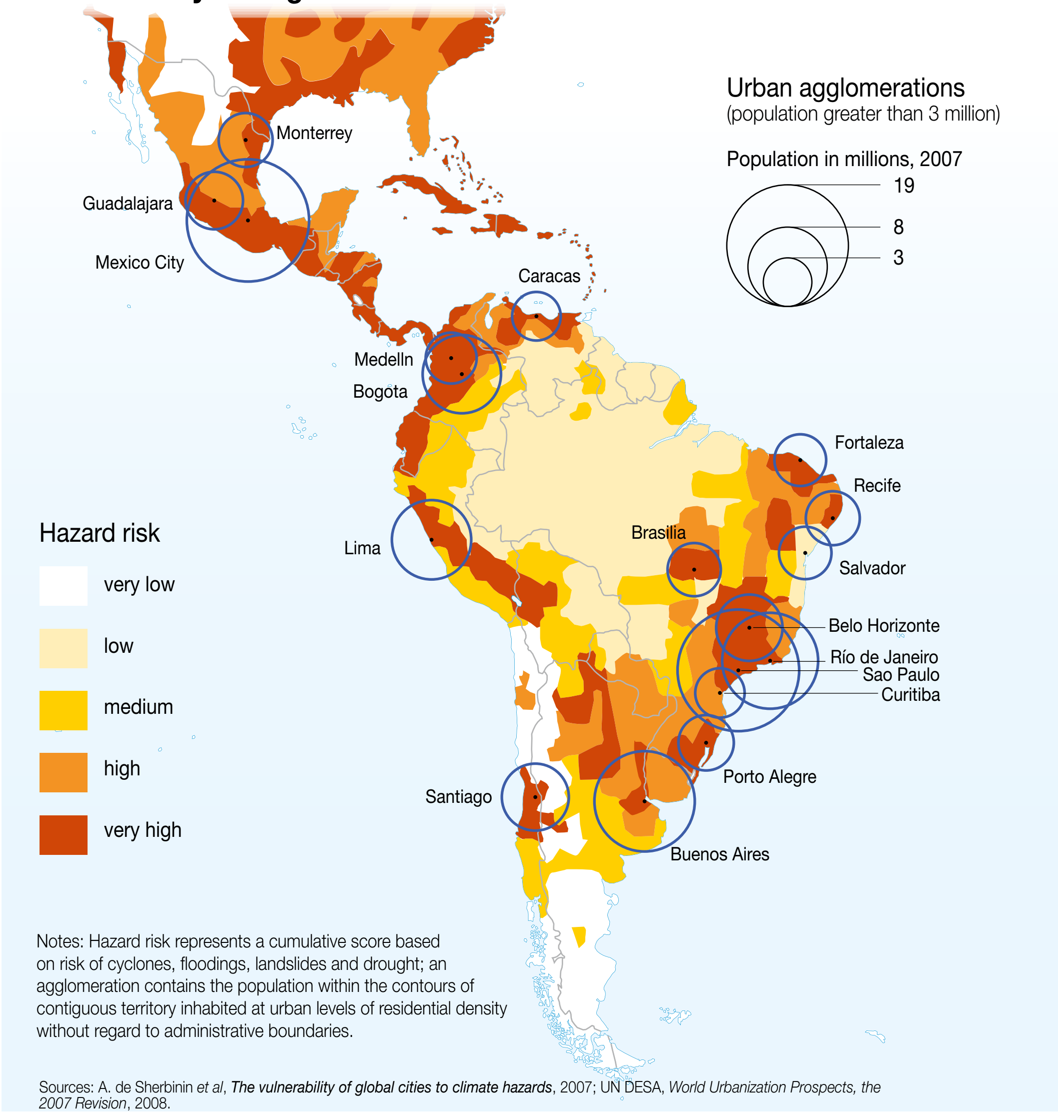


Figure 2.3

Climate change has effects on the health of the population, not only through heat waves and waterborne diseases, but also as a result of the expansion of geographical areas conducive to the transmission of vector-borne diseases such as yellow fever, dengue and malaria. Species of mosquitoes, such as the group *Anopheles gambiae, A. funestus, A. darlingi, Culex quinquefasciatus* and *Aedes aegypti*, are responsible for propagation of the majority of vector-borne diseases and are sensitive to changes in temperature (Githeko *et al.*, 2009). The resulting effects on health can already be detected. While in 1970 the only areas in the region infected by *Aedes aegypti* – the mosquito responsible for transmitting yellow fever and dengue – were Venezuela, Suriname, the Guyanas and the Caribbean countries, in

Re-infestation by *Aedes aegypti*[1]

Source: UNEP, *Global Environment Outlook GEO 4: Environment for development*, 2007.

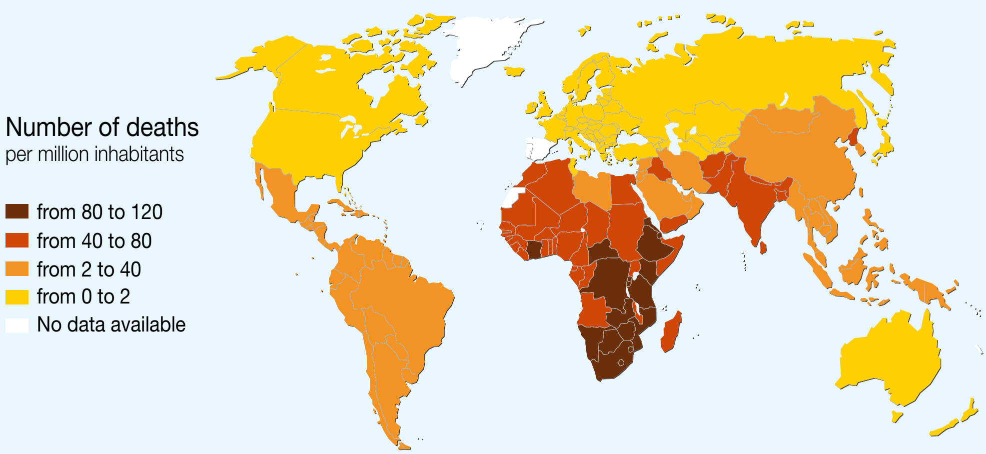
Figure 2.4

2002 virtually the only areas unaffected by these tropical diseases were the southern portions of the continent (figure 2.4) (UNEP, 2007).

The extent to which mortality is attributable to climate change remains a matter of intense debate. Data from the World Health Organization (WHO) for 2000 indicate that, in Latin America and the Caribbean, there were between 2 and 40 deaths per million inhabitants from floods, malaria and diarrhoea (figure 2.5). In terms of regions, the most severe health effects have been in Africa, though significant effects are also being felt in Latin America and in certain parts of Asia. This is creating a major economic impact on the health systems of the countries of these regions.

Biodiversity is vitally important to human well-being, given that it supports a wide range of services on which human societies have depended. Ecosystem services can be divided into four categories, namely those related to provision, regulation, support and cultural (CBD, 2010). There are species at risk of extinction due to the destruction of their habitat, overexploitation of the resource, indiscriminate hunting and illegal traffic. However, for many species that are sensitive to even small variations in climate, the threat is primarily that of climate change. Variations

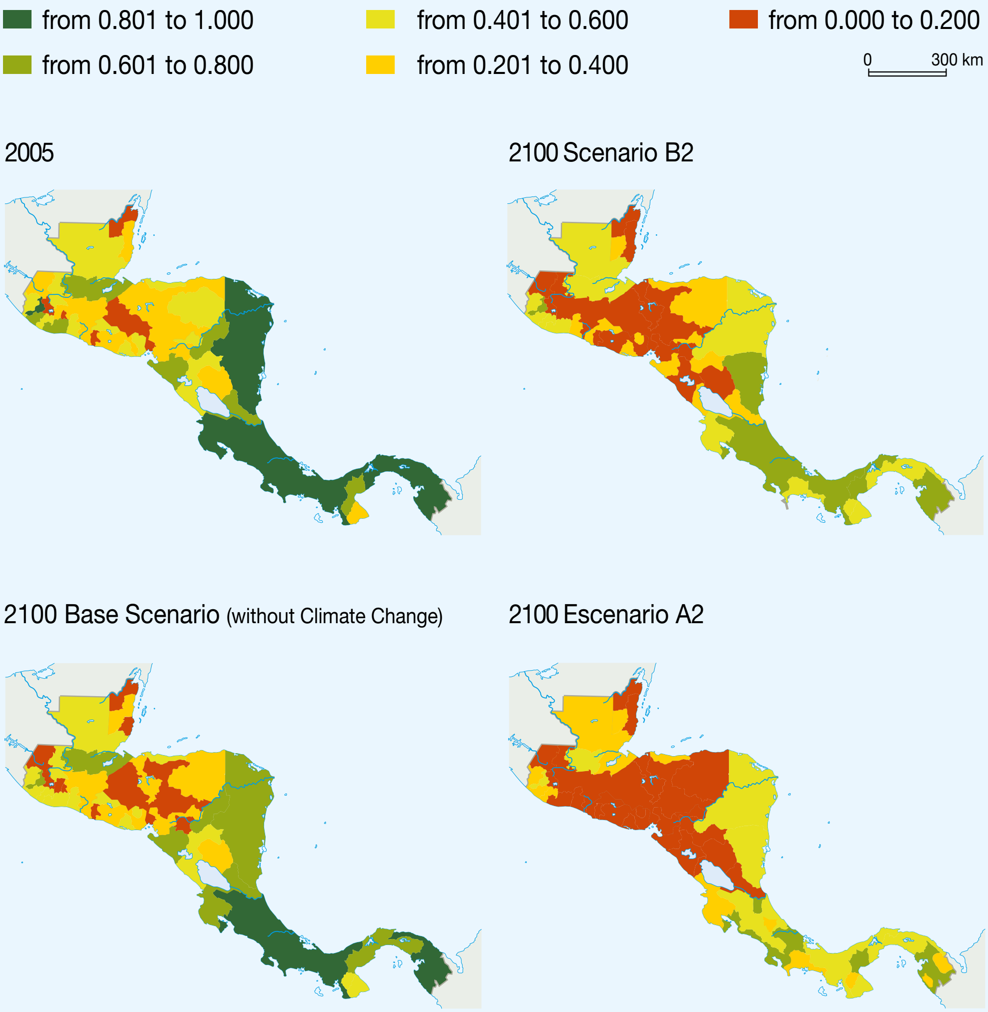
Estimated deaths attributable to climate change, 2000



Source: ECLAC, *Climate Change and development in Latin America and the Caribbean. Overview 2009*, on the basis of WHO, *Climate Change and Human Health. Risks and Responses. Summary*, 2003.

Figure 2.5

Index of biodiversity potential in Central America



Source: ECLAC/CCAD/DFID, *La economía del cambio climático en Centroamérica*. *Síntesis*, under preparation.

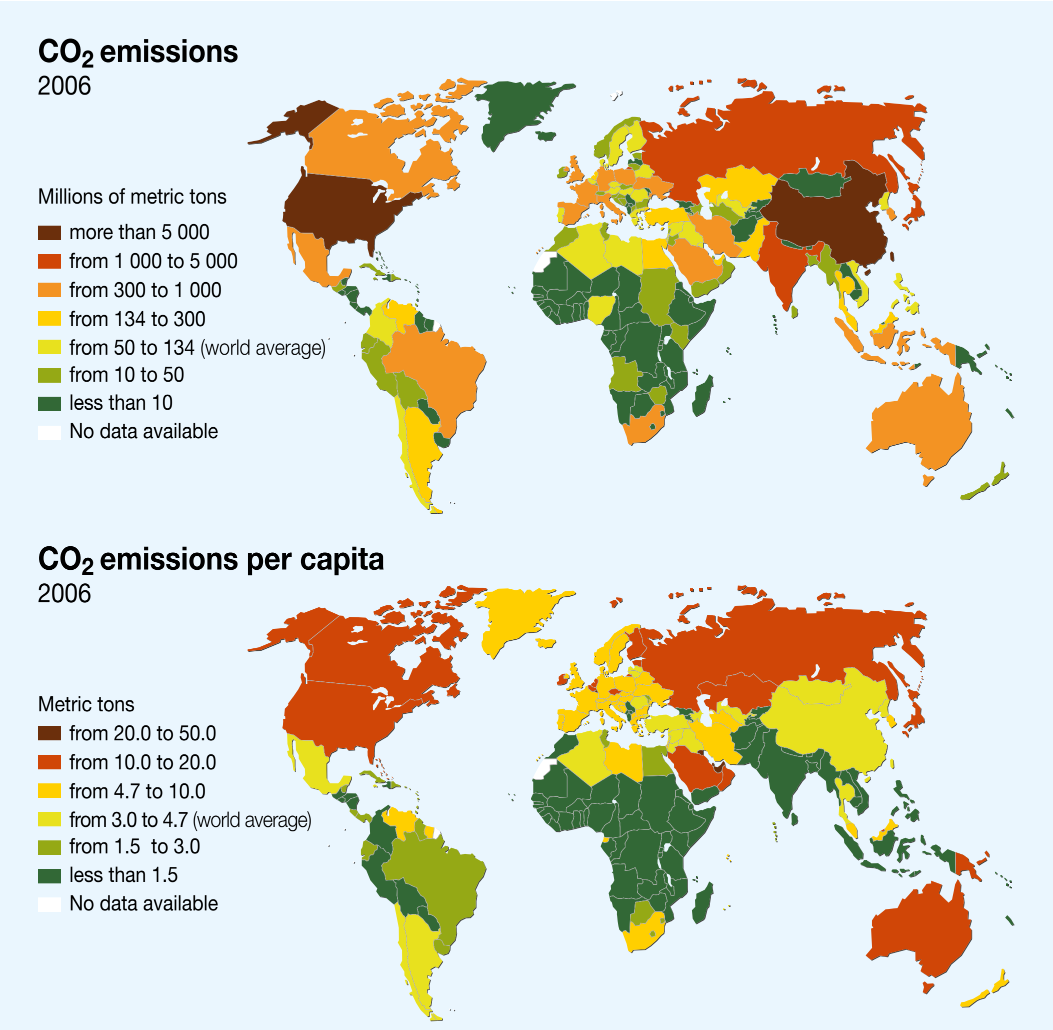
Figure 2.6

in climate affect different species of flora and fauna differently, producing, in some cases, a disruption in food chains and/or in reproductive patterns. It is therefore necessary to reduce or control GHG emissions to avoid causing temperature increases that threaten the extinction of many of the species that inhabit the region. In Central America, biodiversity is one of the sectors most severely threatened by climate change (IPCC, 2007b). Estimates of the potential biodiversity index[2] for the region for the year 2005, using the baseline scenario (without climate change) and emissions scenarios B2 and A2, show the magnitude of the loss of biodiversity that would occur towards the end of the century (ECLAC/CCAD/DFID, 2010) (figure 2.6).

2 The potential biodiversity index was constructed on the basis of information on climatic and territorial variables. The index takes account of latitude, orography, temperature, humidity and the availability of water.

3. Emissions and mitigation processes

The LAC region is highly vulnerable to climate change, despite the fact that it contributes relatively little to global greenhouse gas emissions. Thus, global carbon dioxide (CO_2) emissions in 2006 (excluding those associated with land use changes) amounted to 38,754 million of metric tons of CO_2 equivalent ($MtCO_2$-e), with Mexico and Brazil being the main emitters in the region (WRI, 2010). The importance of Latin America and the Caribbean as a source of emissions can



Source: World Bank, online database, accessed in July 2010.

Figure 3.1

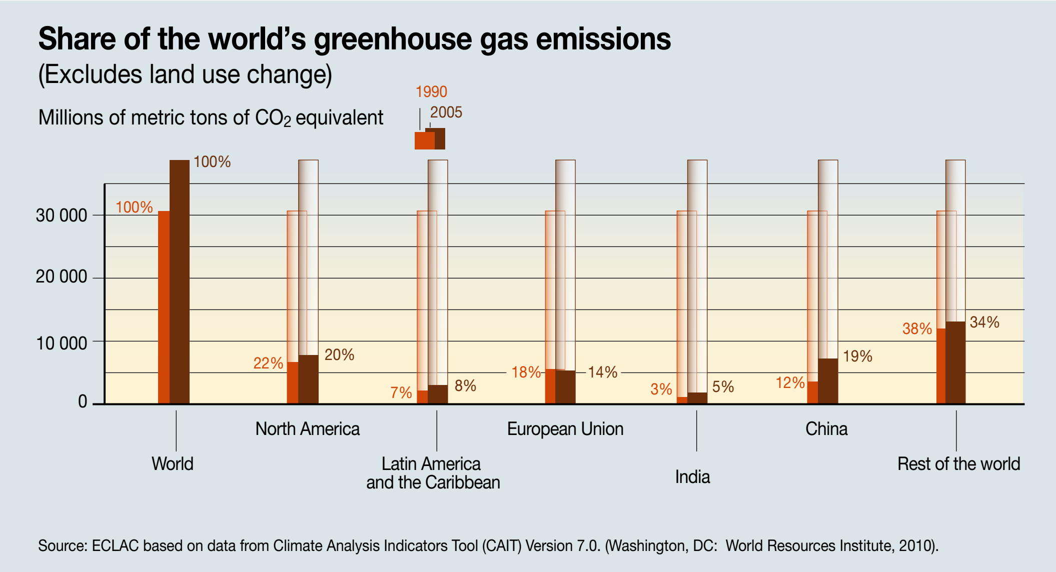


Figure 3.2a

also be seen in per capita terms: the region as a whole emitted fewer tons of CO_2 per inhabitant than the world average, notwithstanding the fact that some countries in the region exceeded that average (figure 3.1).

Thus, in 2005 the countries of Latin America and the Caribbean accounted for only 8% of global GHG emissions, excluding emissions associated with land use changes. Between 1990 and 2005, such emissions in the region increased at an average annual rate of 2.3%, owing to a variety of economic, social and demographic factors. In percentage terms, therefore, 2005 emissions increased the region's share of emissions by one percentage

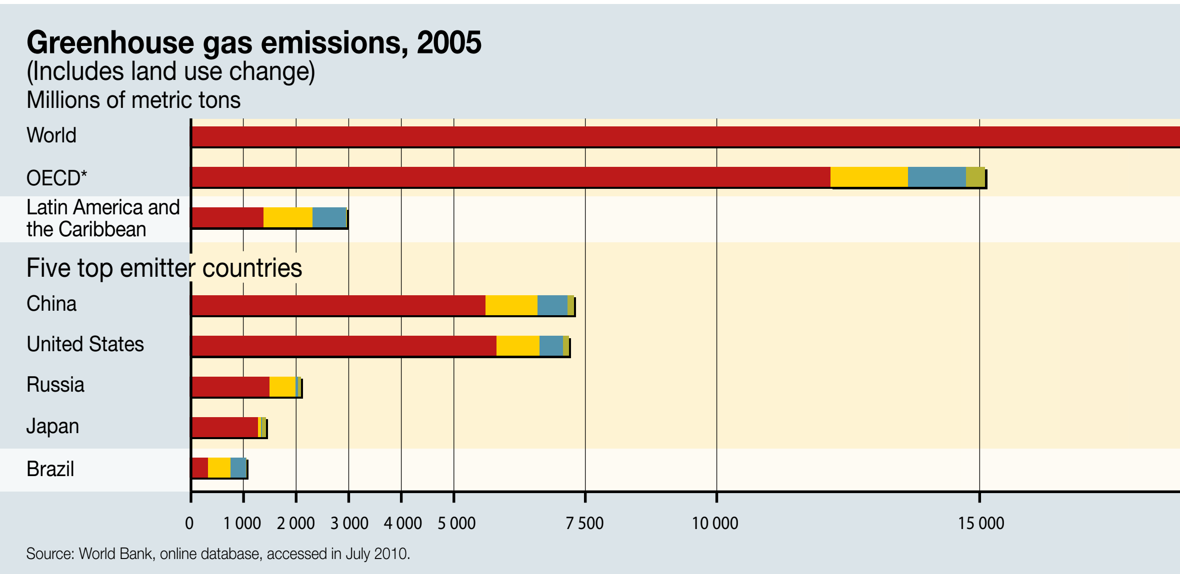


Figure 3.3

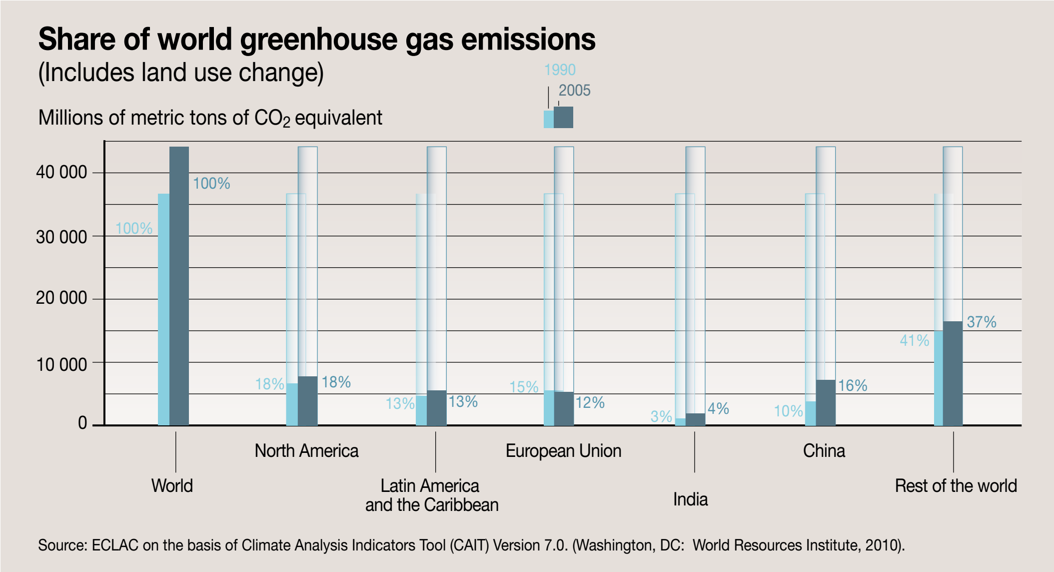
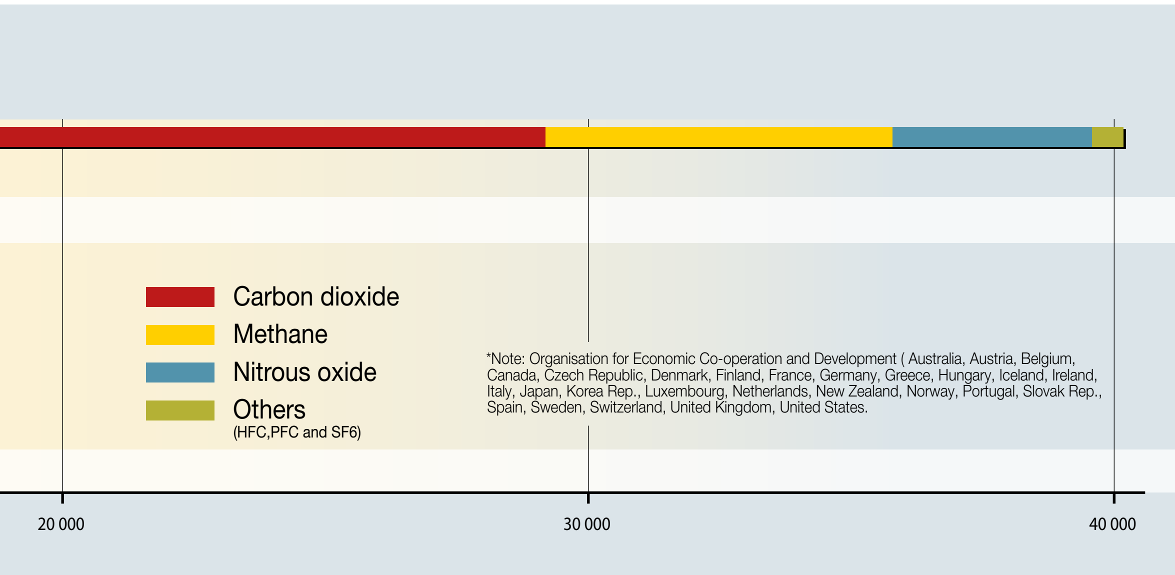


Figure 3.2b

point compared to 1990. Nevertheless, this share is lower than that of regions such as Europe, North America and China (figure 3.2a). It is worth noting that the European Union and the United States managed to reduce their share of global emissions in 1990-2005, while China registered an average annual increase of 4.8% for that period.

The total CO_2 emissions, i.e., including those associated with land use changes, highlight anew LAC's contribution to total global emissions (figure 3.2b), though varying widely within the region, with Brazil contributing the largest share of the region's emissions associated with changes in land use.



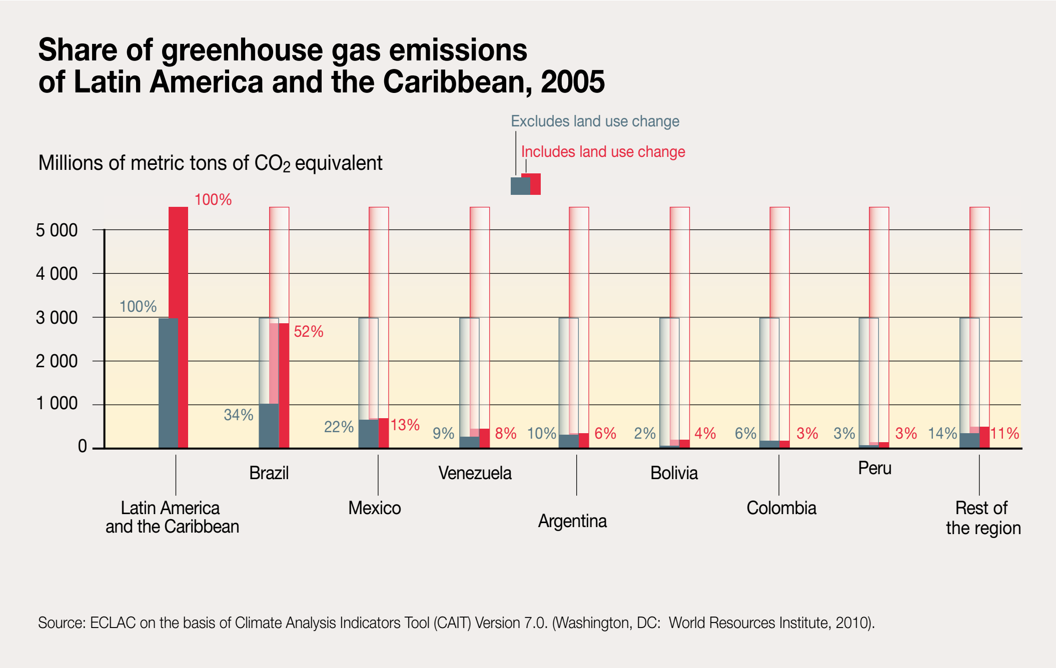


Figure 3.4

The disaggregation of emissions by type of gas makes clear the importance of CO_2, both globally and at the regional level. On a country basis, the United States and China are the highest emitters. Brazil ranks fifth-highest in the world in terms of GHG emissions, including those associated with land use changes (figure 3.3).

Analysis within the region makes it possible to identify the main emitting countries. Chief among these is Brazil, accounting for 52%, which together with Mexico, the Bolivarian Republic of Venezuela and Argentina accounted for 79% of the total GHG emissions of the region in 2005. While specific percentages (excluding emissions associated with land use changes) vary, these four countries continue to be the region's biggest emitters: in 2005, they accounted, as a group, for 75% of the region's GHG emissions (figure 3.4). Particularly noteworthy is Brazil's share of regional and global GHG emissions resulting from land use changes. That sector, alone, emitted more than one billion of metric tons of CO_2 equivalent ($MtCO_2$-e) in the Brazilian Amazon in 2005 (figure 3.5).

In 2005, per capita emissions in the region, excluding emissions associated with land use changes, amounted to 5.5 $MtCO_2$-e, with Trinidad and Tobago, Uruguay and the Bolivarian Republic of Venezuela having the highest levels of per capita emissions (figure 3.6).

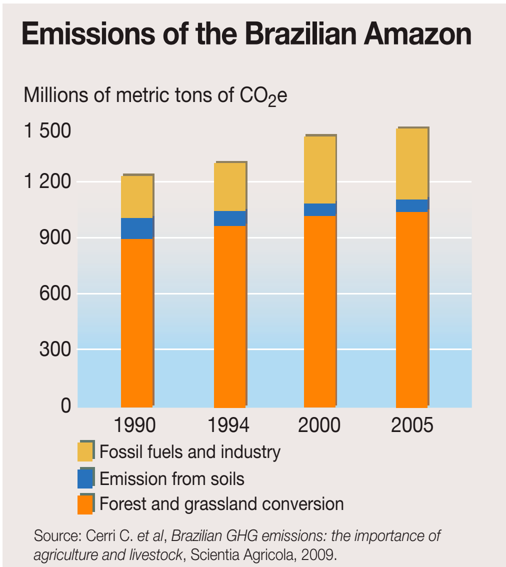


Figure 3.5

According to reports from the region's countries, contained in national communications to the United Nations Framework Convention on Climate Change, the main sources of GHG emissions relate to changes in land use, forestry, agriculture and energy consumption. Brazil stands out as the highest emitter of GHG caused by land use changes, accounting for more than 800,000 metric tons of CO_2 equivalent. The importance of agriculture in the region can also be seen in emissions figures, with Brazil, Paraguay, Argentina, Jamaica and Colombia accounting for a significant share of total emissions for the sector. In terms of emissions resulting from energy consumption in the region, Mexico and Brazil account for the greatest share, with a combined total of more than 500,000 tons of CO_2 equivalent (figure 3.7). This structural composition is vital in considering the various possible regional mitigation measures that could be adopted.

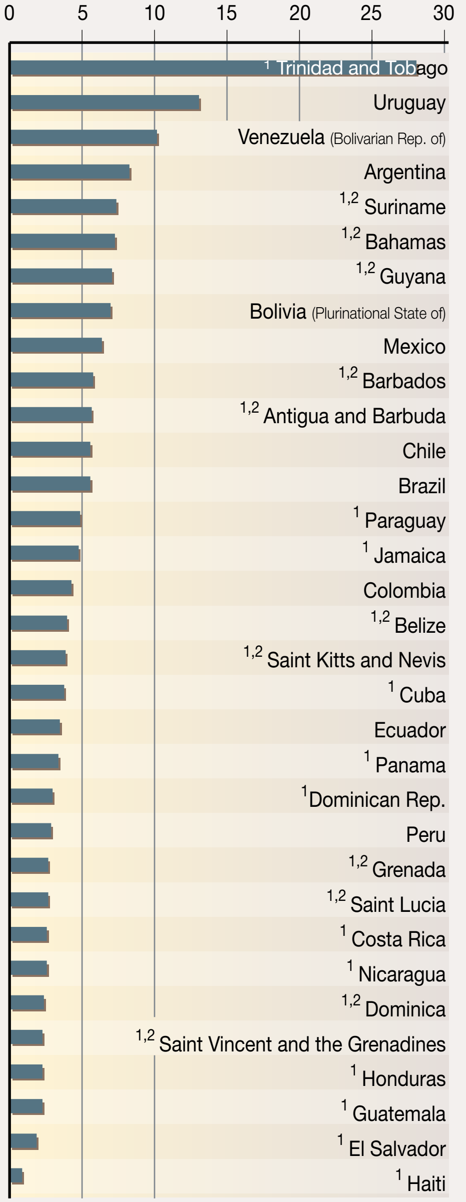
In addition to CO_2, other GHG that play an important role in the region are methane (CH_4) and nitrous oxide (N_2O), which are produced primarily in the sectors of waste management, mining, industrial processes, and in the production and distribution of natural gas, petroleum and agricultural products. Among the region's countries, Brazil is the highest emitter of both methane and nitrous oxide. Other countries that account for a major share of emissions of these gases in the region are Mexico, Argentina and the Bolivarian Republic of Venezuela (figure 3.8).

Available evidence indicates that energy intensity – the ratio between energy consumption and gross domestic product (GDP), expressed in purchasing power parity (PPP) at 2005 prices – in Latin America and the Caribbean remained almost constant in the 1980-2007 period. This shows that the region has not made the progress necessary, in terms of energy efficiency, to reduce its emissions of GHG. The stagnation in energy-intensity levels in Latin America is probably related to the weakness of, or lack of priority in, the energy efficiency policies of the region's countries,

Greenhouse gas emissions per capita in Latin America and the Caribbean, 2005

(Excludes land use change)

Metric tons of CO_2 equivalent per capita



Notes: 1. PFC, HFC and SF6 data not available; 2. Int'l Bunkers data not available.

Source: ECLAC on the basis of Climate Analysis Indicators Tool (CAIT) Version 7.0. (Washington, DC: World Resources Institute, 2010).

Figure 3.6

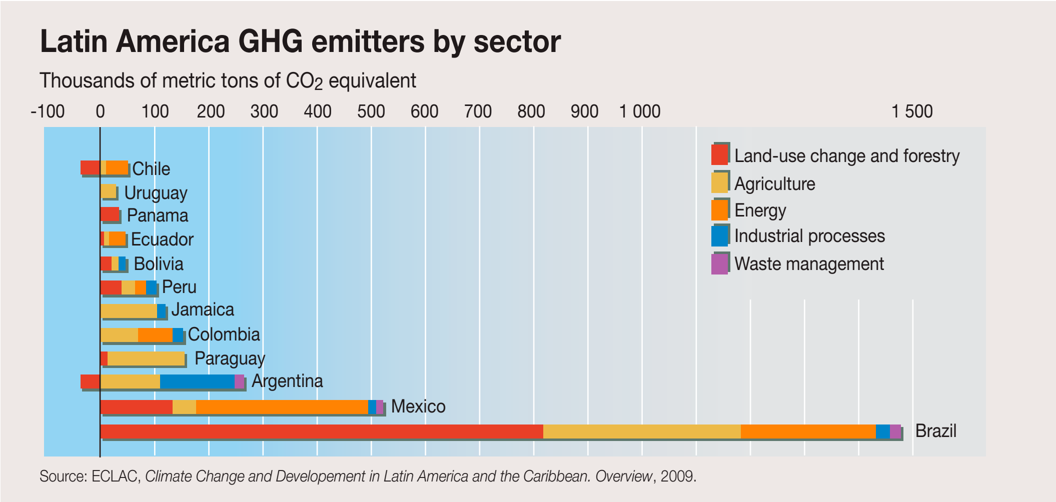


Figure 3.7

along with a price structure that tends to favour energy intensity and the increased energy consumption from transportation, among other factors.

In 2007, energy intensity in Latin America and the Caribbean was 134 kg of oil equivalent per US$1,000 of GDP (at 2005 prices), less than either the world mean (186 kg) or the figure for the OECD countries (152 kg). Among the countries of the region, varying levels of energy intensity can be seen, with energy-intensity figures for Peru, Panama, Colombia, Uruguay, Costa Rica, the Dominican Republic, Ecuador, El Salvador and Mexico being below the regional average (figure 3.9). In the future, these levels could become a key factor in international competitiveness.

Evidence at the international level also shows that there is a positive, but not a linear, relation between GHG emissions and changes in output. Thus, examining CO_2 emissions in 2005, excluding emissions associated with land use changes, it can be seen that LAC has a higher level of emissions per US$ million

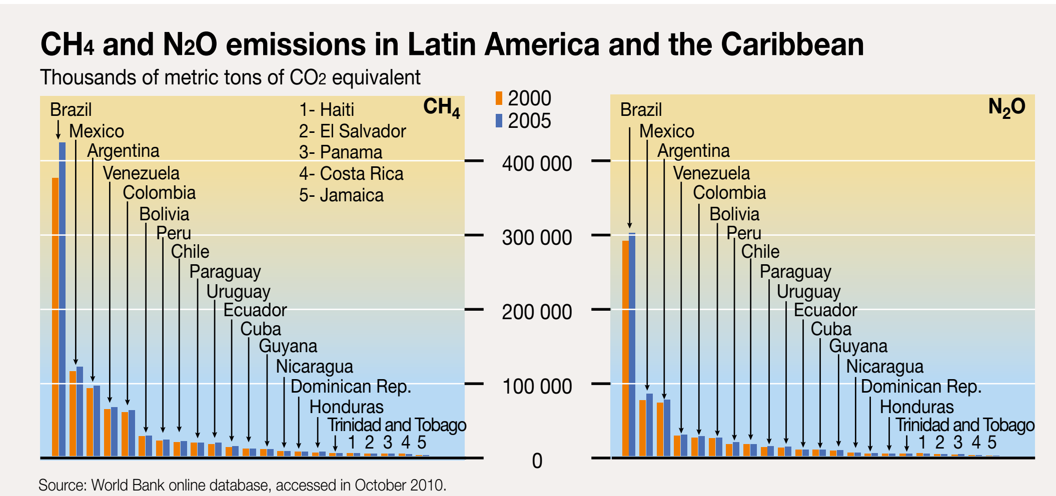


Figure 3.8

of GDP (598 tCO_2e/US$ million) than the OECD countries (468 tCO_2e/US$ million), but less than the world average (652 tCO_2e/US$ million) (figure 3.10a-b). Within the region there are differences in the ratio between emissions and GDP; in general, for example, the levels of emissions per US$ million of GDP in the Caribbean sub-region are lower than in the region as a whole.

Taking into account total CO_2 emissions, including those associated with land use changes, LAC rates poorly compared to other regions with regard to emissions of CO_2e per US$ million of GDP. Latin America emits 1,152 tCO_2e/US$ million, compared to 481 tCO_2e/US$ million emitted by the OECD countries. This indicates that for each US$ million of GDP, Latin America and the Caribbean is emitting more CO_2e than is the OECD. One sees a high degree of variation, from one country to another within the region, in the ratio of emissions-to-GDP if emissions from land use changes are taken into account (figure 3.10 c-d). Particularly notable among the region's countries are Brazil, Uruguay, Paraguay and the Plurinational State of Bolivia for their high levels of emissions from agriculture, forestry and other land uses (AFOLU).

Emissions increase as economies and populations grow; however, there can also be an energy decoupling (relation between energy and GDP) and a decoupling of emissions and decarbonization (relation between emissions and energy consumption). In this way, an increase in per capita income is achieved with less energy consumption and reduced emissions (ECLAC, 2009). Examining an energy intensity index by region for 1980-2005 (figure 3.11), one sees that, in aggregate for Latin America and the Caribbean, there is no sustained process of energy decoupling, as occurred in other regions of the world. This is reflected in the fact that, in terms of world averages, increases in income have been accompanied by decreases in energy consumption.

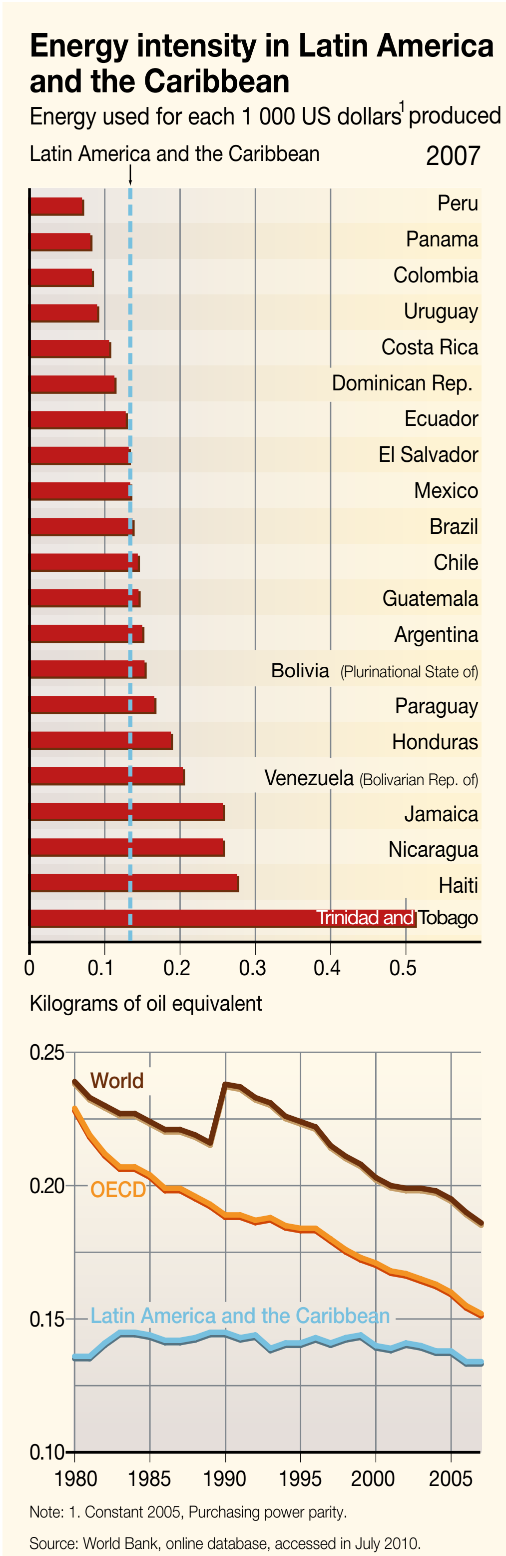


Figure 3.9

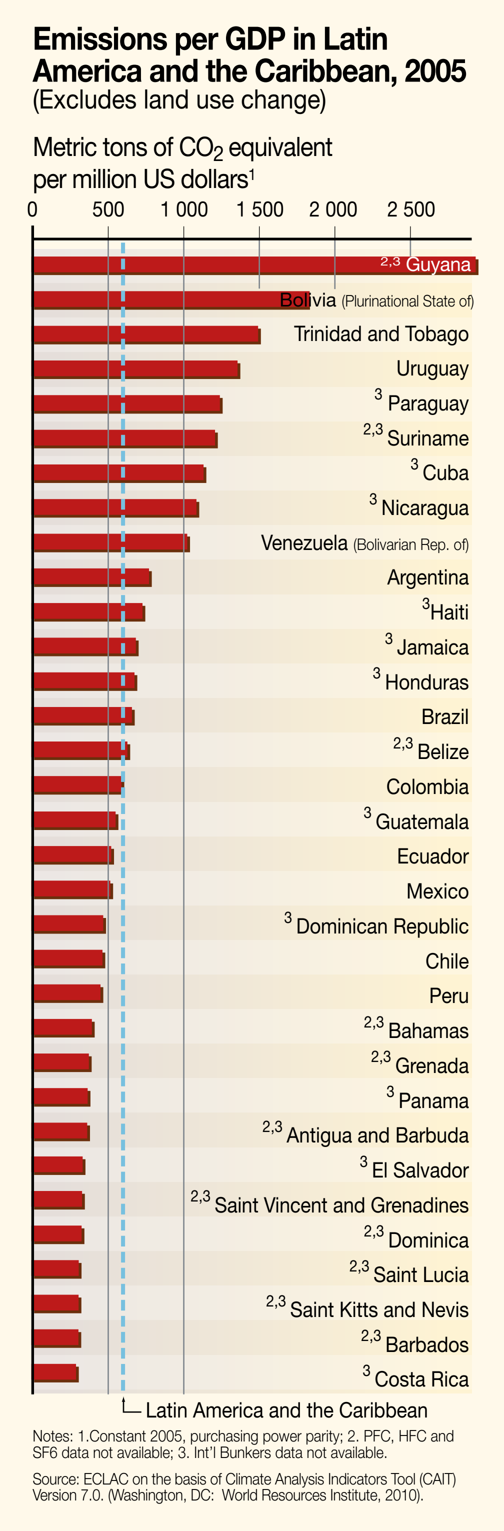


Figure 3.10a

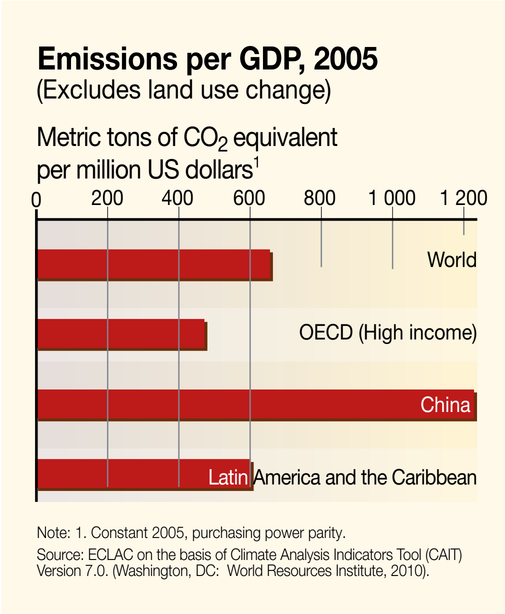


Figure 3.10b

The trajectories for CO_2 emissions and energy consumption in Latin America and the Caribbean in 1980-2005 show that there is a positive relation between these two variables, though it varies from one country to another. During the period in question, both energy consumption and CO_2 emissions (excluding those associated with land use changes) grew in the region at an average annual rate that was higher than the world average. Likewise, for the same period, emissions in Latin America and the Caribbean grew at a rate somewhat lower than the increase in energy consumption, suggesting that there has been a slight process of decarbonization in the region.

Comparing the emissions:energy ratio (carbon intensity) between regions, one finds different patterns over time. Thus, between 1980 and 1995, decarbonization in LAC was in line with the world average; in the first half of the 1980s, the region progressed, in this respect, even faster than did the OECD countries. However, between 1995 and 2003, the emissions-to-energy consumption ratio increased (figure 3.12). The ratio of emissions to GDP in the

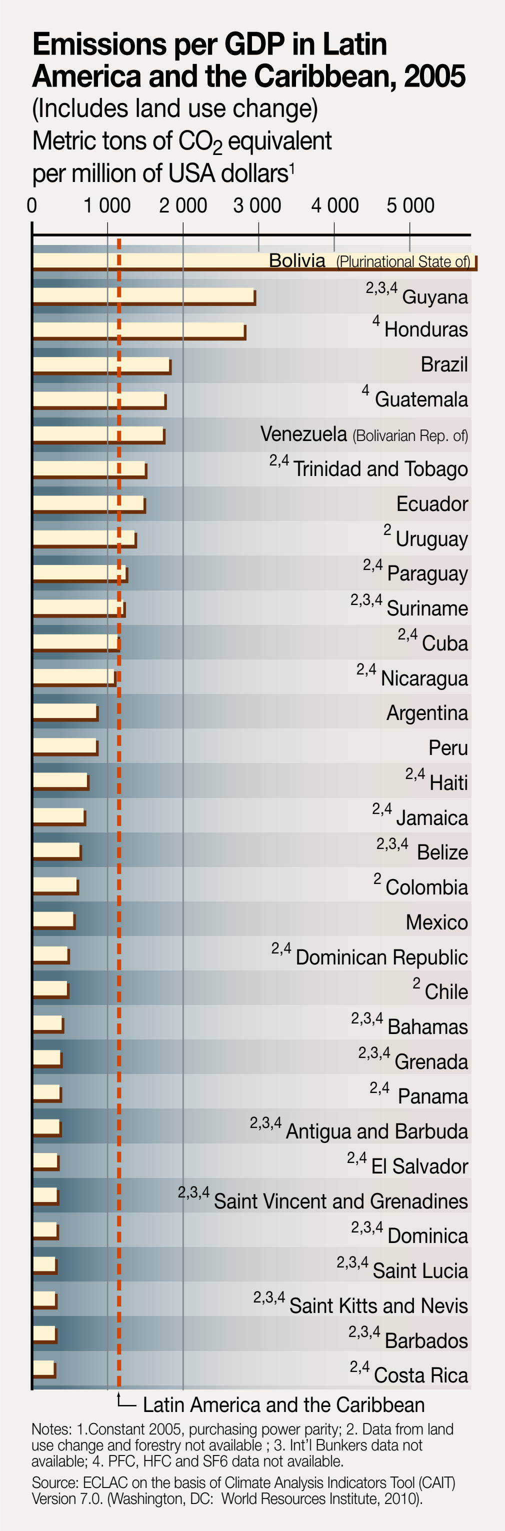


Figure 3.10c

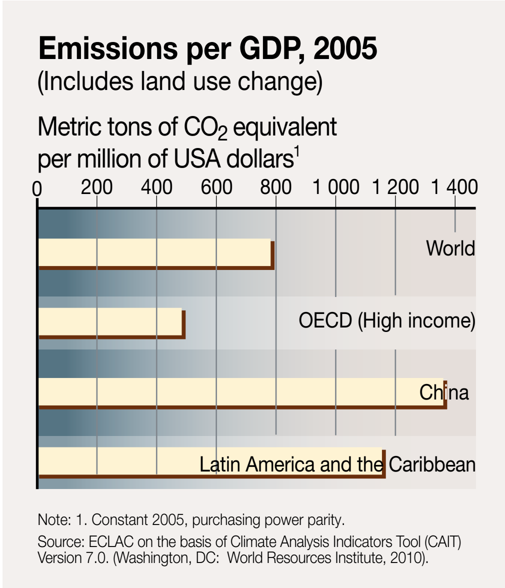


Figure 3.10d

region remained constant between 1980 and 2005 (figure 3.13), in contrast to the figure for the world as a whole, for the OECD countries and for China. This highlights the need to intensify efforts within the region to transition to less carbon-intensive economies.

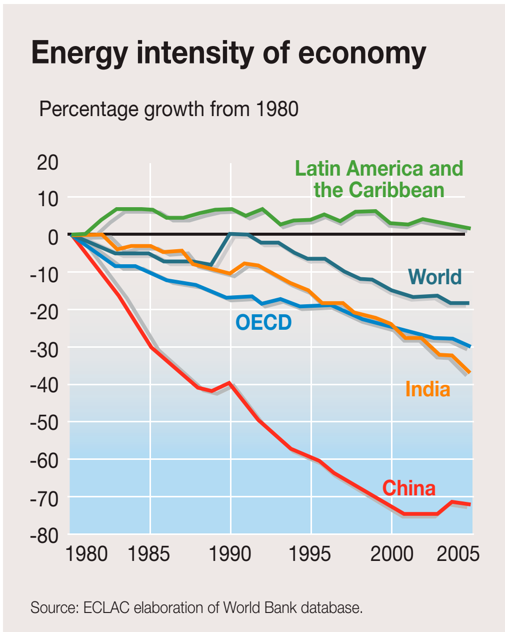


Figure 3.11

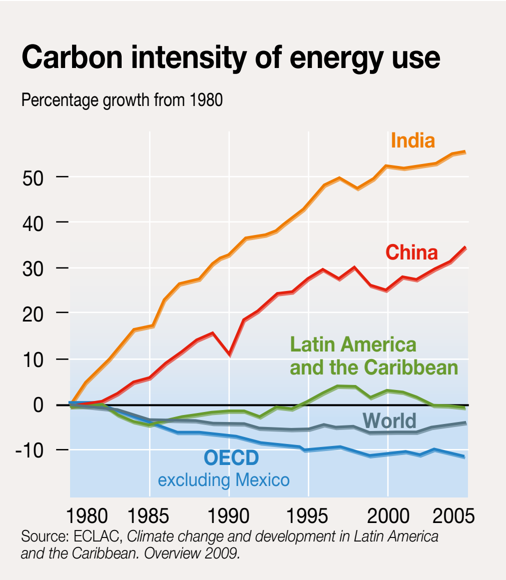


Figure 3.12

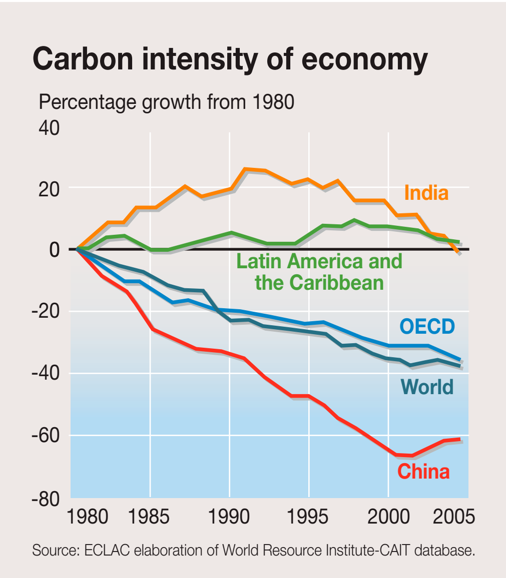


Figure 3.13

By the same token, changes in energy intensity in the region point to the importance of improving energy efficiency levels, on both the supply and the demand side, and of expanding the use of renewable energies. In South America, 70% of the electricity produced comes from hydroelectric sources (figure 3.14). However, in Central America and the Caribbean, electric-power generation continues to rely predominantly on fossil fuels.

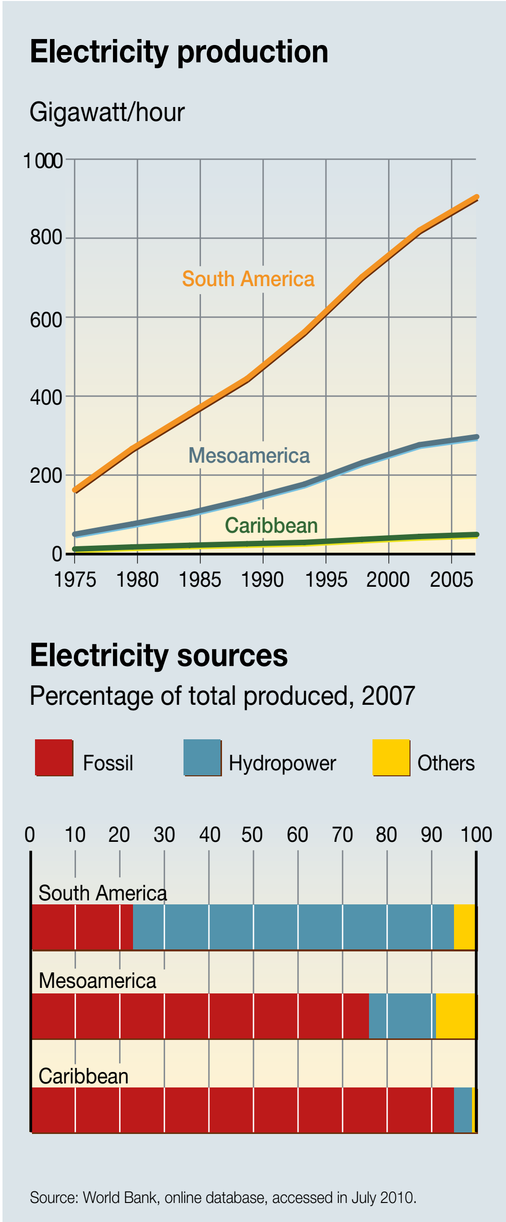


Figure 3.14

For Latin America and the Caribbean overall, fossil fuels (primarily oil and natural gas) continued, in 2007, to be the most important source (76%) for producing energy. Of the energy produced in the region, only 23.1% comes from renewable sources, primarily water, sustainable fuelwood and sugarcane products (figure 3.15).

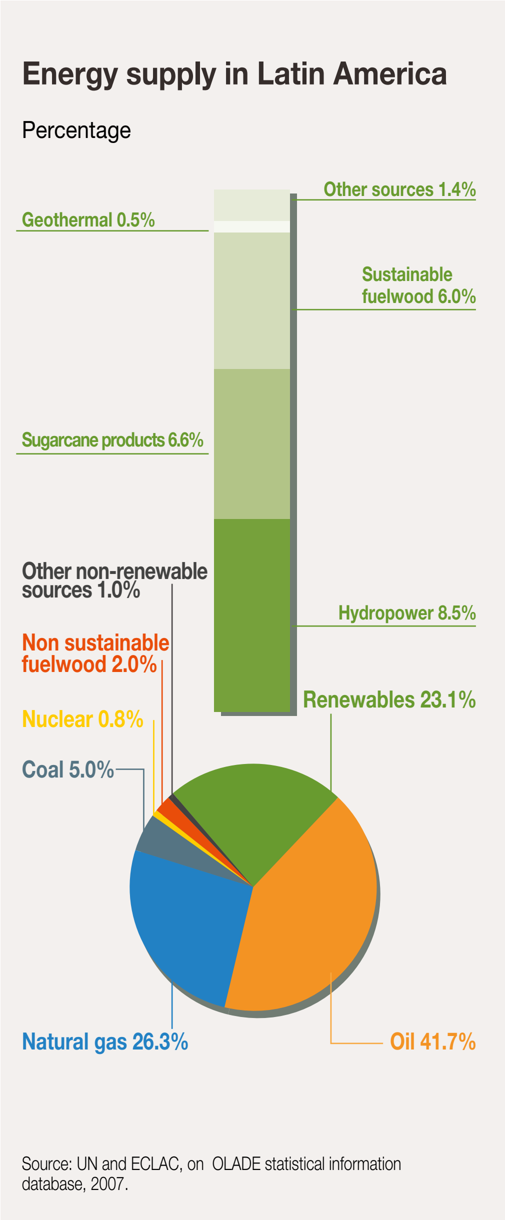


Figure 3.15

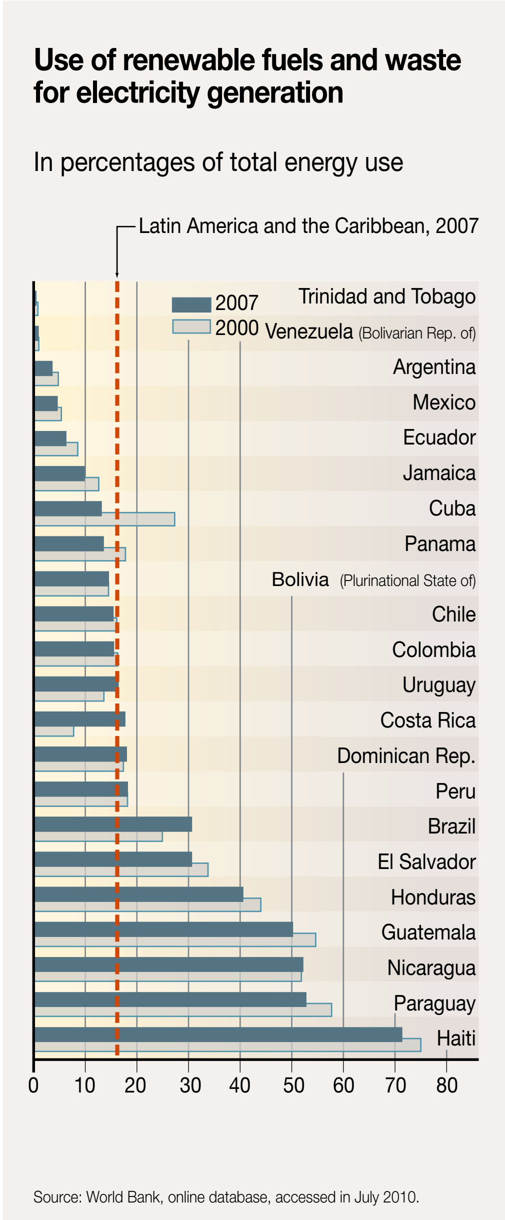


Figure 3.16

In 2007, 15.8% of the supply of primary energy in Latin America and the Caribbean came from renewable fuels and waste (solid and liquid biomass, biogas, and industrial and urban waste). This is higher than the worldwide average of 9.5% for the same year. Of the region's countries, Haiti, Paraguay Nicaragua and Guatemala each obtain more than 50% of their primary energy from renewable fuels and waste (figure 3.16). However, this figure includes the use of fuelwood for cooking, a practice that causes increased deforestation.

Forest conservation and sustainable management initiatives

Sources: R. Landa *et al, Cambio climático y desarrollo sustentable*, 2010; FAO, *State of the world's forests*, 2007.

Figure 3.17

The total forested area in the world exceeds 4 billion hectares, representing an average of approximately 0.6 hectares per person. South America has the largest forest cover (49%); Brazil, with 520 million hectares (FAO, 2010), ranks second among the world's countries in its expanse of forests. The importance of this sector with regard to climate change lies in its great potential for mitigating greenhouse gases. Thus, the "Copenhagen Accord" recognizes the crucial importance of reducing emissions from deforestation and forest degradation plus conservation (REDD-plus), improving sustainable forest management, increasing the forest carbon stock in the developed countries, and providing incentives for these actions through a mechanism that includes REDD-plus. Such an approach would make it easier to mobilize funds for developing countries and aid mitigation efforts designed to slow deforestation and forest degradation.

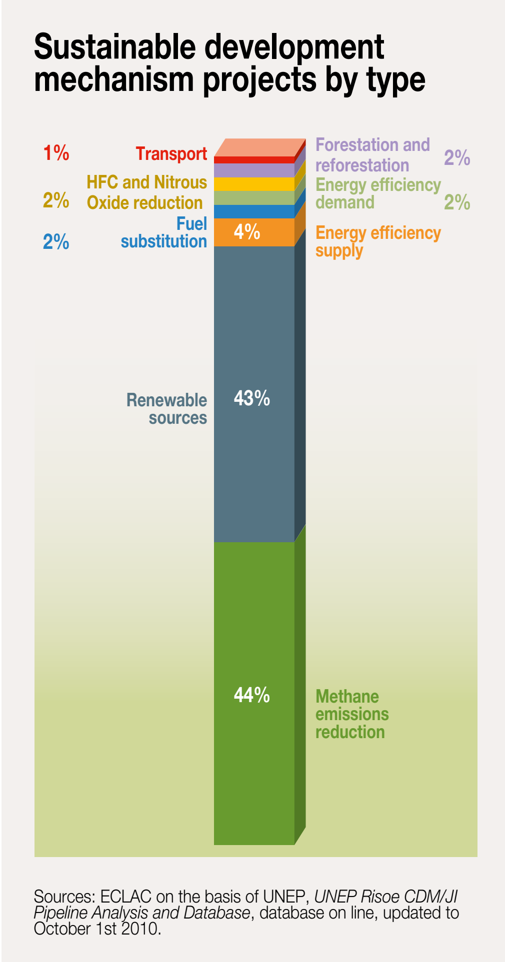
In November 2009, in attempts to preserve the forests and slow deforestation, the Governments of Guyana and Norway signed a memorandum of understanding for cooperation on issues related to combating climate change, protecting biodiversity and improving sustainable development, with a particular focus on reducing emissions from deforestation and forest degradation in the framework of REDD-plus. Within the region, Panama, the Plurinational State of Bolivia and Paraguay are part of the UN-REDD programme that helps developing countries formulate and implement national REDD-plus strategies. In addition, a number of countries in the region are carrying out conservation and forest management initiatives (figure 3.17). Among the mitigation measures announced by Brazil in the framework of the "Copenhagen Accord" is an initiative to reduce deforestation in Amazonia and the Cerrado, as well as efforts to restore grasslands. Mexico, within its national strategy to combat climate change, also considers sustainable forest management to be one of the means of reducing its greenhouse gas emissions.

The pace of deforestation, while showing signs of slowing at the global level, continues to be a source of serious concern for Latin America and the Caribbean. While the region's forests represent one of the most important potential sources for mitigating GHG emissions, LAC accounted for approximately 70% of the world's decrease in forests between 2005 and 2010 (FAO, 2010). The global forest resource assessment (FRA) conducted by the Food and Agriculture Organization of the United Nations (FAO) identifies Brazil as the country with the greatest net annual loss of forest area in the world, though this must be viewed as a historical process caused by multiple factors, both internal and external. Between 1990 and 2000, Brazil lost 2.8 million hectares per year (ha/year) of forests, while between 2000 and 2010 the loss was 2.6 million ha/year. The list of the ten countries with the highest net forest losses in the last decade includes the Plurinational State of Bolivia and the Bolivarian Republic of Venezuela, with a combined loss of 290,000 ha/year. These countries, along with Peru, Mexico, Colombia and Ecuador, constitute critical areas of deforestation in the region (figure 3.18).

Figure 3.18

Source: ECLAC, on the basis of UNEP, *UNEP Risoe CDM/JI Pipeline Analysis and Database*, database on line, updated 1st October 2010.

Figure 3.19a



Sources: ECLAC on the basis of UNEP, *UNEP Risoe CDM/JI Pipeline Analysis and Database*, database on line, updated to October 1st 2010.

Figure 3.19b

At present, LAC has 1003 projects in various stages, within the framework of the Clean Development Mechanism (CDM).[3] The countries in the region with the greatest number of CDM projects are Brazil (with 42% of the total), Mexico (with 20%), Chile (with 8%) and Colombia (with 7%). The largest number of CDM projects (87% of the total) in which the region is involved are in the areas of renewable energies and methane reduction (figure 3.19a-b). This highlights the need to more extensively explore mitigation measures in forestry, transportation, fuel substitution and energy efficiency.

[3] According to the United Nations Environment Programme (UNEP), "UNEP Risoe CDM/JI Pipeline Analysis and Database" [online database] http://dcmpipeline.org/, updated as of 1 October 2010.

One source of funds for developing countries facing climate change, in addition to funds from CDM projects, are those designated as Official Development Assistance (ODA). Between 2000 and 2007, the LAC region was the recipient of 8.5% of these resources. One category of these resources is directed at providing development assistance that targets the objectives of the three Rio Conventions – the United Nations Convention on Biological Diversity, the United Nations Framework Convention on Climate Change and the United Nations Convention to Combat Desertification – under the rubric of the so-called Rio Markers. Between 2000 and 2007, the region received approximately US$1.4 billion (in current dollars) for sectors attempting to deal with climate change (figure 3.20). In addition to ODA, there are other sources of international financing to help developing countries address the challenges of climate change, in terms of both mitigation and adaptation. These include the Clean Technology Fund, the GEF Trust Fund - Climate Change focal area (GEF 4 and 5), the Amazon Fund (Fundo Amazônia) and the Hatoyama Initiative.

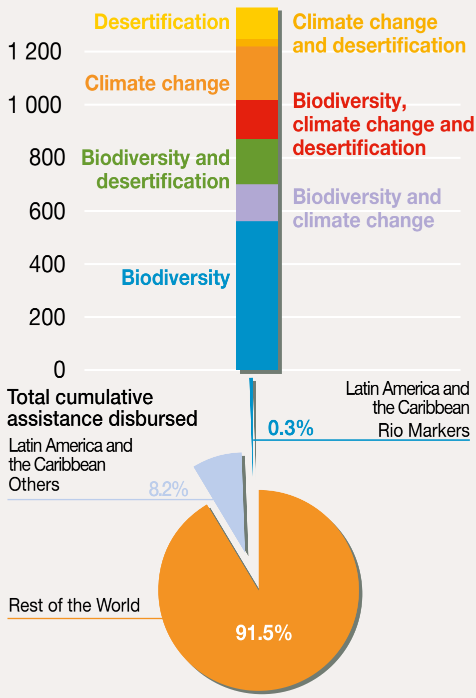
Although estimating the costs of GHG mitigation is a complex task, involving a high degree of uncertainty due to the numerous variables involved (Galindo, 2009), studies have been conducted in the region for a number of countries. These identify potential mitigation measures in different sectors, along with the associated costs. The cost of mitigation varies according to sector, region and country. Generally, however, there are effective and practical options that could be adopted in the developing countries, amounting to a cost of 40 euros or less per ton of CO_2 (Enkvist *et al.*, 2007).

The mitigation actions announced by the non-Annex I countries in the framework of the "Copenhagen Accord", as set forth in their respective national climate change plans (Fransen *et al.*, 2009), have, as a common feature, initiatives geared to the sectors that generate and use energy, as well as to the transportation and forest sectors. The associated costs are consistent with the lowest marginal costs of reducing emissions reported in the Regional Studies on the Economics of Climate Change (ECLAC, 2009). In Mexico, for example, there is the potential for significant emissions reductions in the transportation sector, as well as in the overall energy sector (Galindo, 2009), while Uruguay continues to have significant options for mitigation related to agricultural activities. The marginal costs of some of the main mitigation measures for Mexico, Central America and Uruguay are presented in figures 3.21, 3.22, and 3.23 respectively.

Official Development Assistance

Cumulative assistance disbursed in Latin America and the Caribbean, Rio Markers

Million US dollars, cumulative 2000-2007



Source: ECLAC, on the basis of OCDE, *OCDE StatExtracts*, online database , accessed August 2009.

Figure 3.20

The statistics, charts and maps presented in this report illustrate both the urgency of taking action and the significant benefits that could be gained from promptly undertaking adaptation measures, reducing regional vulnerability to climate change and mitigating the region's contribution to global GHG emissions.

The report shows that Latin American and the Caribbean countries will need significant resources and assistance to reduce vulnerability and build resilience against the increasingly prominent and harmful impacts of climate change. Moreover, it demonstrates the growing need for regional coordination and sharing of best practices in making sound

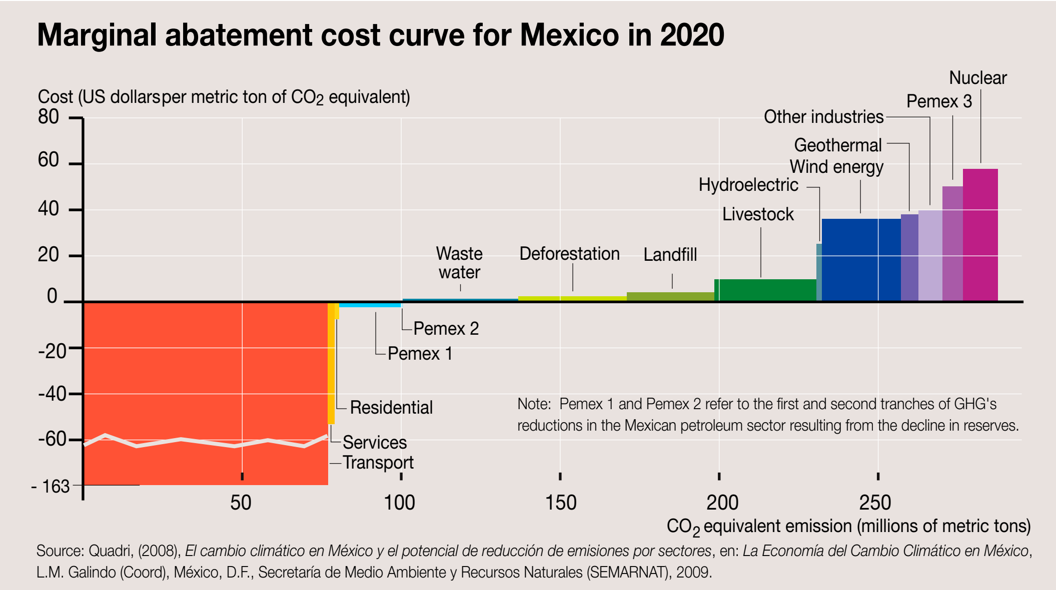


Figure 3.21

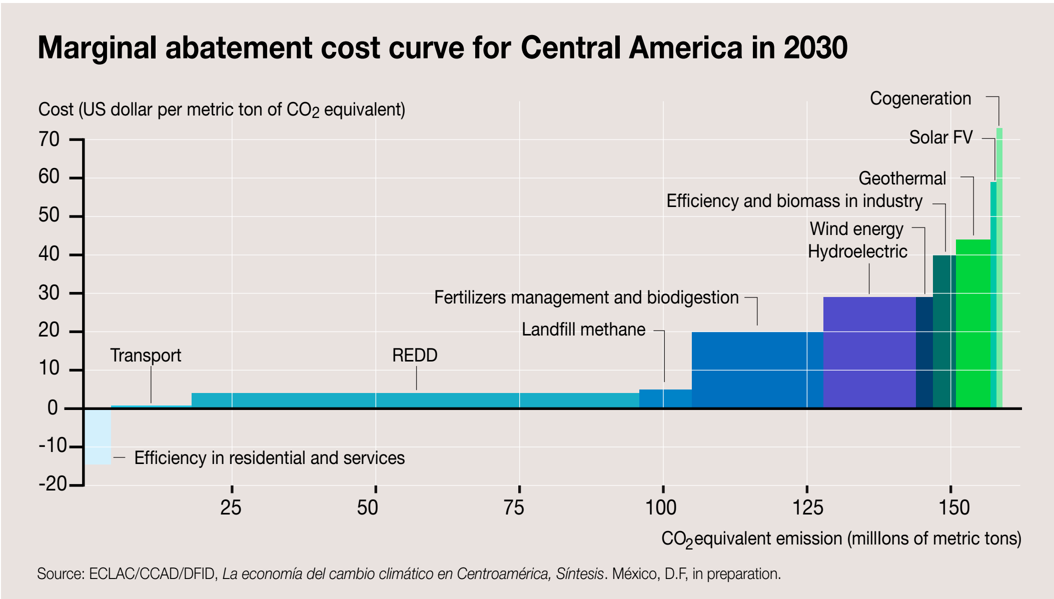
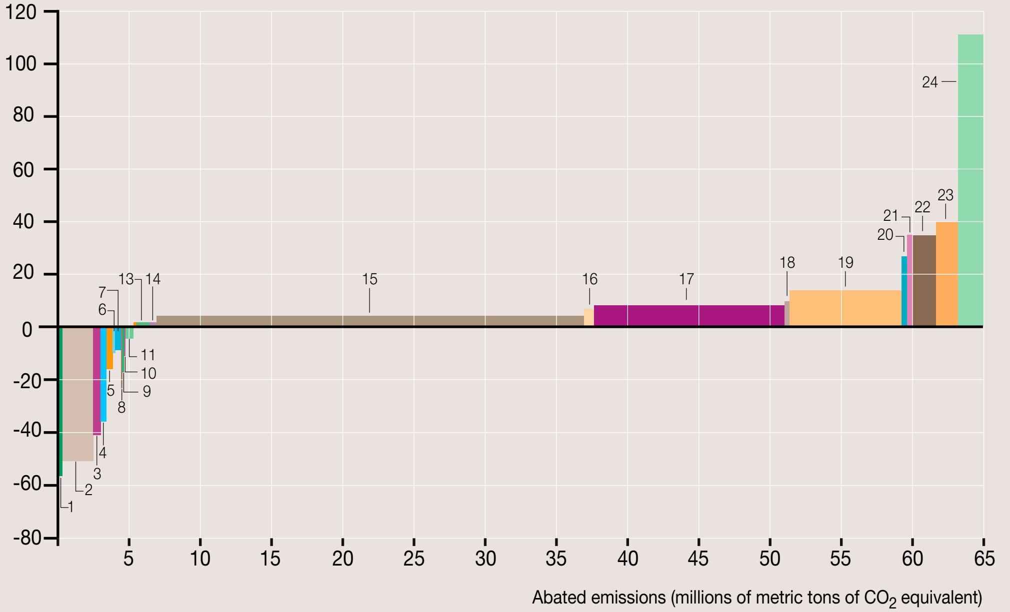


Figure 3.22

policy, technology and investment choices leading to GHG emission reductions, with a focus on scaling up clean and renewable energy sources, energy efficiency and energy conservation. With regards to the region's forest resources, the graphics illustrate that rapid advances in reducing emissions from deforestation and degradation will be needed to reverse negative trends and overcome a key challenge of the region's success in acting against climate change.

Marginal abatement cost curve for Uruguay in 2030

Emission reduction cost (dollars per metric ton of CO_2equivalent)



1- Replacement of diesel and fuel into compressed natural gas

2- Improve energy efficiency in businesses/services

3- Improved residential energy efficiency

4- Air conditioning technology in businesses and services

5- Improved vehicular performance

6- Improved industrial energy efficiency

7- Residential lighting

8- Commercial/industrial lighting

9- Industrial lighting

10- Public lighting

11- Reorganization of the metropolitan transport system

12- Improved truck load factor

13- Wastewater

14- Biogas capture

15- Planting of grassland

16- Biodiesel use in transport

17- Forest management

18- Ethanol use in transport

19- Greater efficiency for energy, replacing fossil fuels, reducing losses in transmission and distribution

20- Biomass generation

21- Improving the efficiency of boilers and heat recovery

22- Industrial solid waste

23- Improve motor efficiency in the other sectors

24- Wind energy

Source: ECLAC, *La economía del cambio climático en el Uruguay. Síntesis,* 2010.

Figure 3.23

In all of the three abovementioned areas, many countries of the region have already pioneered innovative climate change policies, investments and solutions. Today, these success stories and best practices have to be scaled up and integrated into comprehensive national and regional pro-growth, pro-jobs and pro-poor development strategies.

Acronyms and abbreviations

CAN	Andean Community
CBD	Convention on Biological Diversity
CDM	Clean Development Mechanism
CH_4	Methane
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
ECLAC	Economic Commission for Latin America and the Caribbean
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse gases
HFC	Hydrofluorocarbons
INPE	Instituto Nacional de Pesquisas Espaciais (National Institute of Spatial Research)
IPCC	Intergovernmental Panel on Climate Change
m	meters
MDG	Millennium Development Goals
mm	millimeters
$MtCO_2$-e	Million of metric tons of CO2 equivalent
N_2O	Nitrous Oxide
NASA	National Aeronautics and Space Administration
ODA	Official Development Assistance
OECD	Organization for Economic Co-operation and Development
PFC	Perfluorocarbons
PPP	Purchasing Power Parity
REDD	United Nations Collaborative Programme on Reducing Emsissions from Deforestation and Forest Degradation in Developing Countries
SF6	Sulfur hexafluoride
UN	United Nations
UNEP	United Nations Environment Programme
WHO	World Health Organization
WRI	World Resources Institute

Bibliography

CBD - Secretaría del Convenio sobre Diversidad Biológica, Perspectiva Mundial sobre la Diversidad Biológica 3. Montreal, 2010.

CEPAL/CCAD/DFID, (2010), La economía del cambio climático en Centroamérica, Síntesis. México, D.F. (in press).

CEPAL, Comisión Económica para América Latina y el Caribe (2010). La economía del cambio climático en el Uruguay. Síntesis. Documento LC/W.330.

CEPAL, Comisión Económica para América Latina y el Caribe (2009), La economía del cambio climático en América Latina y el Caribe. Síntesis (LC/G.2425), Santiago de Chile.

CEPAL/BID (Comisión Económica para América Latina y el Caribe/Banco Interamericano de Desarrollo) (2010), Cambio climático. Una perspectiva regional. (LC/L.3207), Santiago de Chile.

CEPAL/BID/Gobierno de Chile (Comisión Económica para América Latina y el Caribe/Banco Interamericano de Desarrollo/Gobierno de Chile) (2009), La economía del cambio climático en Chile. Síntesis (LC/W.288), Santiago de Chile.

Church, J. A. y J. M. Gregory, (2001), Changes in Sea Level. In J. T. Houghton, L. G. M. Filho, B. A. Callander, N. Harris, A. Kattenberg, y K. Maskell (Eds.), Climate Change 2001: The Scientific Basis. Cambridge, Cambridge Univ. Press.

Costanza R. *et al*. (1997), The value of the world's ecosystem services y natural capital. Ecological Economics 25; 3–15.

Dyurgerov, M. (2002), Glacier mass balance and regime: Data of measurements and Analysis. Occasional Paper No. 55. Institute of Arctic and Alpine Research, Boulder.

Dyurgerov, M. (2003), Observational Evidence of Accelerated Glacier Wastage: Uncertainty in Prediction. En: Workshop on Assessing Global Glacier Recession, 16-17 March 2003. World Data Center for Glaciology, Boulder.

Enkvist, P., Nauclér, T. y Rosander, J. (2007), "A cost curve for greenhouse gas reduction". The McKinsey Quarterly, 2007, Number 1.

FAO, Food and Agriculture Organization of the United Nations (2010), Evaluación de los recursos forestales mundiales 2010, Informe principal.

Francou, B.,M.Vuille, P.Wagnon, J.Mendoza and J.-E. Sicart, (2003), Tropical climate change recorded by a glacier in the centralAndes during the last decades of the twentieth century: Chacaltaya, Bolivia, 16°S. J. Geophys. Res., 108, doi:10.1029/2002JD002959.

Fransen, T., Nakhooda, S., Chu, E. and McGray, H. (2009), National climate change strategies: comparative analysis of developing country plans. World Resources Institute. December 2009.

Galindo, L.M. (2009), La economía del cambio climático en México. Síntesis, México, D.F., Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT).

Githeko, A. K., Lindsay, S.W., Confalonieri, U. E. y Patz, J.A. (2009), El cambio climático y las enfermedades transmitidas por vectores: un análisis regional. Revista Virtual REDESMA. December 2009 Vol. 3(3).

IPCC, Intergovernmental Panel on Climate Change (2007a), Climate Change 2007 - The Physical Science Basis: Working Group I Contribution to the Fourth Assessment Report of the IPCC, Cambridge University Press, September.

IPCC, Intergovernmental Panel on Climate Change (2007b), Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Core Writing Team, Pachauri, R.K. and Reisinger, A. (Eds.) IPCC, Geneva, Switzerland. pp 104.

Landa, R., B. Ávila y M. Hernández. (2010), Cambio Climático y Desarrollo Sustentable para América Latina y el Caribe. Conocer para Comunicar. British Council, PNUD México, Cátedra UNESCO-IMTA, FLACSO México. México D.F. 140 pp.

Magrin, G., C. Gay García, D. Cruz Choque, J.C. Giménez, A.R. Moreno, G.J. Nagy, C. Nobre and A. Villamizar, (2007). Latin America. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 581-615.

Meehl, G.A., T.F. Stocker, W.D. Collins, P. Friedlingstein, A.T. Gaye, J.M. Gregory, A. Kitoh, R. Knutti, J.M. Murphy, A. Noda, S.C.B. Raper, I.G. Watterson, A.J. Weaver and Z.-C. Zhao, 2007: Global Climate Projections. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

NASA. (2003). South American Glaciers Melting Faster, Changing Sea Level. Información del 16 de octubre, 2003. http://www.jpl.nasa.gov/releases/2003/138.cfm

NC-Perú, 2001: 1st National Communication to the UNFCCC, 155 pp. http://unfccc. int/resource/docs/natc/pernc1.pdf.

Parry, M.L., O.F. Canziani, J.P. Palutikof and Co-authors (2007), Technical Summary. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 23-78.

Rignot, E., A. Rivera, y G. Casassa. (2003), Contribución de los Campos de hielo de la Patagonia en Sudamérica a la elevación del nivel del mar. Science, Vol 302.

Samaniego, J. (coord.) (2009), Cambio climático y desarrollo en América Latina y el Caribe. Reseña 2009 (LC/L.3140), Santiago de Chile, Comisión Económica para América Latina y el Caribe (CEPAL), November.

Stern, Nicholas (2007), The Economics of Climate Change: The Stern Review, Cambridge University Press, January.

UNEP – United Nations Environment Programme (2007). Global Environment Outlook: GEO 4, Environment for Development. Ed, Phoenx Design Aid, Denmark.

WDI, World Development Indicators (2010). World Bank database for development data [database] <http://www.worldbank.org/>.

WRI, World Resources Institute (2010), "Climate Analysis Indicators Tool (CAIT) version 7.0.," [database] <http://cait.wri.org>.

NOAA, National Oceanic and Atmospheric Administration (2010), National Hurricane Center. [database] <http://www.nhc.noaa.gov>

United Nations Environment Programme (UNEP)
Regional Office for Latin America and the Caribbean
Avenida Morse, Edificio 103, Clayton, Ciudad del Saber
Corregimiento de Ancón, Panama City, Panama
P.O. Box 03590
Tel: (+507) 305-3100 / Fax: (+507) 305-3105
www.pnuma.org E-mail: enlace@pnuma.org

www.unep.org

United Nations Environment Programme
P.O. Box 30552 - 00100 Nairobi, Kenya
Tel.: +254 20 762 1234
Fax: +254 20 762 3927
e-mail: uneppub@unep.org
www.unep.org

UNEP