GLOBAL ENVIRONMENT OUTLOOK

GEO-6

REGIONAL ASSESSMENT FOR

LATIN AMERICA AND THE CARIBBEAN





Job No: DEW/1966/NA
ISBN: 978-92-807-3546-8

Suggested citation:
UNEP 2016. GEO-6 Regional Assessment for Latin America and the Caribbean. United Nations Environment Programme, Nairobi, Kenya.

Credits
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Cover Design: Audrey Ringler, UNEP
Design and Layout: Audrey Ringler, UNEP; UNON/Publishing Services Section
Printing: UNON/Publishing Services Section/Nairobi, ISO 14001:2004-Certified

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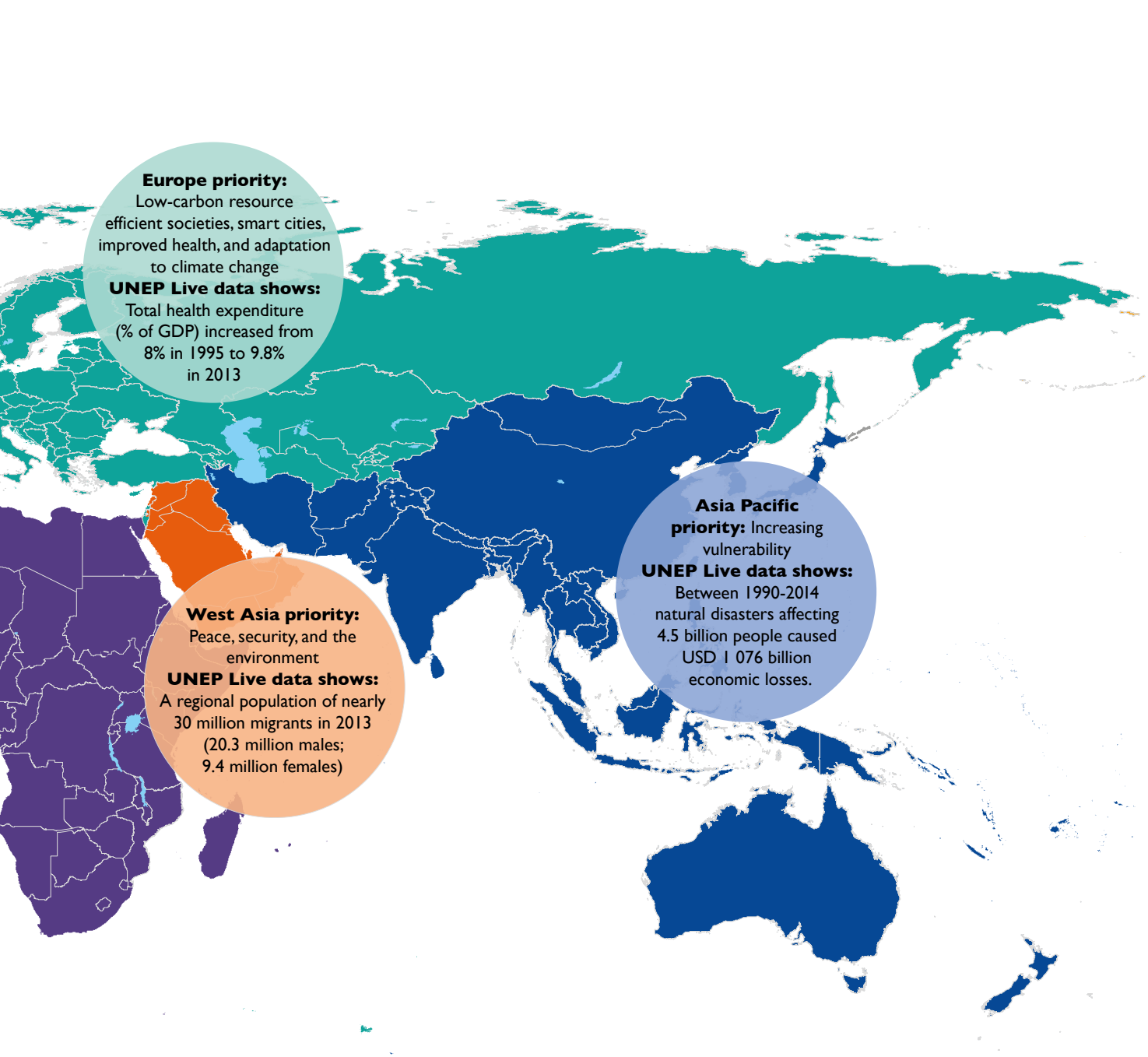
UNEP


North America priority:
Reducing GHG emissions, energy transition, and city-level innovation
UNEP Live data shows:
Per capita CO_2 emissions increased by 11.5% (1960-2012)
Africa priority:
Land management and use
UNEP Live data shows:
Total arable land increased by 53% but arable land per capita decreased by 59% (1961-2012)
Latin America and the Caribbean priority: Sustainable management of biological resources
UNEP Live data shows:
20.3% of LAC's terrestrial and marine area is protected (2010)


Europe priority:
Low-carbon resource efficient societies, smart cities, improved health, and adaptation to climate change
UNEP Live data shows:
Total health expenditure (% of GDP) increased from 8% in 1995 to 9.8% in 2013
Asia Pacific priority: Increasing vulnerability
UNEP Live data shows:
Between 1990-2014 natural disasters affecting 4.5 billion people caused USD 1 076 billion economic losses.
West Asia priority:
Peace, security, and the environment
UNEP Live data shows:
A regional population of nearly 30 million migrants in 2013 (20.3 million males; 9.4 million females)

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Foreword

The sixth *Global Environment Outlook (GEO-6) Regional Assessment for Latin America and the Caribbean* paints a comprehensive picture of the environmental factors contributing to human health and well-being at the regional level. Backed by a large body of recent, credible scientific evidence, regional-wide consultations and a robust intergovernmental process, the assessment demonstrates important progress in achieving several of the targets set out under the Millennium Development Goals. It also highlights the complexity of the interlinked environmental, social and economic challenges now confronting decision makers.

The launch of the *GEO-6 Regional Assessment for Latin America and the Caribbean* comes at a critical time. The world is on a new pathway to combat climate change and unleash actions and investment towards a low carbon, resource-efficient, resilient and sustainable future. At the same time, the 2030 Agenda for Sustainable Development provides a clear pathway to a world in which everyone can enjoy prosperity within the ecological limits of the planet.

There is a clear trend in Latin America and the Caribbean towards addressing pressing issues. These include improving access to water and sanitation, reducing poverty, phasing out ozone-depleting substances and expanding the network of protected areas. However, the region still faces significant environmental challenges characterized by land degradation, biodiversity loss, pollution, vulnerability to climate change, and unsustainable production and consumption patterns.

The governments of Latin America and the Caribbean region have the opportunity to build on existing efforts, and to focus on transformative actions to put the region on the path towards sustainable development. As expressed at the twentieth Meeting of the Forum of Ministers of Environment of Latin America and the Caribbean in March 2016, the rich experience of the region plays a vital role in delivering low-carbon economic growth, resource efficiency and effective ecosystem management.

I would like to extend my gratitude to the large body of policymakers, leading scientists and representatives from major stakeholder groups and partners who contributed to this comprehensive and illustrative assessment report. I extend an invitation to all countries in the region to engage with this report and use the opportunity provided to transform the vision of the 2030 Agenda for Sustainable Development and its Sustainable Development Goals into a reality for Latin America and the Caribbean.

Achim Steiner

United Nations Under-Secretary-General and
Executive Director, United Nations Environment Programme

Acknowledgements

Co-Chairs
Keisha Garcia (independent consultant, Trinidad and Tobago) and Diego Martino (Asesoramiento Ambiental Estratégico - AAE, Uruguay)

High Level Intergovernmental and Stakeholder Advisory Group (LAC members)
Victoria Rodríguez de Higa (Ministry of Environment and Sustainable Development, Argentina), Paulo Rogerio Gonçalves (Ministry of Environment, Brazil), Rodolfo Lacy Tamayo (Ministry of Environment and Natural Resources, Mexico)

Scientific Advisory Panel (LAC members)
John B. R. Agard (University of the West Indies, Trinidad and Tobago), María Amparo Martínez Arroyo (National Institute of Ecology and Climate Change, Mexico), Paulo Eduardo Artaxo Netto (Federal University of São Paulo, Brazil), Carlos Alfonso Nobre (Ministry of Environment, Brazil)

Assessment Methodologies, Data and Information Working Group (LAC members)
Sandra de Carlo (Secretariat for Strategic Affairs of the Presidency, Brazil), Rosario Gómez (University of the Pacific, Peru)

Author Teams
Chapter 1
Coordinating Lead Authors: Amrikha Singh (Caribbean Community - CARICOM) and Guillermo Castro (City of Knowledge Foundation, Panama)

Lead Authors: Sandra Amlang (United Nations Office for Disaster Risk Reduction - UNISDR), Jonathan Lashley (University of the West Indies, Barbados), Winston Moore (University of the West Indies, Barbados)

Contributing Authors: Abdullah Abdulkadri (United Nations Economic Commission for Latin America and the Caribbean - UNECLAC), Leonie Barnaby (Ministry of Water, Land, Environment and Climate Change, Jamaica), Garfield Barnwell (Caribbean Community - CARICOM), Annette Greene (University of the West Indies, Barbados), Ana Rosa Moreno (National Autonomous University of Mexico - UNAM, Mexico), Asha Singh (Organization of Eastern Caribbean States – OECS)

Chapter 2.1
Coordinating Lead Authors: Ricardo Barra (University of Concepción, Chile) and Karina S. B. Miglioranza (IIMyC, CONICET - Mar del Plata University, Argentina)

Leading Authors: Hector Ginzo (Argentinian Academy of Environment Sciences, Argentina), Ana Rosa Moreno (National Autonomous University of Mexico - UNAM, Mexico), Sergio Sánchez (The Clean Air Institute)

Chapter 2.2 and 2.3
Coordinating Lead Authors: Rianna Gonzales (Caribbean Youth Environment Network, Trinidad and Tobago) and Andrea Salinas (UNEP)

Lead Authors: Ana Rosa Moreno (National Autonomous University of Mexico - UNAM, Mexico), Donna-May Sakura Lemessy (Institute of Marine Affairs, Trinidad and Tobago), Milenka Sojachenski *(*Asesoramiento Ambiental Estratégico, Uruguay*)*, Laura Borma (National Institute of Spatial Research – INPE, Brazil)

Contributing Authors: Gino Casassa (Magallanes University, Chile), Arturo Dominici-Arosemena (Ramsar Regional Center – CREHO, Panama), Ricardo Jaña (Chilean Antarctic Institute, Chile), Amhed Cruz Leyva (Ministry of Environment and Natural Resources, Mexico) César Rodríguez-Ortega (Ministry of Environment and Natural Resources, Mexico), Sharda Mahabir (Water Resources Agency, Water and Sewerage Authority – WRA/WASA, Trinidad and Tobago), Arjen Hoekstra (University of Twente, Netherlands), Johanna Granados

(independent consultant, Colombia), Marc A. Levy and Kytt MacManus (CIESIN, Earth Institute, Columbia University)

Chapter 2.4
Coordinating Lead Author: Andrés Guhl (University of the Andes, Colombia)

Lead Authors: Alice Altesor (University of the Republic, Uruguay), Robert Hofstede (independent counselor, Netherlands), José Paruelo (University of Buenos Aires, Argentina), Ximena Rueda (University of the Andes, Colombia), Ana Rosa Moreno (National Autonomous University of Mexico - UNAM, Mexico)

Contributing Author: Mauricio Aguayo (University of Concepción, Chile)

Chapter 2.5
Coordinating Lead Author: César Rodríguez-Ortega (Ministry of Environment and Natural Resources, Mexico).

Contributing Authors: Miriam Aldasoro Maya (The College of the South Border - ECOSUR, Mexico), Hamish Asmath (Institute of Marine Affairs, Trinidad and Tobago), Erick Hernández Cervantes (Ministry of Environment and Natural Resources, Mexico), Dora Ann Lange Canhos (Reference Center on Environmental Information - CRIA, Brazil), Ana Rosa Moreno (National Autonomous University of Mexico – UNAM, Mexico), Marcia Chame (Escola Nacional de Saúde Pública-Fiocruz, Brazil), Marina Rosales (Federico Villarreal National University, Peru), Ruleo Camacho (School of Marine Science, Antigua and Barbuda), Luisa Ricaurte (Independent Consultant, Switzerland), Wilson Ramírez (Humboldt Institute, Colombia), Andrew Simmons (Caribbean Youth Environment Network, Saint Vincent and the Grenadines)

Chapter 3
Coordinating Lead Authors: Asha Singh (Organization of Eastern Caribbean States – OECS, Saint Lucia/Guyana) and Kalim U. Shah (Indiana University, United States/Trinidad and Tobago)

Chapter 4
Coordinating Lead Authors: Elsa Galarza (University of the Pacific, Peru) and Gladys Hernández (Research Centre on the World´s Economy - CIEM, Cuba)

Lead Authors: John B. R. Agard (University of the West Indies; Trinidad and Tobago), Dale Rothman (University of Denver, United States), Jacqueline Alder (FAO)

Reviewers

Marina Rosales Benites de Franco (Federico Villarreal National University, Peru), Neil C. Hawkins (The Dow Chemical Company), Andrea Sonnino (Italian National Agency for New Technologies, Energy and Sustainable Economic Development), Sandra De Carlo (Secretaria de Governo/ Presidencia, Brazil), Patricia Maccagno (Consejo Nacional de Investigaciones Científicas y Técnicas – CONICET, Argentina), Susanna De Beauville-Scott (Ministry of Sustainable Development, Energy, Science and Technology, Saint Lucia), Tatiana Terekhova (Basel, Rotterdam and Stockholm Conventions), Ana Cristina Fiahlo de Barros (Ministry of Environment, Brazil), Bruno Siqueira Abe Saber Miguel (Ministry of Environment, Brazil), Carlos Alberto de Mattos Scaramuzza (Ministry of Environment, Brazil), Carlos Augusto Klink (Ministry of Environment, Brazil), Cassandra Maroni Nunes (Ministry of Environment, Brazil), Clarissa Souza della Nina (Ministry of Environment, Brazil), Francisco Jose Souza de Oliveiro Filho (Ministry of Environment, Brazil), Julio Cesar Baena (Ministry of Environment, Brazil), Mario Mottin (Ministry of Environment, Brazil), Ney Maranhao (Ministry of Environment, Brazil), Roberto Ribas Gallucci (Ministry of Environment, Brazil), Rui Manuel Goncalves (Ministry of Environment, Brazil), Sergio Enrique Collaco de Carvalho (Ministry of Environment, Brazil), Veronica Marques Tavares (Ministry of Environment, Brazil), Vicente Andreu Guillo (Ministry of Environment, Brazil), Zilda Maria Veloso (Ministry of Environment, Brazil), Anita James (Saint Lucia), Manfred Denich (Center for Development Research – ZEF, Germany), Genoveva de Mahieu (University of El Salvador - USAL, Argentina), Torkil Jønch Clausen (DHI, Denmark), Marcos Serrano Ulloa (Ministry of Environment, Chile), Elizabete de Souza Cândido (Universidade Católica de Brasília, Brazil), Neil

Burgess (UNEP-WCMC), Nicolo Gligo (Universidad de Chile, Chile), Philip Weech (Best Commission, Bahamas), Nery Diaz (Ministry of Environment and Natural Resources, Guatemala).

Partners

International Centre for Sustainable Development (CIDES), UNEP-World Conservation Monitoring Centre, The Clean Air Institute (CAI), .Punto Aparte Bookvertising

UNEP Team

Overall coordination: Juan Bello, Francesco Gaetani, Andrea Salinas, Suzanne Howard

Support: Pierre Boileau (GEO-Head), Johannes Akiwumi, Joana Akrofi, Elisabetta Bonotto, Jillian Campbell, Ludgrade Coppens, Gerard Cunningham, Harsha Dave, Volodymyr Demkine, Priyanka DeSouza, Sami Dimassi, Angeline Djampou, Philip Drost, Ngina Fernandez, Valentin Foltescu, Sandor Frigyik, Betty Gachao, Winnie Gaitho, Dany Ghafari, Loise Gichimu, Virginia Gitari, Tessa Goverse, Caroline Kaimuru, Esther Katu, Fredrick Lerionka, Erick Litswa, Esther Marsha, Elizabeth Masibo, Jacqueline McGlade, Patrick M'Mayi, Pascil Muchesia, Pauline Mugo, Ruth Mukundi, Josephine Mule, Caroline Mureithi, Jane Muriithi, Onesmus Mutava, Nyokabi Mwangi, Monica Mwove, Joyce Ngugi, Trang Nguyen, Victor Nthusi, Franklin Odhiambo, Hanul OH, Brigite Ohanga, Thierry Oliveira, Evelyn Ongige, Samuel Opiyo, Neeyati Patel, Christina Power, Audrey Ringler, Pinya Sarassas, Gemma Shepherd, Asha Sitati, Simone Targetti Ferri, Mwangi Theuri, Kaisa Uusimaa, Peninah Wairimu-kihuha, Josephine Wambua, Jochem Zoetelief, Zinta Zommers

Contents and review: Leo Heileman, Mara Murillo, Piedad Martin, Andrea Brusco, Alberto Pacheco, Isabel Martínez, Gustavo Mañez, Elena Pita, Gabriel Labbate, Marisela Ricárdez, Jordi Pon, Mirian Vega, Marco Pinzón and Maite Aldaya

Regional Environmental Information Network (REIN) Conference Participants

Ministerial Representatives: Tricia Lovell (Antigua and Barbuda), Mirta Laciar (Argentina), Arana Pyfrom (Bahamas), Sean Sealy (Barbados), Edgar Ek (Belize), Francisco J.B. Oliveira Filho (Brazil), Marcos Serrano Ulloa (Chile), Maria Saralux Valbuena (Colombia), Alvaro Aguilar (Costa Rica), Ileana Saborit (Cuba), Sisha Birmingham (Dominica), Diana Patricia Pabón (Ecuador), Kenton Fletcher (Grenada), Kenset Rosales Riveiro (Guatemala), Carlos Roberto Izaguirre Velásquez (Honduras), Marvette Brown (Jamaica), Arturo Flores (Mexico), Augusto Flores (Nicaragua), Roberto Bonilla De La Lastra (Panama), Luz Marina Coronel de Casco (Paraguay), Julio Diaz Palacios (Peru), Jeanel Volney (Saint Lucia), Hayden Romano (Trinidad and Tobago).

Representatives from Statistical Offices: Norka Tapia (Bolivia), Elena Rodríguez Yate (Colombia), Fabio Herrera Ocampo (Costa Rica), Evelyn Martínez Mendoza (Cuba), Christian Cando (Ecuador), Cristofer Maruc Muñoz Aguilar (El Salvador), Janet Geoghagen-Martin (Jamaica), Carlos Guerrero Elemen (Mexico), Anjali Kisoensingh (Suriname).

GEO-6 Experts: Genoveva De Mahieu (Argentina), Gabriel Blanco (Argentina), Oswaldo Dos Santos Lucon (Brasil), Carlos De Mattos Scaramuzza (Brasil), Laura De Simone Borma (Brasil), Andres Guhl (Colombia), Gladys Hernández (Cuba), Héctor Antonio Tuy Yax (Guatemala), Amrikha Singh (Guyana), Ana Rosa Moreno (Mexico), César Rodríguez Ortega (Mexico), Graciela Raga Binimelis (Mexico), Emma Gaalaas Mullaney (USA), Elsa Patricia Galarza Contreras (Peru), Keisha Garcia (Trinidad and Tobago), Kalim U. Shah (Trinidad and Tobago), Donna-May Sakura-Lemessy (Trinidad and Tobago), Diego Martino (Uruguay).

GEO-6 Advisory Bodies: Paulo Eduardo Artaxo (SAP), María del Mar Viana (SAP), Sandra De Carlo (AMG), Rosario Gómez (AMG).

Delegates from Intergovernmental Agencies and International Organisations: Ligia Castro, Octavio Carrasquilla (CAF), Christa Castro Varela (CCAD), Birgit Altmann (CEPAL), Lars Gunnar Marklund (FAO), Gonzalo Pizarro (UNDP), Leisa Perch (PNUD), Agnes Soares da Silva (OPS), Marilyn Thompson Ramírez (OPS), Eric van Praag (GeoSUR/ESRI), Stephanie Alice Adrian (US Environmental Protection Agency), Andy Estep (Global Coral Reef Monitoring Network)

Key Findings and Policy Messages

Overall picture

The GEO-6 Regional Assessment for Latin America and the Caribbean (LAC) identifies the main environmental changes that have been observed in the region since GEO-5 (2012) and GEO LAC 3 (2010); and considers priorities for action within the overall framework of the new 2030 sustainability agenda. At the beginning of the GEO-6 process, governments of LAC and other key stakeholder groups (at the GEO REIN Conference held in Panama City in May 2015) identified a number of regional priorities that helped to shape the focus for assessing suitable response options for the region. These priorities included: impacts from climate change and natural hazards; biodiversity and ecosystem services; natural resources and tourism; economic development and sustainable consumption and production; health and environment; land use, land degradation and land planning; environmental governance; environmental information; and communication and public awareness.

The GEO-6 LAC report is structured into four chapters; the first two present the results of the assessment following the Drivers-Pressures-State-Impact-Responses (DPSIR) framework, focusing on 5 major environmental themes (Air, Freshwater, Oceans, Land, and Biodiversity). Chapter 3 evaluates policy progress made in key regional priority areas; reviews particular policy success stories; and assesses the enabling conditions for achieving the Sustainable Development Goals that include the natural environment as an important component/ consideration. Chapter 4 presents a set of regional scenarios, and thereby provides insights into some of the options available to decision-makers as they consider how to move the countries of the region onto more sustainable development pathways.

Key findings

LAC is a **biologically rich region** with a complex tapestry of political, social and natural contrasts. These contrasts are evident in the spectrum of the sizes of countries and economies; in the diversity of geographical and ecological features; and in the manners in which cultures continue to interact with the natural environment. Within the diversity and contrasts however, LAC economies continue to share a persistent, heavy reliance on primary products and natural resources, which account for approximately 50 per cent of all good exports. On the mainland, there has been an increase in the reliance on exports largely driven by extra-regional demands for commodities such as agricultural products (including soybean, coffee and meat) and mineral resources (ores and metals). These transformations are most prominent in South America, where there was an increase in exports from 24 to 40 per cent between 1990 and 2015. Additionally, in 2013, international tourism receipts were 45 per cent of total exports from the Caribbean region, more than twice the amount earned by Mesoamerica, and 9 times greater than South America.

Urban areas continue to grow in LAC. Urban population increased by more than 35 million people between 2010 and 2015, and is expected to climb to a total of 567 million persons by 2025. Urbanization is highest in South America, with an estimated 346 million people (83 per cent of the population) living in urban areas in 2015. However, the rate of urbanization is fastest in the Caribbean where 62 per cent of the population resided in urban areas at the start of the millennium, increasing to 70 per cent in 2015 and projected to reach 75 per cent in 2025. In most cases, the concentrations of people as well as the patterns of production associated with urbanization exacerbate environmental degradation.

Air quality in cities has declined, and in most cities where data are available, the concentrations of particulate matter and ozone are above the WHO guidelines. This increases the vulnerability of urban dwellers to respiratory diseases;

and more than 100 million people in the region live in areas susceptible to air pollution. Moreover, the impacts of cities are not restricted to the urban areas. According to the World **Water Quality** Assessment (UNEP 2016), it is estimated that 25 million rural people are in contact with polluted surface waters originating from urban areas. This increases health risks and mortality rates in rural areas.

LAC currently accounts for only 5 per cent of global **GHG emissions;** however the region's contribution to global aggregates is growing, particularly because of demands from the transport and industry sectors. According to World Bank (2015), carbon dioxide emissions from the burning of fossil fuels and the manufacture of cement in LAC increased in absolute terms (+14.18 per cent) over the period 2006 to 2011, although their levels as a proportion of GDP have declined. Reducing emissions of greenhouse gases with long residence time in the atmosphere is considered an important challenge in LAC; and contaminants such as black carbon are now a priority because of their radiative forcing action on the climate system.

While **climate mitigation** must be a key component of strategies to combat climate change in LAC, the urgency of strengthening **adaptation measures** to increase resilience and lower the region's vulnerability cannot be ignored. The scenarios analysis indicates that LAC is likely to continue to be the region with lowest carbon content of any regional energy mix through to 2050. However, current data are showing that the region's systems are already under pressure from changes in global climate, and these trends are expected to worsen. Andean glaciers, which provide vital water resources for millions of people, are shrinking; extreme stream flow is affecting communities; and an increase in the intensity and frequency of extreme weather events are affecting economies. In the Caribbean Basin, climate change contributes an additional USD 1.4 billion to Average Annual Loss based on wind damage alone. In addition, climate change exacerbates many other driving forces and therefore amplifies environmental and related socio-economic impacts.

As a result of the range and growing intensity of many driving forces, important **ecosystems** and ecological processes in the region continue to be affected. Data indicate that although the rate of conversion of natural systems has begun to slow, the overall rate of loss of ecosystems remains high. Forests have shown an overall decrease of 9.5 per cent across the region since 1990, however this regional aggregate masks a noteworthy area of success - in the Caribbean, there has been an increase in the extent of forested area by 43 per cent over the 1990 baseline. Average coral cover is estimated to have declined in the Caribbean from 34.8 per cent to 16.3 per cent between 1970 and 2011. Species continue to be lost across LAC, and what is of particular concern is that where losses are occurring, the rate at which they are happening is, more often than not, increasing. Human-induced water erosion has been reported to affect as many as 2.23 million square kilometres of land in LAC, and river networks transport these sediments and other land-based sources of pollution to the oceans, impacting coastal ecosystems. The World's Water Quality Assessment (2016) states that about one-quarter of all river stretches in LAC are in the severe pollution class; and the number of rural people coming into contact with polluted surface waters is estimated to be as high as 25 million.

The future of the region's economies, as well as the ability of LAC countries to fight poverty and reverse inequality, depends heavily on the region's **natural capital** and the capacity of governments to effectively manage it. Although there are noteworthy successes in the region's efforts to manage its natural asset base (e.g. between 1990 and 2014 the total terrestrial area under protection in the region increased from 8.8 per cent to 23.4 per cent); and LAC has made some important progress in addressing a number of high-priority socio-economic concerns (e.g. the percentage of people living below the poverty line decreased from 31 per cent in 2010 to 26 per cent in 2014; during the past 15 years, the percentage of people living in slums decreased from 29 to 20 per cent; and the number of people with improved access to water and sanitation has increased), the data in this report indicate that progress is likely taking place at the expense of the natural environment in many cases. Whether driven by

the demands of a growing population; fuelled by economic factors within or outside of LAC; or facilitated by the absence of effective governance structures, it is generally accepted that patterns of production and consumption within the region are currently unsustainable. These trends need to be addressed with urgency if LAC is to secure the well-being of its growing population.

In the context of the persistent challenges presented by the environment-development nexus, the Sustainable Development Goals, adopted by world leaders in September 2015, are considered an important opportunity by the governments of LAC as they go forward. The SDGs and the associated 2030 Agenda for Sustainable Development landscape have a unique, interconnected nature which offers a more robust framework for the region's governments to identify key policy entry points and responses that will allow very specific actions with associated synergies, and consequently offer multiple benefits for environment and society. In this regard, there are a few important issues that Governments and other stakeholders in LAC may wish to consider.

Firstly, Governments will likely need to find innovative solutions to allow for the **decoupling** of economic growth and resource consumption. This will be critical for attending to many of the persistent anthropogenic activities that are driving environmental change. Current patterns of development, including production and consumption are, in many cases, unsustainable; and with future anticipated increases in population size, it will be necessary to ensure that needs can be met with minimal damage to the natural environment. Reducing dependence on fossil fuels, and diversifying energy sources, will also be important for countries of the region. One such area where this type of thinking would be critical is in the context of urbanization: cities provide the opportunity to improve access to health and education services, cultural facilities, and transportation. Investment in urban planning, such as through the better use of environmentally sound infrastructure and clean transport, can turn the urban challenge into opportunities for sustainable development in LAC.

The **scenarios** indicate that focusing on measures that ensure greater protection of the natural environment will not compromise economies or human well-being in adverse ways. Though some trade-offs may be necessary, issues such as poverty and health may be better managed where emphasis is placed on effectively managing environmental assets. Many governments of the region have engaged in some aspect of 'green economics' or green growth' and there are emerging strategies amongst countries to ensure a coordinated approach. Efforts such as these should be promoted and supported.

Governments of the region also likely need to invest in **ecosystem-based resilience** in order to reduce vulnerability and increase adaptation. Better investments in ecological infrastructure and implementation of measures to reduce pollution and other environmental pressures will help to safeguard some of the region's precious ecosystems and their services. This is especially important in the context of adapting to a changing climate, which is anticipated to have widespread and adverse impacts in the region.

The use of a range of policy support tools, mechanisms and approaches should help to boost regional success in addressing environmental changes and meeting the SDGs. Some of these include education and communication; the development of strategic partnerships especially within the region, but also beyond; innovation; proper monitoring and evaluation; effective implementation of policies and enforcement of laws; and adequate financing. As a core consideration of the sustainability agenda, governments of the region have also recognised the importance of improving the information base upon which environmental decisions are made. Greater investments into research, and building the necessary capacity for collecting and applying data to strengthen the science-policy interface, must therefore be a priority for the region.

Governments also have the opportunity to build on progress made in participation with various sectors of society, from the **business sector to local and indigenous groups.** Civil society has played a key role in the past decades by placing environmental concerns high on the political agenda. The challenge for governments is to integrate these viewpoints in an effective way, moving from informative participation to a more productive dialogue that results in integrated planning and result-based management.

Stronger and focused **intergovernmental coordination** at the regional and sub-regional level will improve governance issues that are of regional priority. Understanding and action in areas such as data and information generation, climate change adaptation, water resource management, environment and health, sustainable production and consumption, and management of biodiversity will be strengthened with regional coordination.

The Latin America and the Caribbean region recognises the tremendous merit that is inherent in the overarching theme of GEO-6 'Healthy Planet, Healthy People'. At the Twentieth Meeting of the Forum of Ministers of LAC held in March 2016, governments of the region reaffirmed 'their commitment to comply with that stated in the 2030 Agenda for Sustainable Development, with the aim of eradicating poverty, protecting the environment and fostering inclusive, social and economic development in harmony with nature'. In keeping with this, a call was made 'to take coordinated and accelerated action at all levels to implement the environmental dimension of the 2030 Agenda for Sustainable Development, recognising the profound connections and the interdependent relationship that it has with the economic and social dimensions of sustainable development, in a balanced comprehensive manner, pursuant to our countries' policies and circumstances'. In this regard, the region can expect to see shifts in development pathways in the coming years that will put LAC countries further along the road to achieving greater sustainability, thus protecting the region's natural wealth.

Introduction

Welcome to the GEO-6 Regional Assessment for Latin America and the Caribbean (LAC). This assessment provides an objective evaluation and analysis designed to support environmental decision making.

Existing knowledge has been assessed to provide scientifically credible answers to policy-relevant questions (UNEP 2015). These questions include, but are not limited to:

- What is happening to the environment in Latin America and the Caribbean and why?
- What are the consequences for the environment and the human population of Latin America and the Caribbean?
- What is being done and how effective is it?
- What are the prospects for the environment in the future?
- What actions could be taken to achieve a more sustainable future?

This regional Global Environment Outlook (GEO) report, the fourth for Latin America and the Caribbean (with the previous GEO regional assessment for LAC published in 2010), places emphasis on identifying some of the most worrying and persistent threats to the region through an environmental lens, but also on the achievements, success stories and opportunities in the region. Overall, the GEO-6 experts involved in this assessment have focused on providing options for action that can help boost the region's success as it looks forward to meeting the 2030 Agenda for Sustainable Development.

The decision to undertake regional assessments was taken at the Global Intergovernmental and Multi-stakeholder Consultation in Berlin, October 21-23, 2014. Participants expressed that the sixth edition of the global GEO assessment should 'build on regional assessments' which would be conducted in similar fashion to the global GEO process (UNEP/IGMS.2 Rev.2).

Member States attending the first United Nations Environment Assembly (UNEA-1) in Nairobi, June 23 – 27, 2014, requested:

> *"the Executive Director, within the programme of work and budget, to undertake the preparation of the sixth Global Environment Outlook (GEO-6), supported by UNEP Live, with the scope, objectives and procedures of GEO-6 to be defined by a transparent global intergovernmental and multi-stakeholder consultation informed by document UNEP/EA.1/INF/14, resulting in a scientifically credible, peer-reviewed GEO-6 and its accompanying summary for policy makers, to be endorsed by the United Nations Environment Assembly no later than 2018"*

In addition, Member States also requested (UNEP/EA.1/10):

> *"the Executive Director to consult with all United Nations Environment Programme regions regarding their priorities to be taken up in the global assessment"*

Following this request, the regional priorities for Latin America and the Caribbean were established through the Regional Environmental Information Network (REIN) Conference for the LAC region held in Panama City, 4-8 May 2015. These regional priorities have been used to guide the analysis conducted in this regional assessment.

The regional assessment is structured in 4 main chapters:

- **Chapter 1** reviews the regional priorities established at the REIN conference and explains why each priority is of importance to the region;
- **Chapter 2** describes the state of the environment in the region around five key themes (air, water, oceans, land, biodiversity), analysing key environmental issues;
- **Chapter 3** assesses the policy responses to the mentioned environmental issues in the region;
- **Chapter 4** reviews future trends that can affect the regions environment in the future and analyses the actions needed for the region to achieve a more sustainable future.

The data underpinning the assessment can be found in UNEP Live (**uneplive.unep.org**). The full assessment is also available through UNEP Live as a pdf and eBook.

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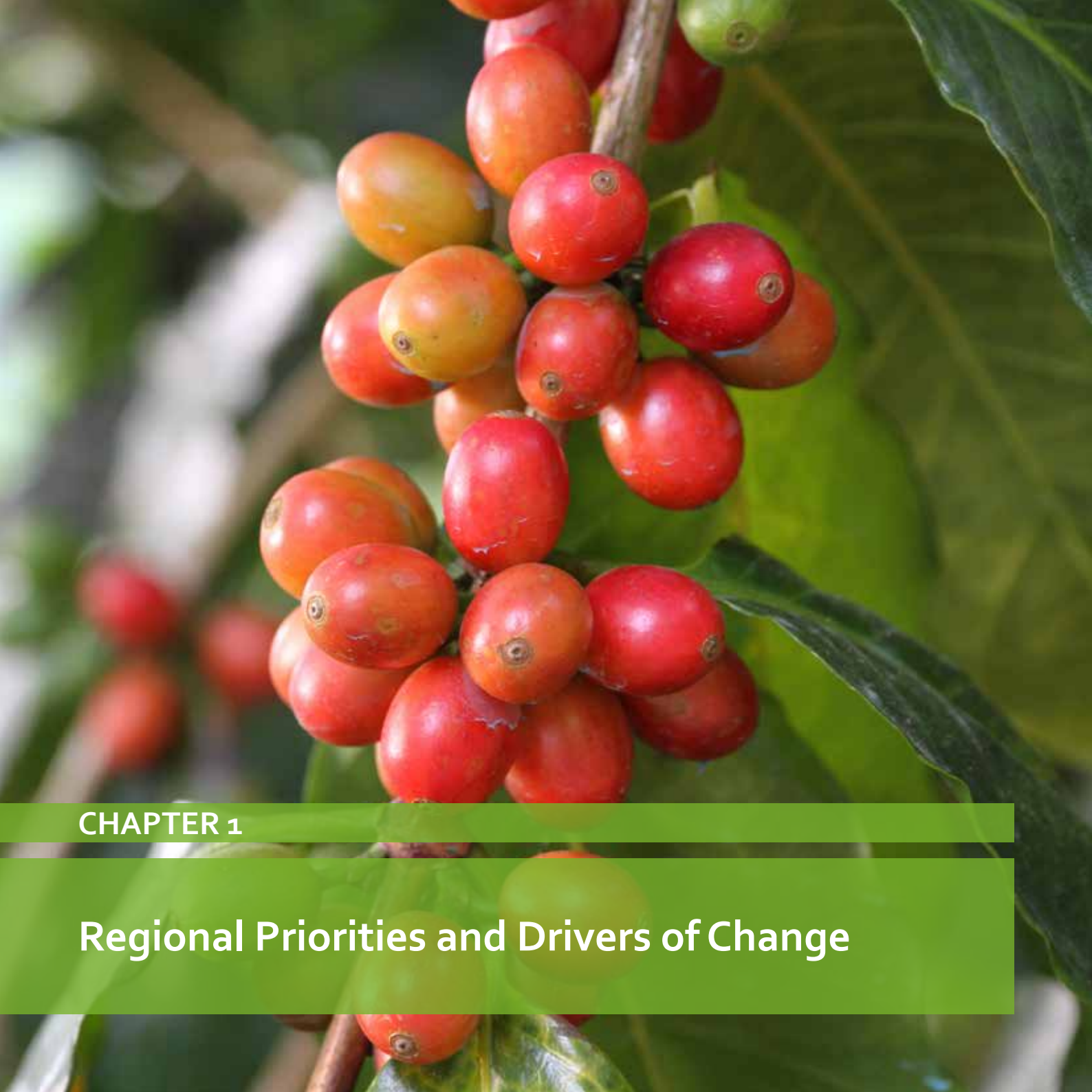

CHAPTER 1

Regional Priorities and Drivers of Change

1.1 The GEO-6 Regional Assessment for Latin America and the Caribbean: a call for action

The Latin American and the Caribbean (LAC) region has more than 5 million square kilometres of arable land; 20 per cent of the world´s proven oil reserves (Walter 2016); 23 per cent of the world's forest areas; between 60 and 70 per cent of all life forms on Earth; receives 29 per cent of the world's rainfall, and about 30 per cent of the world's renewable water resources, which also represent some 70 per cent of the entire American continent's reserves (FAO 2015a, FAO 2015b). The Caribbean, in particular, has an excellent recreational climate, which is vital in an age when travel tourism has become the world's largest and fastest-growing economic sector (IDB 2016).

The wide range of biodiversity, including ecosystems, and other assets such as minerals and land found in the region, offer opportunities and the potential to support livelihoods and a good quality of life to its population of over 600 million people at all scales well into the future.

Since the preparation of the last GEO LAC in 2010 (UNEP 2010a), population growth remains a strong driver for the region. LAC's population has increased by almost 50 million people during the last 6 years reaching 626 million in 2015. The process of urbanization continues with an increase in urban populations from 79 per cent in 2010 to 80 per cent in 2015 (UNECLAC 2015b). During the last ten years, 15 cities moved from small to medium size (from 52 in 2005 to 67 today); and 2 new names were added to the list of megacities in LAC: Bogotá and Lima (with 9.7 and 9.8 million inhabitants respectively). There was a decrease in the number of people living in slums from 117 million to 110 million between 2008 and 2014 (UN 2015). Additionally, 96.2 per cent of the urban population in LAC now has access to drinking water (compared to 92 per cent in 2006); and 86 per cent have access to improved sanitation services (compared to 78 per cent in 2006).

In general, despite the fact that Latin America and the Caribbean is still the region with the highest level of inequity in the world (around 0.5 Gini index), there is a clear trend towards poverty reduction. While in 2009 35.1 per cent of the total population in the region was living in poverty (17 per cent in extreme poverty), in only five years, that proportion was reduced to 26.7 per cent (UNECLAC 2013). However, as in other regions of the world, the overall GDP growth rate in LAC is slowing down, from 4.2 per cent in 2011 to 0.9 per cent in 2014 but with diverging developments across the region (World Bank 2015).

While there has been important progress across the region in achieving several of the targets set out under the Millennium Development Goals (UN 2015), it cannot be ignored that many of the region's environmental assets are under increasing pressure from multiple drivers of change, including climate change and endogenous and exogenous socio-economic factors. Failure to address these issues - such as the loss of critical ecosystems; increasing GHG emissions; species loss, and deterioration of natural sources of water, *inter alia* - will undermine the very basis upon which so much of the region's activity is dependent. This ultimately increases the vulnerability of the societies of Latin America and the Caribbean, and will likely have a profound impact on progressive economic and social growth in the future.

The recently adopted 2030 Agenda for Sustainable Development provides the countries of Latin America and the Caribbean with an opportunity to realign and strengthen their efforts to achieve greater prosperity in a more inclusive manner and within the capacity of the region's life support system. This process, initiated in 2000 by the Millennium Development Goals and transitioned to the Sustainable Development Goals in 2015, offers a new framework for the effective mainstreaming of environmental considerations into the economic and social dimensions of development. There is tremendous scope for governments to build on efforts already in place, given that there are many successful

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policies and actions that already exist in the region. Yet, what is now required is a shift in thinking to focus on those critical policy entry points and transformative actions that would attend to the most pressing driving forces and environmental pressures in an urgent and integrated way.

1.2 Regional Priorities

While there has been important progress across the LAC region in achieving several of the targets set out under the Millennium Development Goals, the tripartite relationship between sustained economic growth, social inequity and environmental degradation that has characterized the region over the last few decades, remains at the centre of regional development discourse (UNEP 2010a). LAC countries have begun capitalising on the opportunity provided by the Sustainable Development Goals to realign and strengthen their efforts to move towards more sustainable development pathways. The SDGs offer a new framework for the effective mainstreaming of environmental considerations into the economic and social dimensions of development. In the context of the 2030 Agenda, Governments of the region have individually and collectively identified a range of environmental issues that require urgent attention; and there is general congruence, as reflected in strategic development frameworks across the region, on the issues that should receive highest priority (UNEP 2016).

The regional priorities presented below build upon the priority issues identified by regional government representatives and stakeholders at the GEO REIN Conference held in Panama City in May 2015: a) Impacts from climate change and natural hazards, b) Biodiversity and ecosystem services, c) Natural resources and tourism, d) Economic development and Sustainable Consumption and Production, e) Health and environment, f) Land use, land degradation and land planning, g) Environmental governance, h) Environmental information, and i) Communication and public awareness. They also reflect the regional priorities identified through several regional platforms - the Small Island Developing States (SAMOA Pathway); the Caribbean Community, CARICOM (2015-2019 Strategic Plan); OAS (2015-2030 Inter-American Program on Sustainable Development); CCAD (2015-2020 Regional Environmental Framework Strategy); Andean Community (2012-2016 Andean Environmental Agenda); Amazon Cooperation Treaty Organization (Amazonian Strategic Cooperation Agenda); Forum of Ministers of Environment of LAC, and MERCOSUR Working Group Nr. 6 on Environment. Last, but not least, they take into account the various aspects of the environmental dimension of the SDGs. The priorities have been grouped in six main focal areas which respond to the main topics covered throughout this assessment: climate change, water resource management, sustainable management of natural resources, environment and health, sustainable consumption and production, and good governance.

1.2.1 Climate change

Climate change remains high on the agenda of every government in LAC because of the impacts that are expected on national economies of the region and the well-being of communities (**Figure 1.2.1**). Some of the effects of climate change in LAC will include water stress due to reductions in water availability; loss of low-lying areas on account of sea level rise; increased risk of environmental disasters (hurricanes and storms, flooding and droughts); changes in agricultural productivity, loss of biodiversity, and increased incidence of vector- borne diseases.

Effective climate-change policies will depend on the level of transboundary cooperation between countries and the deployment of economic incentive instruments. The current divergence of policies among countries and the lack of regional coordination can hinder efforts, where the impact of the innovations of one country may be diminished by policies of other nations. Policy priorities for the region might consider including cooperation in designing climate-change policies. The other critical intervention point is the need for more effective implementation of policies at the national and sub-national levels.

Figure 1.2.1: Some examples of the impacts of climate change in Latin America.

Source: CDKN 2014a; CDKN 2014b

Reducing the vulnerability of the region to climate change impacts will require robust adaptation policies and strategies. Particularly in the context of adaptation, policy development needs to be adjusted to the challenges of growing urbanization. Focus must also be placed on the high-risk coastal communities, particularly in the Caribbean, that will be affected by sea level rise and extreme weather events. Climate adaptation policies also have to be cross-cutting to address nexus issues such as the water-energy-food nexus. In addition ecosystem-based adaptation could help maintain and improve ecosystem integrity and at the same time reduce economic and social vulnerability.

In the context of climate mitigation policies, while the region accounts for only 5 per cent of global GHG emissions, many countries have been leading the formulation of global mitigation strategies (see for instance the policy responses in Sections 2.1.5 and 2.4.5, or Section 3.2.6). Two policy areas could advance LAC's climate change mitigation goals and support economic growth: reducing energy subsidies and improving energy efficiency. Further, policies that promote clean technologies and facilitate more diversified low-carbon economies can, over time, greatly improve environmental quality.

1.2.2 Water resources management

LAC's economy and social development depend largely on natural resources, particularly on water. Being one of the most water-rich areas of the world, management of demand from different sectors was until recently on the background of water governance. But given the increasing pressure from population and economic growth and the influence of climate change, governments, private sector and civil society have acknowledged the need for integrated approaches to water management. Governments of the region are important advocates of water protection issues in the framework of the United Nations (Sustainable Development Goals, the Human Right to Water and Sanitation, the Samoa Pathway), at regional level (LAC's Initiative for Sustainable Development – ILAC) and at national level (governance approaches recognizing rights of nature, implementation of water accounting, etc.).

Nevertheless, there is still a long way to go. Addressing the challenges of water management is complex considering its cross-cutting nature. Water cannot be decoupled from energy generation and food production. Similarly, water cannot be decoupled from climate change and health. Finally, water is an important source of jobs and thus key to sustain livelihoods.

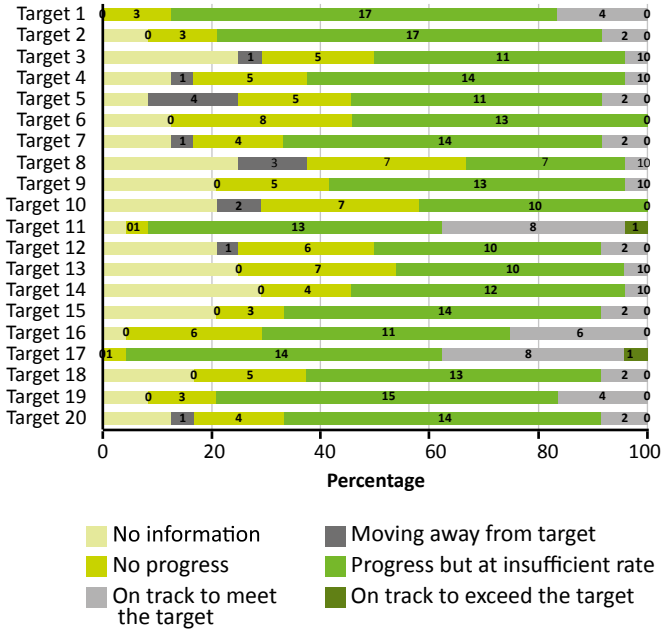
1.2.3 Sustainable management of biological resources

The wide diversity of ecosystems in LAC provides critical services to support economic development and ensure a good quality of life. Approximately one quarter of the tropical forests in the world are found in LAC, and they contribute significantly to the regulation of the global climate. The region also provides several other biodiversity-related services including food, freshwater, tourism and fisheries.

Yet, the biodiversity of the region continues to be threatened, putting many ecosystems and species at risk. Unsustainable patterns of production and consumption and global demand for food and raw materials continue to place growing pressures on the region's ecosystems. Land use change continues to be the greatest threat, with natural habitats converted to agricultural lands being a key pressure. Other pressures such as pollution, overharvesting, climate change, unsustainable tourism, and alien invasive species continue to exacerbate already stressed systems.

Data shows that, although the rate of conversion of natural systems has begun to slow, the overall rate of loss of ecosystems remains high (see Sections 2.4.3 and 2.5.3). Pockets of success, such as increasing forested areas such as in the Caribbean, halting the rate of forest loss across the entire region and protecting threatened species continue to be masked by deterioration of biodiversity in many other

Figure 1.2.2: Assessment of progress towards the Aichi Biodiversity Targets based on information in the fifth national reports for Latin America and the Caribbean countries.



Note: a list of the Aichi targets and related descriptions is available at https://www.cbd.int/sp/targets/

Source: UNEP-WCMC *in press*

respects. In the case of species, what is of particular concern is that where losses continue to occur, the rate at which they are happening is, more often than not, increasing. The continued loss of LAC's biodiversity is set to have far reaching consequences.

The region has demonstrated leadership and shown success in meeting some of the targets under the Millennium Development Goal 7 (MDG 7), and in advancing towards meeting the Aichi Biodiversity Targets (**Figure 1.2.2**), but more progress is needed. At the national level, successful interventions have included the development of new or improved legislation, mobilization of additional resources for biodiversity protection, enhanced dialogue among the stakeholders in biodiversity governance, and the implementation of a variety of policy support tools. Twenty three governments of the region are now members of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), established in 2012. Effective mainstreaming of biodiversity considerations into development planning, and the more effective use of biodiversity management and policy support tools such as protected areas, natural capital accounting and payments for ecosystem services, *inter alia*, will help in efforts to ensure more sustainable use of the region's biological resources – both on land and in the marine environment.

1.2.4 Environment and health

GEO-6 has adopted the theme 'Healthy Planet, Healthy People', which recognises the strong links between environment and human health. Air pollution is the largest environmental threat to public health in the region. An estimated 100 million people in the region live in areas susceptible to air pollution, mostly in highly populated areas of cities with more than 500 000 inhabitants (Romieu *et al*. 2012). In most cities exposure to $PM_{2.5}$ exceeds the international recommended standards (Green and Sanchez 2012), and many deaths occur on account of diseases related to air pollution (WHO 2014c). Although many countries and cities in LAC have set official air quality standards to protect health, many others, including some of the small island developing states (SIDS) in the region, still lack such legislated standards.

Between 1992 and 2012, access to drinking water in Latin America increased from 86 to 92 per cent, while basic sanitation increased from 70 per cent to 78 per cent. The MDG 7 target on sanitation has not been met, especially in rural areas, and the risk of exposure to waterborne diseases, especially amongst vulnerable members of the population, is ever-present (CCSP 2008). There are also important impacts on health from deforestation, particularly related to the spread of malaria. Deforestation, as well as infrastructure

development, exacerbate other tropical diseases such as leishmaniosis (WHO 2015). Recent outbreaks of the Zika virus are causing significant health effects among new-borns.

1.2.5 Sustainable Consumption and Production

Patterns of production and consumption within the region have been placing growing stress on the region's natural capital, as outlined in later sections of this report. Sustainable Consumption and Production (SCP) has thus become an important area in the sustainability agendas of LAC countries.

The LAC region has been firmly committed to the implementation of the 10 Year Framework of Programmes on Sustainable Consumption and Production (10YFP): SCP is seen as "an important approach to mitigate the effects of desertification and climate change, and to contribute to the conservation of biodiversity, and other global and regional environmental priorities". The Regional SCP Strategy, developed in 2003, has been revised and updated in the context of the 10YFP (UNEP 2015b); it also integrates the decisions of the Forum of Ministers of Environment of LAC, and the recently adopted Sustainable Development Goals (SDGs).

During the XVII Meeting of the Forum of Ministers of Environment for LAC, the ministers stated in their Decision number 5 their willingness to: "support the implementation of the priority areas of SCP [...]" and initially include *inter alia* the following priority themes:

- National SCP policies, programmes and strategies;
- Small and medium enterprises;
- Sustainable public procurement; and
- Sustainable lifestyles.

Subsequently Decision number 7 of the XIX Meeting of the Forum, the ministers recalled the 4 priorities mentioned above and reiterated "... the commitment of the Latin American and the Caribbean Region to support the 10YFP and to maintain a leading role in its implementation". In the same Decision the ministers stressed the importance and commitment to "foster additional programmes for the 10 YPF on integrated sustainable waste management" and "request the consideration of an additional programme [...] for Small and Medium Enterprises (SMEs)".

Accordingly, the Ministers of the Environment of the LAC region approved the following nine thematic and sectoral priorities for the Regional Strategy on SCP for the 10YFP implementation in Latin America and the Caribbean (2015-2022). These include:

- National SCP policies, programmes and strategies
- Sustainable public procurement
- Sustainable lifestyles and education
- Consumer information
- Sustainable tourism, including ecotourism
- Sustainable buildings and construction
- Sustainable food systems
- Small and Medium Enterprises (SME)
- Integrated waste management

1.2.6 Good governance

The Report of the United Nations Secretary General's High-Level Panel on Global Sustainability on Strengthening Institutional Governance noted that: *"To achieve sustainable development, we need to build an effective framework of institutions and decision-making processes at the local, national, regional and global levels. We must overcome the legacy of fragmented institutions established around single-issue "silos"; deficits of both leadership and political space; lack of flexibility in adapting to new kinds of challenges and crises; and a frequent failure to anticipate and plan both challenges and opportunities - all of which undermine both policymaking and delivery on the ground."*

Despite the progress made in the region in terms of environmental governance, some critical gaps remain at the country level for several countries in the region, which

will require priority action. For many countries, especially the SIDS, environment negotiations are conducted by environment ministries which may be poorly coordinated with the ministries in charge of foreign affairs, finance and development planning which in turn may not be receptive to commitments made by environment ministries at negotiating tables; there remain deficiencies in the legal authority and institutional capacity needed for implementation and enforcement. These often result from the lack of or outdated regulatory legislative frameworks, as well as legislative uncertainties (UNEP 2012).

There remains the need for information at all levels for sound policy making. This was recognised in Agenda 21 chapter 40 and has been reiterated in subsequent international agreements on sustainable development. It is now especially the case with the adoption of the 2030 Agenda for Sustainable Development which calls for a 'data revolution' going forward. It has been acknowledged that considerable data already exist, in public and private sectors, in universities, think-tanks and community groups. The perpetual challenge remains in developing improved mechanisms for coordination among environmental, demographic, social and developmental data and information activities. It also remains a challenge that within the environment sector itself information is often scattered and disaggregated. This impacts monitoring, data collection, and assessment, which affect accountability, and result in insufficient review mechanisms that could create incentives for performance and early action.

Mechanisms for effective participation by all the relevant stakeholders in policy development and decision making, especially by the marginalised, socially excluded and disadvantaged groups, are still more an exception than the rule. If this is rectified it could strengthen environmental management.

Environmental governance is also negatively affected by corruption, and the cost of corruption or mismanagement of public resources can be very high. Transparency International estimates that damage from corruption normally ranges from 10 to 25 per cent of the contract value worldwide. The impact of corruption can be significant considering that public procurement transactions represent up to 20 per cent of GDP in LAC (OECD/IDB 2014).

1.3 Drivers of Environmental Change

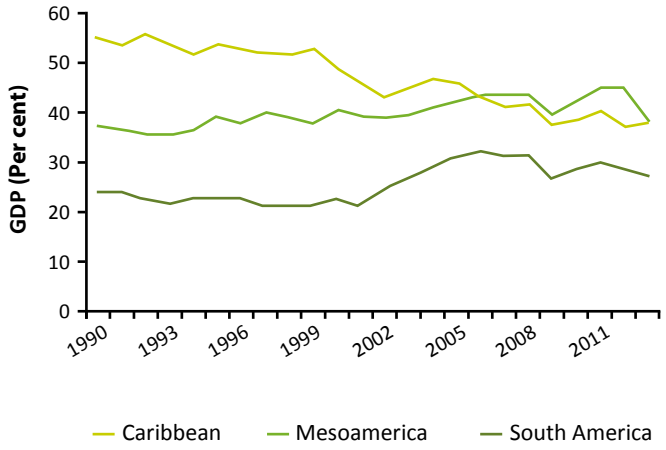
The overarching economic trends discussed below demonstrate the dependency that LAC countries' economies have on natural resources. On the other hand, the global financial crisis has been a critical driving factor in the region in that reduced financial flows have the potential to impact how the region responds to environmental degradation as well as reducing the total amount of financial resources available to environmental programming.

1.3.1 Economic trends

The export industries in LAC are based mainly on the use of the region´s natural resources (UNCOMTRADE 2015). Exports of goods and services have changed their relative importance over recent decades in the region: for example two decades ago in the Caribbean such exports accounted for 60 per cent; in 2013 they were around 40 per cent. Such exports have increased slightly in Mesoamerica and South America, currently around 40 per cent and 30 per cent respectively, compared to 37 per cent and 24 per cent in 1990 (**Figure 1.3.1**).

In the Caribbean, tourism, which is dependent on natural resources and, as described in Chapter 2, can have a direct impact on them, is a key source of foreign exchange earnings, together with financial services. In 2013, international tourism receipts were 45 per cent of total exports from the region, more than twice the amount earned by Mesoamerica and 9 times greater than South America (WTO 2015). In some countries, the dependency ratio is even greater. For example, the earnings from tourism were more than 80 per cent of total services exports in the Bahamas and Saint Lucia, and more than 70 per cent in Aruba, the Dominican Republic, Grenada and Jamaica (IDB 2016).

Figure 1.3.1: Exports of goods and services (per cent of GDP).



Source: World Bank 2015

The economy of many South American countries still depends on natural resources, including the export of ores, metals, food and fossil fuels (UNCOMTRADE 2015) (**Table 1.3.1**). In 2014, food exports accounted for more than half of merchandise exports in six countries. In relation to fossil fuels, more than 50 per cent of exports from Colombia, Venezuela, Ecuador, Trinidad and Tobago and Bolivia were attributed to fuel (**More…1**).

Table 1.3.1: Source Markets for Exports from Latin America and the Caribbean (%) (2013).

Source Markets	Caribbean	Mesoamerica	South America
East Asia and Pacific	2.8	3.1	12.5
Europe and Central Asia	2.4	0.5	1.2
Latin America and the Caribbean	21.6	24.8	21.0
Middle East and North Africa	0.3	0.4	1.7
South Asia	0.7	0.9	2.9
Sub-Saharan Africa	3.0	1.9	0.8
North America	69.2	68.5	59.8

Source: World Bank 2015

LAC countries continue to produce goods with low levels of value-added and export markets remain very concentrated (UNCOMTRADE 2015). By and large, export markets are located in other LAC countries and North America (**More…2**).

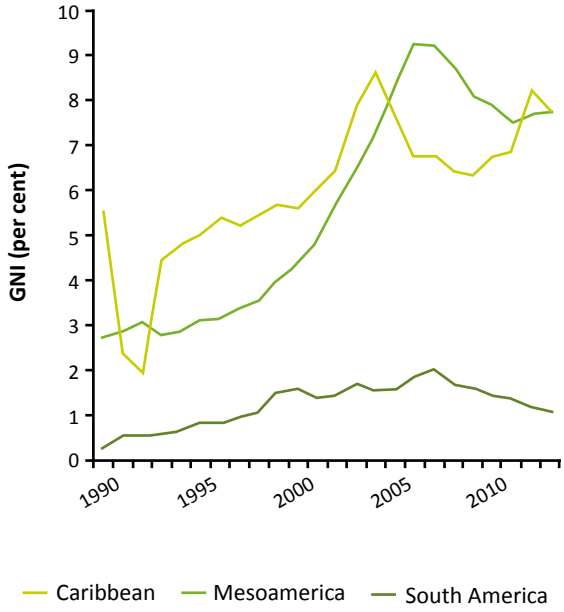
Many countries in the region are among the most indebted countries in the world. At the end of 2013, Caribbean countries had external debt stocks of approximately 165 per cent of exports of goods and services, while the figure for Mesoamerica was 130 per cent and just over 100 per cent for South America (World Bank 2015). Given these strained public finances, resources directed towards the protection of the environment are usually limited, or the first to be eliminated in times of crisis.

Some countries in the region have benefited from rising remittance inflows as well as foreign direct investment (FDI). These remittance flows can reduce poverty (Ratha 2013), and can also be catalyst for growth in the region (Nsiah and Fayissa 2013). In Mesoamerica and South America FDI inflows more than doubled during the period under review, while in the Caribbean FDI inflows were more than 2 percentage points higher than those witnessed by other LAC countries (**Figures 1.3.2 and 1.3.3**). These FDI and remittance flows, while helping to address issues related to poverty in the region, can also put pressure on the environment, as they tend to be aimed at industries that extract environmental assets, such as mining, quarrying and tourism.

1.3.2 Demography and other social drivers

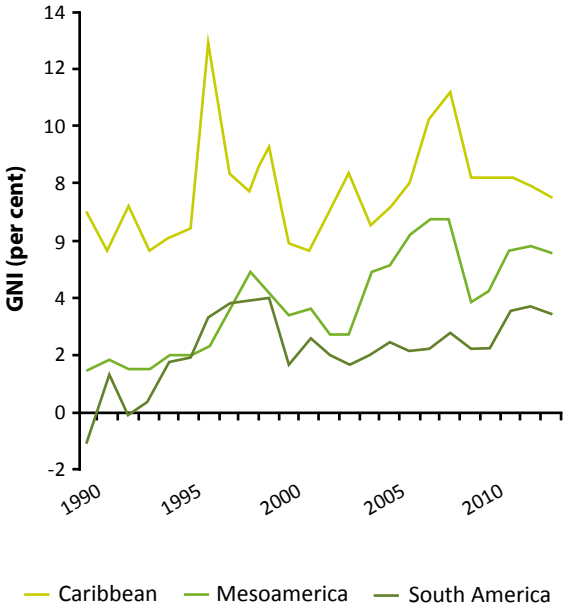
The population of LAC stood at 597 million in 2010 and has grown to 630 million by the end of 2015. Population growth rate is projected to decline gradually over the next decade, falling by 5.1 per cent between 2015 and 2020 and 4.4 per cent between 2020 and 2025 (UNDESA 2014). Associated with this growth is the ageing of the population in the region.

Figure 1.3.2: Remittance as percentage of gross national income (GNI) in Latin America and the Caribbean.



Source: World Bank 2015

Figure 1.3.3: FDI inflows as percentage of gross national income (GNI) in Latin America and the Caribbean.



Source: World Bank 2015

The median age increased from 24.3 years at the start of the millennium to 27.5 years in 2010, and is estimated to be 29.2 years in 2015 and 32.7 years by 2025. Related to this is the increase in life expectancy across the region. During 2000-2005, average life expectancy at birth was 72.7 years. Life expectancy at birth increased to 74.5 years during 2010-2015 and is projected to increase further to 76.8 during 2020-2025 (UNECLAC 2015b; PAHO 2015).

Furthermore, while it is noted that the region has realised gains in its human development index (UNDP 2014), it is faced with persistent concerns regarding inequality, which has the potential to affect crime rates, social cohesion and civic mindedness with associated impacts of poor societal responses to environmental management and sustainable resource use.

The critical driving forces relate primarily to the associated impacts of urbanisation and the fact that most of the LAC region's population now live in urban areas. This has associated impacts on the environment especially as it relates to waste and chemicals management, air quality, water consumption and land use change.

Urbanization

The population of LAC is increasingly urbanized; it went from mainly rural in the 1950s to 75 per cent in 2000 and has now gone over 80 per cent (UNECLAC 2015b). Projections are that it will reach 567 million people or 82 per cent of the population by 2025 (**Table 1.3.2**). Urbanization is highest in South America with an estimated 346 million people (83 per cent of the population) living in urban areas in 2015, but

the rate of urbanization is fastest in the Caribbean where 62 per cent of the population resided in urban areas at the start of the millennium, increasing to 70 per cent in 2015 and projected to reach 74 per cent in 2025 (UNDESA 2014).

The population of megacities in the region has grown from 59.2 million in 2000 to 66.4 million in 2015 and is projected to keep growing, reaching 76.1 million people in 2025. However, the share of the total population living in megacities has remained fairly stable at between 11.1 per cent and 11.2 per cent during 2000-2015. The percentage of the total population of LAC living in megacities is projected to fall marginally to 11 per cent in 2025 (UNDESA 2014). Despite the rapid rural to urban migration and the living conditions of many urban citizens, studies have shown that in Latin America, unlike North America for example, there is no difference in life satisfaction between residents of urban and rural areas (Valente and Berry 2016).

Although approximately 250 million urban citizens in LAC live in cities with more than 200 000 inhabitants, an important percentage live in small and medium sized cities, which receive much less attention and resources but face the same environmental challenges, are growing at faster rates and are absorbing most urban population growth (Libertun de Duren and Guerrero Compeán 2015). This has important governance implications that will be described in Chapter 3 of this report.

The urban growth described above has not been accompanied with adequate urban planning, especially in small and medium sized cities. As shown in Chapter 2, this concentration of population with lack of adequate planning, coupled with low or non-existent water treatment facilities and inadequate solid waste treatment has been placing increasing pressure on ecosystems, particularly on urban freshwater ecosystems and coastal areas.

The absolute number of people living in slums has remained hard to reduce, but the percentage of the total urban

Table 1.3.2: Urban and rural population distribution and projections (at midyear, in millions).

	2000 (% of population)	2005 (% of population)	2010 (% of population)	2015 (% of population)	2020 (% of population)	2025 (% of population)
LAC	526	563	597	630	662	691
Urban	396 (75 %)	433 (77 %)	468 (78 %)	503 (80 %)	536 (81 %)	567 (82 %)
Rural	130 (25 %)	130 (23 %)	129 (22 %)	127 (20 %)	126 (19 %)	124 (18 %)
Caribbean	39	40	42	43	44	46
Urban	24 (62 %)	26 (65 %)	28 (67 %)	30 (70 %)	32 (73 %)	34 (74 %)
Rural	15 (38 %	14 (35 %)	14 (33 %)	13 (30 %)	12 (27 %)	12 (26 %)
Mesoamerica	139	150	161	172	182	193
Urban	96 (69 %)	106 (71 %)	116 (72 %)	127 (74 %)	137 (75 %)	148 (77 %)
Rural	43 (31 %)	44 (29 %)	45 (28 %)	45 (26 %)	45 (25 %)	45 (23 %)
South America	349	372	394	415	434	452
Urban	277 (79 %)	301 (81 %)	324 (82 %)	346 (83 %)	366 (84 %)	385 (85 %)
Rural	72 (21 %)	71 (19 %)	70 (18 %)	69 (17 %)	68 (16 %)	67 (15 %)

Source: UNDESA 2014

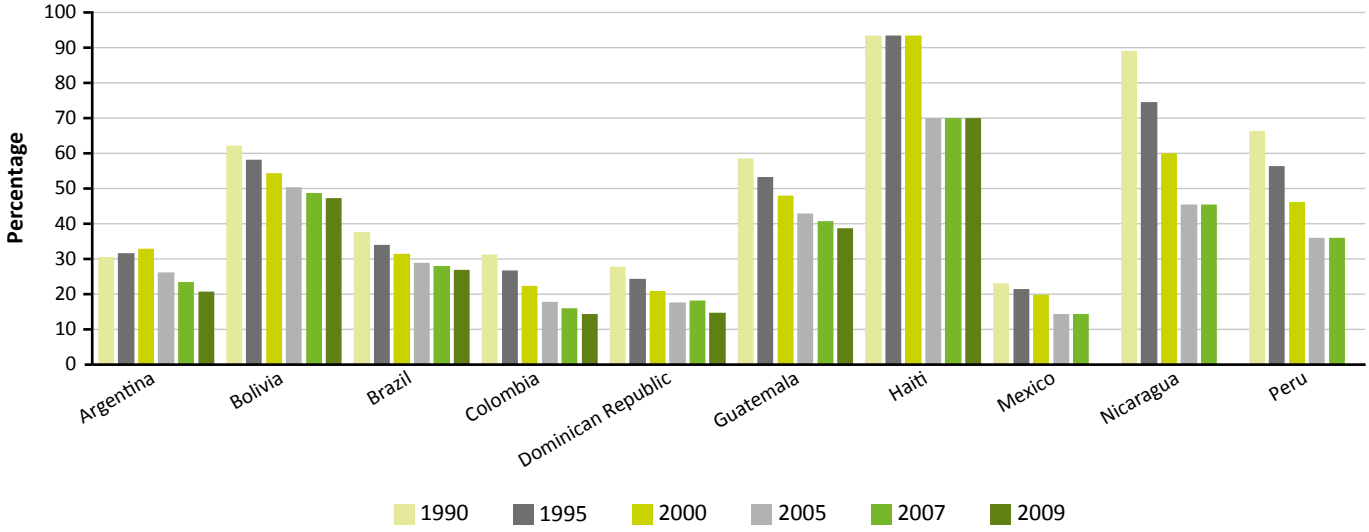
population living in slums in the early 1990s was 30 per cent (**Figure 1.3.4**). The figure has gone down to 29 per cent in 2000 and is currently close to 20 per cent (UN-Habitat 2013a).

Green areas play an important role for recreation, health, urban biodiversity and as regulators of urban water flows. Nine square meters of green area per capita is a useful indicator, but it provides incomplete information to assess their social and ecological value. At the same time, the distribution and size of these areas is important to assess their relevance for biodiversity conservation and water flow regulation. The actual use of green spaces by urban citizens depends on several other factors associated to location, accessibility, transportation, etc. For example, Parra *et al.* (2010) found that in Bogotá the use of parks by older adults was positively associated with areas with multiple uses. Martinez *et al.* (2016) point out that in the case of Curitiba almost 50 per cent of residents do not make use of these spaces due to lack of proximity. Moreover, they point out the unequal distribution of green spaces and their concentration close to high-income neighbourhoods.

Trends in Human Development

LAC is highly heterogeneous in terms of development, both between and within countries. According to the Human Development Report (UNDP 2014), countries in the region ranged from very high human development (e.g. Chile, ranked 42 in the Human Development Index 2013) to low human development (e.g. Haiti, ranked 168 out of a total of 187 countries included in the Human Development Index 2013). There are also sub-regional differences with 85 per cent of Caribbean countries and 64 per cent of South American countries categorized as high, and 50 per cent of Mesoamerican countries as medium. South American countries' average Human Development Index (HDI) rank is the highest at 81, followed closely by the Caribbean at 83. The lower performance of the Caribbean sub-region may be attributable to the global financial crisis inflicting a greater blow to these mostly small open economies, or as a result of disasters due to natural events as in the case of Haiti. Mesoamerica demonstrates the lowest average HDI rank at 99, above the median value of 94.

Figure 1.3.4: Proportion of urban population living in slums at midyear by country (1990-2009).



Source: UN-Habitat 2013a

The Gini indexes (a measure of income inequality) estimates elaborated by the World Bank (2015) for some LAC countries, as shown in **Table 1.3.3**, highlight that inequality is lowest in the Caribbean at an average of 43.0 and highest in Mesoamerican at 48.5.

1.3.3 Climate change as a key driver

The importance of climate change as a driver is that its causes and consequences are global. However, climate change also transfers risk, as many of the territories most affected are those that have contributed least to GHG emissions (UNISDR 2015).

Table 1.3.3: Gini index for some Latin America and the Caribbean Countries (World Bank estimate).

Country	2011	2012	2013	2014
Argentina	43.6	42.5	42.3	
Bolivia	46.3	46.7	48.1	
Brazil	53.1	52.7	52.9	49.7[1]
Chile	50.8		50.5	
Colombia	54.2	53.5	53.5	
Costa Rica	48.6	48.6	49.2	
Dominican Republic	47.4	45.7	47.1	
Ecuador	46.2	46.6	47.3	
Guatemala	52.4			
Honduras	57.4	57.4	53.7	
Haiti		60.8		
Mexico		48.1		
Panama	51.8	51.9	51.7	
Peru	45.5	45.1	44.7	
Paraguay	52.6	48.2	48.3	
El Salvador	42.4	41.8	43.5	
Uruguay	43.4	41.3	41.9	

Source: World Bank 2015

1 Data for Brazil in 2014 is from IBGE 2015.

Through changing air and seas temperatures, precipitation regimes and sea levels, among other factors, global climate change feeds back into changes in hazards and magnifies disaster risks. Climate change is already altering the frequency and intensity of many weather-related hazards (IPCC 2014), as well as steadily increasing the vulnerability and eroding the resilience of exposed populations that depend on arable land, access to water, and stable mean temperatures and rainfall (UNDP *et al.* 2013).

In most countries, climate change increases the Annual Average Loss (AAL[2]). For the Caribbean Basin as a whole, climate change contributes an additional USD 1 400 million to the expected AAL associated with wind damage alone, excluding changes in AAL associated with storm surge due to sea level rise (CIMNE and INGENIAR 2014). Given that Caribbean countries are collectively responsible for only a small proportion of global GHG emissions, the additional AAL of USD 1 400 million raises important questions regarding accountability for risk generation and who should pay for these additional losses.

Within the region, however, the effects of climate change are not evenly distributed. For example Trinidad and Tobago has a fivefold increase in the AAL due to climate change. In contrast, Mexico would actually see a reduction in AALs (UNISDR 2015).

1.3.4 Natural hazards

The LAC region is highly exposed to various types of natural hazards (UNECLAC 2014b). The main hazards are weather-related events, earthquakes, volcanic eruptions, tsunamis, and storms and hurricanes. Hydro-meteorological events associated with rain patterns or extreme events like the El Niño Southern Oscillation (ENSO), generate either

2 The Annual Average Loss is the average expected financial/budgetary loss annualized over a long time frame considering the range of loss scenarios related to different return periods. It represents the amount that countries would have to set aside each year to cover the cost of future disasters in the absence of insurance or other disaster risk financing mechanisms (UNISDR 2013 and 2015).

frequent floods or droughts and can also cause landslides and mass movements. The negative impacts of weather-related disasters erode the natural capital base of nations, reducing their overall wealth and competitiveness (UNISDR 2013). The UNECLAC Handbook for Disaster Assessment indicates that for the period 1970 to 2011 in all sub-regions (Caribbean, Mesoamerica and South America) meteorological and hydrological events were the main causes of disasters. Flooding was the main cause of disasters in South America, including Brazil, and Mesoamerica, while in the Caribbean and Mexico it was hurricanes, which were also the second-greatest cause of disasters in Mesoamerica (UNECLAC 2014b).

The areas most exposed to earthquakes and volcanic eruptions are the Pacific seaboards of Mesoamerica, Mexico and South America located in the 'ring of fire'. Between 1970 and 2011, about 10 per cent of disasters in the South American sub-region and 12 per cent in Mesoamerica were due to earthquakes and about 5 per cent to volcanic eruptions (**Table 1.3.4**). In Mexico, earthquakes were responsible for 12 per cent of geophysical disasters and volcanic eruptions for 4 per cent. Mass movements, landslides and earthquakes were mainly responsible for disasters of geophysical origin in South America, including Brazil (UNECLAC 2014b) (**Table 1.3.4**).

In South America disasters triggered by earthquakes impact mainly the social sector (60 per cent), rather than the productive sector (30 per cent) and infrastructure (10 per cent) (UNECLAC 2014b). In the case of extreme precipitation, on average similar impacts in the three sectors are produced (about 30 per cent). Droughts on the other hand impact mainly the productive sector (68 per cent) and floods and landslides mainly the social (48 per cent) and infrastructure (44 per cent) sectors.

Natural hazards can have such an impact on the environment that damages cannot be reversed and recuperation of the ecosystem is not possible. However, a healthy and intact environment can reduce the impact of a natural hazard. The impact can be worse if the environment is degraded. Environmental degradation, deforestation and overexploitation of natural resources all result in increased risks to natural capital (UNISDR 2015).

Table 1.3.4: The Americas, disasters by region and originating event type, 1970-2011 (%).

	Threat	Mexico	Mesoamerica	Caribbean	South America
Geological	Earthquakes	12.2	11.5	2.4	9.8
	Mass movements	5.1	4.4	1.2	13.4
	Volcanic eruptions	4.1	5.2	2	3.7
	Total	21.4	21.1	5.6	26.9
Meteorological and hydrological	Hurricanes and storms	38.1	23	57.9	8.1
	Floods	27.9	38.3	27.6	45.9
	Droughts	3.6	7.1	4.9	5.7
	Extreme temperatures	7.6	1.4	0.0	5.0
	Total	77.2	69.8	90.4	64.7
Biological	Epidemics and plagues	1.5	9.3	3.9	8.4
	Total	100	100	100	100

Source: UNECE 2014

In March 2015, the Sendai Framework for Disaster Risk Reduction 2015-2030, the successor of the Hyogo Framework for Action, was adopted. In this framework, the scope of disaster risk reduction has been broadened significantly to focus on both natural and man-made hazards and related environmental, technological and biological hazards and risks. Health resilience is strongly promoted throughout. Priority Action three suggests, among others, to strengthen the sustainable use and management of ecosystems and implement integrated environmental and natural resource management approaches that incorporate disaster risk reduction.

1.3.5 Scientific and technological innovation for sustainable development

Many countries in LAC have acknowledged that science and technology is critical for ensuring sustained economic growth and development. It has also been shown that there are correlations between research and development spending and innovation, productivity and per person income. This is even more evident in the environmental field where the deployment of technologies in the energy and water sector has realised gains in resource efficiency leading not only to improved environmental performance but also to increased competitiveness for the private sector. Further, in the lead up to Rio +20, it was suggested that the LAC region should develop economic potential in biotechnology, building on gains realized by Cuba, Argentina, Brazil, Mexico, Colombia, and to a smaller extent, Jamaica (UNECLAC 2012).

However, concern remains that the LAC region is falling behind most of the international benchmarks relating to development of a critical mass of human resources adequately skilled and specialised in science, technology and innovation. In fact, given the size of the region's economies, there are relatively fewer scientists, researchers, technicians and engineers in LAC, and the investment in research and development has been trailing behind other economies. It is also of concern that the region's allocation is below 2 per cent of GDP, well behind developed countries with between 2 and 10 per cent of GDP being spent on research and development and science and technology.

1.3.6 Institutional and governance frameworks

In the more than twenty years since the Rio Declaration, there has been progress in the region with the development of appropriate legislation, policies, institutions and personnel to address the issues related to environmental governance (UNECLAC 2011). While these efforts have been laudable, there are persistent challenges to progress including:

- Adequate and consistent financing;
- Coordination of responsibilities among various ministries and departments;
- Enforcement of legal frameworks and development of standards;
- Enhanced integration of environmental issues into national planning and development; and
- Consistent and enhanced participation in decision making of civil society and major groups.

Over the years there have been many initiatives, mechanisms and platforms to address some of these challenges, mainly through regional approaches and interventions leading to enhanced cooperation and collaboration on environmental issues. This is critical in ensuring that attention is paid to transboundary matters and to ensuring that the region can benefit from best practices and exchange of experiences. The multilateral environmental agreements have been instrumental in this regard and will be elaborated in Chapter 2. The major regional platforms for collaboration on environment and sustainable development issues are summarized in (**More…3**).

In addition to the political mechanisms there are opportunities through the development banks (**More…4**), the multilateral trading system and regional organizations to address specific environmental issues as well as persistent gaps and challenges.

With regard to economic partnerships, there has been an emergence of the inclusion of environmental provisions into Regional Trade Agreements (RTAs) internationally and some of that is occurring within LAC. Environmental cooperation mechanisms are usually contained in the RTAs and address issues such as capacity building, standards, and mechanisms for public participation. While there is a significant debate on the benefits of such provisions to the region, there are potential benefits to be accrued including strengthened national environmental enforcement, capacity building, enhanced environmental standards and enhanced regional cooperation. Prominent examples include the Mercosur Framework Agreement for Environment, where parties undertake cooperation on harmonization on environmental standards and the Forum of the Caribbean Group of African, Caribbean and Pacific States CARIFORUM-EU Economic Partnership Agreement, which focuses on developing environmental capacity in the CARIFORUM region to enhance international trade. It should be mentioned that some countries are also utilising this measure in bilateral trade agreements for example the United States-Peru Free Trade Agreement (PTPA) signed in 2009 incorporates provisions concerning the protection of the environment, enforces own domestic environmental laws. The Environment Chapter includes an Annex on Forest Sector Governance and includes provisions recognizing the importance of conserving and protecting biodiversity.

Also of significance to the region is that following the United Nations Conference on Sustainable Development (Rio+20), held in Rio de Janeiro in June 2012, the Declaration on the application of Principle 10 of the Rio Declaration on Environment and Development in Latin America and the Caribbean was adopted. This declaration calls for signatory countries, with technical support from the Economic Commission for Latin America and the Caribbean (UNECLAC), to advance the implementation of a regional agreement enabling rights of access to information, public participation and access to justice in environmental matters.

The Declaration currently has 20 signatory countries[3] and is open to all countries of LAC. This instrument can be used as a critical tool in ensuring participation at all levels (regional, national and local) in the environmental governance process.

1.4 Multiple national approaches to Sustainable Development

The Rio+20 outcome recognized the existence of a number of "different approaches, visions, models and tools available to each country, in accordance with its national circumstances and priorities, to achieve sustainable development" (UN 2012). The 2030 Agenda for Sustainable Development builds on this concept recognizing that "targets are defined as aspirational and global, with each government setting its own national targets guided by the global level of ambition but taking into account national circumstances" (UNGA 2015).

LAC countries are as diverse in terms of their national priorities as they are in their approaches to development. An analysis of the visions of Argentina, Bolivia, Cuba, Ecuador, Nicaragua, and Venezuela (UNEP 2013a) and the recently issued "Multiple Pathways to Sustainable Development: Initial findings from the Global South" (UNEP 2015c) show that each national sustainable development approach emphasize different things and have different conceptual underpinnings. However, the goals to which these approaches ultimately aspire are universal.

A multiplicity of sustainable development approaches exists as countries develop their own responses to their unique challenges. Market-based approaches place human well-being and sustainability at the centre of the economy, challenging the way it is configured by using mechanisms to address policy, governance, and market failures. Ethics-based concepts, such as 'Living Well', define principles to

3 The signatories are Mexico, Guatemala, El Salvador, Costa Rica, Panama, Colombia, Ecuador, Peru, Bolivia, Chile, Argentina, Uruguay, Paraguay, Brazil, Honduras, Saint Vincent and the Grenadines, Trinidad and Tobago, Antigua and Barbuda, Dominican Republic, and Jamaica.

guide our relationship with nature and firmly root it in our collective value system. Both approaches recognize that there are many cases where economics cannot capture the intrinsic value of nature or culture and, therefore, could be seen as complementary.

In the LAC region, nearly all countries acknowledge the critical role of nature and ecosystems in their development plans and the subsequent need to preserve them. Another important common feature is the recognition of the essential role of the state to ensure government leadership for developing and enforcing the necessary regulatory frameworks and incentives to promote environmental protection, economic advancement and social equity. The one common element that unites all of these approaches is that "they all see sustainable development as much more than simply economic growth in the traditional sense, and they all place paramount importance on increased well-being, equitable (re)distribution of wealth, and the health of the environment" (UNEP 2015c).

See references for Chapter 1.

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CHAPTER 2

State and Trends

All of the GEO-6 regional assessments follow the traditional Drivers, Pressures, State, Impacts and Response (DPSIR) assessment framework; however, each integrated environmental assessment considers the elements of this framework in a regional context. For LAC drivers of environmental change include economic development, population growth, climate change, natural hazards, technological innovation, and governance frameworks. Unsustainable consumption and production, highlighted in the regional priorities, affect sectors such as energy, mining as well as both commercial and personal consumption.

This Chapter of the Regional Assessment considers these drivers and the pressures they exert on the environment by analysing the recent trends in the state of the environment as well as the impacts of this environmental change on human health, productive activities and ecosystems. The analysis is conducted according to four environmental themes, namely:

- Air, including common and toxic air pollutants as well as GHG emissions;
- Freshwater, including quantity and quality;
- Oceans, including pollution sources and commercial activities;
- Land, including fragmentation and degradation; and
- Biota, including both plant and animal biodiversity.

2.1 Air

2.1.1 Overview and main messages

The atmosphere is a thin and delicate layer that constitutes a key link between humans and ecosystems. Its role in biogeochemical cycles is vital in keeping planet Earth functioning within boundaries that enable life to exist in the way we know it. Anthropogenic air emissions are changing the natural composition of the atmosphere at unprecedented rates (UNDESA, UNEP and UNCTAD 2012) and might lead to local, regional and global impacts on health, environment, society and the economy (IPCC 2014).

Key Messages: Air

There have been sharp increases in concentrations of greenhouse gases in the atmosphere, surpassing planetary limits for climate change (Steffen *et al.* 2015). GHG emissions are growing rapidly in the region as a result of urbanization, economic growth, energy consumption and land use changes, among other chief factors (IPCC 2014).

According to the World Bank (2015), carbon dioxide emissions from the burning of fossil fuels and the manufacture of cement in LAC have increased in absolute terms, +14.18 per cent in the period 2006-2011, although their levels as a proportion of GDP (kg per PPP USD of GDP) have declined by 14.35 per cent in the same period. In 2005, the region's countries accounted for almost 10 per cent of global GHG emissions (EC 2016). More recent figures confirm such a level with 10.6 per cent reported in 2012 (EC 2016).

Urban growth has been described as a major pressure of air pollution in LAC, due mainly to increased energy consumption and transport. In the past decade there has been a dramatic increase in private car ownership in countries in the region with high GDP growth (UN-Habitat 2013). The countries with the biggest growth in the total number of cars between 2005 and 2008 are Mexico (8 543 807), Chile (768 874) and Peru (328 692). Suriname leads the list of countries with the highest number of cars per 100 habitants (30.3), followed by Mexico (27.8), Uruguay (21.7) and Chile (19.8) (UNECLAC 2015b).

◄ Credit: Shutterstock/ elnavegante

These changes result in degradation of the air in urban and rural areas, both indoors and outdoors, at local, regional and global scales. Far from clean air, many populated areas in LAC register deleterious concentrations of criteria pollutants, air toxics, Persistent Organic Pollutants (POPs), mercury and other harmful substances (**More...5**). Particulate Matter, PM10 and PM2.5, and ozone are major pollutants in urban areas, while soot constitutes to be a major health concern in rural areas.

The LAC region has made large progress on the reduction of ozone-depleting substances and the elimination of lead in gasoline, reducing significantly the impacts on the ozone layer and lead concentrations in air, in particular in urban settings. But new threats are appearing on the horizon such as the increase in particulate matter in almost all urban centres where there are monitoring records, and the complexity of chemicals released into the air having direct or indirect impacts on air quality but also on the climate.

Emerging issues include secondary pollutants formed in the atmosphere by reactions in the urban atmosphere. The reduction of emissions of greenhouse gases having long residence time in the atmosphere is also an important challenge. Toxic chemical emissions are also of concern. Overall, improving emission inventories is regarded as necessary to implement better policies at national and regional levels. Contaminants such as black carbon have received more attention during recent years and are now a priority because of their radiative forcing on the climate system.

Biomass burning is recognized as an important topic at the regional level, and the impacts are both in terms of air quality and releases of greenhouse gases; more attention should be paid on waste burning considering that new chemicals may be released from these practices which, very unfortunately, are still very common throughout the region.

As the region improves its economy, energy demand increases. Since fossil fuels are still an important source of energy for transport and industry, the increased energy consumption is producing a steady increase in carbon dioxide emissions. Reducing fossil fuel use, together with the widespread adoption of more efficient, energy-saving and cleaner technologies, are necessary in the region to achieve any significant reductions in emissions over the coming years.

Regional governance and policies on air quality are needed because pollution is a transboundary issue. Initiatives such as the Regional Action Plan on Atmospheric Pollution, mandated by the Forum of Ministers of Environment of LAC in 2014, are critical to coordinate this effort. However, a more holistic approach including urban planning, with enough green areas and connecting with ecosystems services reduction or fuel oil consumption, cleaner technologies, and the improvement of living conditions in impoverished areas, are needed to maximize environmental, social and economic co-benefits.

Moreover, the potential of the atmosphere to act both as a sink and a source of anthropogenic pollutants highlights the need to strengthen and disseminate knowledge to inform decision makers and engage stakeholders in increasing a comprehensive understanding of atmospheric issues and their relationship to human and ecosystem health. For this to happen there is a need to improve and coordinate the air quality monitoring networks to cover the entire region and produce enough data to inform the development of reliable policies for protecting human health and the environment.

2.1.2 Pressures

Major sources of air pollution in Latin America include transport, large-scale combustion, industry, residential and commercial combustion, fossil-fuel extraction and distribution, waste and landfills, and open burning of biomass.

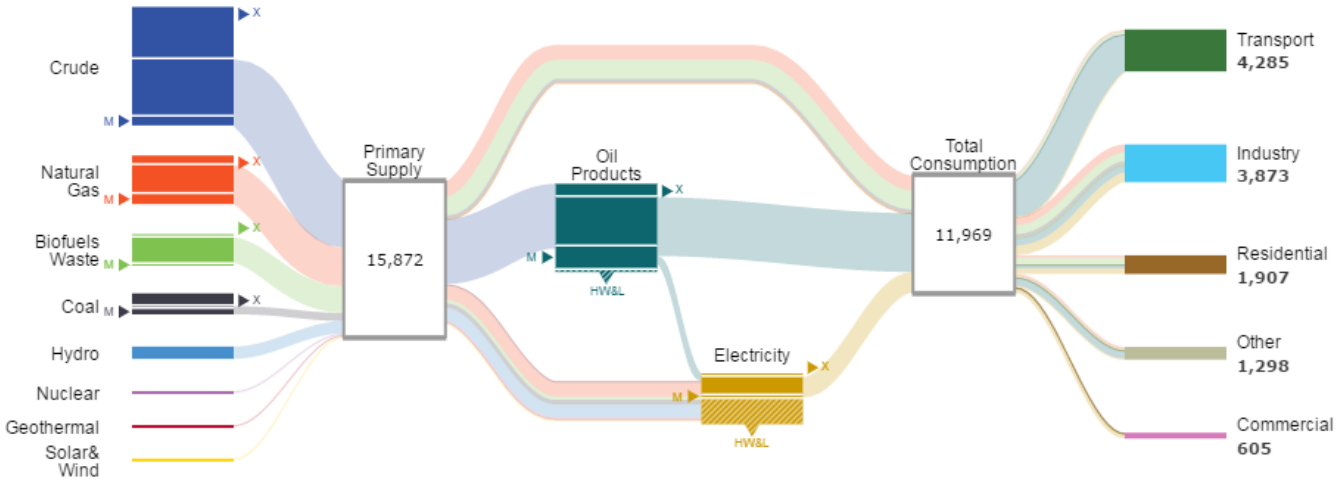
LAC's motorization rate is one of the highest in the world (OICA 2013). While public transport systems still have the largest share for the provision of collective transport, cars and motorcycles are rapidly taking over. Overall, this results in increased transport externalities including health and ecosystems impacts from increased air pollutant emissions, as well as traffic congestions and accidents.

The transport sector is the major cause of air pollution in LAC, both in terms of emissions (22 per cent of the regional total) and harmfulness (Timilsina and Shrestha 2009). In this context, it is important to note that in LAC vehicles are not the only cause of air pollution. Shipping is also an increasingly important source of air pollution and GHG emissions, mainly sulphur and nitrogen oxides, and particulates. It is estimated that 70 to 80 per cent of air toxics from ocean-going vessels are released within 400 kilometres of the shore, where they can have substantial effects on human health.

International shipping is a major source of diesel black carbon emissions, which are not yet subject to international regulation. Carbon dioxide emissions from international shipping more than doubled between 1990 and 2007 and the marine sector now generates about 2.7 per cent of global carbon dioxide emissions. Recent growth projections suggest it could account for 7 per cent of global emissions by 2050 (ICCT 2015).

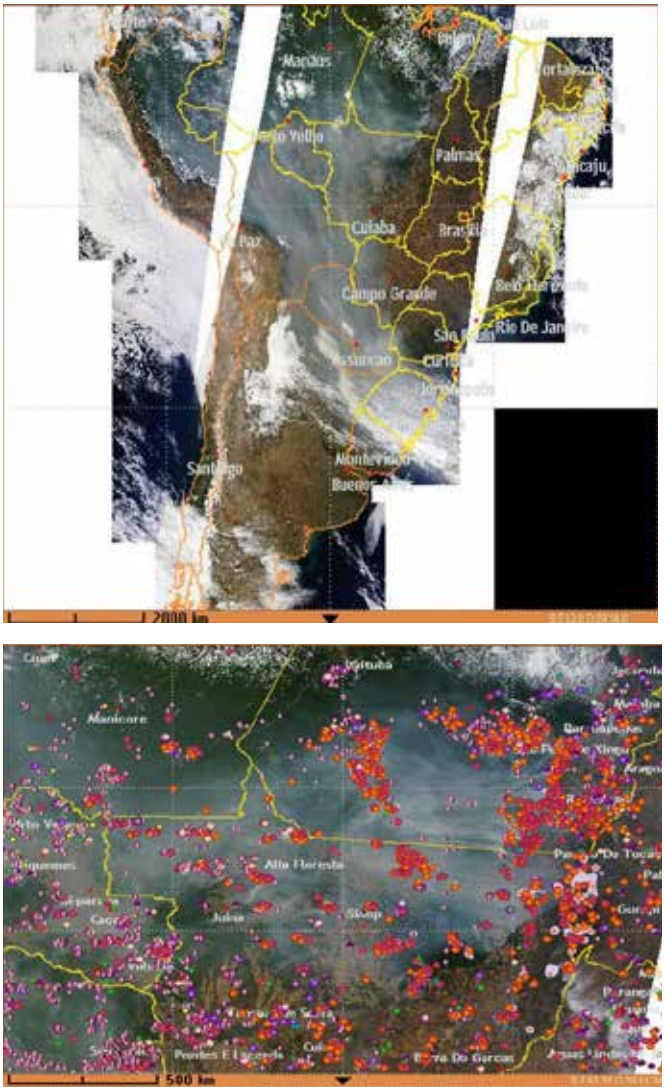
An important aspect that should be considered when analysing the pressures on air quality refers to the use of energy and the intensity of changes in land use patterns. **Figure 2.1.1** shows the energy balance for LAC: transport and industry are leading sectors in demand for energy and, in turn, the leading sources of pollutant emission. Residential sources cannot be neglected, as the use of biomass for heating and cooking is common throughout the region.

Figure 2.1.1: Energy matrix in Latin America and the Caribbean, 2013 (all figures in kBOE/day).



Source: IDB 2016a based on IEA data and other sources

Figure 2.1.2: On 23 August 2010 Brazilian INPE's fire system (INPE 2015a) using NASA-AQUA MODIS imagery observed a plume of smoke covering several million square kilometres flowing southwards from Amazonia and advecting into the South Atlantic Ocean in the extreme south of Brazil. The detail shows individual detections of fires and the associated smoke plumes.



Source: INPE 2015

Fossil fuel power stations are also an important source of emissions in LAC, particularly in the Caribbean. There are also many industries in the region that use a variety of fuels in their own power plants, but the emissions from these in most cases are not reported, so it is very difficult to estimate and assess their impact. There are also several industries and industrial processes which involve the combustion of a range of materials. Their emissions, however, are poorly understood and documented.

The burning of biomass as an energy source for cooking and heating is still widely used in LAC, usually in rural areas, and is also a major cause of indoor air pollution. The use of fire in agriculture is widespread in the region. Native forests, grasslands and other natural habitats are burnt after being cleared to provide more land for agriculture; in some areas fire is also used as part of crop rotation practices. Overall, emissions from agriculture and deforestation-related fires in the region are a major contributor to atmospheric trace gases and aerosol mass concentrations (see for example **Figure 2.1.2**). In 2014, the net amount of CO_2 emissions/removals related to land use[4] in South America was 709 554 gigagrams (FAO 2015).

Another important source related to fire in the region is the open burning of waste; this releases new chemicals into the atmosphere, mostly toxic chemicals with negative effects on human health (Laborde *et al.* 2015). Waste and sanitary landfills are also sources of emissions, although they are considered as a minor contributor in LAC. However, data on these is very scant, making it difficult to provide a robust assessment of the magnitude and impacts from this source. The estimate of 36 per cent of methane emissions coming from waste in Peru (World Bank 2013; La Giglia *et al.* 2014) gives some clues about the role of waste in atmospheric pollution in LAC.

4 Includes forest land, cropland, grassland and biomass burning.

2.1.3 State and trends

Air quality data and concentrations

The WHO cities database released in 2014 shows that most of the cities in the region for which data are available have concentrations of particulate matter above the WHO guidelines (**Table 2.1.1**). This means that most of the urban population in the region is exposed to poor air quality, with consequences for both health and the environment.

Particulate matter $PM_{2.5}$ and PM_{10}

The data analysed in the report by the Clean Air Institute (Green and Sanchez 2012) strongly support the concern over particulate matter and ozone. Of the 16 cities that measured concentrations of PM_{10} in 2011, all exceeded the WHO annual air quality guidelines of 20 micrograms per cubic metre (annual mean) and nine exceeded the EU annual standard of 40 micrograms per cubic metre (**Figure 2.1.3**). From the 11 cities that recorded concentrations of $PM_{2.5}$ in 2011, 10

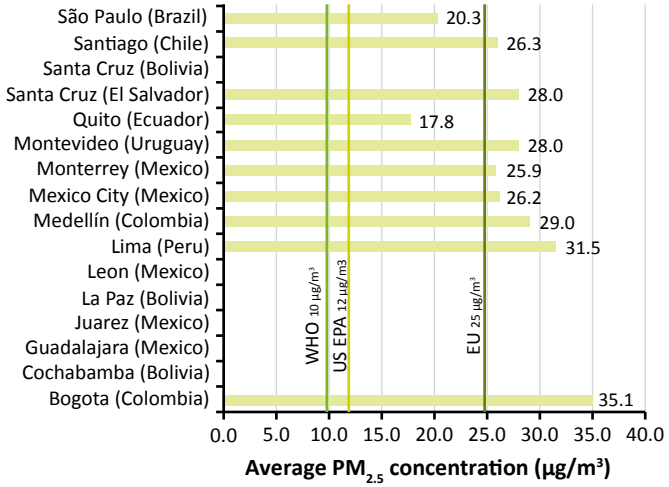
Table 2.1.1: Annual mean concentration of particulate matter of less than 10 microns of diameter (PM_{10}) [$\mu g\ m^{-3}$] and of less than 2.5 microns ($PM_{2.5}$) in major cities in LAC countries.

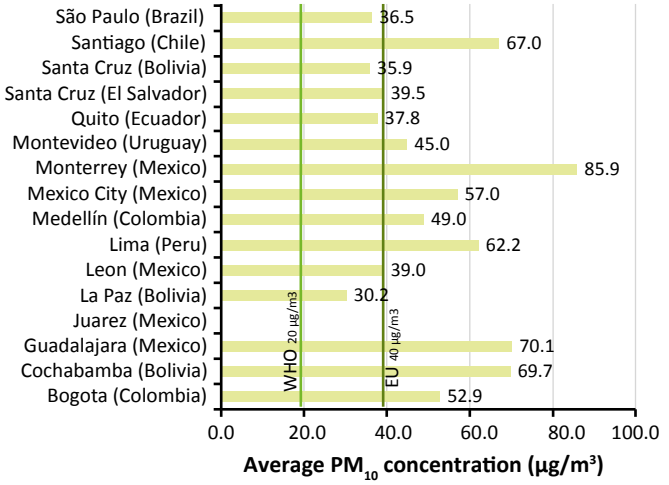
Country	PM_{10}: annual mean, mg m^{-3}	Year	$PM_{2.5}$: annual mean, mg m^{-3}	Year	Number and type of monitoring stations
Argentina	30	2012	16	converted	3 stations, 2 stations in residential/ commercial with fixed sources and 1 in mixed zone with medium to low traffic in capital city
Bolivia	51	2010	27	converted	5 stations in 2 cities
Brazil	41	2012	22	converted	>56 stations in 40 cities
Chile	64	2011	28	2008-2012	47 stations in 24 cities
Colombia	43	2010-2012	24	converted	37 stations in 10 cities
Costa Rica	31	2011	17	converted	8 stations in 4 cities
Ecuador	38	2012	18	converted	9 cities
Guatemala	45	2012	33	2012	4 stations in capital city
Honduras	58	2013	32	2013	2 stations in capital city
Jamaica	36	2011	20	converted	12 stations, mixed, in 3 cities
Mexico	79	2011	27	2011	>24 stations in 9 cities
Paraguay			18	2010	3 stations in capital city
Peru	63	2011	38	2011	4 stations in capital metropolitan region
Uruguay	27	2012	18	2012	2 stations for PM_{10}, 1 station for $PM_{2.5}$, in capital city
Venezuela	47	2011	26	converted	Monitoring in 2 cities

Note: Annual mean PM_{10} data were estimated, when not available, on the basis of $PM_{2.5}$ using a conversion factor. As the conversion factor $PM_{2.5}/PM_{10}$ may vary according to location, the converted PM_{10} value for individual cities may deviate from the actual value (generally between 0.3 and 0.8), and should be considered as approximate only.

Source: WHO 2014c

Figure 2.1.3: Annual average concentrations of $PM_{2.5}$ and PM_{10} ($\mu g\ m^{-3}$) in selected cities in Latin America and the Caribbean (2011). The vertical lines represent respectively WHO, US-EPA, and EU quality standards for PM defined as the annual average of maximum amount of airborne particles that can be present in outdoor air without threatening the public's health.





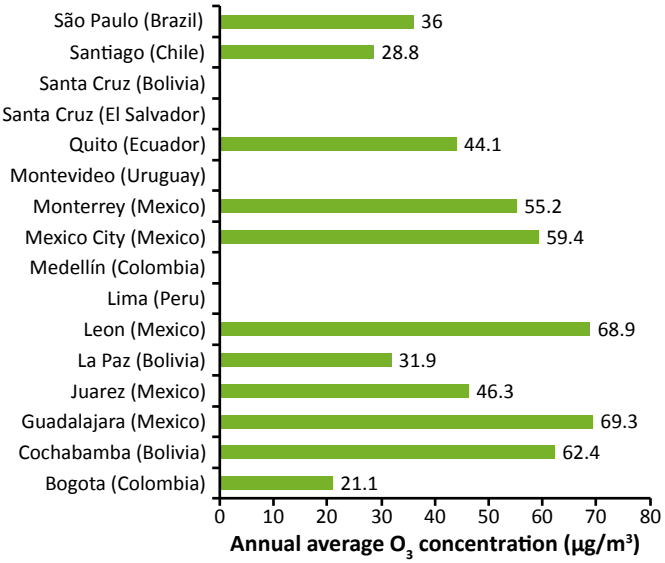
Source: Green and Sanchez 2012

exceeded the annual WHO air quality guideline of 10 micrograms per cubic metre (annual mean) and the US EPA annual standard of 15 micrograms per cubic metre, and 8 of them exceeded the EU annual standard of 25 micrograms per cubic metre. All of the exceedances were also over the WHO Interim Target 3 of 15 micrograms per cubic metre (annual mean).

Ozone

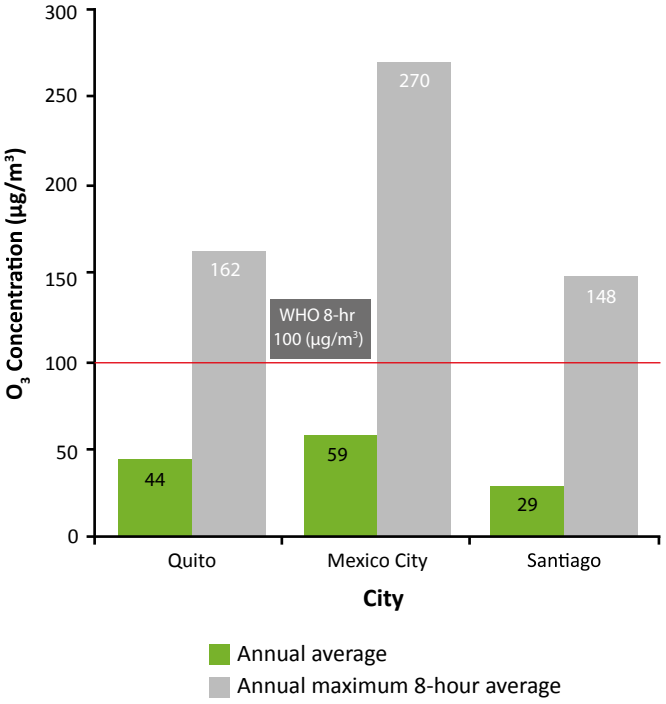
The significant variation in annual average ozone concentrations across the region (**Figure 2.1.4**) suggests that there are spatial differences in the key drivers of ozone formation i.e. the emissions of ozone precursor pollutants and the solar radiation required for the photochemical transformation processes that lead to ozone formation.

Figure 2.1.4: Annual average ozone concentration in selected cities in Latin America and the Caribbean in 2011.



Source: Green and Sanchez 2012

Figure 2.1.5: Annual average ozone concentration and maximum eight hour average concentration (gray bar) in three major cities in Latin America in 2011. The horizontal red line represents the WHO standard for ozone exposure (eight-hour average).



Source: Green and Sanchez 2012

The exceedances of the 8-hour WHO air quality guidelines in all the considered cities (**Figure 2.1.5**) suggests that even cities with a low annual average concentration are likely to have short-term concentrations of ozone above what is deemed unsafe for public health by WHO.

Persistent Organic Pollutants (POP) levels in air

The Global Monitoring Plan (GMP) is an initiative established to evaluate the effectiveness of the Stockholm Convention and monitor the presence of POPs in all the regions, including LAC. The second regional monitoring report for LAC, published in November 2014, includes several datasets available from air samples throughout the region in (UNEP 2014a). The sampling method for providing comparable results consisted of establishing a network of passive sampling stations, including urban, rural and background sites. These methods use polyurethane foam (PUF Samplers) and Styrene divinilbenzene samplers (XAD-2 resin).

Greenhouse gases

Transport is one of the largest and fastest growing sources of GHG emissions in Latin America and the Caribbean. The transport system in the region together with the increase in motorization rates have led to an increase in the overall regional GHG emission rates, also in part due to the growing GDP and the increase of the middle class across the region. The transportation sector represents 35 per cent of the total GHG emission in Latin America and the Caribbean, accounting for 506.4 million tonnes of carbon dioxide per year (IDB 2013). A description of the main greenhouse gases emitted in LAC is provided in the Supplementary Information (**More...6**).

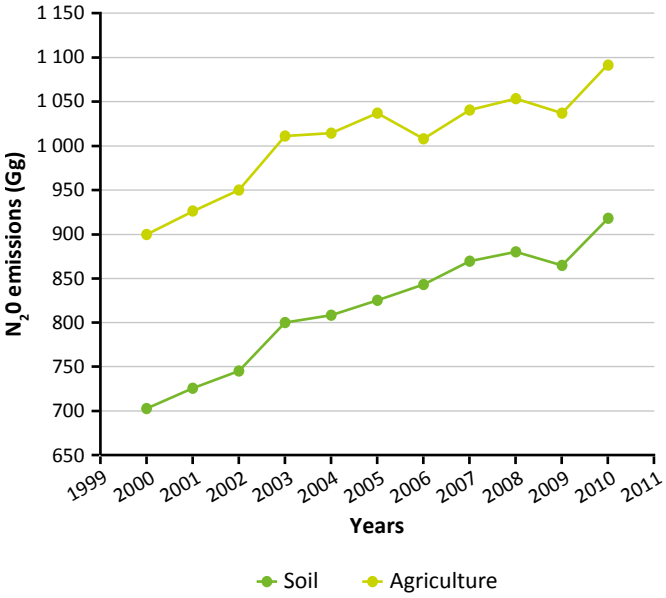
Nitrous oxide

Agriculture has a strong effect on emissions of nitrous oxide (**Figure 2.1.6**) and, to a lesser extent, carbon dioxide. Nitrogen fertilizers result in emissions of nitrous oxide from the soil and these emissions increase rapidly with the amount of fertilizer added to crops. In LAC nitrous oxide emissions from soils, from leaching and runoff, direct emissions, and animal manure, increased by about 29 per cent between 2000 and 2010.

Methane

Methane emissions from rice (paddy) cultivation increased significantly and fairly linearly at a rate of 32 gigagrams methane per year during 2000-2010 (**Figure 2.1.7**). In these years, methane emissions increased by about 29 per cent. The percentage share of total global methane emissions from rice (data only from Africa, Asia and Pacific, Latin

Figure 2.1.6: N_2O emissions from soil emissions and agriculture (gigagrams) in LAC. Refer to the main text for the N_2O processes each of these sources represents.



Source: UNEP 2015d

America and North America) also showed a significant and fairly linear trend in 2000-2010. The share in that period increased by 15 per cent.

The livestock population in LAC is mostly beef and dairy cattle. The abundance of ruminants in the region results in large methane emissions, mostly from enteric fermentation (**Figure 2.1.8**). With a growing livestock population, these emissions from enteric fermentation increased significantly and linearly at a rate of 448 gigagrams methane per year in 2000-2010, resulting in a 19 per cent increase in emissions. The share of these emissions in the total global emissions from the same source and period also showed a significant and fairly linear trend: emissions in 2010 were 7.3 per cent higher than in 2000.

Figure 2.1.7: LAC methane (CH_4) emissions from rice cultivation (left axis) and their relative share of global total methane emissions from the same source (right axis).

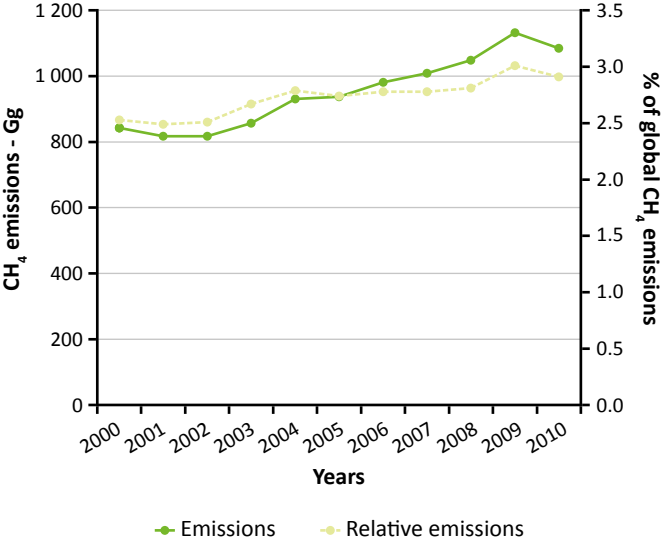
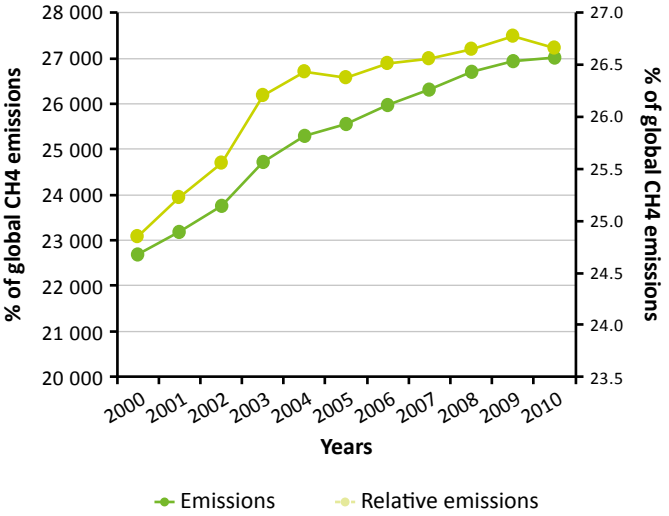


Figure 2.1.8: LAC CH_4 emissions from enteric fermentation in cattle (left axis) and their relative share of global total methane emissions from the same source (right axis).



Globally, 5 per cent of methane emissions from livestock come from manure management[5]. Although the amount is about one-eighth of the mean methane emissions from enteric fermentation, improving the management of manure to reduce these emissions is currently much simpler than acting on enteric fermentation.

Carbon dioxide emissions

The most recent data for carbon dioxide emissions in LAC is from 2011 (World Bank 2015). This data shows interesting patterns, especially when the contributions of each sub-region are considered (**Figure 2.1.9**). In general, carbon dioxide emissions are on the increase, mostly in South America, with countries like Argentina, Brazil, Mexico and Venezuela, each of them exceeding 150 million tonnes per year.

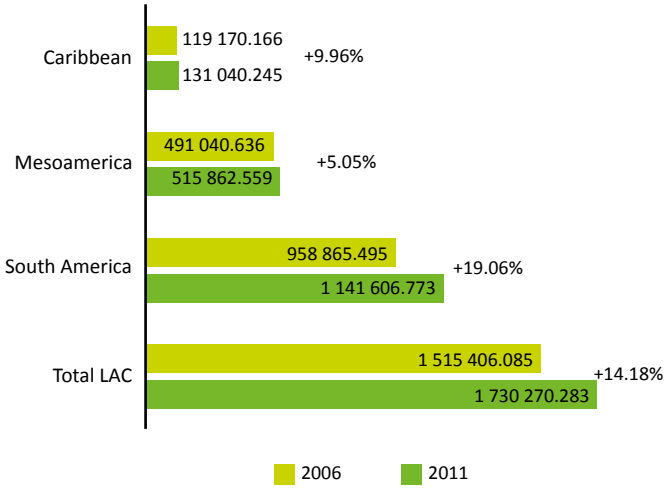
A further analysis of the carbon dioxide emissions in LAC over a five year observation period (2006-2011), shows some differentiated patterns in the region. The difference in total emissions between 2006 and 2011 at national level accounts for an average increase of 14 per cent in LAC, with Peru, reporting 50 per cent more CO_2 emitted in 2011 with respect to 2006 and a small group of countries (El Salvador, Guatemala, Suriname and Jamaica) reporting a decrease in the CO_2 emitted in 2011 (**More...7**).

A normalization of the data reported above by the number of inhabitants provides a clearer picture of the emission levels by country in LAC. Of particular concern are the emissions in Trinidad and Tobago, which exceeds the 37 tonnes per person in 2011. In general, only 6 countries were able to reduce their emissions per person as reported in 2011 with reference to 2006. Among them, Jamaica, Guatemala and Suriname were able to reduce their emissions by more than 20 per cent.

Figure 2.1.10 provides an additional perspective on the emissions, in relation to GDP and population. The Mercosur economic area, which is the largest in terms of both population and GDP, has the greatest share in CO_2 emissions in LAC. On the other end are the countries from the Mesoamerica Integration System (SICA), which have the lowest emission level in the region.

Fires of anthropogenic origin are quite an important source of emission in the region. Occurrence of wildfires of anthropogenic nature is common in South America during the winter season (June to September) when fires are lit to clear vegetation or biomass waste when land is converted to agriculture or forestry. Biomass burning produces many pollutants including carbon dioxide, carbon monoxide, sulphur dioxide, nitrogen oxides, methane, ammonia, dimethyl sulphide, non-methane organic compounds, halocarbons, and gaseous organic acids. Carbon monoxide and nitrogen oxides are ozone precursors.

Figure 2.1.9: Total emissions of carbon dioxide in 2006 and 2011 (kilo tonnes per year) in LAC subregions.

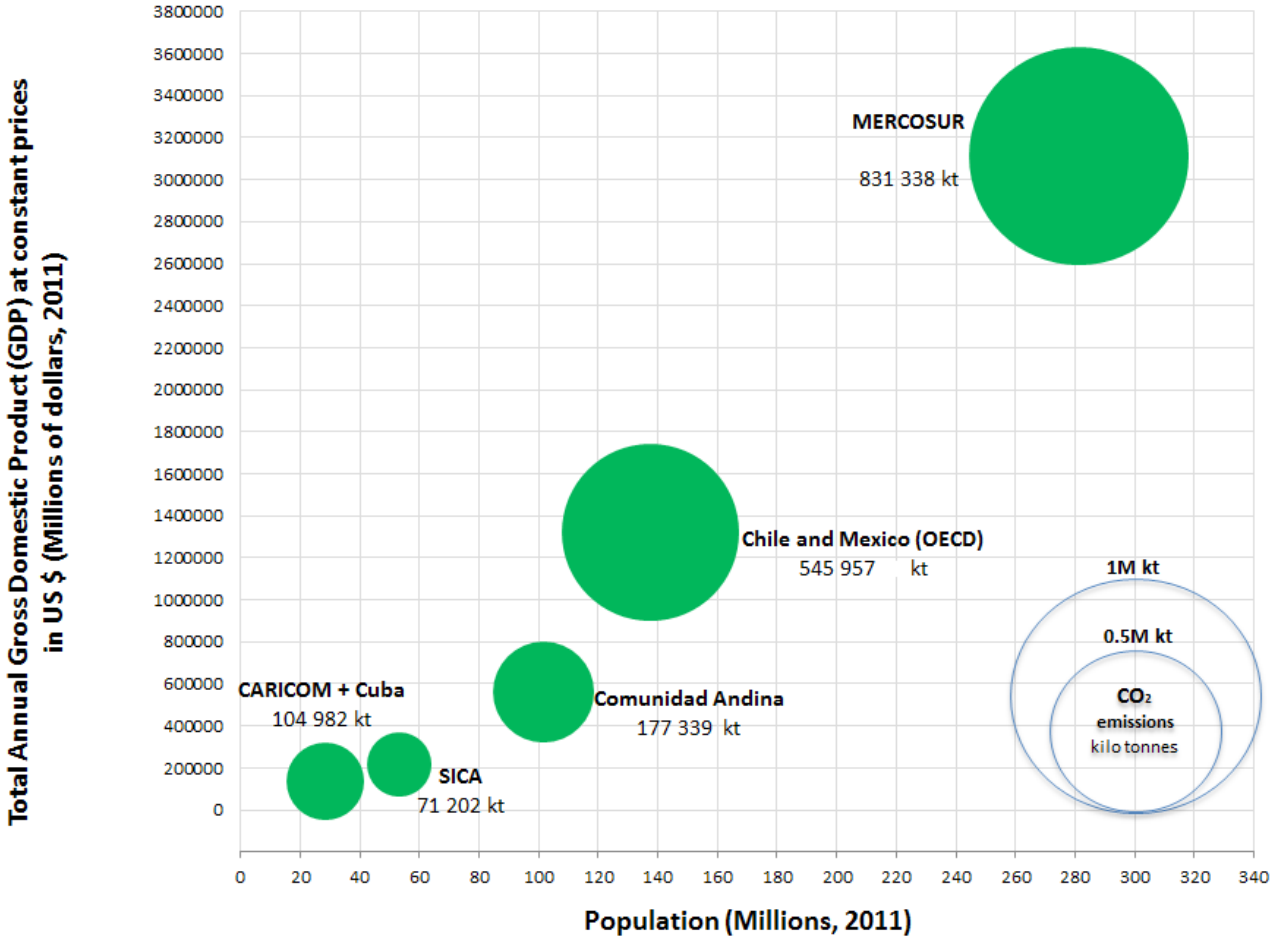


Note: The emissions reported are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.

Source: World Bank 2015

5 GLEAM 1.0 - Assessment of GHG emissions and mitigation potential. www.fao.org/gleam/results/en/

Figure 2.1.10: Total CO_2 emissions (2011) per economic area in LAC according to GDP and population.



Note: the emissions reported are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.

CARICOM: Antigua and Barbuda, Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Jamaica, Montserrat, Saint Lucia, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago

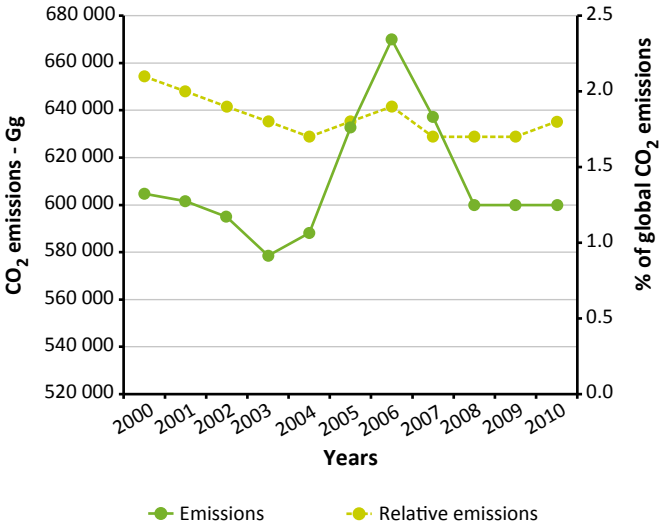
Comunidad Andina: Bolivia, Colombia, Ecuador, Peru

MERCOSUR: Argentina, Brazil, Paraguay, Uruguay, Venezuela

Sistema de la Integracion Centramericana (SICA): Belize, Costa Rica, Dominican Republic, El Salvador, Guatemala, Nicaragua, Panama

Source: World Bank 2015

Figure 2.1.11: LAC. Carbon dioxide emissions from forest fires and decay of biomass after burning (left axis) and their relative share of global total carbon dioxide emissions (right axis).



Data are model estimations by EDGAR v.4.2 FT2010.

Source: UNEP 2015

In LAC estimated emissions of carbon dioxide from forest fires were fairly stable with a mean of 609 790 (1.34 per cent)[6] Gigagrams (**Figure 2.1.11,** left axis). These emissions represented a significant[7] and decreasing proportion of the global total carbon dioxide emissions in the period 2001-2010 (**Figure 2.1.11,** right axis), with a mean of 1.81 per cent (1.92 per cent)[8].

6 The number in parentheses next to the value of a mean is the relative uncertainty of the mean, computed as 100 times the ratio of half the value of the 95%- confidence interval for the mean and the mean value.

7 *Significant* (or *significantly*) means a statistical probability equal to or less than 5%.

8 The number in parentheses next to the value of a mean is the relative uncertainty of the mean, computed as 100 times the ratio of half the value of the 95%- confidence interval for the mean and the mean value.

Toxic chemicals

The presence of toxic chemicals in the atmosphere has been documented in the region through the monitoring of POPs regulated by the Stockholm Convention (Barra *et al.* 2007). The wide occurrence, even at low concentrations, of dioxins and furans in urban areas is of concern given the highly toxic nature of these pollutants. For the first time, regional results on dioxin exposure have been documented throughout the LAC region. This was possible thanks to the establishment of a monitoring network, created by the regional centres of the Basel and Stockholm conventions and the support of the Global Environment Facility (GEF) and the scientific community in the region.

2.1.4 Impacts

Health

Impacts of air pollution on human health have been documented both at global and regional levels (WHO 2012). Air pollution is one of the main avoidable causes of disease and death globally. It causes significant morbidity and mortality in all countries. Pollutants of major public health concern include particulate matter, carbon monoxide, ozone and nitrogen and sulphur dioxides. Fine particulate matter ($PM_{2.5}$), which is widespread, both indoors and outdoors, damages the health of more people than any other air pollutant.

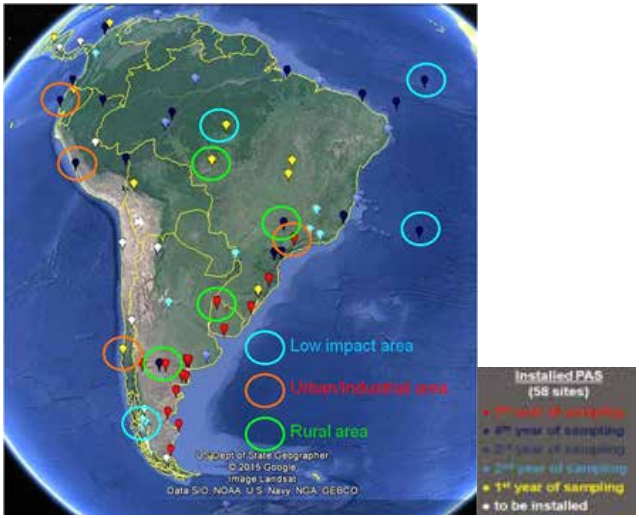
Globally, more than 1.5 million deaths per year from respiratory infections are attributed to the environment, including at least 42 per cent of lower respiratory tract infections and 24 per cent of upper respiratory infections in developing countries (WHO 2015b).

In LAC, an estimated 100 million people live in areas susceptible to air pollution, mostly in highly populated areas of cities with more than 500 000 inhabitants (Romieu *et al.* 2012). In most such cities exposure to $PM_{2.5}$ exceeds the internationally recommended standards (Green and

Latin America Passive Atmospheric Sampling Network

The Latin America Passive Atmospheric Sampling Network (LAPAN) was established in 2010 to enable studies of long-term spatial and temporal trends of atmospheric contaminants (PCB, PBDE, organochlorine pesticides and current use pesticides). The network runs 73 sites, covering areas with different backgrounds (low impact-remote, urban, industrial and rural) including Argentina, Bolivia, Brazil, Colombia, Chile, Ecuador, Honduras, Peru, Uruguay, and Venezuela. It also includes some sites from Antarctica. The passive atmospheric samplers consist of a stainless steel mesh cylinder filled with XAD-2 (styrene/divinylbenzene – copolymer resin). The highest DDT, endosulfan and PBDE levels were found in Argentina (Fillmann *et al.* 2015).

The use of monitoring networks is recommended for evaluating atmospheric contamination in order to take action on prevention and mitigation strategies.



Sanchez 2012). The groups that are most vulnerable to the health effects from exposure to air pollutants are the elderly, the young, those with chronic health problems and the poor (Green and Sanchez 2012).

In 2010, particulate air pollution was responsible for about 190 million Disability-Adjusted Life Years (DALYs)[9]. This puts the burden of particulate matter air pollution among the biggest risk factors, much higher worldwide than any other, competing or exceeding other environmental risks and risk factors such as smoking, hypertension, malnutrition and alcohol (Smith *et al.* 2014).

A study on mortality in Latin America associated with air pollution (Romieu *et al.* 2012) found that a daily increase in PM_{10} was associated with small percentage increases in daily mortality from all natural causes including from respiratory, cardiopulmonary, cardiovascular, and chronic obstructive pulmonary diseases; and cerebral-vascular stroke in most of the cities studied, even though the strength of the association varied from city to city.

In LAC, 16 per cent of households use solid fuels, although there is a wide variation between countries (IARC 2013). For example, in Guatemala 65 per cent of the total population uses solid fuels, out of which 88 per cent are in rural areas and 29 per cent in urban areas. In the case of Mexico, 15 per cent of the total population uses these fuels, 45 per cent in rural areas and less than 5 per cent in urban areas (WHO 2012). Exposure to pollutants from indoor pollution coming from solid fuel contributes to a higher risk of pneumonia

9 DALYs for a disease or health condition are calculated as the sum of the Years of Life Lost (YLL) due to premature mortality in the population and the Years Lost due to Disability (YLD) for people living with the health condition or its consequences. See: http://www.who.int/healthinfo/global_burden_disease/metrics_daly/en/

in younger children (Dherani *et al*. 2008). Other impacts include an increased risk of lung cancer (Kurmi *et al*.2012) and chronic bronchitis (Kurmi *et al*. 2010).

Factors such as high-density settlement and other environmental and social conditions of some hazards are responsible of the risks. Poor and wealthy people in Santiago de Chile and Bogotá are comparable in their health risk from air pollution and heat (Magrin *et al*. 2014). The elderly are considered a vulnerable group to air pollution and heat because they have conditions that limit the body's ability to respond to this kind of stress (Gamble *et al*. 2013).

Reducing air pollution does not always promote the objectives of protecting health and climate, but can pose trade-offs. All particles are hazardous to health, and some are contribute to climate warming, such as black carbon, and some contribute to climate cooling, such as sulphates (Smith *et al*. 2009). In fact, if all anthropogenic particles are eliminated in the atmosphere, it would be a great success for health, but only have a minor net impact on climate change (Smith *et al*. 2014).

IPCC (2013) indicates that there is little evidence that climate change, by itself, will affect the levels of particulate matter in the long term in a consistent manner. Some scenarios of future climate change indicate that chronic exposure to ground level ozone can be improved (Smith *et al*. 2014).

If temperature rises, many air pollution models project an increase in ground level ozone production, particularly in urban areas and surroundings (Hesterberg *et al*. 2009). Increased temperature also accelerates ozone destruction, and it is believed that the net direct impact of climate change on ozone concentrations around the world can be reduced (IPCC 2013). However, some scenarios (IPCC 2013) suggest that tropospheric ozone can be increased through increased methane emissions stimulated by climate change. Models also show that local variations may produce a different result at the global level (Selin *et al*. 2009).

In 2012 a total of 138 000 deaths in the Americas (low and middle income) were attributed to ambient air pollution (58 000) and household air pollution (80 000) (WHO 2014a, WHO 2014b). Deaths per person due to ambient and household air pollution were 47 per 100 000 people, mainly due to ischaemic heart disease, stroke and chronic obstructive pulmonary disease (WHO 2015b).

Health and costs of air pollution in Latin America and the Caribbean

WHO and others, including the Health Effects Institute (HEI), have estimated country and regional levels of health impacts from air pollution, by using mortality as an indicator. The SCALA study (HEI 2012), used a methodology for attributing mortality to measured environmental levels of air pollutants such as PM_{10} and ozone. The use of a common methodology concluded that a small but significant link exists between mortality data and exposure to PM_{10} and ozone. Comparatively, these results were similar to those observed in other parts of the world by using the same methodological approach. These results, considering the lack of information at the city level and its relation with natural corridors to connections to ecosystems, is becoming a powerful tool to support investment in the improvement of public transport, cleaner fuels, development of low-emission technologies and other interventions that promote more sustainable cities and cleaner air. This kind of valuation should be promoted in the region in order to provide decision makers and communities with information about the impact of air pollution in their cities.

2.1.5 Response

In December 2015 at the 21st Conference of the Parties of the UNFCCC, governments of LAC presented their Intended Nationally Determined Contributions (INDC) (**More... 8**). In March 2014, the XIX Meeting of the Forum of Ministers of Environment for Latin America and the Caribbean adopted

the Regional Plan of Action on Atmospheric Pollution[10], as an example for the development of national action plans appropriate to the particularities of each country with emphasis on technical exchange, capacity building and design alternatives to reduce air pollution (**More…9**).

This plan, which is the first of its kind in the world, recognizes the importance of the issue of air quality for the healthy development of the LAC population and the conservation of the environment, and encourages governments to identify the economic resources needed for the sustainability of the air quality monitoring networks as an essential and priority element for decision making.

The plan provides a guide for developing national action plans appropriate to each country to reduce air pollution. The ministers' decision includes provisions to update the plan every four years and encourage governments to identify economic resources needed for maintaining air quality monitoring networks as an essential and priority element for decision making. It also commits to strengthening public-private dialogue and emphasises the role of all sectors and levels of government involved in the promotion of commitments and actions to implement the overall plan.

Short Lived Climate Pollutants

Because of their relatively short life in the atmosphere and high radiative forcing, substances such as methane, black carbon, tropospheric ozone and many hydrofluorocarbons (HFCs) have been categorized as short-lived climate forcers (UNEP 2011b). Since black carbon, tropospheric ozone and methane affect air quality, these substances have also been called short-lived climate pollutants (SLCP).

In 2012, the Climate and Clean Air Coalition (CCAC) decided to undertake a major integrated assessment of Short Lived Climate Pollutants (SLCP) in LAC, to support and provide a framework for national action, underpin regional co-operation on SLCP mitigation, and provide a regional focus for engagement with policy makers, scientists, technical experts, and other key stakeholders. The report includes a review of the available data on SLCP and Criteria Pollutants for the region. In order to assess the emissions, the LAC region was subdivided into 13 countries and groups of countries. The estimates included in the regional assessment of SLCP constitute the first comprehensive emissions inventory for the whole region for all sectors and substances at a detailed level.

Air quality standards

The air quality standards situation is heterogeneous in the region. While it is encouraging that many countries and cities in LAC have set official air quality standards to protect health, some countries still lack such legislated standards. Even when standards exist they sometimes exceed the WHO guidelines (WHO 2006). In other cases countries do not have national $PM_{2.5}$ standards and both the annual and 24-hour PM_{10} standards for all countries are higher than the WHO air quality guidelines. Most countries also have standards set significantly above the WHO 1-hour air quality guidelines or have no short-term standard at all, which is crucial, since the health effects of nitrogen dioxide are most significant with short-term exposure.

Air quality monitoring

LAC has a limited number of air quality monitoring programmes in place. Existing air pollution monitoring capabilities are restricted to some countries where air pollution is a serious problem, in metropolitan areas and a few other places. Buenos Aires, Mexico City, Sao Paulo and Santiago de Chile have good monitoring examples that could be replicated in other cities.

Air quality management plans at local level

Major cities in LAC have worked to implement air quality management plans over the past three decades. There

10 http://www.pnuma.org/forodeministros/19-mexico/documentos/decisiones/Contaminacion_Atmosferica/Decision_on_Air_Pollution.pdf

are successful examples that highlight the importance of comprehensive, long-term efforts (see for instance CAME 2011), but many of the cities have still not established their plans. A combination of incentives, technological changes, taxes, and the 'polluter pays' principle, played a role in achieving the policy implementation in each case. In Chile, the reduction of particulate matter releases involved the development of cleaner fuels by reducing the sulphur content in diesel and gasoline, better car regulations, by mandating the use of catalytic converters (improving combustion efficiency), transport restrictions according to the level of air quality, reduction of the most polluting vehicles from the public collective transportation system, the introduction of diesel particulate filters (DPF), and low emission vehicles (Euro 5 standard) in public transportation fleets (**More...10**).

2.2 Freshwater

2.2.1 Overview and main messages

In 2005, the General Assembly of the United Nations (UN) in its resolution A/RES/58/217, proclaimed 2005–2015 as the International Decade for Action, *Water for Life*. The resolution states that the main goal of the decade should be a greater focus on water-related issues at all levels, and on the implementation of water-related programmes in order to achieve internationally agreed goals in the framework of the *Agenda 21*, the UN Millennium Development Goals (MDGs) and the Johannesburg Plan of Implementation.

Key Messages: Freshwater

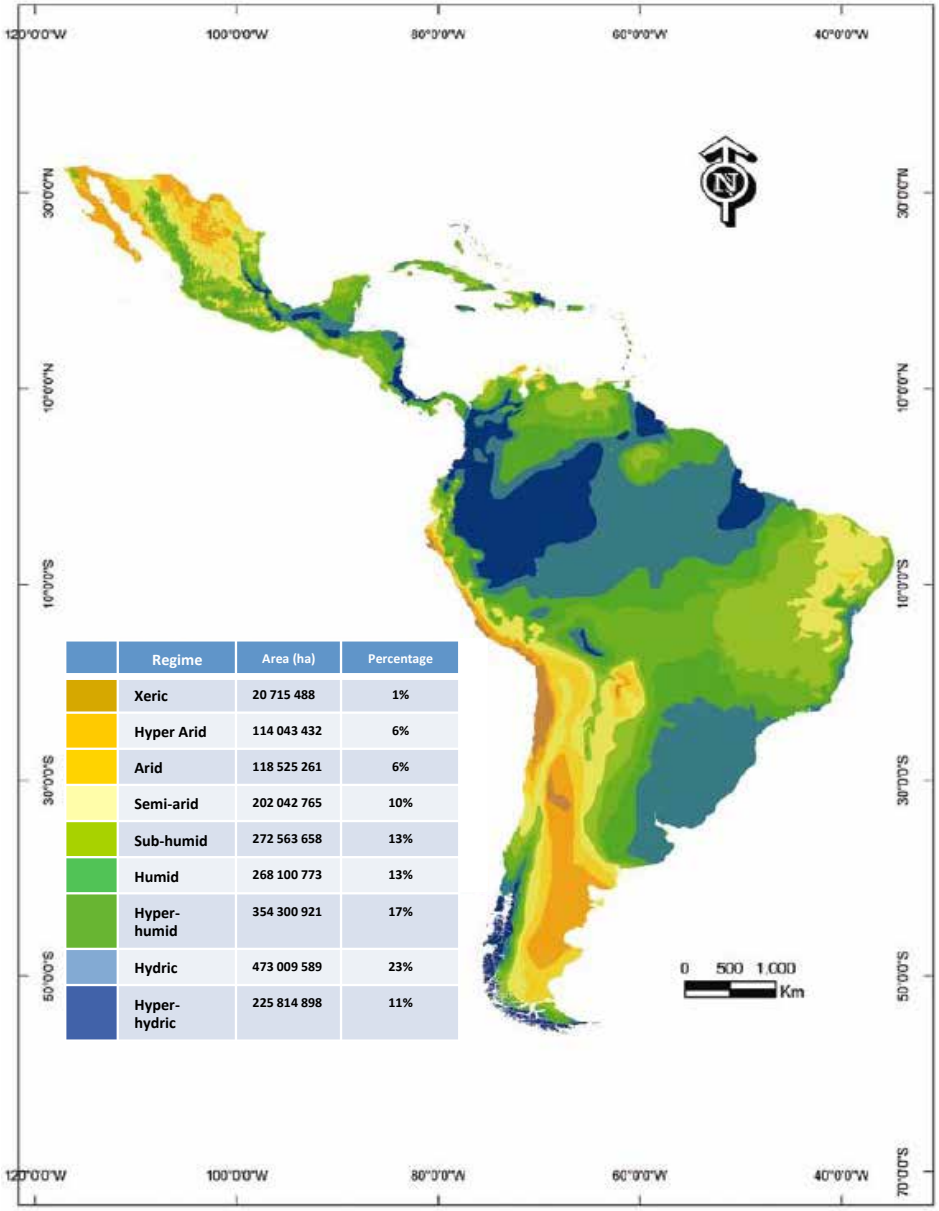
The main pressures affecting water quality and quantity differ vastly within the sub-regions but have not changed since previous assessments. Agriculture, industries and households demand more water resources than ever before as population growths, the global economy expands and extreme climatic events become more frequent. While the construction of new infrastructure and the development of regulatory instruments are important measures to address the situation, integrated approaches that consider the water-energy-food nexus are necessary.

Data on water quality and quantity is scarce both spatially and temporally. As a reference, the average density of monitoring stations for water quality that are part to the GEMS/Water Programme Network is only 0.3 per 10.000 square kilometres (UNEP 2016). There is also a need to develop technical and research capacities to assess the state and trends of water and to build on information gathering and sharing. This information is key for any management effort, just as information on employment, GDP or poverty is essential to run economic policies.

Climate change translates into hydrological variability and in turn to shifting agricultural seasons, frequent extreme climatological events and glacier retreat. In terms of decision making, this represents important uncertainties and challenges in natural resources management. Therefore, a robust and effective structure for water governance that follows an integrated approach should be implemented at all levels. In recent years, many examples of good practices in water resources management have been implemented at the local scale in the region. It is time to upscale these experiences to national and regional contexts.

To fully achieve the SDGs and the human right to water and sanitation, it is necessary to change current consumption and production patterns across all sectors, reducing water loss, updating technologies and conserving ecosystem services.

Figure 2.2.1: Latin America and the Caribbean, arid and humid areas.



	Regime	Area (ha)	Percentage
	Xeric	20 715 488	1%
	Hyper Arid	114 043 432	6%
	Arid	118 525 261	6%
	Semi-arid	202 042 765	10%
	Sub-humid	272 563 658	13%
	Humid	268 100 773	13%
	Hyper-humid	354 300 921	17%
	Hydric	473 009 589	23%
	Hyper-hydric	225 814 898	11%

Source: UNESCO 2010

Figure 2.2.2: Annual freshwater withdrawal in the region as percentage of total renewable water.

Note: The value range for Mexico (not included in the map) is greater than 3 per cent.

Source: FAO 2015a

2.2.2 Pressures

As mentioned in Chapter 1, there is an increasing demand for water for agriculture, industry, energy generation and domestic use. These demands, coupled with climate change and increasing pollution, collectively produce significant changes to the hydrological cycle and water resource systems. These pressures and changes also result in increased competition for water among the various users.

The sub-regional situation with regards to freshwater demand is quite heterogeneous as **Figure 2.2.2** shows. The same heterogeneity is found with regards to other freshwater indicators in the region.

Table 2.2.1: Annual water withdrawals by sector in Latin America and the Caribbean.

	Total water withdrawals (10^9 m^3/year)		Withdrawal for agriculture (10^9 m^3/year)		Agricultural withdrawal as % of total withdrawal (%)		Withdrawal for industry (10^9 m^3/year)		Industrial withdrawal as % of total withdrawal (%)		Withdrawal for domestic use (10^9 m^3/year)		Domestic withdrawal as % of total withdrawal (%)	
Antigua and Barbuda	2012	0.01	2012	0.00	2012	15.65	2012	0.00	2012	21.74	2012	0.01	2012	62.61
Argentina	2011	37.78	2011	27.93	2011	73.93	2011	4.00	2011	10.59	2011	5.85	2011	15.48
Bahamas											2013	0.03		
Bolivia	2009	2.09	2008	1.92	2009	91.95	2009	0.03	2009	1.53	2009	0.14	2009	6.51
Brazil	2010	74.83	2010	44.90	2010	60	2010	12.72	2010	17.00	2010	17.21	2010	23.00
Chile														
Colombia	2008	11.77	2008	6.39	2008	54.3	2008	2.24	2008	19.05	2008	3.13	2008	26.63
Costa Rica	2013	2.35	2013	1.33	2013	56.6	2013	0.26	2013	11.06	2013	0.76	2013	32.34
Cuba	2013	6.96	2013	4.52	2013	64.94	2013	0.74	2013	10.63	2013	1.70	2013	24.43
Dominica	2010	0.02	2010	0.00	2010	5	2010	0.00	2010	0.00	2010	0.02	2010	95.00
Guyana	2010	1.45	2010	1.36	2010	94.33	2010	0.02	2010	1.41	2010	0.06	2010	4.24
Haiti	2009	1.45	2009	1.21	2009	83.38	2009	0.05	2009	3.52	2009	0.19	2009	13.10
Mexico	2011	80.30	2011	61.58	2011	76.69	2011	7.28	2011	9.07	2011	11.44	2011	14.25
Nicaragua	2011	1.55	2011	1.19	2011	76.7	2008	0.07	2011	4.76	2008	0.29	2011	18.51
Panamá	2010	1.04	2010	0.45	2010	43.01	2010	0.01	2010	0.96	2010	0.58	2010	56.03
Paraguay	2012	2.41	2012	1.90	2012	78.62	2008	0.15	2012	6.38	2011	0.36	2012	15.00
Perú	2008	13.66	2008	12.12	2008	88.73	2008	0.29	2008	2.12	2008	1.25	2008	9.18
Dominican Republic	2010	7.16	2010	5.72	2010	79.86	2010	0.59	2010	8.19	2010	0.86	2010	11.95
Saint Kitts and Nevis	2012	0.02	2012	0.00	2012	1.282	2012	0.00	2012	0.00	2012	0.02	2012	98.72
Saint Vincent and Grenadines	2013	0.01					2013	0.00	2013	0.02	2013	0.01	2013	100.00
Trinidad and Tobago	2011	0.38	2011	0.02	2011	4.358	2011	0.13	2011	33.64	2011	0.24	2011	62.00
Venezuela			2008	16.71										

Source: World Bank 2015

Agriculture

In 2011 agriculture accounted for 68 per cent of the total freshwater withdrawals in LAC, the industrial and domestic sectors accounting for 11 per cent and 21 per cent, respectively (Mekonnen *et al.* 2015). Agriculture is a strategic sector for rural development and poverty alleviation, and plays a key role in overcoming local and global food insecurity. Data from 2005 presented in **Figure 2.2.3** shows that most water export from LAC relates to agricultural products.

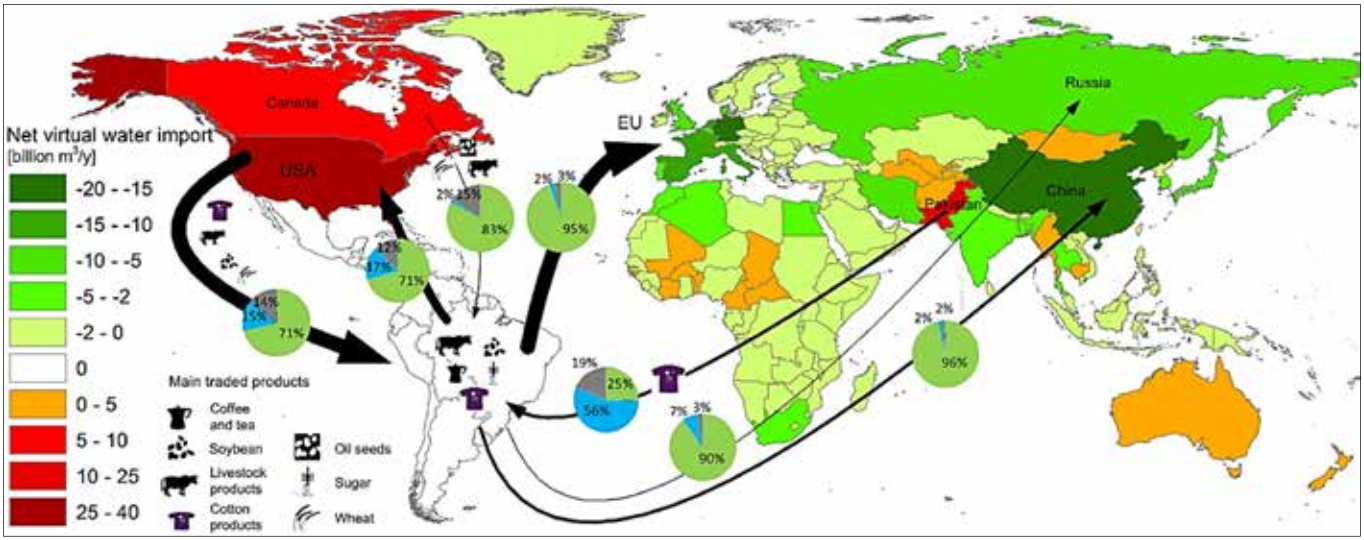
Industries

Many industries use more resources than their production processes require, due to the continued reliance on outdated and inefficient practices (for example the use of hydraulic monitor extraction in the mining industry), limited investment in environmental control (for example, water recycling is not done if pumping of used water is not economically feasible), failure to adopt proper management systems through the supply chain and failure to comply with laws and norms (UNECLAC 2015c).

Mining

Mining is a water-intensive sector and directly competes for ground and surface water with agricultural and domestic users. The average amount of water used in mining varies by commodity sector, project scale, local climate and hydrology, mine management and the grade of ore. Gold and copper use the most water per ton of metal and mineral, respectively. Dewatering, one stage in the mining process, can alter local hydrogeology, depleting water resources available for local agriculture and drinking water supplies. Cyanide and sulphuric acid is used to separate ore from rock in the processing stage. If not properly collected, they may

Figure 2.2.3: Net virtual water import (red) and export (green) of Latin America and the Caribbean in relation to the rest of the world (10^9 m^3/year) in the period 1996 - 2005. Only the biggest gross virtual water flows (>10^9 m^3/year) are shown.



Source: Mekonnen *et al.* 2015

leach into local waters from processing plants or percolate to ground waters through unprotected tailings ponds.

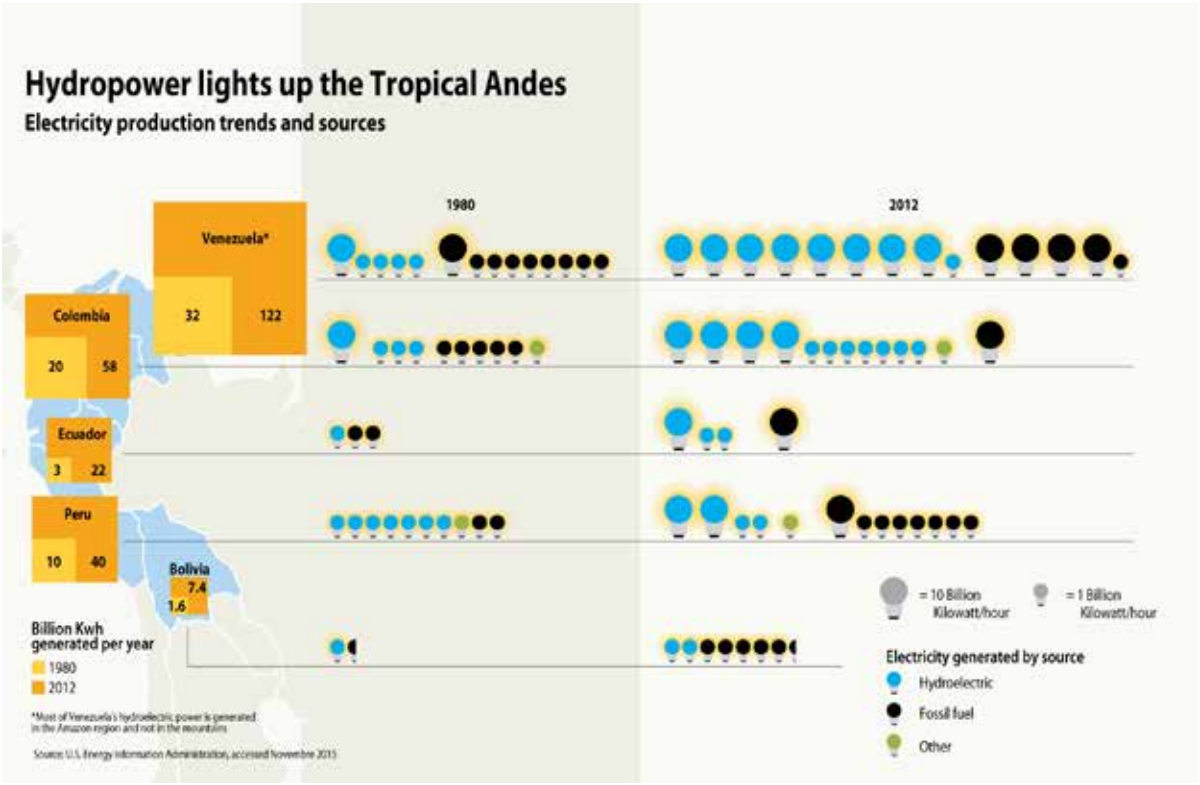
In Latin America many mining projects usually occur in areas that are already water stressed and facing water security issues. Some of the major areas include the Atacama Desert in northern Chile, the high Andes of Argentina, many sites in Mexico and the Pacific-facing Peruvian slopes of the Andes.

Energy production

Hydropower is a key electricity source in the region and still has a large growth potential (Campuzano *et al.* 2014) (**More…11**). In 2014, LAC had an installed capacity of 162.2 GW, 15.7 per cent of the world's total. In Brazil, hydropower represents 67 per cent of the total existing power generation capacity (132.6 MW) (EPE 2014). In Costa Rica, this sector holds 82 per cent of the water licenses (Blanco *et al.* 2014).

To feed this power source a number of reservoirs have been built, many of which also serve other purposes. A large number of dams are dedicated to the generation of electricity in Mesoamerica, Colombia and Peru while Cuba and Bolivia use most of their dams for irrigation and domestic supply purposes (**More…12**). These dams, whether they are used for electricity, irrigation or providing drinking

Figure 2.2.4: Hydropower lights up the Tropical Andes.



Source: Schoolmeester *et al.* 2016

water, reduce water flows and can have a detrimental effect in water quality, particularly with an increased intensity and duration of heat events.

Tourism

IDB (2015) found that international tourism in the LAC region increased by 50 per cent in the past decade. Tourism is an important source of revenue for the region; in 2011 it accounted for USD 36 300 million (WTTC 2015) and governments across the region remain keen to encourage tourism growth. Tourist facilities are large consumers of water, with visitors often consuming at least three times as much as the local population (Cashman 2014). While in some instances hotels are responsible for their own water supply, many are supplied from municipal distribution systems, and they can account for up to 10–15 per cent of all water supplied to a given district (Cashman 2014).

Domestic supply

In LAC the urbanization process in the region develops very quickly and is often poorly planned, particularly in medium size cities, as highlighted in **Table 2.2.4**. This situation poses major challenges for the delivery of key services such as access to safe water and sanitation, protection against water hazards such as floods and guaranteeing water provisioning services during drought periods.

Floods and drought

Considering climate change as a major driver of environmental processes (Chapter 1), vulnerability to growing water hazards stands as an important priority when attempting to increase regional water security. Rapid urbanization and land use changes in general have increased runoff in many areas of the region due to the expansion of paved surfaces, rural land abandonment, and clearing of forests (**More…13**).

Table 2.2.2: Urbanization and land use planning for water provision in medium-size cities.

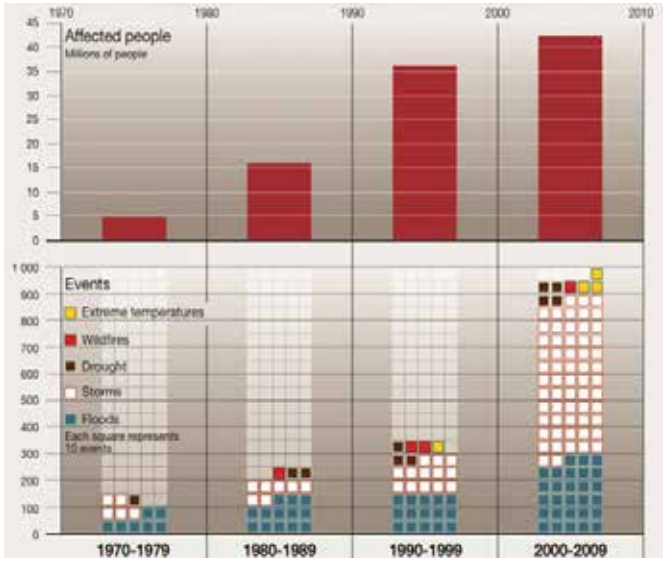
City	Urban (net) population density (persons/km²)		Yearly rate of growth of the urban footprint (average last 5 years)		Percentage of households that don´t comply with national habitability standards		Existence and active implementation of a land use plan	
	Year	Value	Year	Value	Year	Value	Year	Value*
Quetzaltenango	2013	4094.8	2013	9.1	n/a	7.0	n/a	3
Añelo	2010	31.9	0	4.6	2010	13.8	2013	3
Asunción (Metropolitan)	2014	3046.5	2014	2.9	2012	46.4	2014	3
Barranquilla	n/a	7768.0	2005	8.9	2005	12.3	n/a	2
Bucaramanga	n/a	10233.0	2005	3.8	2005	4.9	n/a	2
Cochabamba (Metropolitan)	2013	8200.0	2014	3.5	n/a	29.3	2013	1
Campeche	n/a	4171.0	n/a	1.3	n/a	12.3	n/a	2
Cuenca	n/a	4702.0	n/a	4.9	n/a	12.3	2011	1
Cumaná	2014	5902.0	2014	4.4			1997	1
Florianopolis	n/a	4523.0			2010	7.6	n/a	1
Goiania	2010	1777.0	n/a	6.7			n/a	1

City	Urban (net) population density (persons/km²)		Yearly rate of growth of the urban footprint (average last 5 years)		Percentage of households that don´t comply with national habitability standards		Existence and active implementation of a land use plan	
	Year	Value	Year	Value	Year	Value	Year	Value*
Xalapa	n/a	6829.0	n/a	7.5	n/a	4.0	n/a	1
Joao Pessoa	2013	8205.9	2013	1.0	2008	41.3	2009	2
La Paz (Mexico)	2012	4560.0	2012	2.3	2012	6.9	n/a	2
Las Heras	2010	2600.0	2011	4.0	2010	12.0	2013	1
Montego Bay	n/a	2556.4	n/a	1.6			n/a	2
Mar del Plata	n/a	4042.0	n/a	3.2	2005	62.3	n/a	1
Managua	2011	3850.8	2005	0.9	2011	12.1	2012	3
Montería	n/a	7907.0	n/a	2.1	2005	5.4		
Montevideo	n/a	65.9			2005	6.4	n/a	1
Manizales	n/a	2500.0			2010	28.2	n/a	2
Panama City	2010	5325.0					2014	1
Pereira	n/a	1397.0	2005	6.5			n/a	2
Palmas	2010	3671.0	2014	6.0			2014	1
Port of Spain	n/a	3650.0	n/a	3.0			n/a	2
Paraná	2013	4226.4	2013	1.8	2010	11.4	n/a	1
Pasto	n/a	15169.0	2009	0.2	n/a	12.6	n/a	1
Salta	n/a	4299.0	n/a	0.6	n/a	22.8	2012	1
Santa Ana	n/a	6540.0	n/a	4.8			n/a	3
Santiago de los Caballeros	2014	6449.8	2014	7.6	2010	13.0	2015	2
Tegucigalpa	n/a	5402.0	n/a	4.0			2008	3
Trujillo	n/a	6045.0	n/a	5.0	2008	16.0	2014	1
Vitoria	2012	6253.0	2013	0.0	2010	3.8	n/a	1
Valledupar	2015	10100.0	n/a	2.2	n/a	18.6	n/a	1
Valdivia	2012	4945.0	2012	0.9	2002	4.0	1998	1

* Coding:
1 – The city has a master plan that is legally binding, has been updated within the last ten years, and actively implements it.
2 – Either: a) the city has a master plan and it is legally binding but has not been updated in the last 10 years; or b) the city has a master plan that has been updated within the last ten years but it´s not legally binding
3 – The city does not have a master plan but it is neither legally binding nor has it been updated within the last ten years

Source: IDB 2015b (n/a: not available)

Figure 2.2.5: Number of hydro-meteorological events and related affected people in Latin America and the Caribbean (1970-2010).



Source: UNEP and UNECLAC 2010

The frequency of hydro-meteorological extreme events such as floods quadrupled between 2000 and 2009 compared with 1970 – 1979 (UNEP and UNECLAC 2010), while hydro-climatic variability in the form of droughts has increased over the past few years (**Figure 2.2.5**).

From 2014 till early 2016 the region has experienced high temperatures and reduced rainfall resulting in extreme drought conditions. Countries that depend on hydropower such as Brazil have been severely impacted due to the lack of rainfall. Low water levels in reservoirs affect electricity generation (**Figure 2.2.6**).

In Mesoamerica, the 2015 drought followed successive years of poor rainfall in some areas, particularly in the "Dry Corridor" area (OCHA 2016). The term Dry Corridor, although referred to as a climatic phenomenon, has an ecological basis and defines a group of ecosystems of dry tropical forests in Mesoamerica covering the lowlands of the Pacific coastal area, and most of the central pre-mountain region of El Salvador, Guatemala, Honduras, Nicaragua, Guanacaste in Costa Rica and Panama's *Arco Seco* area (FAO 2015e). It has been estimated that over 1 million farmers that rely

Figure 2.2.6: The Cantareira Reservoir that serves 8.8 million persons in Sao Paulo, Brazil's largest city was at 10 per cent of its total capacity by March 2015.

Source: NASA 2015

on subsistence farming for their livelihoods live in the Dry Corridor (FAO 2015e).

The ongoing El Niño-induced drought remains a major concern for many countries in Latin America and the Caribbean due to the below-normal rainfall recorded during the previous dry and wet seasons. Drought warnings have been issued for Antigua and Barbuda, Barbados, Dominica, northern Guyana, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago and northern Suriname. The outlook beyond March 2016 will see a drier early part of the year in the Lesser Antilles, and this may lead to drought concerns towards the end of the Caribbean dry season. In Central America, the 2015 drought, which followed successive years of poor rainfall in some areas, has left many poor households reliant on limited labour opportunities to fulfill food needs, particularly in Dry Corridor areas. Furthermore, although aggregate coffee production in Guatemala, Honduras and Nicaragua continues to recover from the impact of the coffee rust outbreak since 2012, El Salvador remains heavily affected, as do many small- and medium-scale producers throughout the region (OCHA 2016).

2.2.3 State and trends

Available quantities

There are three widely-used thresholds for defining levels of water stress on the basis of per person availability (Brown and Matlock 2011). Areas with average resources between 1 000 and 1 700 cubic metres per person per year are typically classed as having moderate water shortage, and if resources are below 1000 cubic metres per person per year, the region is classed as having chronic water shortage. If resources are below 500 cubic metres per person per year then the shortage is considered extreme (FAO 2012).

In Meso and South America there has been a steady decrease in water availability per person in recent decades, due mainly to the fact that the population increased from 463 to 606 million between 1992 and 2011 (UNECLAC 2015b). Water availability ranges from Mexico's 3 500 cubic metres per person per year to Peru's 55 000 cubic metres per person per year. Also, according to the Falkenmark Index (1990), countries of Meso and South America are still safely located above 1 700 cubic metres per person per year threshold for water scarcity (Campuzano *et al*. 2014).

In 2007, the World Bank estimated the availability of freshwater in some SIDS: Jamaica was ranked as most abundant with 3 514 cubic metres per person per year; Haiti, stressed at 1 338 cubic metres per person per year; while Bahamas' freshwater was the scarcest at 60 cubic metres per person per year. By 2014, however, statistics show a decline: Jamaica had 3 483 cubic metres per person per year; Haiti, 1297 and the Bahamas 55 cubic metres per person per year (UNEP 2014c).

Barbados is using nearly 100 per cent of its available water resources, Saint Lucia has a water supply deficit of approximately 35 per cent, Nevis (Saint Kitts and Nevis) is at 40 per cent, Trinidad (Trinidad and Tobago) has had a deficit since 2000, Jamaica was projected to experience deficits in areas of important economic activity by 2015, Antigua and Barbuda rely on desalination to meet demands for water, and in Dominica, Grenada, and Saint Vincent and the Grenadines, demand can exceed supply during the dry season due to reduction in stream flows.

Groundwater

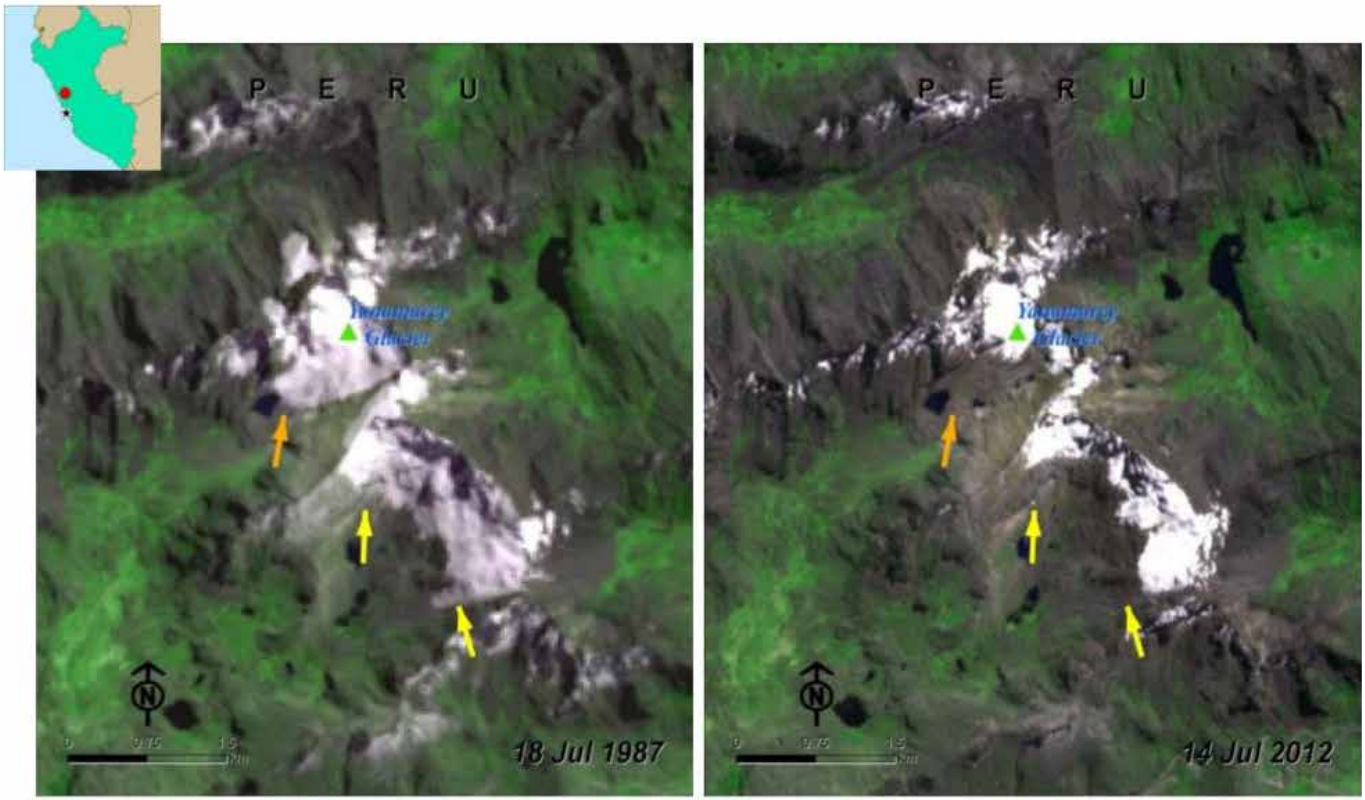
While surface water is the most common source of water in the region, groundwater use has increased in recent decades (Campuzano *et al*. 2014). This is partly because of the growing costs associated with surface water storage and treatment, and changes in precipitation patterns, and partly because the advantages of groundwater use are becoming more accepted (Llamas and Martinez-Santos 2005). Groundwater use is especially relevant in Argentina, where it accounts for 30 per cent of total water withdrawals. In Chile, where it is of particular importance in the mining sector, it accounts for 46 per cent. Likewise, in Costa Rica and Mexico groundwater

accounts for 50 per cent of industrial demands, 70 per cent of domestic supply in cities and practically all domestic supply in rural areas (Campuzano *et al*. 2014). These trends represent a threat to groundwater resources if they are not managed properly. Intense pressure due to increasing demands is leading to over-pumping of the reserves, depleting this sensitive source faster than it can recharge.

Glaciers

More than 99 per cent of the world's tropical glaciers are located in the Andes Mountains in South America, of which 71 per cent are located in Peru, concentrated on the Cordillera Blanca, and 20 per cent in Bolivia (UNEP 2013b; Kaser 1999; Rabatel *et al*. 2013; Bury *et al*. 2011; IRD *et al*. 2007). Recent studies from the region have found glaciers to be melting at an accelerated rate (Villacis *et al*. 2010; Chevallier *et al*. 2011; Rabatel *et al*. 2013). In the Andes this melting is directly related to climate change. This situation is combined with a growing and dense population and urban centres such as Lima, La Paz and Quito in areas that depend on these glaciers as water sources. Scientists are monitoring the retreat of glaciers (**More...14**).

Figure 2.2.7: Retreat of the Yanamarey glacier in central Peru between 1987 (left) and 2012 (right).



Source: UNEP/GRID 2013

More than 80 per cent of freshwater available for downstream populations and ecosystems in the semi-arid tropics and sub-tropics originates in mountains (UNEP 2013b). Glaciers partly contribute to the water that travels down the western slope of the Andes, supplying coastal regions with water, mostly during the dry season (Chevallier *et al.* 2011). Therefore, reduction in glacier size will affect availability of water downstream (Vuille *et al.* 2008). For example, glacier retreat in the area surrounding the Shallap, Tararhua and Uruashraju glaciers along the Cordillera Blanca could lead to a 30 per cent decrease in average dry season discharge (Baraer *et al.* 2012). In Bolivia, glaciers of the southern Cordillera Real supply approximately 15 per cent of potable water for the urban areas of La Paz and El Alto and can increase to approximately 30 per cent during the dry season from May to August (World Bank 2014b). The hydropower industry will also feel the residual effects of melting glaciers such as reduced streamflow, which could result in decreased efficiency and energy output (UNEP 2013b).

Considerations on consumption and production patterns

The importance of water for productive activities and the availability of funds from foreign assistance, international financial institutions and increased national budgets, have driven many governments to develop ambitious plans to expand infrastructure, often forgetting basic requirements: demand management and efficient use of water.

According to IWA (2014) "while it is accepted that in some areas water resources are insufficient to provide the necessary supply, it is also evident in many areas that the problem is not the availability of water, but the fact that so much is lost through leakage".

Losses can also be a function of an aging water network, constructed in the 20th century with no anticipation of population growth. Resources and local capacity to maintain and operate water distribution networks are limited in many areas. This has led to water stress and scarcity[11] in countries like Antigua and Barbuda, Barbados, and Saint Kitts and Nevis (GWP 2014; UNEP 2008).

In a recent meeting of water utility agencies from Latin America (World Bank 2013) it was estimated that 45 per cent of water is lost before it reaches the customer. In some countries the figure can be as high as 67 per cent loss in urban water systems (ANAM 2014; Cashman 2014).

UNEP (2011b) estimated that "with no improvement in the efficiency of water use, water demand is projected to overshoot supply by 40 per cent in 20 years time" (globally). Water use efficiency is usually measured as the amount of water used to produce value (litres/USD); as the amount of water used to generate a product (litres/item) or the amount of water used per person (litres/capita). Thus, water use efficiency translates into water savings and increased productivity.

There are several approaches that can be applied to achieve water use efficiency at different levels. They include the adoption of technology (from household rainwater harvesting systems to advanced wastewater treatment) and production methods (e.g. closed loop systems and "cradle-to-cradle" design), regulatory frameworks (water use permits, economic incentives), natural resources planning (consideration of the water-energy-food nexus, water/

11 Water stress versus water scarcity:
Hydrologists typically assess scarcity by looking at the population-water equation. An area experiences water stress when annual water supplies drop below 1 700 cubic metres per person. When annual water supplies drop below 1 000 cubic metres per person, the population faces water scarcity, and below 500 cubic metres, absolute scarcity.
Water scarcity is defined as the point at which the aggregate impact of all users impinges on the supply or quality of water under prevailing institutional arrangements to the extent that the demand from all sectors, including the environment, cannot be fully satisfied. Water scarcity is a relative concept and can occur at any level of supply or demand. Scarcity may be a social construct (a product of affluence, expectations and customary behaviour) or a consequence of altered supply patterns, for example stemming from climate change.

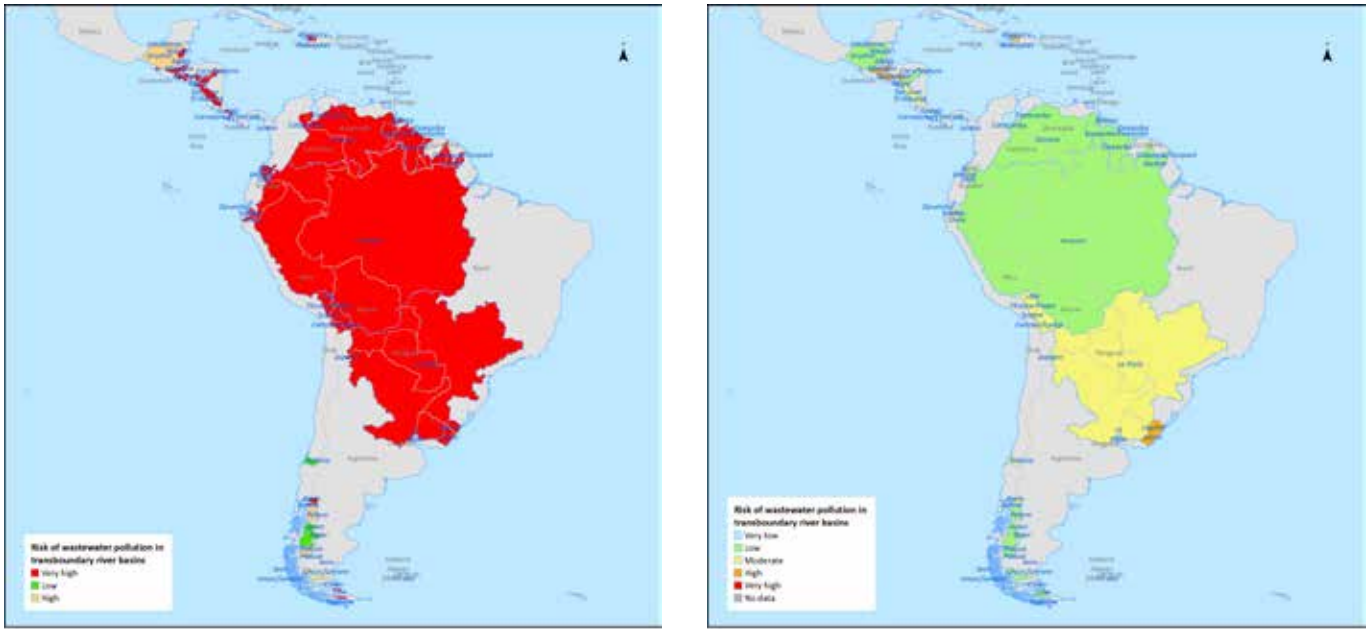
sanitation safety plans) and education and communication strategies (curricula reforms, World Water Day campaigns).

One of the most effective, cheapest and practical ways to achieve water use efficiency is the reuse of water. While reuse is an old practice in many locations, there are many opportunities for expansion, especially if reuse is combined with conventional wastewater treatment.

Quality

Pollution, directly related to population growth, is a recurrent and increasing problem in many areas of the region. While the agriculture sector is the biggest consumer of water, the domestic and commercial sectors are jointly the biggest emitters of toxic substances to water. Several national monitoring systems (CONAGUA 2015; MMA-Chile 2013; ANAM 2014) report that the most contaminated water bodies are situated around metropolitan areas. At the basin level, 37 transboundary river basins in LAC were found to be highly polluted with wastewater, while nutrients (mostly related to agricultural activities and eutrophication of water bodies) were identified, by far, to be the second major pollutants (UNEP and UNEP-DHI 2016). For these basins, a combined human and ecosystem vulnerability estimation to nutrient pollution and wastewater is shown in **Figure 2.2.8**. Heavy metals, pharmaceuticals, personal care products, endocrine disrupting compounds[12] and even illicit drugs are

Figure 2.2.8: Relative risk of wastewater pollution (left) and nutrient pollution (right) in transboundary river basins of LAC.



Source: UNEP and UNEP-DHI 2016

12 Endocrine disrupting compounds can be found in household products like plastic bottles (bisphenol A), refrigerant liquids (polychlorinated biphenyls), cooking pots (phthalates) and repellents (DDT).

substances of emerging concern as well because water is the transport agent of some of these pollutants which are later accumulated in living organisms (including humans) and ecosystems. "Sewage epidemiology" is a new approach still not tested in the region (IWA 2014).

2.2.4 Impacts

IPCC (2014b) identified runoff, demand, recharge, glacier change and unmet demand/water availability as the variables of most concern in LAC. Also, land use changes (covered in Section 2.4) are recognized as influencing the hydrological regime. The state and trends described previously have created impacts in the areas of food security, health, energy production, domestic supply and increased the vulnerability of impacts related to climate change.

Climate change related impacts

"Climate change over the 21st century is projected to reduce renewable surface water and groundwater resources in most dry subtropical regions (robust evidence, high agreement), intensifying competition for water among sectors (limited evidence, medium agreement)" (IPCC 2014b).

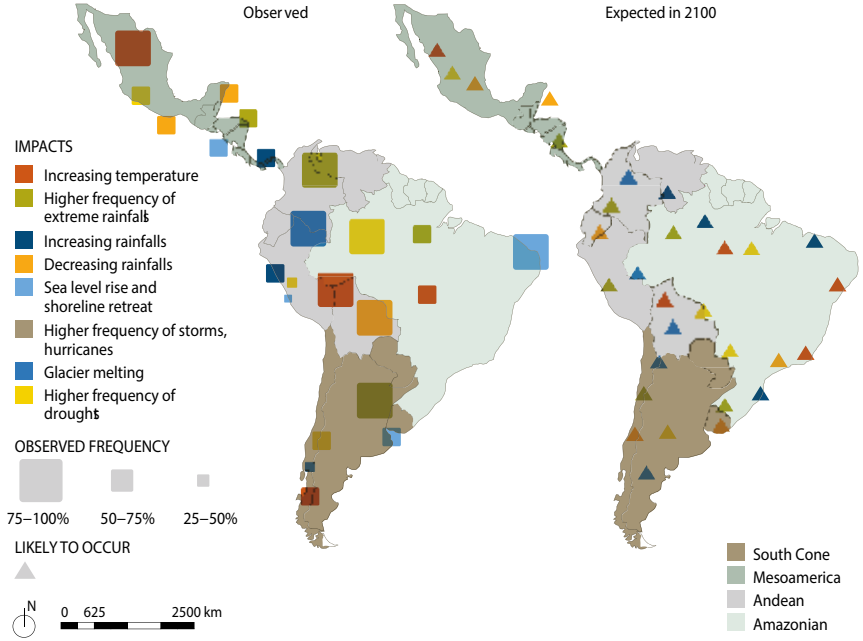
Climate change will undoubtedly cause major changes in the patterns of the water cycle and its geographic distribution in the near future. The most frequent impacts reported include an increase in average temperature, higher frequency of extreme rainfall, sea level rise and coastal retreat, droughts, hurricanes and strong winds, and glacier melting. The magnitude and importance of each impact differs across regions and within countries. Many countries in Latin America and the Caribbean reported changes in climate trends in the recent past (**More...15**).

Changes in streamflow and water availability have been observed and are projected to continue in Central and South America, affecting already vulnerable regions. Because the Andean glaciers are retreating, the seasonal distribution of flows is affected. The decrease in runoff in the Central Andes, Chile and Argentina, and to the Rio de la Plata, as well as in Mesoamerica in the second half of the 20th century, was associated with changes in rainfall (IPCC 2013). Current practices to reduce the imbalance between supply and demand for water could be used to reduce future vulnerability (IPCC 2014b), including increase in water supply from groundwater pumping, fog interception practices, and reservoirs and irrigation infrastructure; and improvements in water demand management associated with increased irrigation efficiency and practices and changes toward less water-intensive crops. Flood management practices also provide a suite of options to deal with actual and future vulnerabilities related to hydrologic extremes. Ongoing legal reforms toward more efficient and effective water resources management and coordination constitute another adaptation strategy.

Changes in climate variables are expected to affect water supplies to urban and rural settlements, hydropower generation, agriculture, and other economic activities. Extreme coastal storms along the Gulf of Mexico, which are a major concern, can cause excess mortality and morbidity, and also significant damage to important infrastructure (IPCC 2014b).

On the Great American *Chaco*, UNF *et al.* (2013) identify measures in order to increase adaptability to climate change in the water sector, such as (i) Water Resources Management Planning: plans to create enabling environments in which stakeholders with diverse interests agree on specific adaptation measures; (ii) Implementation of new technologies for efficient water use and improvement of the infrastructure to access safe water: focus on guaranteeing access to water for communities, at affordable costs, also improving human health, agricultural productivity and animal health; (iii) developing water infrastructure systems and water harvesting (productive and domestic use): investments in resilient infrastructure that do not collide with local culture and biodiversity, supporting the area´s economic development.

Figure 2.2.9: Observed (left) and expected (right) impacts linked to climate change in Latin America.



Source: Campuzano *et al.* 2014

Even in countries with relatively high availability and even distribution of water, such as Uruguay, climate change is adding pressure on water quality. Increased warm periods coupled with drought and agricultural runoff are causing algal blooms that affect water quality and increase water treatment costs (Boyle 2011).

Food security

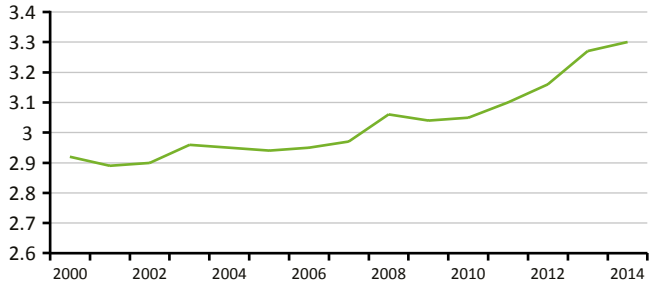
It has been said that there is enough food produced to feed the world's population, with South America being the 'bread-basket' of the world. But food production depends largely on water. Can the water available meet the growing demand for water to feed the world? As stated by IPCC (2014) "All aspects of food security are potentially affected by climate change, including food production, access, use and price stability (high confidence)".

The distribution of climatic changes and hydrological patterns will affect specific areas of LAC differently. Although demand, changing consumption patterns, and trade restrictions strongly influence food prices, climate change may multiply the complexity of food security in LAC, not to mention social inequalities that restrict access to food in poor populations.

"Rural areas are expected to experience major impacts on water availability and supply, food security, infrastructure and agricultural incomes, including shifts in the production areas of food and non-food crops around the world (high confidence)" (IPCC 2014b).

In Mesoamerica, a climate change vulnerability and impact assessment (VIA) (CATIE and CIAT 2013) shows that increases in average temperature and decreased precipitation

Figure 2.2.10: Domestic Food Price Index (FPI) for Latin America and the Caribbean.



Source: FAO 2015a

are expected in 2030 (because of global warming), with significant impacts on agriculture in all countries of this sub-region. As a result, suitable areas for crops that sustain agricultural exports and rural food security will change. Some administrative units (municipalities, counties and districts) will be more productive for certain crops, others may be less. The areas increasing productive capacity, which are generally at higher altitudes, are usually those competing for other land uses, such as upland forests that are a key element in regulating the hydrological cycle (UNF 2013).

The VIA assessment for the Andean region shows that, given the importance of water resources and the impact they may suffer under climate change conditions, strategic management of watersheds becomes a key factor, especially in high and medium altitudes that generate important water regulation services (CIAT 2014). Also, throughout the region, climate change will encourage potato-growing in high-altitude zones. Thus, it is critical to protect highland zones, which play important roles in hydrologic regulation. A significant challenge will be to prevent displacement of farmers by offering potato varieties that are resilient to the alteration of the phenological changes and exposure to pathogens due to an increase in average air temperatures (CIAT REGATTA 2014).

Energy

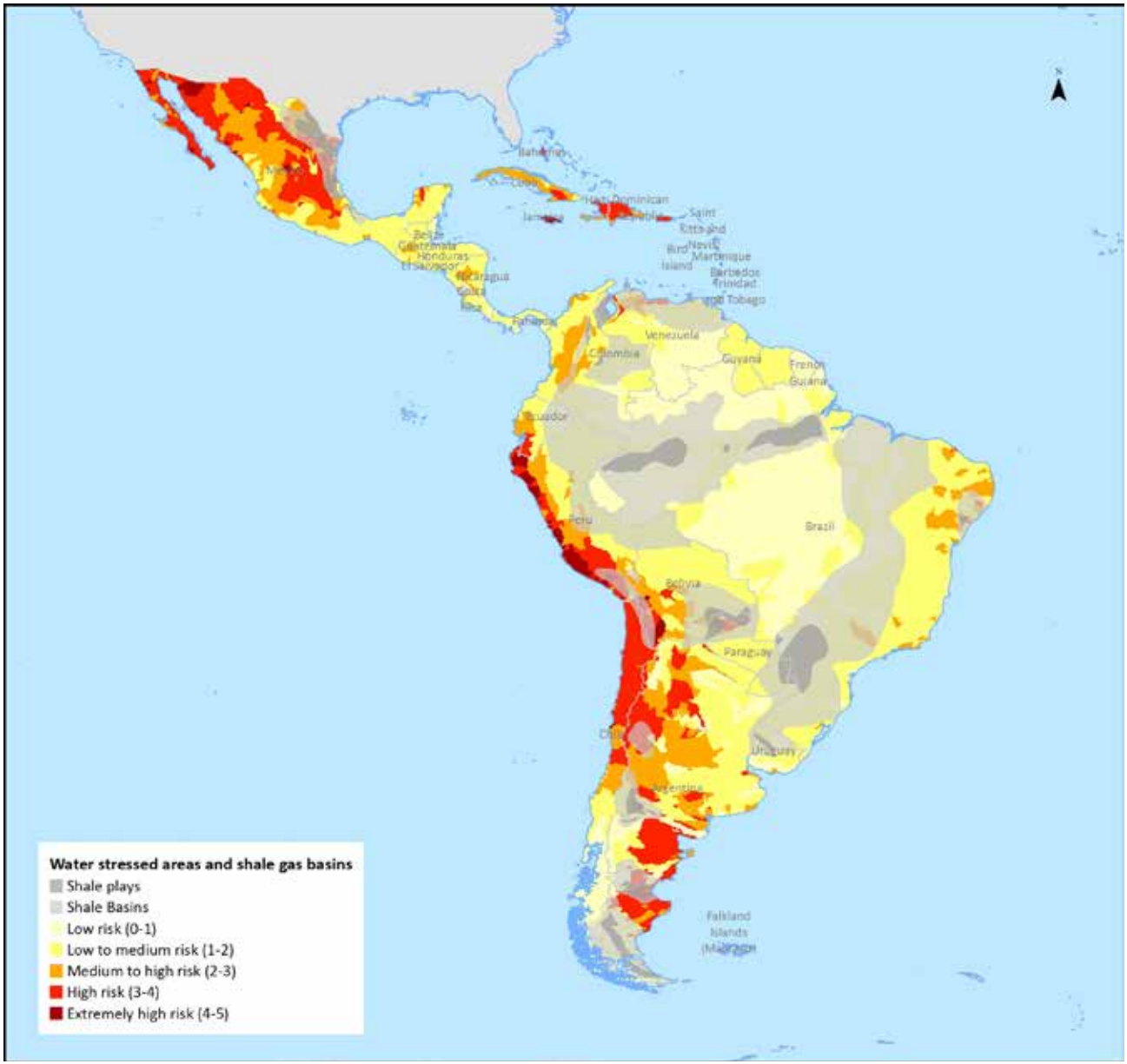
"Although many sectors and economic activities are being affected by climatic changes the energy sector is particularly vulnerable to climatic changes. Hydropower generation is sensitive to the amount, timing and geographical patterns of precipitation" (Kabat and van Schaik 2003) (**More...16**). Brazil gets about 70 per cent of its electricity from hydroelectric power. In 2015 the country experienced one of the most debilitating droughts in its recorded history. Due to a decrease in rainfall, reservoir levels and lake flow, many hydroelectric facilities neared zero capacity, triggering power cuts in several major Brazilian cities (Poindexter 2015).

In a recent past, high oil prices coupled with increasing energy demand, new technologies, and reduced quantities of oil in some areas have led to the implementation of new extraction methods, such as hydraulic fracturing or fracking. This is a technique of extracting oil and gas from dense rock or sand using water, sand and chemicals at very high pressure. Around 20 000 cubic metres of water are required to build, drill and fracture a typical well (IWA 2014). To date, there is no comprehensive assessment or reliable information on the impacts of fracking on water resources in the region where wide-scale operations take place. Useful assessments might consider current competition for the use of water resources, the water-energy-food nexus and the variability of the hydrological cycle due to climate change. **Figure 2.2.11** shows the areas where water resources might be under pressure in the future. In order of magnitude, Argentina, Mexico, Brazil, Venezuela, Colombia and Paraguay are the countries with more technically recoverable shale gas resources in the region (WRI 2015). Water stress conditions affect Mexico specially (**Figure 2.2.11**).

Livelihoods

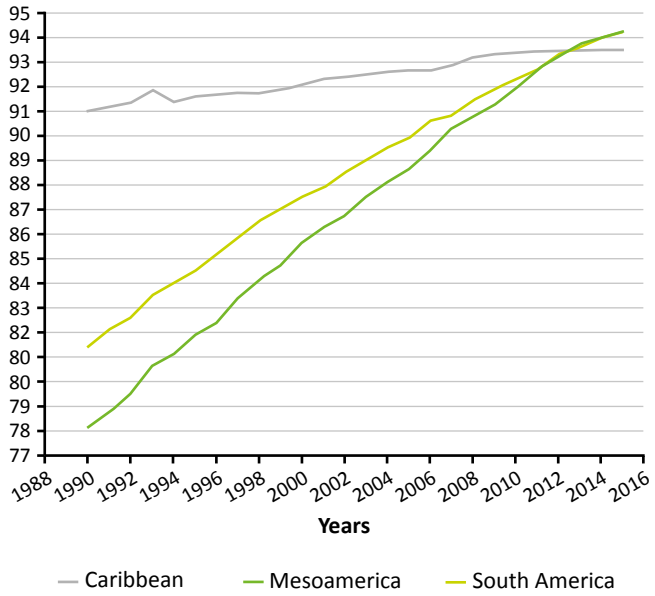
As **Figure 2.2.12** shows, there has been an increase in water and sanitation coverage in the region. However, 30 million people still lacked safe water supply in 2013 (World Bank 2015). One of the most notable impacts of water resource

Figure 2.2.11: Water stressed areas and shale gas basins in Latin America and the Caribbean.



Source: WRI 2015

Figure 2.2.12: Improved drinking water coverage in Latin America and the Caribbean and sub-regions (percentage).



Source: UN 2015

variability and extremes is on human health (see **Table 2.2.5**), either through water scarcity or sudden abundance of it through natural disasters. It is now widely acknowledged that inadequate supply of water, collapsed sanitation systems and contaminated water are the main causes of illness, such as malaria, cholera, dysentery, schistosomiasis, infectious hepatitis and diarrhoea (OMS 2012). The impacts of this in different segments of the population are a sign of their vulnerability and of the growing gap between the rich and the poor.

A complex issue affecting livelihoods is the practice of productive activities at the small and artisanal levels, which many times use outdated and ill-managed systems that contaminate water. For example, artisanal gold mining in the Amazon basin is releasing important quantities of mercury to rivers and causing poisoning in humans and damage to ecosystem health downstream. At the same time, gold mining is an important source of income for poor families (**More...17**).

The provision of ecosystem services, key to sustain livelihoods through water for consumption, food and jobs in the fisheries and tourism sectors, is being affected by poor water quality. For instance, in Panama, fish kills due to intoxication with pesticides and waste as well as episodes of acute contamination of water sources for human consumption are frequently observed. Some of the affected rivers include the Changinola and Sixaola. La Villa River had two contamination episodes with the atrazine herbicide in 2014 leading to water supply restrictions (MINSA 2014). In Panama City, the disposal of wastewater and solid waste in the Juan Díaz river is affecting the capacity of mangrove forests to protect coastal settlements from tidal waves.

Considerations for sustainable development

The underpinning theme of GEO-6 is "Healthy Planet, Healthy People". Water and air are the environmental elements most directly related to human health. Economic and social development are slowly making populations less dependent on direct water withdrawal from rivers and aquifers and are instead expanding piped and tanked water supply systems. The next step, as stated in SDG 6.3, is to improve water quality, reducing the burden of disease on those who have recently gained access to improved water sources.

Water quality means safe water for drinking, producing food, bathing and many other uses. According to the World Water Assessment Programme (WWAP), the number of people without safe water could be as large as those who do not have access to basic sanitation (WWAP 2015). This clearly shows the need for action and for the success of the 2030 Agenda for Sustainable Development.

Table 2.2.3: Impacts of inadequate water, sanitation and hygiene in 2012.

	Death Rate	Deaths, children aged under 5 years	Deaths per 100 000 population	Disability-adjusted life years (DALYs) total. (000s)	DALYs, children under 5 years (000s)	DALYs per 100 000 population
Antigua and Barbuda	0.4	0.1	0.5	0.1	0	59
Argentina	148.7	30.7	0.4	14	7	34
Belize	2.1	1.2	0.6	0.3	0.2	87
Bolivia	353.7	220.7	3.4	30.5	22.6	290
Brazil	1137.4	168.1	0.6	89.8	39.6	45
Chile	53.7	1.6	0.3	5.2	1.9	30
Colombia	157.5	64.3	0.3	24	14.2	50
Costa Rica	17.6	1.3	0.4	1.8	0.8	38
Cuba	48.9	1.8	0.4	4.8	1.3	42
Dominica	0.2	0	0.3	0	0	42
Dominican Republic	111.5	78.9	1.1	12.2	9.4	119
Ecuador	147	75.7	0.9	14.3	9.9	92
El Salvador	80.4	28.7	1.3	6.3	3.9	100
Grenada	0.5	0	0.5	0.1	0	50
Guatemala	717.8	273.2	4.8	46.7	29.5	310
Guyana	18.8	8.3	2.4	1.6	1	198
Haiti	1769.8	886.1	17.4	124.5	84.3	1224
Honduras	333.1	76	4.2	19.3	8.9	243
Jamaica	27.5	4.3	1	2	0.9	72
Mexico	729	227.9	0.6	69.6	40.7	58
Nicaragua	101.1	61.3	1.7	9.3	7	155
Panama	79.1	30.8	2.1	6	3.5	157
Paraguay	83.2	46	1.2	7.5	5.5	112
Peru	99.9	40.2	0.3	9.7	6	32
Saint Lucia	0.7	0	0.4	0.1	0	44
Saint Vincent and the Grenadines	0.4	0	0.4	0	0	43
Suriname	2.4	0.6	0.4	0.3	0.1	55
Uruguay	18.8	1	0.6	1.2	0.4	34
Venezuela	199.7	97	0.7	21.4	14.3	72

Source: Global Health Observatory data repository, Burden of disease. Inadequate water in low- and middle-income countries (WHO 2015b)

2.2.5 Responses

Access to safe drinking water has been a longstanding challenge for the region (**More...18**), but significant policy reforms to foster alignment of fragmented national and cross-jurisdictional policies have provided the foundation for integrated practices in many parts of the region. Another important issue is the political importance placed on access to potable water as a basic right of every citizen, which often triggers strong political ambition to provide household coverage.

Integrated Water Resources Management

Integrated Water Resources Management (IWRM) has been widely acknowledged as a way of achieving long-term solutions to water problems because of its interdisciplinary approach (UNEP 2012a). It is also one of the best approaches to managing the impact of climate change on water. IWRM has not been fully implemented in the region (UN Water *et al.* 2012), but advances in legislation, institutional mechanisms and action plans at local levels are a first and very important step towards sustainable water management and socio-economic development (**Table 2.2.6**).

Policies and legislation are not the only indicators of implementation of IWRM or improvement of water governance and management, as in many cases the implementation of these national instruments lag behind. For IWRM to work, stakeholder participation and good quality up to date information is essential.

Knowledge about the variability of the distribution of water resources is key for their governance and management. While global, regional and national trends can inform policy makers, local information is very important for socio-economic activities and investment, as well as for supporting livelihoods.

Water quality and quantity information is essential for IWRM. Stakeholder involvement and decision making also require up to date information and analysis on how water quality and quantity is affected by land use activities, climate change impacts and infrastructure development. Increasing the capacity in communities to support the implementation of IWRM has shown to not only improve the management of watersheds but also contributed to the improvement of community livelihoods (**More...19**). Moreover, water resources are not static: they interact with the atmosphere according to seasons and flows through natural connections: i) surface water to groundwater; ii) rivers to lakes; iii) glaciers to lakes and rivers; iv) surface freshwater to the sea. Marine

Table 2.2.4: Referential list of policies, programmes and plans on progress towards integrated water resources management in Latin America and the Caribbean.

Country	Action
Antigua and Barbuda	Sewerage management strategy (2011)
Argentina	IWRM Roadmap - Sub-secretariat of Water Resources (2007) Creation of INA. (National Water Institute), Sub-secretary of Hydric Resources, and COHIFE. (Federal Hydric Council) Law of Minimum Budget. (Budgets or Standards) N° 25688 (2010) and National Glacier Inventory Creation of the Federal Water Council to establish Ruling Principles for Water Policy.
Bahamas	National IWRM Plan
Barbados	National Water Resources Management and Development Policy – National Water Law Emergency Drought Management Plan IWRM and Water Efficiency Plan

Country	Action
Belize	National integrated water resources management policy (including climate change)
Bolivia	National River Basin Plan Binational Authority of the Titicaca Lake Basin. (Bolivia-Peru) Strategic Programme for the bi-national Bermejo Basin. (Bolivia-Argentina)
Brazil	National Water Resources Plan - Ministry of Environment. (SRH/MMA), National Water Council. (CNRH) and National Water Agency (ANA) (2007) Water Conservation Funds
Chile	National Policy for Water Resources 2015
Colombia	National Development Plan 2006-10 - National Planning Department. (2006) Water Conservation Funds
Costa Rica	National Strategy for integrated Water Resources management National IWRM Action Plan National Water Law
Cuba	National Water Policy – Ministry of Science Technology and Environment. (2000) National Water Strategy – Water Conservation and Efficient Use Strategy National Environmental Strategy
Dominica	Hurricane Preparedness Plan for water supply services
Dominican Republic	Mesoamerican Strategy and Plan for IWRM National Hydrologic Plan
Ecuador	Water Conservation Funds Territorial Planning and Sustainable Development Plan for the bi-national Basins Mira, Mataje and Carchi-Guaitara Inventories of drinking water and groundwater
El Salvador	Trifinio Plan National Plan for IWRM
Grenada	Simultaneous preparation of IWRM Road Map and National Water Policy – Water Policy Steering Committee Tariff Reform 2010
Guatemala	National Water Policy (2004) Plan for the Sustainable Use and Management of Water Resources (Initiative 3419) - (2005) National Law for the Protection of River Basins (Initiative 3317) - (2006) National IWRM Policy and Strategy (2006) Environment and Natural Resources Protection and Conservation Policy (2007)
Guyana	Water Safety Plan National Water Council
Haiti	Haiti's Artibonite Valley. Initiatives

Country	Action
Honduras	IWRM Action Plan - Honduran Water Platform. (2006) Vision and Nation Plan towards 2038, considering watersheds as the basic unit for territorial planning
Jamaica	National Water Policy, Strategy and Action Plan National Water Resources Development Master Plan National IWRM Framework - Water Resources Authority (2011) Natural Resources Conservation. (Water and Sludge) regulations (2013)
Mexico	National Hydrological Plan 2014 – 2018 Water Banks National System of Water Information
Nicaragua	General Law on National Waters (2007) Programme for the Sustainability of the Water and Sanitation Sector in Rural Areas
Panama	National Investment Programme for the Restoration of Priority Basins – PROCUENCAS Water and Sanitation Programme in Indigenous and Rural Areas with emphasis on community management
Paraguay	National Water Resources Plan IWRM Initiative in the Eastern Region of Paraguay National Water Resources Registry
Peru	Action Plan 'Lima 2040' Economic Regime for Water Use
Saint Lucia	Water Safety Plan 'Trust for the Management of River' in the Fond D'or watershed
Saint Kitts and Nevis	OECS Model Water Policy and Legislation Water resources management plan for the Basseterre Aquifer Valley
Saint Vincent and the Grenadines	IWRM Road Map for Union Island Water Safety Plan
Suriname	Water Forum Suriname Suriname Water Resources Information System
Trinidad and Tobago	National Integrated Water Resources Management Policy (2005) Water Pollution Rules (2006) Integrated Coastal Zone Management Policy (Draft 2014) National Spatial Development Strategy (2014) Adopt A River Programme. (2011)
Uruguay	Water determined as a Human Right in the National Constitution Act National Response System to Climate Change
Venezuela	National Water Plan 'Every Drop Counts' Campaign based on national drought study (2014)

Source: compilation from different sources

waters can also permeate into aquifers, resulting in salt intrusion.

Monitoring, information management and dissemination

There are many initiatives that study and monitor patterns in the distribution of water resources, notably:

- Those which study precipitation variability in the light of climate change, for example the World Climate Research Programme. They use numerical models based on state-of-the-art technology and scientific knowledge. Many of the models produced are global, with adjustments at the regional level, but still with a coarse resolution and high uncertainty if downscaled.
- *In situ* hydrometeorological observations and measurements in the field using specialized equipment. The devices range from outdated to high-tech in different locations of the region, but are poorly distributed in terms of providing a fully reliable picture of actual hydrological patterns at the regional scale. The density of hydrometeorological stations in LAC varies among countries but, considering the average range of measurements, is generally low (**Figure 2.2.13**).

Meteorological forecasting is particularly challenging in many countries of the region. The lack of a reliable and meshed regional observation network, coupled with the complex topography make the operational use of Limited Area Models quite difficult. For this reason, early warning systems based on coupled *in situ* monitoring, remote sensing data and numerical models are a fundamental tool for keeping the water cycle under constant review.

Several countries have also been building up the institutional and scientific framework needed to have good quality information on water quality and quantity. The water agency in Brazil (ANA) is now monitoring a significant network of freshwater resources throughout the country and has done so based on information collected and provided by the different states. Many countries are collecting data but there is a need to better integrate, coordinate and systematize data collection efforts by institutions at different scales in order to enhance our understanding of the state and trends in water quality and quantity. This information is key for any management effort, just as information on employment, GDP or poverty is essential to run economic policies.

The water – energy - food nexus

According to the IWA, "solving the water-energy nexus to preserve our environment is undoubtedly the challenge of this century" (IWA 2014). In fact, finding a balance between the use of energy-for-water and water-for-energy is a complex task from a decision-making perspective.

Unlike past practices, investment projects in agricultural infrastructure rely heavily on long-term projections of seasonal water availability, runoff and other climate variables. The relevance of water availability for the agricultural sector is related not only to irrigation demand, but also to soil quality and plant growth. This means that a constant monitoring at all production scales is needed to guarantee satisfactory yields.

In the case of energy production, traditional sustainable energy sources[13] such as biofuels require large quantities of water for production, in this case water for plant growth, while fossil fuel plants require water only for cooling. Under projected drought conditions in some areas of the region, plans for bioenergy production should take into account irrigation requirements. Fossil fuel plants will need to be resilient to extreme events, and a lack of cooling water might force them to reduce their output.

With regards to the provision of drinking water, there is a link between water quality deterioration and energy needed to provide potable water. Every effort placed on maintaining water quality from drinking water sources will also have an effect on energy consumption.

13 "sustainable" is usually attributed to energy sources with low carbon footprint, e.g. with low GHG emissions.

The MDG on water and sanitation[14] was achieved by a number of countries in the region, mainly through the development of infrastructure. As the achievement of universal access to drinking water and sanitation (SDG 6.1), to food security (SDG 2), and to sustainable energy (SDG 7) have become a priority, a comprehensive approach, based on reliable and updated information, is necessary. The Supplementary Information (**More…20**) identifies the links betweeen different SDGs on water, food and energy that have potential to be addressed by comprehensive policies that take into account the water-energy-food nexus.

Figure 2.2.13: Latin America and the Caribbean, meteorological stations.

Source: WorldClim 2015

14 "Halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation".

2.3 Oceans, Seas and Coasts

2.3.1 Overview and main messages

From the rains to rivers to oceans and seas, the cycle of water through the planet connects every human, plant and animal. These links across multiple habitats and ecosystems are often poorly understood. The natural connection between fresh and seawater is a complex system in which hydrological processes and ecosystem interactions take place and cannot be decoupled. Rivers and streams transport freshwater and nutrients into estuaries and eventually into the seas. However, this linkage also allows land based pollution to enter marine areas.

Coastal zones are the end point of many river basins; therefore they cannot be managed in isolation. Of particular importance are those South American rivers that discharge large quantities of freshwater to the Caribbean Sea. Deltas are also a good example of areas where sedimentation, erosion and beach dynamics are in a delicate equilibrium. In LAC, deltas are formed at the end of major rivers with large and highly impacted basins like the Amazon, Paraná, Paranaiba (all in Brazilian territory), Orinoco (Venezuela) and Bravo (Mexico).

Recognizing their close relationship is important to guarantee that the ecosystem services provided by the marine environment (food provision, carbon storage, coastal protection and flood regulation, recreation and sense of place) will be available to future generations.

2.3.2 Pressures

Land use change (LUC) is a concept that encompasses a series of events, processes and actions that lead to environmental change. It refers mostly to land-clearing activities such as expansion of agriculture/cattle ranching, urbanization, construction and mining, but it includes also the establishment of protected areas and site restoration, among others (see Section 2.4). LUC, not only at the coast but

Key Messages: Oceans, Seas and Coasts

The LAC region has a maritime territory of 16 million square kilometres and 64 000 kilometres of coastline (World Bank 2015). Even though some of the coastline is protected by coral reefs, sea grass beds and mangrove forests (**More...21**), they are still vulnerable to natural and man-made threats. Improperly managed coastal developments have created serious problems related to water pollution from land-based sources, degradation of critical habitats, and depletion of natural resource stocks. These impacts negatively affect the economy and society through loss of employment, increased costs of living, decreased investment and health problems.

Climate change and its associated impacts coupled with degradation of natural defences (mangroves, coral reefs, etc.) have made the coastal zone more susceptible to disasters. More than 8.4 million people in LAC live in the path of hurricanes, and roughly 29 million live in low-elevation coastal zones where they are highly vulnerable to sea-level rise, storm surges, and coastal flooding (World Bank 2014b).

Governments need to identify areas that are most at risk and implement adaptive strategies in the most cost effective and integrated manner. Although local waste collection campaigns take place frequently in different parts of the region, they can´t cope with the magnitude of the waste stream into the oceans. Governments need to design comprehensive policies at all levels to ensure proper disposal of waste in all forms.

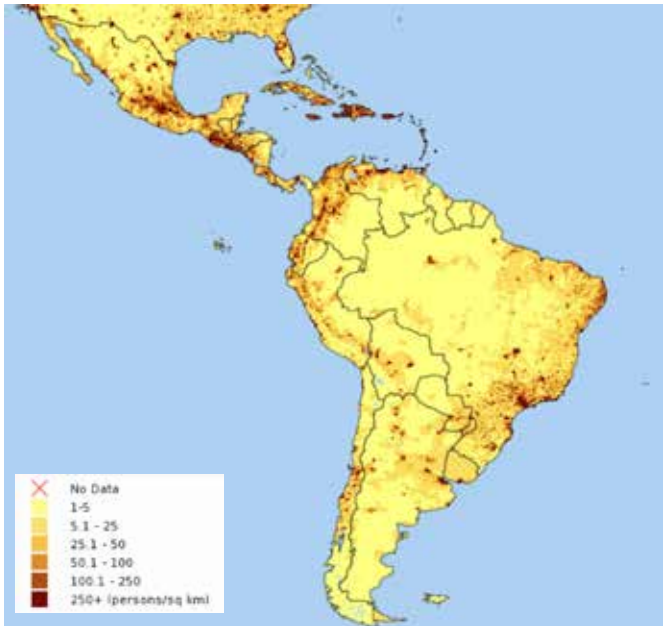
There is an urgent need to address the challenges that are described in this section. One of the main challenges for the future is the need for a more effective and integrated approach to the management of marine resources. The achievement of national and international goals on sustainable development will depend ultimately on new consumption and production patterns, institutional capacity building, pollution control, financial investment, monitoring, information management and dissemination.

in very distant areas inland of the coast can have a significant impact on the marine environment. Urbanization in particular continues to transform areas near river courses and low-lying coastal areas. **Figure 2.3.1** shows the population distribution in the region being highly concentrated along the coastline, especially in the Caribbean islands and also in large cities like Bogota, Rio de Janeiro or Lima, and along important rivers (Buenos Aires at the Rio de la Plata River or Manaus at the Amazon River). Many economic activities such as tourism and shipping are also concentrated in coastal areas (IDB 2016). In Small Island Developing States, pressures arise over limited land resources as people are dependent on them for economic development and their livelihoods.

Together with LUC, extreme climatic events trigger changes in beach extent, in the amount of sediments and pollutants released to the sea and in the health of marine/coastal ecosystems.

Finally, consumption and production patterns are becoming a bigger and more important pressure on coastal areas. World Bank (2012b) highlighted that there is a connection between the income level and urbanization of a country and the amount of waste generated. A range of different industrial inputs and consumer products end up in marine waters as populations increase, consume more and lack capacity to recover, reuse or treat waste. Extractive and commercial

Figure 2.3.1: Population density in Latin America and the Caribbean.



Source: CIESIN 2015

activities are also a reflection of the global consumption and production patterns, as will be described below.

Coastal tourism

Ecotourism, typically small-scale and low impact, is not prevalent in coastal regions (Honey and Krantz 2007). Instead, coastal and marine tourism is dominated by mass tourism, where large numbers of people fill large beach front hotels and marinas. Marine litter in touristic beaches is a major concern (**More…22**). The majority of tourists come from outside the region. In the Caribbean, 35 per cent of the 24 million arrivals[15] in 2012 were from the United States of America, 14 per cent from Europe and 12 per cent from Canada (UN 2016; CTO 2013).

The influx of high numbers of tourists to coastal resorts inevitably results in problems in the treatment and disposal of the large amounts of solid waste and waste water (sewage). Not only do the nutrients contained in this sewage add to the levels of nutrients in the seawater (leading to eutrophication problems), but inadequate management can also easily result in health risks to tourists bathing or boating in the sea. Such health hazards for tourists can be self-defeating in attracting business in a highly competitive market.

A special case of these problems of waste and sewage is presented by cruise ships, particularly in the Caribbean, one of the major cruising markets leading globally at 34 per cent as the main target area in terms of itineraries and ship deployment in 2013 (UN 2016). Large cruise ships come into relatively small ports which have limited facilities for handling waste and sewage for the large influx of visitors on a daily basis. For instance, a moderate-size cruise ship transports around 3 500 passengers. On a one-week voyage it generates some 795 000 litres of sewage, 3.8 million litres of grey water, 500 litres of hazardous waste, 95 000 litres of oily bilge water and 8 tonnes of garbage (WWF 2015). It has been estimated that Caribbean cruise activity hosted 24.4 million passengers in 2015, an increase of 1.3 per cent from previous year (CTO 2016).

Urbanization and waste

As mentioned in Section 2.2, agriculture, industry and households compete for freshwater resources. In the case of marine waters and their resources, competition for the use of coastal land constitutes one of the major pressures. LAC´s coasts host cities and towns, recreation sites and increasingly other types of infrastructure. Therefore, knowledge of the degree of efficiency in the use of water is fundamental to understand the pressures of urbanization and waste on marine waters.

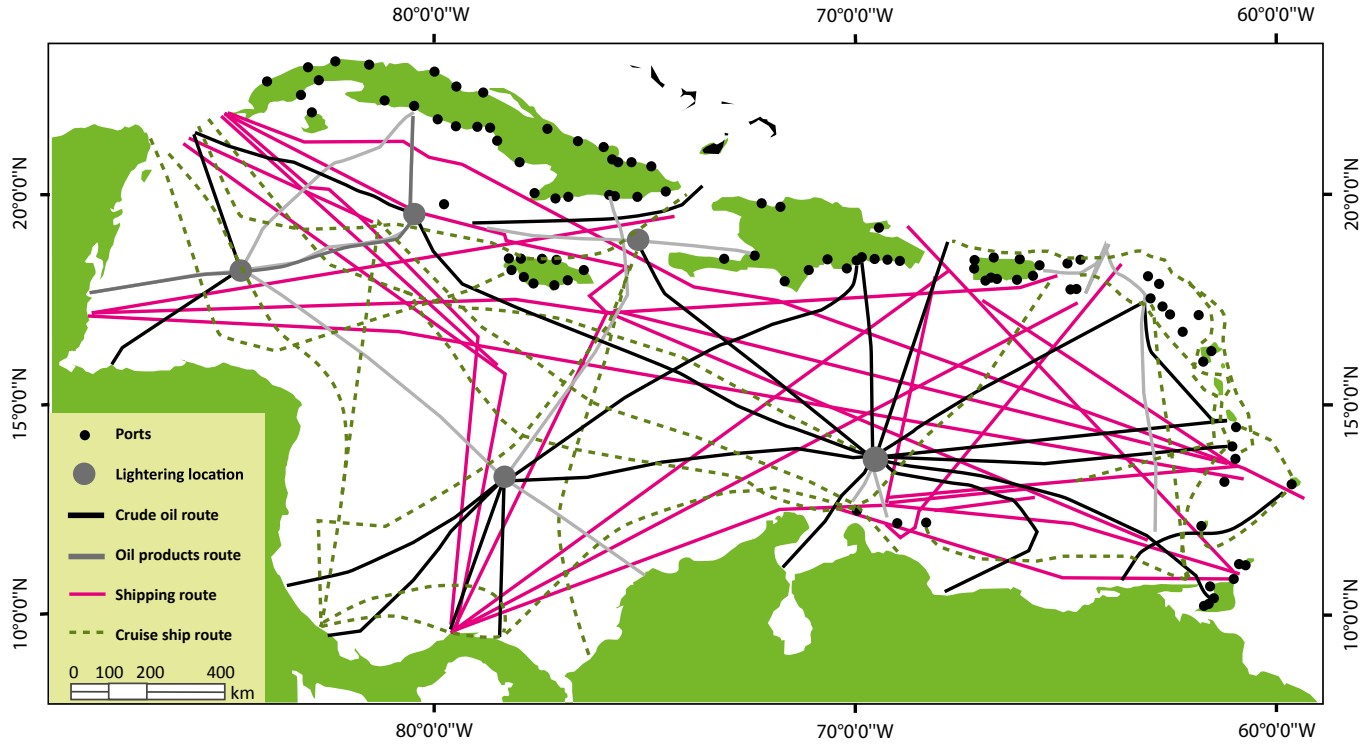
15 Caribbean Tourist Organization (CTO) includes Belize and Cancun, Mexico in Mesoamerica and Guyana in South America.

Also, a significant volume of the waste and untreated wastewater is dumped directly into the marine environment or is dumped into rivers and ends up in the sea. In Mesoamerica, except for Panama, urban settlements at the coast do not reach 100 000 habitants, but unsustainable consumption patterns and the lack of proper waste management in the basins of rivers flowing to the sea lead to serious environmental problems, even in communities where no intense tourism activities take place. This is the case in Omoa, a municipality in the border between Honduras and Guatemala whose beach was reported to be flooded with urban waste transported by rain through the Motagua River in mid-2015 (El Heraldo 2015).

Shipping: port activities and accidents

The sea waters have historically been the dominant transportation mechanism for moving large quantities of goods, especially over long distances. **Figure 2.3.2** shows the numerous shipping routes that create a web within the Caribbean Sea. In the last decade, the expansion of markets and increasing economic prospects fostered an increase in port activities, with an increase of 1.3 per cent in 2014. The largest investment in infrastructure development is the expansion of the Panama Canal, the gateway between the Atlantic and Pacific Oceans. Since its opening in 1914 the annual traffic increased from 1000 to 13 660 ships in 2013

Figure 2.3.2: Shipping routes in the Caribbean.



Source: Singh 2015

(ACS 2015) accounting for about 4 per cent of the world's trade (Scherer *et al*. 2014). The new locks of the canal allows the traffic of "Post-Panamax" ships through deeper and wider navigational channels. "Post-Panamax" ships have a cargo capacity of 13 000 twenty-foot-equivalent units (TEU), in contrast to the 5 000 TEU ships that currently cross the canal.

The pressures that sea transport and shipping have on the environment are mostly related to the waste and residues that their normal operations involve. This includes ballast water, sewage, solid waste, hazardous materials and old/broken/rotten parts of the ships or cargo. The maritime transportation of main commodities of LAC (minerals, grains, and oil and gas) tend to have a higher proportion of return journeys in ballast (UN 2016). Therefore, monitoring and inspection of ships are fundamental to maintain the health of the ocean.

Accidents on the sea can have acute effects on the integrity of marine areas and ecosystems. In the Wider Caribbean only 51 ship accidents have been registered in the period 2002 – 2013, of which 3 occurred in 2013 (UN 2016). In this region, ships are more vulnerable during the hurricane season.

2.3.3 State and trends

Marine water quality

The state of marine water quality of the LAC region has not been assessed thoroughly and with enough continuity. Therefore complete, open, updated and relevant information is not always available, as was confirmed in UNDESA (2015). The World Oceans Assessment (UN 2016) is the latest attempt to fill this gap, although specific data for the region is not included. Previously, Halpern *et al*. (2012) developed the Ocean Health Index, an indicator-based assessment of all Exclusive Economic Zones (EEZ) and high seas of the world. Combining indicators on water pollution and water governance[16] a "Clean Waters" score was calculated. The results show that, with 100 being the best score, EEZ in the Caribbean, Mesoamerica and South America had an average score of 55.13, 63.88 and 68.36, respectively. According to this study, the "cleanest" marine area in LAC is the South Pacific coast.

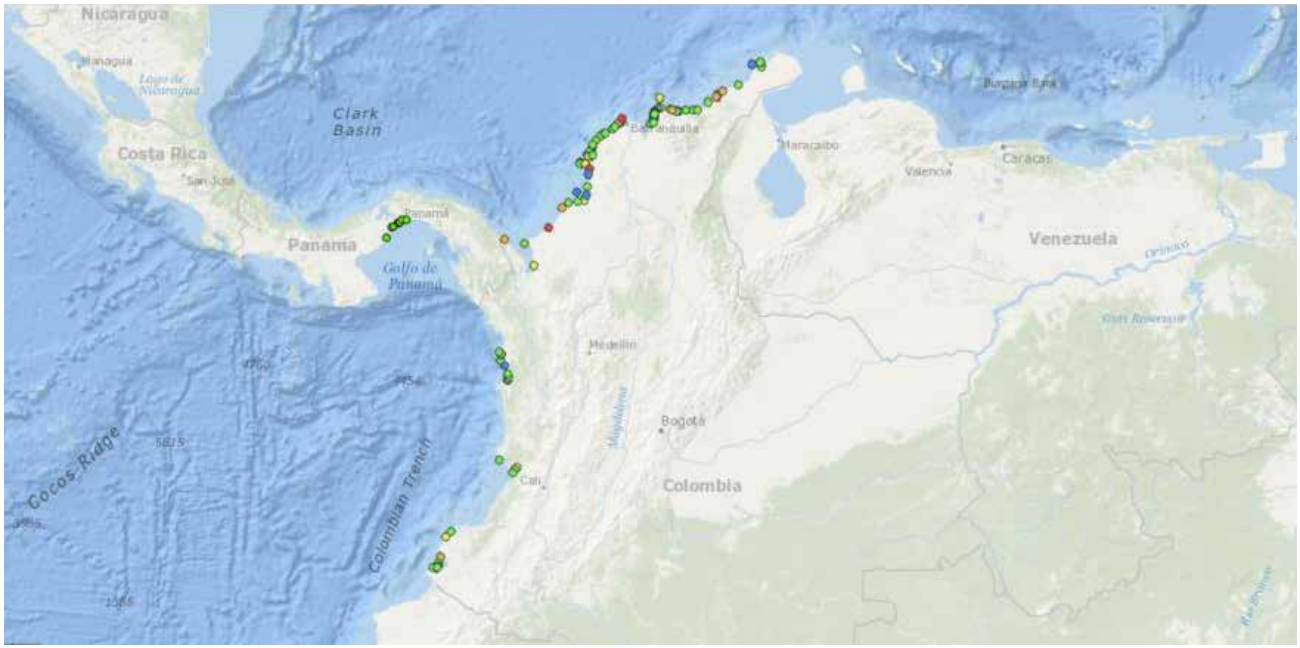
Marine water quality is mostly affected in the near-shore areas (direct dumping of solid and liquid waste from ships, abandoned and lost fishing gear as well as ballast water discharges) except for specific pollution events such as oil spills. Near-shore marine water quality depends on the effluent that is released from rivers and flows into marine areas. Some of the major activities that impact water quality are runoff of agricultural chemicals, improper wastewater treatment, deforestation and coastal development. It is believed that, because of the vast volume of the marine water, these pollutants are diluted. However, there are instances where the natural dilution capacity of the sea is being exceeded by the concentration of effluents (Campuzano *et al*. 2013).

Naturally, mangrove forests and sea grass beds act as filters to remove harmful pollutants, absorb nutrients from runoff and trap sediments helping to increase the clarity and quality of marine waters. Unfortunately, due to the development of some ports, harbours, marinas, tourism infrastructure and charcoal production these systems have been degraded or destroyed.

Data on salinity, nutrients, sea surface temperature, chlorophyll concentration and eutrophication for the region is derived mostly from global models, satellite products available from NOAA (2016), ESA (2016), WRI (2008) and other providers.

16 Indicators on pollution: chemical pollution and trend, nutrient pollution, pathogen pollution, trash pollution, trend in the use of fertilizers, coastal population trend. Indicators on governance: access to sanitation, weakness/strength of governance, Convention of Biological Diversity´s survey on water.

Figure 2.3.3: Marine water quality measured in different points of the Colombian and Panamanian coasts.



Legend: Green – adequate; Yellow – acceptable; orange – moderate; blue – unacceptable; red – contaminated

Source: CPPS 2015

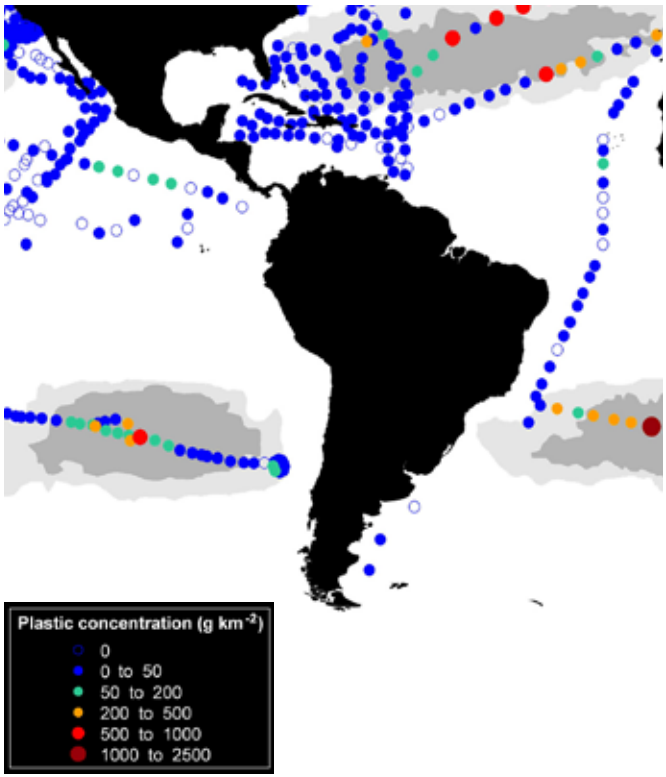
At the national level, several sources can be consulted; for instance, in environmental impact assessment studies, technical reports and some national environmental information systems. In the case of the Pacific coasts, the Southern Pacific Permanent Commission makes marine water quality data available for Chile, Colombia and Panama (CPPS 2015).

Waste is considered the fastest-growing pollution source for the oceans (UN 2016). Among municipal, electronic, industrial solid waste and abandoned fishing gear (collectively called *marine debris*) plastic is the element that has particularly raised the concern of environmentalists and policy makers given its long lifetime in the sea. The chemical composition and small size makes it particularly dangerous to marine biota. The fragmentation of plastic generates so-called microplastics (<5 mm in diameter), which are more harmful to marine animals than the larger size plastic debris (GESAMP 2015). After the Mediterranean, the Caribbean is reported to be the most plastic-contaminated sea in the world (RCA 2014). Estimations of the volume of plastic waste in this area range from 600 to 1 414 plastic items per square kilometre in different locations (RCA 2014; Law *et al* 2010).

Oceanographic anomalies and climatic events

Coastal and marine areas are some of the first to be affected by climate change through increased temperature of the oceans, sea level rise and increase in the frequency and intensity of storms and hurricanes.

Figure 2.3.4: Concentrations of plastic debris in surface waters of LAC. Coloured circles indicate mass concentrations. Gray areas indicate predicted accumulation zones.



Source: modified from Cozar *et al.* 2014

Ocean temperatures help to regulate the planet's climate, and one of the best examples is the El Nino Southern Oscillation (ENSO) phenomenon which happens seasonally as warm waters move West to East in the Pacific Ocean, altering climatic regimes in LAC. The region experienced one of the worse El Nino events in recorded history in 2015 (NOAA 2015) causing drought in some areas (Mesoamerica and the Caribbean) and floods in others (Paraguay).

High ocean temperatures also contribute to sea level rise (SLR), as warm water expands. As an example, Guayaquil, on the Pacific Coast of Ecuador, is projected to experience 0.62 metres (low estimate: 0.46 metres, high estimate: 1.04 metres) of sea-level rise if global temperature rises 4°C. In contrast Puerto Williams (Chile), at the southern tip of the South American continent, is projected to experience 0.46 m increase (low estimate: 0.38 metres; high estimate: 0.65 metres) and Port-Au-Prince (Haiti) is projected to experience 0.61 metres increase (low estimate: 0.41 metres, high estimate: 1.04 m) (World Bank 2014b). These projections can have disastrous implications for the low lying states of the Caribbean; a 1m SLR would displace an estimated 110 000 people in the CARICOM nations. Bahamas could have the highest percentage of national population affected (5 per cent) because of greater impacts on urban areas (3 per cent inundated). Other nations which could have substantive populations affected by a 1m SLR include Saint Kitts and Nevis (2 per cent) and Antigua and Barbuda (3 per cent) (Simpson *et al.* 2010).

The LAC region also experiences seasonal tropical storms, especially in Mesoamerica and the Caribbean. The projected influence of climate change indicates that the North Atlantic Basin will experience an increase in the frequency and intensity of the strongest tropical cyclones recorded since the 1970s (IPCC 2013).

Also, the occurrence of extreme waves is increasing (UNECLAC 2015c) and their impacts on maritime works should also be taken into account. There is a significant spatial variability of wave height in the region, with less than two metres in equatorial areas and 12 metres in meridional ones.

More than 8.4 million people in LAC live in the path of hurricanes, and roughly 29 million live in low-elevation coastal zones where they are highly vulnerable to sea-level rise, storm surges, and coastal flooding (World Bank 2014b). In 2010, 83 per cent of the population in The Bahamas

(around 293 500 persons) lived in urban areas, of which 23.5 per cent (around 69 000 persons) lived five metres below sea level.

2.3.4 Impacts

Storms and hurricanes can damage and remove corals from a reef through direct wave action, or cause indirect damage through abrasion by sediment and rubble and by depositing sediment which smothers the corals and blocks light (Mumby *et al*. 2014). The destruction of this sensitive ecosystem makes the countries that they surround more vulnerable to the impact of high intensity waves, leading to coastal erosion and infrastructure damage.

Near-shore marine water quality depends on the effluent that is released from rivers and flows into marine areas. The major activities that impact water quality are unregulated agriculture, improper wastewater treatment and coastal development. Some of the most devastating environmental incidents are reported in marine areas. In the last years, important accidents involving broken pipelines, crashed tailings, sinking ships and even negligence have been registered in the region.

Given the vast volume of the marine water, these pollutants are diluted. However, there are instances where the natural dilution capacity of the sea is being exceeded by the concentration of effluents (Campuzano *et al*. 2013).

Impacts on economic activities

In the absence of clear property rights or management, fisheries resources, coastal lands, beaches, mangroves and coral reefs can be depleted, encroached on or overused.

"These trends add to conflicts between, for example, the tourism sector and residents. Most hotels and resorts have developed close to the beach to create ease of access to visitors; however this sometimes limits access for locals. They contribute to escalating land prices, exposure to corruption, the displacement of traditional users, and even civil unrest" (Lemay 1998).

Tropical storms, believed to be more frequent and strong as sea temperature increases due to climate change, severely affect economic development and can generate significant losses and damages. For example, hurricane Ericka killed 37 people in Dominica in 2015 and left over USD 228 million in losses; nearly half of the annual GDP of the country (The Guardian 2015). Port infrastructure is particularly vulnerable to storms as well. The potential increase in tropical cyclone intensity may increase ships' port downtime and thus shipping costs (World Bank 2015).

Changes in extreme waves will determine the design of future infrastructure. CEPAL (2015) estimates that, if long-term changes are not considered, the capacity of future infrastructure could be reduced by around 60 per cent by 2070. Some of the most impacted areas are the coasts of Uruguay, Brazil and the Pacific coast north of Ecuador. In the Caribbean, where the height of waves will not increase significantly, infrastructure is affected mainly by tropical storms.

Rio Doce (Brazil), driving toxic mud into the Atlantic ocean after a mine tailing dam burst in 2015.

Credit: Ricardo Moraes, Reuters

The impact of climate change on fisheries is related to a shifting fish distribution and irregular productivity of fisheries. In the Eastern Pacific region, especially in Peru and Colombia, fishing is dominated by catches of small pelagic fish which respond sensitively to changes in oceanographic conditions such as temperature and pH (Allison *et al*. 2009; Magrin *et al*. 2014; World Bank 2014a). More information on fisheries resources is provided in section 2.3.

The appearance of invasive species in coastal and marine environments can also be related to increasing sea temperature. In 2015, many islands of the Caribbean experienced a high influx of *Sargassum* seaweed washing up onto shores, reportedly three to four feet high in some locations (Caribbean Council 2015). It has been theorised that this event was due to warm water temperature and low winds affecting ocean currents. *Sargassum* has also been linked to increased nitrogen loading due to pollution of the oceans through human activity and increased sewage, oils and fertilizers (CAST 2015). Although the appearance of *Sargassum* is a recurrent phenomenon which is not harmful to humans, it does affect fisheries and the tourism sector by limiting access to the beach and generating visitors' complaints on the strong, bad smell that *Sargassum* emits as it decomposes.

Impacts on health

In the absence of public health services and beach cleaning programmes, from 10 to 100 times more bacteria can be found at the beach than inland (Seas *et al*. 2000). Bacteria (notably the *Vibrio* species responsible for cholera) also thrive in sea waters well populated by plankton and algae, whose increase can be a result of high temperatures in both ocean water and ambient air (Seas *et al*. 2000).

Vibrio cholerae, as well as other infectious bacteria and viruses are also commonly present in large quantities in the ballast water of ocean-going vessels and can be widely disseminated. Millions of litres of ballast water are released into ports every day, releasing also microorganisms in the sea. Viruses can live in the ocean for days or weeks and can be transported long distances through ocean currents (Ruiz *et al*. 2000).

Video 2.1.1: A view of the Sargassum invasion in Barbados.

https://www.youtube.com/watch?v=Izdo2hm8bIo

Plastic waste can be dangerous to humans in many ways. Over time, polymer chains are broken and may enter the human body by, for example, drinking contaminated water or eating fish that has been exposed to toxins (Seltenrich 2015). Substances like bisphenol A (BPA), phthalates and diethylhexyl phthalate (DEHP) have been linked to cancer, birth defects, immune system and hormonal problems and developmental effects in children (Rochman *et al*. 2015).

There are potential health risks from consumption of seafood, particularly at higher trophic levels where environmental contaminants may be concentrated, and where there are occasional outbreaks of toxins in shellfish (UN 2016). One of the main chemicals in fish and shellfish is methylmercury (MeHg), present in species like tuna, marlin, swordfish, shark and pike.

2.3.5 Responses

As of 2015, LAC had 756 marine protected areas (MPA) which covered about 300 000 square kilometres (about 1.6 per cent of marine exclusive zone). The largest MPA in LAC is the marine reserve of the Galapagos Islands in Ecuador (133 000 square kilometres), followed by the biosphere reserve

Seaflower in Colombia (60 000 square kilometres) and the whale sanctuary Banco de la Plata in the Dominican Republic (25 000 square kilometres). Currently, Haiti and Guyana have not declared marine or coastal areas for conservation (National Geographic 2016).

Argentina, Uruguay and Brazil are all committed to the expansion of marine protected areas, in particular the prohibition of whaling activities in their jurisdictional waters. In 2015 there was a proposal of the South Atlantic Whale Sanctuary (SAWS) by the government of Argentina, Brazil, Gabon, South Africa and Uruguay with the support of the International Whaling Commission members (IWC 2016).

In 2014, with the implementation of the Eastern Caribbean Regional Ocean Policy (ECROP), Caribbean States included ocean economy in their development model, and many countries are pleading for greater conservation efforts such as the Caribbean Challenge Initiative which aims to bring 20 per cent of the coastal area under conservation.

With respect to marine pollution, an interesting example is the Regional Action Plan for Marine Litter (RAPMaLi) for the Wider Caribbean Region. Established in 2007, RAPMaLi promotes collaboration and engagement of a wide range of actors in actions aimed at improving the management of marine litter, at local and regional scales (UNEP 2014c). The network includes health, environmental, conservation, education, tourism, and waste management bodies (UNEP 2009). Several international organizations are including litter pollution in the Caribbean in their programming and institutional collaborations: the International Maritime Organization (IMO), the United Nations Educational, Scientific, and Cultural Organization (UNESCO), the Intergovernmental Oceanographic Commission (IOC), the Sub Commission for the Caribbean and Adjacent Regions of the Intergovernmental Oceanographic Commission of UNESCO (IOCARIBE), the UNEP Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (UNEP/GPA), and the Regional Seas Programme of UNEP (UNEP 2009).

Also, countries like Argentina and Chile foster research. Argentina launched the Pampa Azul project, a ten-year strategic initiative with the aim of researching South Atlantic resources in five different areas, to ensure conservation and management through inter-disciplinary campaigns and inter-ministerial support, with the scientific leadership of Argentina's Science, Technology and Productive Innovation ministry.

Integrated Coastal Zone Management

Integrated Coastal Zone Management (ICZM) represents a cross-sectoral, inter-agency, and multidisciplinary approach to the many and varied issues affecting the biological, physical and social resource base within the wider coastal and oceanic environment (Cicin-Sain and Knecht 1998). ICZM has been implemented in Argentina, Barbados, Brazil, Colombia, Costa Rica, Ecuador, Mexico, Jamaica, Venezuela, Uruguay, St Lucia, and Belize. In Trinidad and Tobago a steering committee was sanctioned to produce an ICZM Policy for the country. A coastal zone management policy cluster includes the establishment and execution of legislation, regulations, standards and procedures to prevent or minimize environmental degradation, and to protect and

Video 2.1.2: Coastal patterns in Haiti.

https://www.youtube.com/watch?v=eThpDsywyzc&list=PLZ4sOGXTWw8E52arV33cD

Video 2.1.3: Building Resilience in the Caribbean.

https://www.youtube.com/watch?v=Ct1NfFfQNXo

restore the quality and function of ecological systems within the coastal zone (UNEP 2012a).

One of the greatest hurdles in the implementation of ICZM, especially in small islands, is the definition of the coast. By traditional definitions, an entire country in the Caribbean can be defined as a coastal zone due to its size and this may be the cause of conflict between different regulatory agencies due to overlapping jurisdiction.

Transboundary cooperation

A number of international agreements and conventions have been signed in the last 40 years, notably the MARPOL Convention on Prevention of Pollution from Ships and the London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, with 30 and 21 signatories respectively in the region. In addition, some countries have established Particularly Sensitive Sea Areas (PSSA) where special provisions for ship transit exist. In the region, these areas are: i) the Sabana-Camagüey Archipelago (Cuba); ii) the Malpelo Island (Colombia); iii) the Paracas National Reserve (Peru) and iv) the Galapagos Archipelago (Ecuador), as well as the Saba Bank in the Dutch territory of the Caribbean (UN 2016). Additionally, the MARPOL provides protection of the Antarctica south of 60 degrees North where not more than 15 ppm of oil should be found in marine waters. According to UN (2016), these legal instruments have fostered the development of waste management facilities in the ports of the region, although enforcement still poses challenges for governments and much capacity development is needed.

Another key action to address the impacts on marine areas is building the awareness and capabilities of the coastal communities. At the Caribbean Youth Environment Network (CYEN) for example, young people are taking up the responsibility to share and educate communities and other young people on issues affecting the coastal zone as well as the impacts of climate change. Existing in 19 different Caribbean countries, CYEN has contributed to the Regional Action Plan on Marine Litter (RAPMaLi) for the Wider Caribbean Region (UNEP 2014b), and to several other activities promoting greater participation, ownership, and also national and regional knowledge and awareness.

Best practices: fisheries, governance, industry practices, research

Recent assessments (UN 2016, UNDESA 2015, IPCC 2014b) note the need for information on several biogeochemical and physical processes which are not well known and whose impacts under climate change conditions cannot be predicted with the current state of knowledge. Also, understanding the benefits of marine ecosystem services to human well-being and the impacts of different management options are acknowledged as priorities for further research.

Maintaining the long-term prosperity and sustainability of marine fisheries is not only of political and social significance but also of economic and ecological importance. The United Nations Convention on the Law of the Sea (UNCLOS), the United Nations Fish Stocks Agreement (UNFSA) and the FAO Code of Conduct for Responsible Fisheries require maintaining or restoring Fish stocks at levels that are capable

of producing their Maximum Sustainable Yield (MSY). To fulfill the objectives of these international treaties, Fishery management authorities need to undertake assessment of the state of fish stocks and develop effective policies and management strategies. As the UN agency with a mandate for fisheries, FAO has a mandate to provide the international community with the best information on the state of marine fishery resources.

2.4 Land

2.4.1 Overview and main messages

As described in Chapter 1, Latin America and the Caribbean is rich in natural resources and has an exceptional diversity of ecosystems. The region includes 12 of the 14 world biomes

Key Messages: Land

Habitat loss and degradation continues to be common and one of the greatest challenges in the region. Deforestation, in the Amazon and in other forest ecosystems, and loss of the already decimated grasslands and the fragile mountain biomes are examples of these degradation processes. In turn, habitat degradation decreases ecosystem services, functions and biodiversity, threatening development and human well-being.

The widespread degradation of land ecosystems in LAC is mostly the result of unsustainable land management. Regional and international demand for products such as food crops, livestock, wood, oil, and mining from LAC, coupled with adverse socio-economic conditions and the need for foreign investment, exerts pressure on decision makers to prioritize short-term goals that may result in degradation of lands where the production of those goods and services takes place.

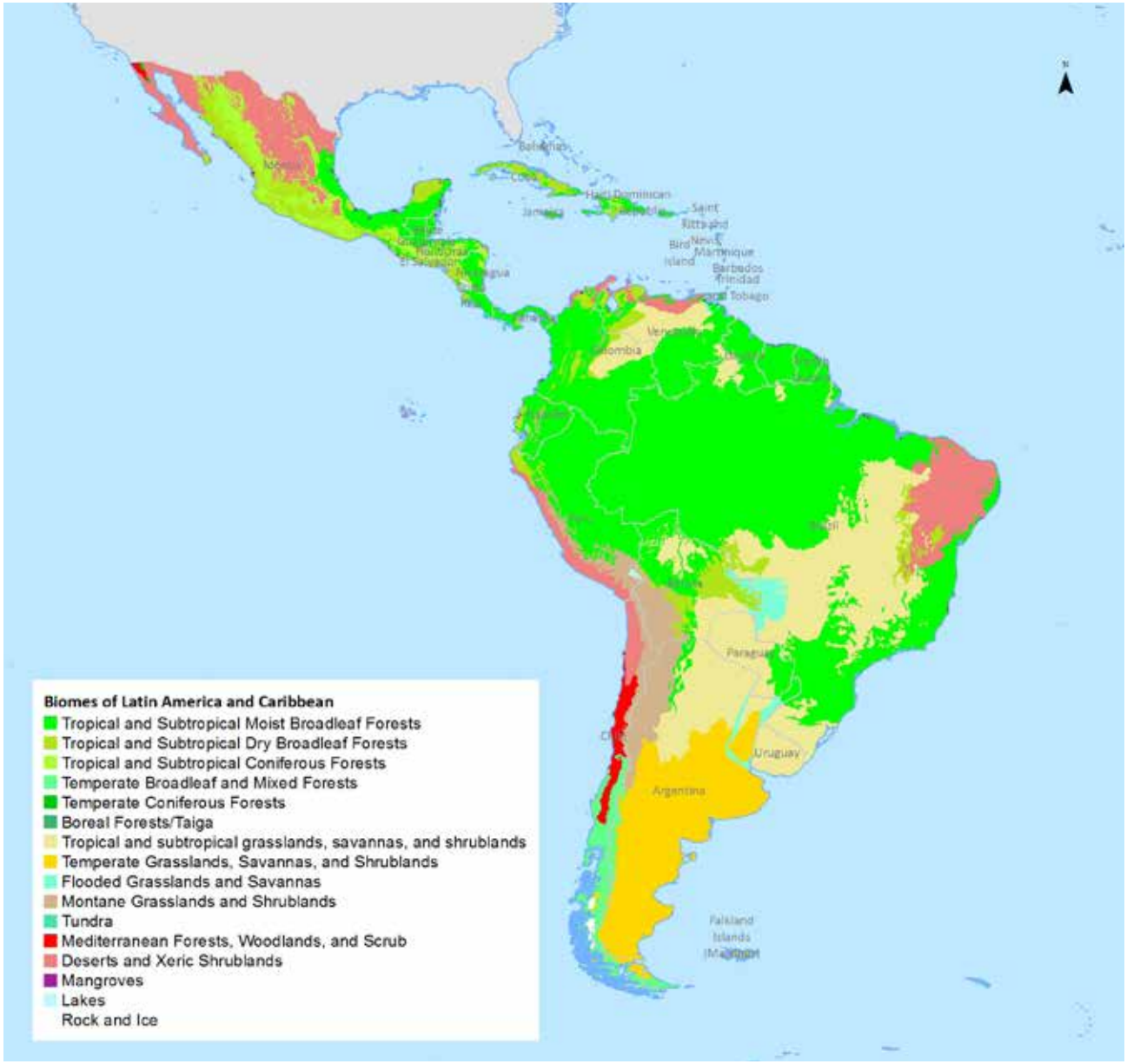
Illegal activities such as mining and logging, cause a very severe impact in the region. Government enforcement is essential to control these extremely damaging activities where some private individuals become rich while environmental impacts affect ecosystems and human settlements. The reduction of illegal logging and clearing in the Brazilian Amazon are examples of how adequate government policies can reduce environmental impact.

The increasing competition for resources (e.g. land) and the growing number of stakeholders (with disparate views, interests and decision making power) in land management and planning has led to a complex land governance structure, where conflicts among actors for finite resources are occurring and are likely to increase.

Land management strategies should remain flexible and include a variety of instruments aimed at reducing land degradation and maintaining the integrity of land that is essential for future well-being. There are sustainable land-management alternatives such as no-tillage agriculture that have been widely adopted in the region. The emergence of certification standards that require goods and services to comply with strict production requirements, environmental awareness, and government policies informed by scientific knowledge are some of the examples that lead to better land management practices that reduce environmental degradation while improving human well-being.

There are still many data and information gaps in the region. Although many countries have datasets available on land resources at various scales, others lack information. In addition, information may not be updated. Adequate decision making depends on the availability of good-quality and timely data.

Figure 2.4.1: Terrestrial Biomes of Latin America and the Caribbean region.



Source: Olson *et al*. 2001

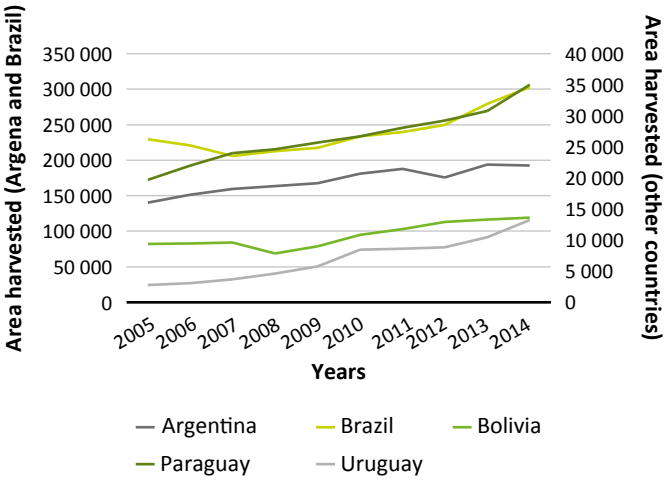
(**Figure 2.4.1**) and 191 of the 867 unique eco-regions of the world (Olson *et al.* 2001). If sustainably managed, this wealth can be the pillar for sustainable development in the region.

2.4.2 Pressures

Most LAC countries base their economies on the export of goods and services. This model relies on the increase of FDI in extractive activities and the "commodification" of natural resources to fight poverty, inequality, and to avoid economic crises or rebound from recession periods.

The driving forces described in Chapter 1 interact in synergistic ways and result in specific pressures on the region´s terrestrial ecosystems. Drivers include climate change, which amplifies the impacts of other drivers and pressures, and socio-demographic drivers, such as urbanization, ageing of the population, and changes in consumption patterns.

Figure 2.4.2: Soybean harvested area (km²) in Argentina, Bolivia, Paraguay, Uruguay and Brazil (2005-2013).



Source, FAO 2015b

The traditional knowledge developed in the Andes for the management of high mountain ecosystems is a valuable resource for adaptation to climate change, given that it was developed through cycles of seasons of climate variability. Nevertheless, conditions are needed in order to fully tap into this knowledge and make sure it strengthens local and traditional people´s adaptation capacity and resilience.

Land management

Agriculture and cattle grazing are the most widespread and, in some areas, the most important pressures leading to land transformation. Agriculture in the region has expanded and continues to grow, driven mainly by international demand for flexible crops that can be used for food, fodder, biofuels and industrial materials (Borras *et al.* 2012). Such demand is mostly derived from the 'westernization' of Asian diets, the reduction in trade barriers, and biofuel mandates (Rueda and Lambin 2014).

Large food-producing companies are part of this process, producing 'teleconnections'[17] between consumers and ecosystems otherwise distant and seemingly unrelated. China is the largest importer of soybean in the world, and 64 per cent of the world trade in this crop goes to this country (USDA 2015). As the demand continues to grow, soybean production has expanded in South America (**Figure 2.4.2**). In Bolivia, the international demand for soybean has caused a 21 per cent expansion in the cultivated area and an 84.7 per cent jump in the value of exports of this crop

17 The term 'land teleconnections' is used to describe causal relations between land uses over large geographical distances (Seto *et al.* 2009). The notion has been adopted from the atmospheric sciences, where it refers to causal links between different weather systems (Wallace and Gutzler 1981), and teleconnections have been defined as "the correlation between specific planetary processes in one region of the world to distant and seemingly unconnected regions elsewhere" (Steffen 2006). As pointed out by Haberl *et al.* (2009), the concept of teleconnections is very useful to understand land change processes globally and regionally, given the exponential growth in global trade of products relying on land resources (such as food, biomass and fibres). This concept has been already used for regional analyses, for instance in Africa (Friis and Reenberg 2010).

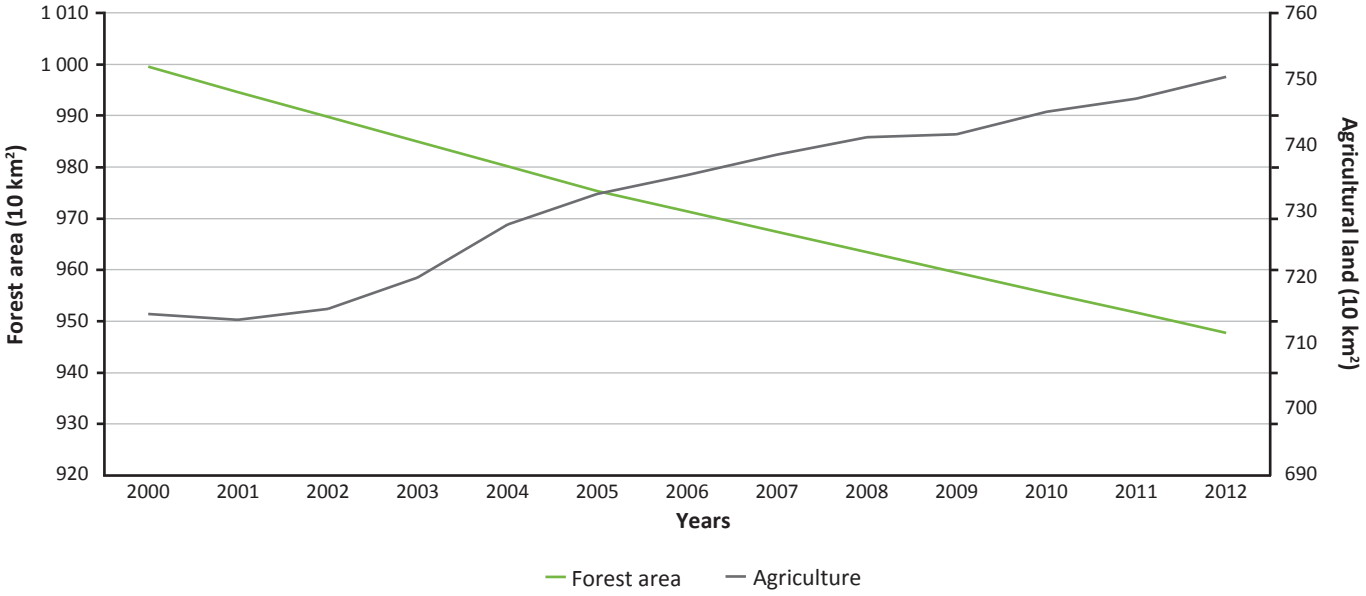
from 2008 to 2012 (IBCE 2013) This example illustrates how teleconnections are becoming a dominant process in land management decision making, connecting environmental pressures and impacts worldwide. These pressures result not only in agricultural expansion but also in a transformation of production systems to increase short-term productivity. This agricultural intensification implies the use of agricultural machinery, pesticides and other agrochemicals, and in some instances genetically-modified crops.

However, there is also a change in production systems associated with market conditions. Certified agriculture, for example, requires products to comply with certain standards that involve changes in production systems, for example limiting the use of certain agrochemicals.

In Brazil, the recent and alarming advance of soy in the cerrado (tropical and subtropical grasslands, savannas, and shrublands in **Figure 2.4.3**) is due to the development of new agronomic production technologies, including varieties that are better suited to regional weather and the cheaper price of soybeans compared to traditional livestock. That is why there are initiatives such as *"Alianza del Pastizal"* who seek to certify and add value to sustainable livestock on natural pasture, with indicators for soil conservation, grassland and biodiversity (De Patta Pillar and Lange 2015).

Soy bean production has transformed ecosystems, in particular the grasslands, shrublands and dry forests of Brazil, Argentina, Bolivia and Paraguay (see Section 2.3.3 on grasslands) *(pampa, chaco, cerrado)* (Aide *et al*. 2013). Meanwhile, some countries in the region have achieved significant results in reducing deforestation in recent years. In

Figure 2.4.3: Trends in forest and agricultural area in Latin America and the Caribbean, 2000-2012.



Source FAO 2015c

the case of Brazil deforestation in the Amazon fell from 27 772 square kilometres in 2004 to 5 831 square kilometres in 2015, a 79 per cent reduction (INPE 2015).

Expansion and intensification of animal grazing, such as cattle and sheep, as a result of the drivers described in Chapter 1, is also a pressure leading to land degradation in LAC. This expansion process is leading to forest clearing in some areas and to intensification in grassland areas in order to increase productivity, resulting in degradation of grassland ecosystems.

In some areas of the region, colonization for small-scale agriculture and grazing driven by rural-to-rural migration still remains a contributing factor to land clearing and ecosystem transformations, particularly in biodiversity-rich forest areas (Carr 2009; López-Carr and Burgdorfer 2013).

In addition to deforestation, the region is also experiencing reforestation and afforestation. Reforested areas in LAC are mainly plantations, but reforestation is also taking place in lands no longer suitable for agriculture, either because of land degradation or because of the costs required for transforming them in areas suitable for new agricultural production systems. In some instances, forest plantations have links to both deforestation and reforestation dynamics because, in some areas of the region, native forests are cleared to be replaced with exotic planted forests (**More...23**). Afforestation is a pressure in some of the grassland areas of the region where exotic species of trees are transforming the original grassland landscapes into forests (Buytaert *et al*. 2007; Farley *et al*. 2004; Hofstede *et al*. 2002a).

As introduced in Chapter 1, the expansion of tourism has the potential to be a sustainable alternative that promotes land stewardship through adequate management, generating incomes with less environmental impacts than other land management strategies. However, tourism is also resulting in pressures on existing land uses, usually displacing them to other areas. Furthermore, it has a potential to create social and cultural barriers that, in most instances, segregate spaces for tourists and local inhabitants, resulting in restrictions on access to land resources. It might also increase the intensity of land management strategies in areas where traditional activities still take place (Dixon *et al*. 2001; Verner 2009).

Land governance and land concentration

The liberalization reforms of the 1990s produced greater decentralization of land governance (Ravikumar *et al*. 2013) and the formal recognition of land rights for some traditional communities (Pacheco *et al*. 2012) in the LAC region. However, land tenure in frontier regions remains highly contested (Borras *et al*. 2012) and unequal in a region that already has one of the most inequitable land distributions (Deininger and Byerlee 2012). This situation exacerbates land conflicts, as multiple actors compete for the same land in a context where property rights are still not thoroughly defined or enforced. It also presents challenges for the use of policy instruments such as payments for ecosystem services.

Land concentration means that there is a large group of people with very little or no land at all. Landless rural dwellers exert pressure on remaining natural habitats through the expansion of the agricultural frontier. Land owners with very little land holdings usually have little access to other resources and livelihood strategies other than agriculture. They therefore may not have the option of letting the land rest (return to fallow). This may lead to overexploitation of the soil, leading to degradation (Griffiths 2004). The expansion of agribusiness and the production of crops for export pose several risks for the region: food crops for internal consumption may be replaced by export commodities and biofuels, compromising food security for the rural poor.

Infrastructure development

Infrastructure development, roads or dams, are usually the first stage of habitat degradation as it allows the inflow, either spontaneous or planned, of landless rural inhabitants and large landholders. For example, with the building of the Inter-oceanic Highway inaugurated in 2011, with a total final cost of USD 2 800 million and a length of 5 404 kilometres, a

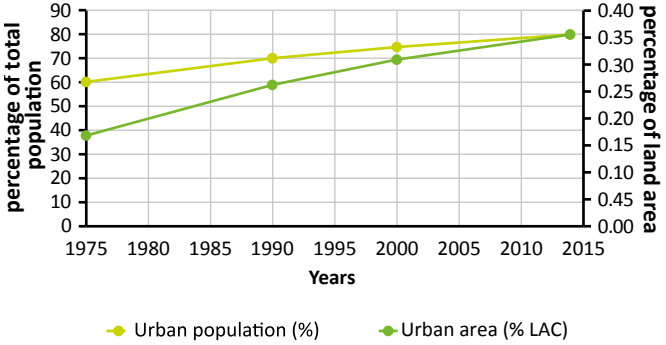
link has been created from the Peruvian ports of San Juan de Marcona to Brazilian ports and cities throughout the City of Rio Branco Special Export Zone (ZPE). Such an infrastructure, part of the Initiative for the Integration of the Regional Infrastructure of South America (IIRSA), is facilitating the transformation of forests and other ecosystems into agricultural lands and pasture for cattle grazing (Fraser 2014; Southworth *et al*. 2011; Calderón and Servén 2010; Delgado 2008).

The population in LAC is mostly urban, (Chapter 1) and growth rates indicate that the proportion of the urban population will continue to grow. (**Figure 2.4.4**).

Cities exert different pressures on land resources. Although their direct impact is restricted to a small area, it has more than doubled between 1975 and 2014 (Pesaresi *et al*. 2014). The indirect impact is more significant. As populations grow, cities need more resources and expand their footprint. At the same, time urban activities take over from rural activities at the edge of the city. At the rural-urban interface, agriculture and urban land uses coexist. However, the most profitable land use activity, usually urban, displaces others.

On the other hand, urban growth in the region is also accompanied by the abandonment of land in rural areas (Chapter 1). Rural development has favoured large landholders. Small holders flock to the cities in search of opportunities. This process reduces pressures on the countryside but usually results in spontaneous and unplanned urban growth (Seto *et al*. 2012).

Figure 2.4.4: Urban population (% of total population) and urban area (per cent of LAC).



Source: Pesaresi *et al*. 2014; UNEP 2016b

Mining and oil exploitation

As stated in Chapter 1, the region has experienced a rapid development of mineral resource extraction. Many countries of the LAC region have been exploiting mineral resources and hydrocarbons since the earlier part of the 20th century, while others have become increasingly dependent on these commodities for export only in recent years (OPEC 2015).

Oil exploration and mining usually displace other useful production such as agriculture, forestry, and cattle grazing. This means that mineral exploitation in one location produces an indirect pressure in other areas through the displacement of activities (Burneo *et al*. 2011).

Since many operations are in remote locations, companies build infrastructure for exploiting, transporting and even processing the mineral resources. This generates the same pressures on land as the building of other infrastructure (Carter 2005; Miranda *et al*. 2005).

Illegal mining is a significant environmental issue in many countries, mostly in South America. For instance, in Madre de Dios, an important area of the Peruvian Amazon, the alluvial gold mining has devastated more than 500 square kilometres of forest (MINAM 2016). This level of earthmoving destroys ecosystems and habitats, alters drainage systems and causes biodiversity loss. Furthermore, this illegal activity produces toxic waste (e.g. cyanide or mercury) which pollutes ecosystems and affects human health.

2.4.3 State and Trends

From 2001 to 2013, 17 per cent of new cropland and 57 per cent of new pasture land in LAC were established in forest

Table 2.4.1: Main crops, area harvested (km²).

Crop		South America		annual growth (%)	Caribbean		annual growth (%)	Mesoamerica		annual growth (%)	TOTAL		Average annual growth (%)
		2005	2013		2005	2013		2005	2013		2005	2013	
Flexible crops	Maize	173616	240629	4	4419	6051.2	4	84372.1	90391.8	0.9	262407	337072	3.2
	Sugar cane	70258	116234	7	6835.4	5836.3	-2	12198.1	13928	1.7	89292	135999	5.4
	Soybeans	402346	529629	4	0	0	0	1147.98	1820.96	5.9	403494	531450	3.5
	Oil palm	4164	6686	6	108	170	5.8	1797.01	3209.94	7.5	6069.4	10066	6.5
Tropical crops	Cocoa	11743	13670	2	1835.1	1920	0.6	764.78	1401.93	7.9	14343	16992	2.1
	Coconuts	3440	3159	-1	1355.1	1358.9	0	1896	1859.72	-0.2	6690.7	6377.6	-0.6
	Mangoes	1282	1669	3	795.42	915.21	1.8	2132.98	2344.12	1.2	4210	4928.4	2
	Rubber	1215	1520	3	0.3	0.19	-5.5	630.69	962.26	5.4	1846.5	2482.4	3.8
	Bananas	8615	8439	0	1166.7	1216.1	0.5	1989.41	2233.93	1.5	11772	11889	0.1
	Coffee	39125	35564	-1	2702.2	2310.7	-1.9	16639.4	15913.9	-0.6	58466	53788	-1
	Oranges	10087	9097	-1	599.59	382.82	-5.5	4094.9	4122.79	0.1	14781	13603	-1
Cereals	Wheat	85488	73102	-2	0	0	0	6413.23	6375.41	-0.1	91901	79477	-1.8
	Rice	60741	48347	-3	3343.8	4195.2	2.9	3452.79	3052.64	-1.5	67537	55595	-2.4

Source: FAO 2015b

areas deforested for that purpose. By 2012, the region had an estimated 1.01 million square kilometres devoted to agriculture and 3.59 million to pasture (Graesser *et al.* 2015). This expansion is associated not only with forests, but with other ecosystems such as grasslands. This is mainly the result of the specialization of the region in tropical and flexible crops for export while the area planted with cereals is decreasing.

Geographically, the expansion has been concentrated in the Southern Cone countries (Brazil, Argentina, Paraguay and Uruguay), particularly in the *gran chaco*, the Brazilian *cerrado* and the state of Mato Grosso in the legal Brazilian Amazon, where most of the available land is concentrated (Lambin *et al.* 2013). But other sensitive ecosystems, such as the lowland forests of Caquetá-Putumayo (Colombia) and Petén (Guatemala) have also been affected (Graesser *et al.* 2015). Flexible crops and tropical commodities are responsible for this increase (**Table 2.4.1**). Large agricultural businesses dominate land expansion. Hotspots of change are not restricted to agricultural areas. Forest cover also exhibits areas of deforestation and the regrowth of woody vegetation (Aide *et al.* 2013).

Forests

In 2015, about 47 per cent of the land in the region had forest cover (FAO 2015c), mostly concentrated in South America (**Table 2.4.2**).

Table 2.4.2: Forest cover by sub-region.

Sub-region	Land area (km²)	Forested area (km²)	Proportion of sub-region (%)
Mesoamerica	2 452 270	862 903	35.19
Caribbean	225 990	71 954	31.84
South America	17 461 110	8 420 106	48.22
TOTAL	20 139 370	9 354 963	46.45

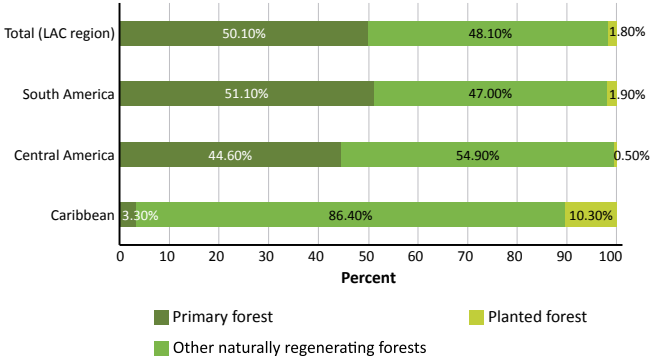
Source: FAO 2015c

In the region, 50 per cent of forests has very little human intervention (primary forests), and about 2 per cent are planted forests, mostly with exotic species. The remaining 48 per cent corresponds to other naturally regenerating forests (FAO 2015c) (**Figure 2.4.5**).

Forest loss is still a dominant process in the region although its rate has dropped (e.g. there is forest gain) since 1990 in all sub-regions (**Figure 2.4.6**). According to FAO (2010a), during the 2005 – 2010 period, the Caribbean had an increase in forest cover of 420 km², while Mesoamerica lost 4 040 km², and South America lost 35 830 km². Deforestation and reforestation are taking place simultaneously, with an increase in woody vegetation in areas where mechanized agriculture is not feasible or land has been abandoned, (Aide *et al.* 2013) (**Figure 2.4.7**).

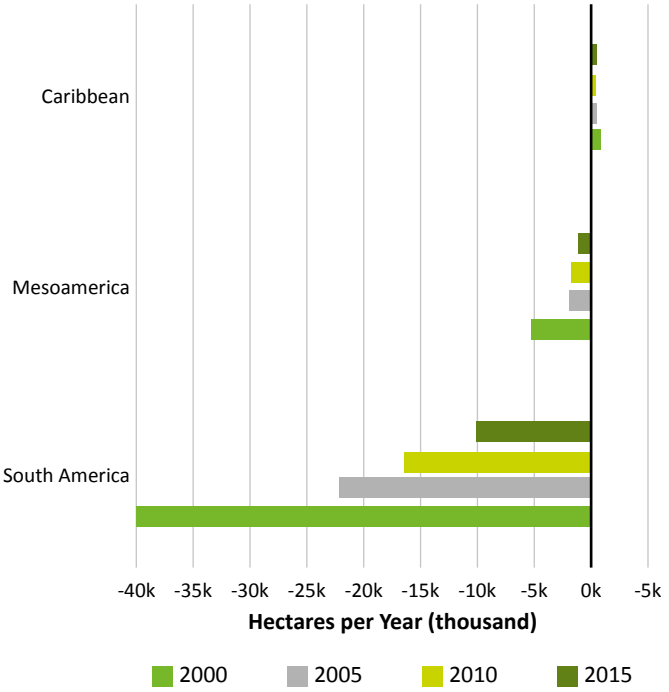
These changes occur in certain hotspots whose locations reflect the close and complex links between land cover, agriculture and consumption patterns both inside and outside the region (Hecht 2014). Processes like forest clearing for creating pastures and agricultural land are still important but have shifted from forests to other natural ecosystems, like *cerrado* (Brazilian savannah) and mostly grasslands, where soybean crops are replacing native grasslands in Argentina, Bolivia, Brazil, Paraguay, and Uruguay.

Figure 2.4.5: Forest cover types.



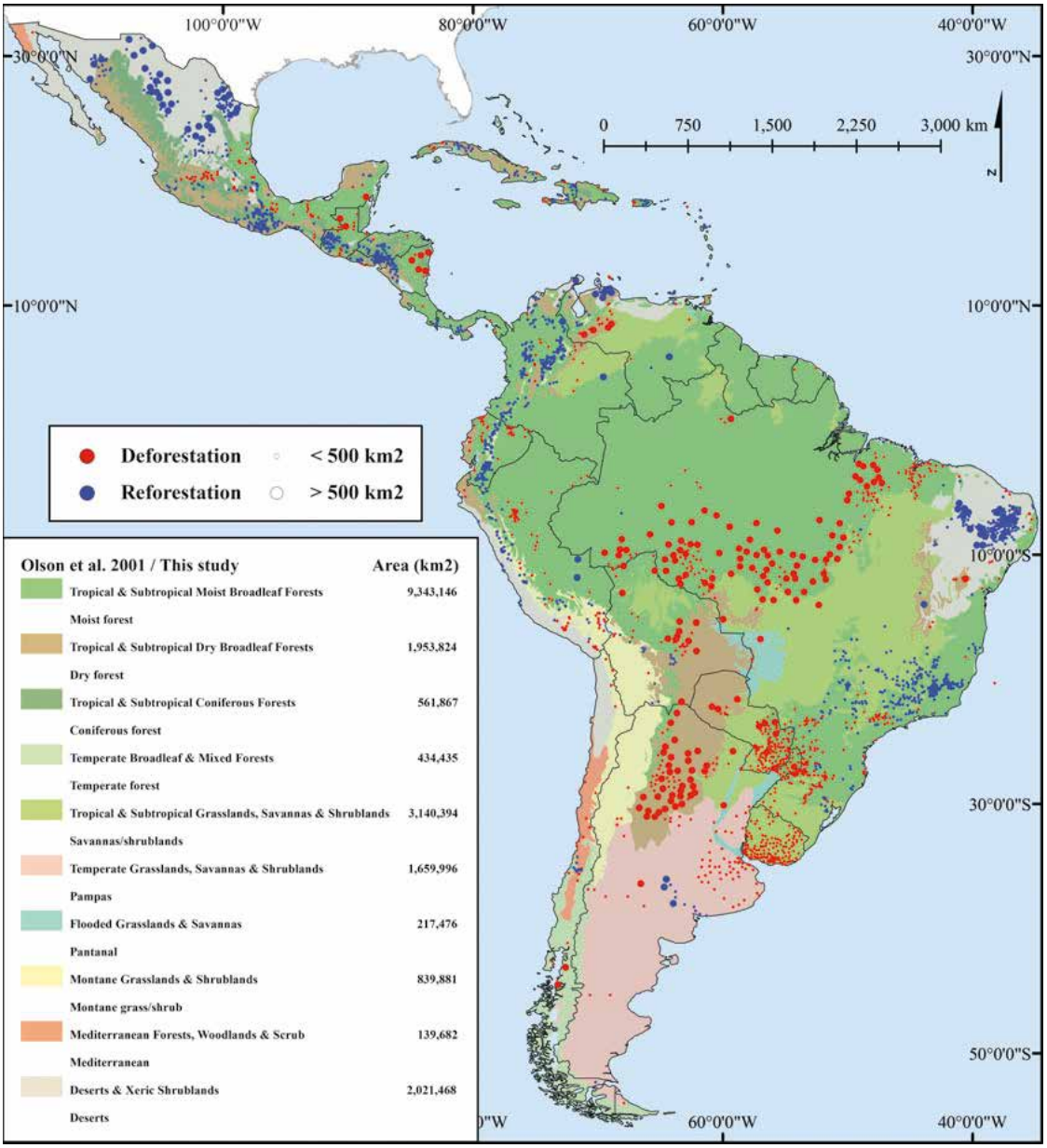
Source: FAO 2015c

Figure 2.4.6: Average annual change in forest extent, 2000–2015 (thousands of hectares per year).



Source: FAO 2016b

Figure 2.4.7: Deforestation and reforestation hotspots, 2001–2010.



Source: Aide *et al*. 2013

Table 2.4.3: Forest area in Latin America and the Caribbean by sub-region. Period 1990-2015 (km²)

Sub-region	1990	2000	2005	2010	2015	1990-2015
Caribbean	50 170	59 130	63 410	67 450	71 950	+21 780
Mesoamerica	967 550	913 040	892 760	875 080	862 900	-104 650
South America	9 308 140	890 8170	8 686 110	8 521 330	8 420 110	-888 030
Total	10 325 860	9 880 340	9 642 280	9 463 860	9 354 960	-970 900

Source: Keenan *et al.* 2015; FAO 2015c

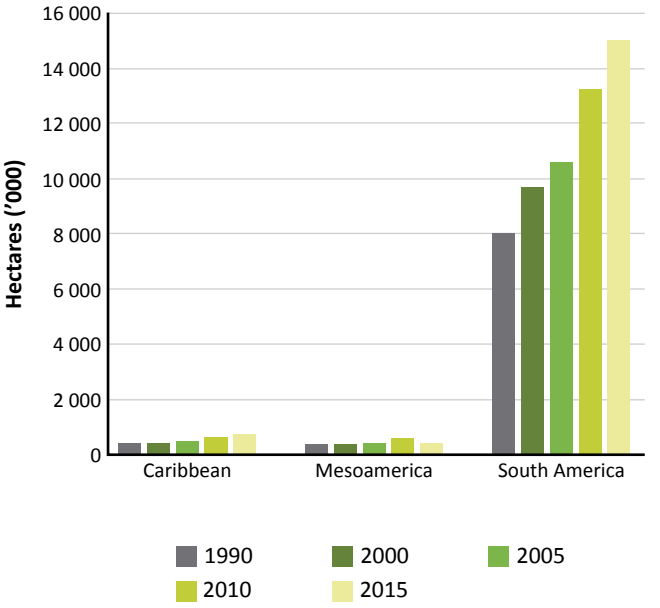
Forest plantations are growing in the region, mostly in Mesoamerica (**Figure 2.4.8**). This reforestation is taking place in areas that were previously deforested, or in grassland areas that did not have forest cover such as the Orinoco llanos in Colombia or *campos* in Uruguay, but is also threatening natural forests. Southern South America is experiencing the conversion of native grasslands to tree plantations.

Grasslands: the example of the Southern Cone

The Patagonian steppes and the Río de la Plata Grasslands (RPG) are one of the most important grassland regions in the world (**Figure 2.4.9**). In the Río de la Plata grasslands agricultural activities have increased during the past 15–18 years. Baldi and Paruelo (2008) characterized changes in the landscape structure for eight pilot areas distributed across the main regional environmental gradients. The area covered by grassland in the Patagonian steppes and the Rio de la Plata diminished from 151320 to 137817 square kilometres from 1985-2004, a decrease of 8.9 per cent, associated with an increase in the area of annual crops, mainly soybean, sunflower, wheat and maize. The area under agriculture increased from 49 348 to 58 057 km², a rise of 17.6 per cent. In Uruguay, the area covered by grassland decreased from 126 490 to 105 180 km², a 16.85 per cent reduction between 1990 and 2011 (MGAP 2014).

In the case of the Brazilian Pampa, data from the Deforestation Satellite Monitoring Project of Brazilian Biomes (MMA-Brazil2011) reveals just 36per cent of this biome remained in 2009.

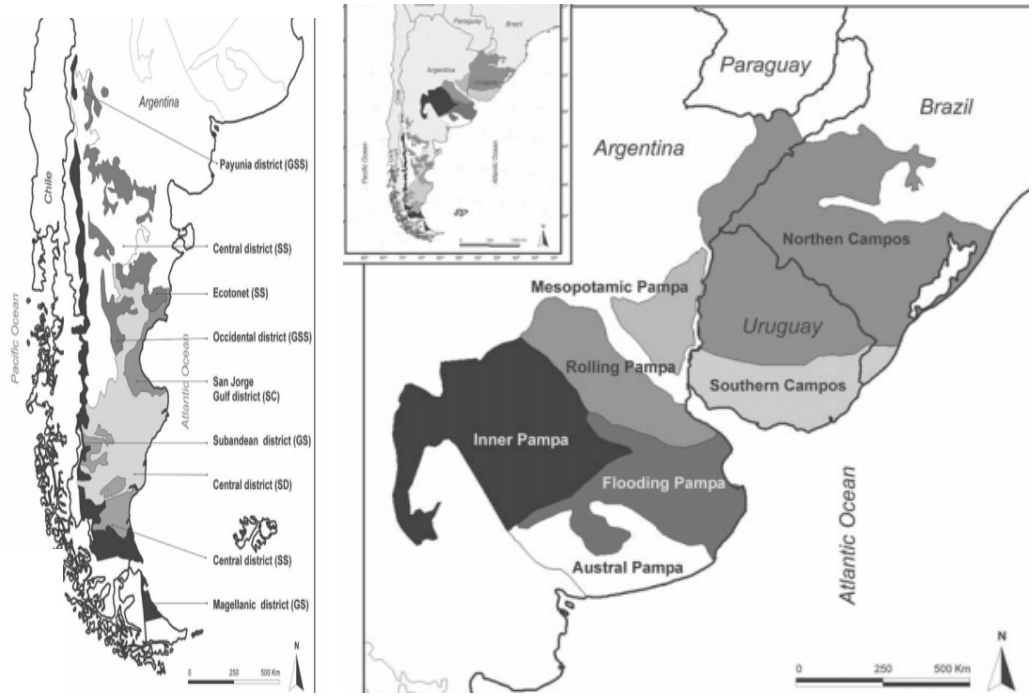
Figure 2.4.8: Extent of forest plantation ('000 hectares) 1990–2015.



Source: FAO 2015c

The cultivation of exotic trees has received many incentives from both private industries and the government. In Uruguay the area afforested with eucalyptus and pine increased from 1.2 per cent to 6.5 per cent of the country during 1990–2011 (MGAP 2014). Afforestation of some of the most productive native grasslands of the continent was rapid and

Figure 2.4.9: Phyto-geographical sub-units of the Río de la Plata grasslands and Patagonian steppes with their phyto-geographical subunits.



Source: Paruelo *et al*. 2007

some authors suggest it might have been reinforced by the prospective carbon market (Paruelo *et al*. 2007).

The proportion of croplands in Uruguay increased from 4.1 per cent to 9.8 per cent between 2000 and 2011 (MGAP 2014). The area devoted to single winter crops (mainly wheat) diminished while the area under summer crops increased (Volante and Paruelo 2015, see **Table 2.4.4** and **Figure 2.4.10**).

Highland Ecosystems

Highland ecosystems in Latin America and the Caribbean are subject to pressure from agriculture, pasture for animal grazing, and, to a lesser extent, mining and forest plantations. For example, the area under potato cultivation, the main staple crop from these high mountain ecosystems, increased from 5 820 to 7 060 square kilometres between 2000 and 2013 in tropical Andean countries[18] (FAO 2015b). A particular response to demand for agricultural crops is the expansion of quinoa *(Chenopodium quinoa)* cultivation: a recent international recognition of this Andean pseudocereal as a 'superfood' has increased its demand, tripled its price and strongly augmented its cultivated area from 670 square kilometres in 2000 to 1200 in 2013[19] (FAO 2015b, Henríquez

18 Bolivia, Colombia, Ecuador, Peru and Venezuela.

19 http://www.theguardian.com/commentisfree/2013/jan/16/vegans-stomach-unpalatable-truth-quinoa

Table 2.4.4: Area cultivated (km²) with winter, summer and double crops in 2000 and in 2010.

		Winter crops	Summer crops	Double crops	Total cropped
Buenos Aires Province (Arg)	2000	23 154.34	45 353.06	15 073.06	83 580.46
	2010	8 588.11	79 160.24	14 726.6	102 474.95
	Change	-14 566.23	33 807.18	-346.46	18 894.49
Entre Ríos (Arg)	2000	50.88	7 992.17	3 356.06	11 399.11
	2010	2.8	12 692.17	6 708.28	19 403.25
	Change	-48.08	4700	3 352.22	8 004.14
Uruguay	2000	937.4	3 879.4	1152.7	5 969.5
	2010	0	11 390.28	5 776.19	17 166.47
	Change	-937.4	7 510.88	4 623.49	11 196.97

Source: Volante and Paruelo 2015

and Jäger 2013;). Local prices in countries like Bolivia have now soared, increasing export-driven production, reducing availability for local consumption and contributing to land degradation in indigenous territories due to reduced area for llamas, introduction of machinery that damages the soil, and the disappearance of native vegetation (Jacobsen 2011).

Local information on Carchi in Ecuador and Chingaza in Colombia (Hofstede *et al*. 2015) shows rising investment in intensive animal husbandry, particularly dairy production, with traditional cropping systems abandoned in favour of lower labour requirements and less dependence on a decreasingly predictable climate. In areas like Chimborazo (Ecuador) where there is a net decrease of population in rural areas because of out-migration, farmers also tend to shift from more labour-intensive agriculture to, in this case, extensive animal husbandry (Gortaire 2013).

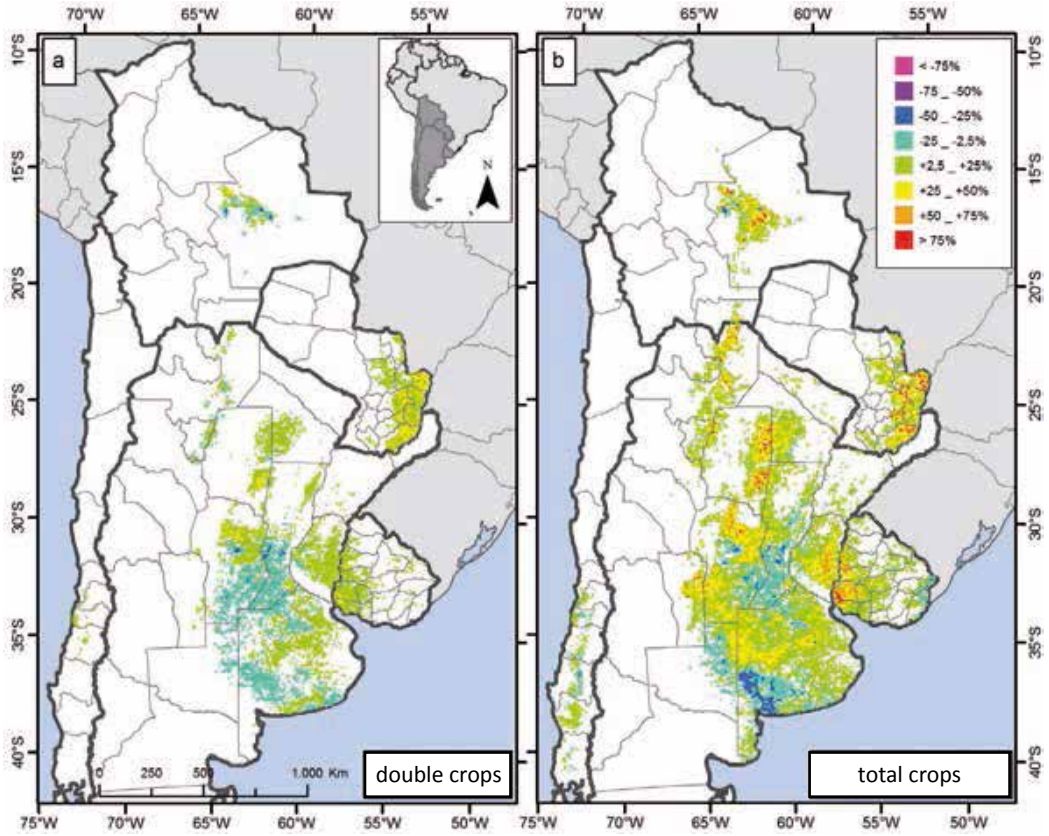
The case of the *páramo,* an endemic ecosystem of the Equatorial Andes, is indicative of the trend towards the degradation of this extremely important ecosystem for water regulation. Although 35 per cent of its extent is included in protected areas (Hofstede 2003), which are relatively well conserved, many other *páramos* are degraded and under threat. A rough estimate revealed that in Ecuador, a third of all *páramo* has been transformed into agricultural land, a third is modified by grazing and burning and a third is conserved, either by protective measures or because of their inaccessibility (Hofstede *et al*. 2002b).

2.4.4 Impacts

Land degradation represents one of the most serious impacts to the productive capability of land and its ability to provide ecosystem services required for human well-being (Oldeman *et al*. 1991, Lal 2003). Although degradation might result from natural factors, land degradation is mostly of human origin. The land-management activities that have contributed the most to land degradation are mechanized agriculture, overgrazing and urban and industrial expansion (Gardi *et al*. 2015). Land degradation has indirect impacts at larger scales (see Chapter 1); for example, a degraded ecosystem may cause migration to cities as rural populations cannot derive a livelihood from their surroundings.

The conversion of ecosystems into other land covers alters their ecological characteristics (see Section 2.4 on biodiversity and ecosystem services). For example, in the Rio de la Plata grasslands, conversion to agriculture has reduced soil organic carbon (Álvarez 2001). In the same area, afforestation has had a large and varied ecological impact

Figure 2.4.10: Change in the area of double crops and total crops, 2000/01–2010/11.



Source: Volante and Paruelo 2015

on water and biogeochemistry; soils under eucalyptus plantations become more acid (Jobbágy and Jackson 2003). In addition, the establishment of tree plantations has had striking effects on evapotranspiration, increasing it by up to 80 per cent (Nosetto *et al*. 2005). There are also qualitative changes to the land associated with animal grazing. Grazing leads to changes in the vegetation and structure of grasslands (Rusch and Oesterheld 1997; Chaneton *et al*. 1996; Sala *et al*. 1986; Lavado and Taboada 1985).

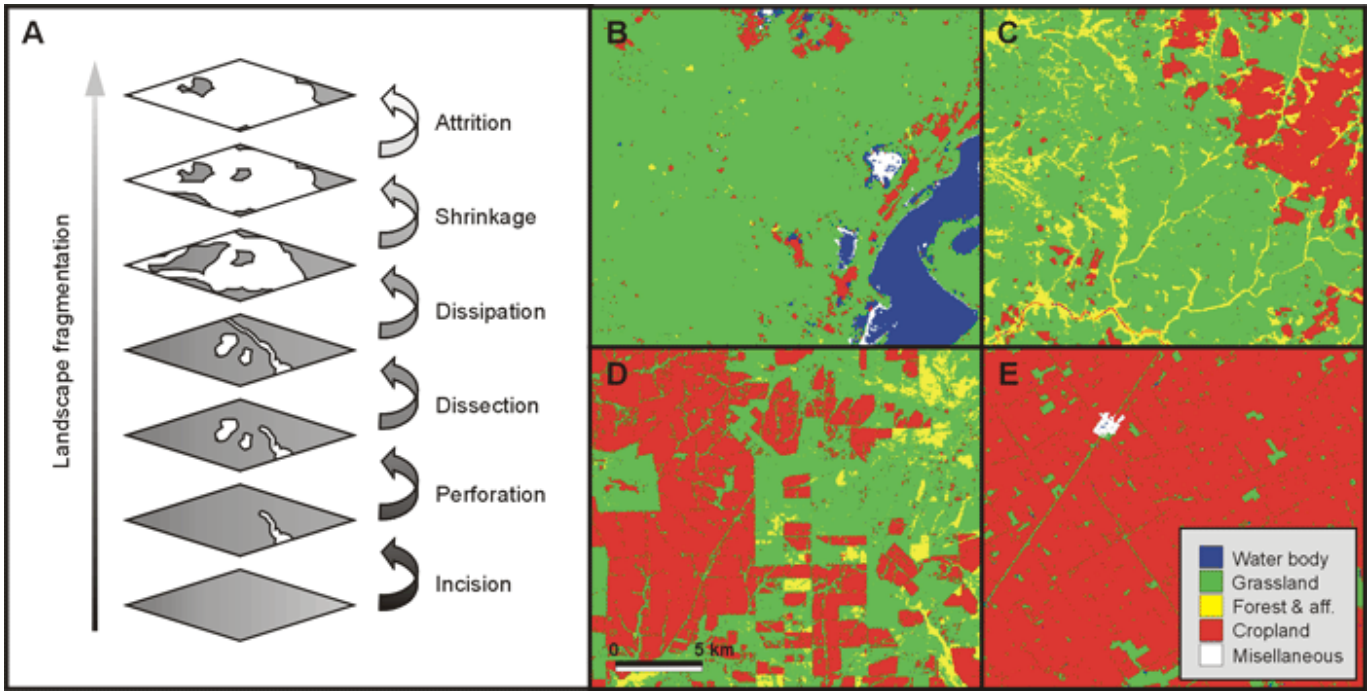
In the Andean highland ecosystems, the destruction of the natural vegetative cover leads to species loss and lack of soil protection. Tilling and short fallow periods after cultivation, together with soil compaction and trampling by cattle and sheep, lead to irreversible soil disturbance, reduced water infiltration, storage and water regulation capacity, and eventually erosion (Hofstede *et al*. 2014; Young 2009; Young and León 2007; Buytaert *et al*. 2006; Poulenard 2004; Podwojewski *et al*. 2002; Hofstede 1995; Verweij 1995). Furthermore, the use of fire to provide fresh fodder has a

significant impact (Hofstede *et al*. 2014; Heil *et al*. 2003) and may prevent the recovery of ecosystems.

Other ecosystem changes may include invasive species or changing species composition due to land management strategies like selective logging in forest areas.

Another important impact on natural habitats is mining. Between 2001 and 2013, in South America alone, about 1 680 square kilometres of forest were lost due to the mining industry (mostly gold) (Alvarez-Berríos and Aide 2015). Companies operating in the mining sector have to follow national regulations, which require them to minimize environmental and socio-economic impacts on local populations and biodiversity, as well as restoring, to the extent possible, the surface ecosystems that have been affected. In illegal and informal mining, the process just moves from one place to another without restoring the lands. In Madre de Dios, the alluvial gold mining has devastated more than 50 000 hectares of forest (MINAM 2016). A recent assessment on illegal mining in the Amazonian region (SPDA 2015) indicates that the difficulty in enforcing regulations and the ambiguity of mining norms in many countries create opportunities for illegal mining.

Figure 2.4.11: Schematic representation of the fragmentation process. (A): Grey represents the original land cover; white represents anthropogenic or new land cover. B-E: Landscape cover type in 2002–2004: (B) Flooding Pampa, (C) Northern Campos, (D) Mesopotamic Pampa, and (E) Rolling Pampa.



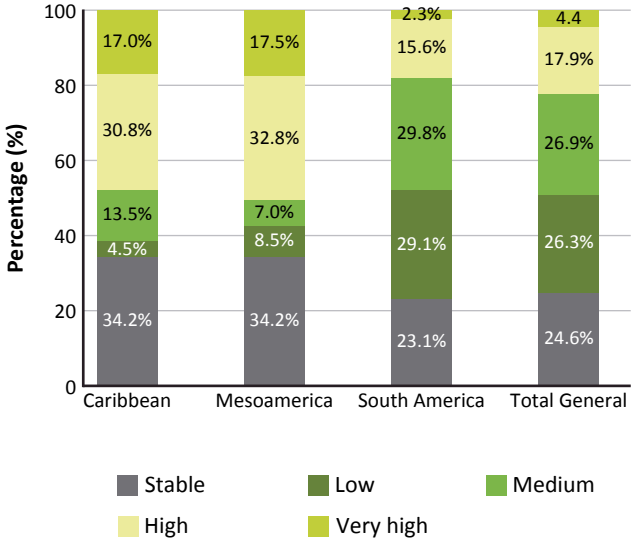
Source: Baldi and Paruelo 2008

Habitat loss also has socioeconomic impacts. Deforestation and increased malaria risk are closely related. Research in the Peruvian and Brazilian Amazon indicate that ecological changes associated with deforestation improve the breeding conditions for the mosquitoes that are vectors of diseases such as malaria (Vittor *et al*. 2009) and exacerbate leishmaniosis, another tropical disease (WHO 2015a).

Natural habitat fragmentation means that a continuous ecosystem transforms into one where patches of it have been cleared, so the remaining ecosystem is interspersed with other types of land cover. Ecosystem fragmentation is detrimental to ecosystem function and therefore to ecosystem services and human well-being.

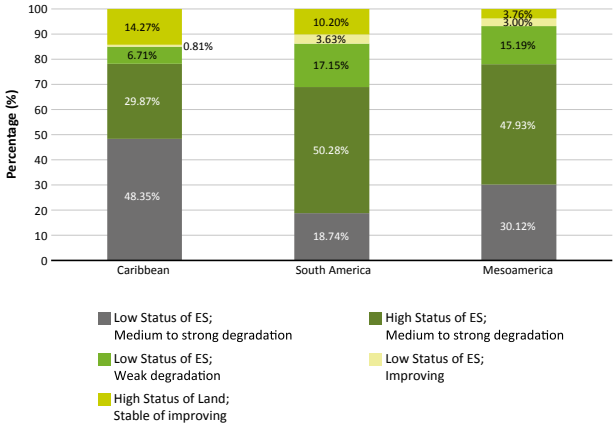
Among other areas, fragmentation has affected the Atlantic Forest of Brazil. In 2009, only 22.23per cent of the original forest remained and was highly fragmented due to centuries of unsustainable use (logging and agricultural conversion) (IBAMA 2012). Baldi and Paruelo (2008) described different situations of fragmentation in the Río de la Plata region. The most important landscape transformations occurred in Argentina, where grassland cover suffered a 16.3 per cent reduction during 1985–2004. In the West Inland and Mesopotamic *pampas*, active fragmentation is underway and the landscapes are at a stage of dissection or dissipation (**Figure 2.4.11**). In these two sub-units, there is a co-dominance of grassland and cropland patches. In the Southern, Rolling and Flat Inland *pampas*, the grasslands are at a stage of shrinkage or attrition characterized by small, isolated, simple-shaped grassland patches (**Figure 2.4.12**). Westward, in the Flat Inland *Pampa*, the patterns are slightly different, with cropland in elevated areas and grassland in lowlands. The Flooding *pampa* is at an incision or perforation stage in which the grassland matrix is only interrupted by small agricultural plots, transport lines, streams, channels and ponds The Northern and Southern Campos grasslands (Uruguay and Rio Grande do Sul, Brazil) are at a perforation or dissection stage in which grassland is the landscape matrix, but there is a large number of cropland and afforestation foci (Baldi and Paruelo 2008). On the other hand by 2009 only 53.4 per cent of Brazilian Northeast Dryland Biome (called

Figure 2.4.12: Severity of soil degradation, 1990.



Source: Oldeman *et al*. 1991

Figure 2.4.13: Land degradation classes and status of ecosystem services, 2006–2010.



Source: Nachtergaele 2011

Table 2.4.5: Evidence of land degradation, selected countries.

Country	Erosion	Degradation	Desertification
Argentina	250 000 km² affected by water erosion, increasing at 2 500 km² per year. 600000 km² suffering moderate to severe erosion. Increasing at 6500 km² per year, with varying degrees of erosion	Salinization in areas that flood	81.5% of the arid and semi-arid surfaces shows some degree of degradation
Bolivia	Estimated land area affected by erosion ranges from 35 to 41% of the country		Approximately 450943 km² (41% of the country) is experiencing desertification.
Brazil			Approximately 1338076 km² (15.72% of the country) are susceptible to desertification
Chile	49% of national territory		Approximately 473000 km² (62.6% of the country is affected by desertification
Colombia	80% Andean region	Soil degradation continues to rise.	17% of national territory
Costa Rica		Reduction in deforestation and forest fires. Overused lands represent 19.8% of the country	
Cuba	Water erosion affecting 43% of territory	71% of agricultural land has low organic matter content	Desertification affects 14% of its territory (1.5million hectares)
Dominica		Almost 14% of the total land area is vulnerable to some land degradation	
Ecuador	50% of country with erosion		15% of territory affected by desertification
El Salvador	75% of country with erosion		
Grenada		Approximately 50% of the country	
Guatemala	12% of country with water erosion	Deforestation exacerbates degradation	
Honduras	Recognized as a problem but not quantified	Recognized as a problem but not quantified	Recognized as a problem but not quantified
Mexico	9% of the country affected by wind erosion and 12% of the country affected by water erosion	18% of the country affected by chemical degradation and 6% of Mexico affected by physical degradation	

Country	Erosion	Degradation	Desertification
Nicaragua	Moderate to extreme erosion affects 58.9% of the country	Recognized as a problem but not quantified	Recognized as a problem but not quantified
Panama		21 000 km² affected by drought and degradation	
Paraguay		Deforestation for agriculture	
Peru			Desertification affects 24% of the country
Uruguay	30% of national territory subject to water erosion		
Venezuela	44% of the land in the country experiences erosion risk due to relief conditions		990 km²

Source: Gardi *et al.* 2015, UNCCD 2015

Caatinga) remained (PMDBBS, Brazil Environment Ministry), mainly due to firewood and charcoal production industries (Beuchle *et al.* 2015).

Soil degradation leading to lower agricultural productivity is another dimension of land degradation. According to the Global Assessment of Soil Degradation - GLASOD (Oldeman *et al.* 1991), nearly 51 per cent of soils in the Latin America and the Caribbean region are in stable areas or have low degradation severity. However, this varies for each sub-region (**Figure 2.4.12**). According to GLASOD, 306 million hectares in LAC have been affected by human-induced soil degradation; the most important degradation types in the region are water erosion (55 per cent), nutrient depletion (23 per cent), and wind erosion (14 per cent) (Bai *et al.* 2008).

A more recent assessment (Land Degradation Assessment on Drylands or LADA) was carried out globally in 2006–2010. Although the focus was on drylands, this assessment evaluated the status of land degradation worldwide. The results for Latin America and the Caribbean (**Figure 2.4.13**) indicate that a large proportion of the region has a high status in terms of ecosystem services (to a lesser extent in the Caribbean) but that land is being degraded, with the percentage of land that is stable or improving being relatively small.

For the majority of the countries in the region there is some information on the extent of land degradation: erosion, desertification or other forms of degradation (Table 2.4.5).

As stated in Chapter 1, migration to cities due to the modernization of agriculture is changing livelihoods. There is increasing urbanization due to more labour opportunities in construction industries and services (CELADE 2011). In some areas, this has caused abandonment of rural areas and therefore decreased pressure from low input-traditional agriculture (Gortaire 2013).

The access to agricultural land has also changed in the region. The large-scale acquisition of land has intensified in response to the 2007–2008 rise in food prices (Rulli *et al.* 2013). Brazil, Uruguay and Argentina are among the 24 most affected countries in the world in this respect (Rulli *et al.* 2013). The Río de la Plata area has been a particular attractive region for land grabbing because of its high productivity and the potential for the expansion of agricultural activities under the agribusiness format. Land acquisition has caused

a reduction in the number of farms and ranches in both the Argentine and Uruguayan Río de la Plata. In Argentina, the number of farms and ranches decreased by 36 per cent between 1988 and 2002 (Hocsman 2015), and the reduction of small farms was particularly sharp (Piñeiro 2015). This process has been accompanied by rising land prices and, in some areas, a reduction in access to land for small farmers and ranchers.

2.4.5 Responses

Sustainable Land Management is defined as *"the use of land resources such as soils, water, animals and plants for the production of goods – to meet changing human needs – while assuring the long-term productive potential of these resources, and the maintenance of their environmental functions"* (UN 1992).

Sustainable land management strategies need to consider land's different roles:

- **Productive functions:** to produce food, fodder, fuel, and other service functions.
- **Physiological functions:** to ensure human health by minimizing toxic substances in water, soils and plants, or hazards such as landslides and other disasters.
- **Cultural functions:** to preserve the integrity of the landscape – the role(s) of water, land, forests and animals as an essential part of the cultural heritage. Strategies should also maintain the historical and aesthetic value of the landscape.
- **Ecological functions:** to ensure maintenance of ecosystem function and global life-support functions.

Sustainable strategies require that different stakeholders take into account the links between different sectors and locations. As presented earlier, teleconnections in the agricultural sector have strong impacts on land-cover change. An adaptive management perspective can assist land managers and decision makers (Stankey *et al.* 2005). Adaptive management requires continuous evaluation of the status and trends of benefits and impacts. Sustainable land management strategies also need to be adaptive, so that they can incorporate uncertainty, unforeseen impacts and changing contexts.

This means that the region needs to move from a piece-meal approach in which different sectors (land, water, health) define policies and strategies that do not take into account the integrity of sustainability. IWRM presented in the water chapter and sustainable land management are part of the same holistic approach to managing ecosystems and the services they provide.

The challenges and opportunities of formulating sustainable land management strategies in Brazil and in Saint Vincent and the Grenadines (**More...24**), clearly illustrate how an effective mix of policy instruments can be successfully deployed to achieve multiple environmental objectives.

Government involvement is essential for promoting sustainable land management strategies in different ecosystems. For example grasslands in Uruguay are increasingly under sustainable production systems that promote soil conservation, which is reducing land degradation (Hill and Clérici 2013). In 2009, Act 18 564 was passed which states, among other things, that landowners are obliged to adopt management techniques proposed by the Ministry for Livestock, Agriculture and Fishing (www.renare.gub.uy). In June 2012 the Ministry established the Native Grassland Board (Mesa de campo natural, Dec. 001/1349/12) with the participation of different institutions from government and academia. The objective of the Board is to advise the government and promote sustainable uses of native grasslands. Some non-governmental initiatives *(Alianza del Pastizal)* developed conservation indicators for Río de la Plata and promoted incentives in Argentina, Uruguay and Brazil for preserving the integrity of native grasslands (Parera 2014). In other areas of the region improved agricultural practices have become more common. No-tillage agriculture has grown very fast in South America. As of 2009, 46.8 per cent of the 1.11 million square kilometres worldwide under no-

tillage agriculture is in this subregion (Derpsch *et al*. 2010). According to the same authors, this kind of production has been adapted to a wide variety of environmental conditions, making it a suitable alternative for the diversity of ecosystems in the LAC region. The advantages of no tillage are many: It improves the physical and chemical characteristics of the soil, therefore increasing the production potential; it increases infiltration and reduces soil erosion; It reduces the need for fertilizers and pesticides because of improved soil characteristics and more habitat for pest predators; it reduces costs; by using crop rotations, including leguminous crops, it provides the necessary nutrients for agricultural production (Derpsch *et al*. 2010).

In many parts of the region agroforestry systems agroforestry systems have been in place for a long time (i.e. coffee and cocoa). For example, shade-coffee production systems provide a permanent ground cover, therefore reducing erosion and evaporation, contribute soil nutrients through tree leaf litter, and provide habitat for a wide variety of wildlife (Gobbi 2000). These kinds of management systems have the potential to improve the environmental quality of agricultural production and of well-being of rural population. Furthermore, they can be adopted in degraded or lands, where they can contribute to improvement of soil conditions as well as human well-being. One example is Jatropha cultivation in Cuba (**More...25**).

Over the last decade LAC has made progress by reducing the net loss of forested land and increasing forest cover. Upon disaggregation, those increases have been mainly through conservation efforts in the Caribbean sub-region. Brazil has been very successful in reducing the deforestation in the Amazon region (see Amazon deforestation biodiversity section). Given this disparity, there is a continuing need to review the causal factors and identify the concomitant potential policy interventions best suited to promoting progress in forest conservation in the region. One critical intervention, which still requires addressing, is resource extraction from forests and the continued negative impacts on biodiversity, water management and the carbon budget, among others (**More...26**).

Market mechanisms

Payment for Ecosystem Services (PES) Schemes

In PES schemes, users of an ecosystem service pay land managers to preserve the ecosystems that supply the service. Preserving forests and other natural ecosystems maintains hydrological conditions as well as provide climate regulation. Costa Rica has successfully implemented PES schemes that combine policy and economic instruments (Porras *et al*. 2013). Other countries (e.g. Paraguay) have new legislation that includes PES schemes, but they have not yet been implemented or their results are still uncertain (Martin-Ortega *et al*. 2012).

A specific example of a PES scheme for climate change mitigation is the initiative known as REDD+, the United Nations collaborative initiative on Reducing Emissions from Deforestation and forest Degradation. According to UNECLAC (2015a) in 2014 there were 117 REDD+ registered projects in 14 countries of the region (Sanhueza *et al*. 2014). Five countries (Brazil, Colombia, Ecuador, Mexico and Peru) are managing 80 per cent of these projects, indicating that REDD+ as a response is not widespread.

Tropical forest in Panama.

Credit: UNEP/Emilio Mariscal

Other PES schemes involve the intensification of agricultural activities while maintaining the supply of ecosystem services. Cattle ranching expanded in Latin America during the 1970s and 1980s. Extensive pastures generate very little employment and are the cause of most of the deforestation and land degradation in parts of the region (Gibbs *et al*. 2010). Recent pressure from other crops, national commitments to ecosystem conservation, and the development of more sustainable technologies have induced the development of large sylvo-pastoral systems that intensify cattle ranching, increasing productivity while protecting land cover, watersheds and biodiversity. These systems are based on the adoption of technologies that increase yields while enriching soils, biodiversity and carbon sequestration. Due to the provision of those additional ecosystem services, they have been tied to payments for ecosystems services stemming from other parts of society.

Two of the largest initiatives on this front have been developed in Brazil and Colombia, supported by the national governments, with additional funding from the GEF, conservation agencies such as The Nature Conservancy (TNC), and local NGOs. The Colombia project targets small and medium-scale ranchers (of up to two square kilometres). Farmers adopt more sustainable practices and receive a payment for ecosystem services and technical assistance. The project expects to reach 580 square kilometres, increase production by 5 per cent, improve soil quality biodiversity, and lead to wider adoption among cattle ranchers (FEDEGAN 2015).

Integrated crop-livestock-forest systems (ICLF) in Brazil have received government attention since 2008 when it started allocating credit for development through the *Programa de Produção Sustentável do Agronegócio* (Produsa), as well as investments in research and technology for good agricultural practices and mitigation of GHG emissions, under the ABC programme *(Agricultura de Baixa Emissão de Carbono)*. The goal of the programme is to reclaim 150 000 square kilometres of degraded pastures, including adoption of ICLF systems on 40 000 square kilometres by 2020. The programme has the support of Embrapa (Brazil's Agricultural Research Corporation), which has established technology transfer centres throughout the country (de Almeida *et al*. 2013).

Adoption of these systems has increased as they have demonstrated higher yields, soil fertility improvements and carbon sequestration. A combination of policies that ensure permanent protected areas, incentives to ICLF by providing low-cost credit and technical assistance, together with payments for environmental services, would foster the rehabilitation of thousands of square kilometres of degraded lands. It is estimated that 50 per cent of the 1.05 million square kilometres of pasture are degraded or in the process of degradation (reference). These systems offer an enormous opportunity for sparing land in a region that faces great demand for crops and other land uses.

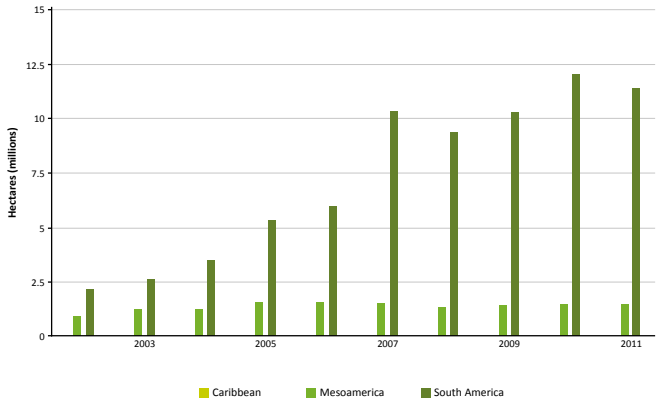
The round tables for Sustainable Consumption and Production (SCP) are multi-stakeholder initiatives composed of voting members, including industry and civil society actors, with equal standing. Their purpose is to bring together all stakeholders in a specific global value chain to discuss and share best agricultural practices in each sector. They have proliferated in recent years under the encouragement of global environmental NGOs, particularly the World Wide Fund for Nature (WWF). They include products like palm oil, aquaculture, cotton, sugar, biofuels, soy, seafood, beef, cacao, forests and even water (WWF 2013). The RSPO and Roundtable on Responsible Soy (RTRS) also offer certification programmes (see below), which outline legal, social, environmental and economic guidelines for crop production.

Most recently a Roundtable on Sustainable Biomaterials (RSB) has been developed to ensure the sustainability and traceability of biomaterials (including biofuels) destined mainly for Europe. Although many regional industries, farmers and associations belong to these initiatives, adoption of the standards is still at a very early stage, probably due to the limited trade that Latin American producers and manufactures have with Europe and North America

Certification and verification schemes

Concerns over the environmental and social conditions of smallholders providing tropical commodities for international markets led NGOs in the global North to devise standards for improving social, environmental and economic conditions of production. An independent, accredited body audits farms, and those which comply with the standard are allowed to sell their products bearing the certification label. Access to market and price premiums are the main incentives for farmers to participate in these programmes, although they also perceive longer-term benefits of improved production practices, ecosystem service provision and labour conditions. Other, second-party verification systems have also been devised, mainly by partnerships between coffee roasters and conservation NGOs that do not necessarily require independent audits. The C.A.F.E. practices code of conduct created by *Starbucks* in alliance with Conservation International, the *Nespresso* Triple A programme created by Nestle and the Rainforest Alliance, and the 4C verification system led by roasters, farmers and other stakeholders, are worthy of mention, given their importance in the market. (Renard 2010; Valkila and Nygren 2009)

Figure 2.4.14: Millions of hectares of forests certified by FSC by sub-region in LAC, 2003–2011.



Source: UNEP 2015d

Coffee, bananas, tea and cacao constitute the bulk of this type of certification, although other commodities such as sugar, palm oil and soybeans are also being included. The standards are supported by sound science, and multiple stakeholders in the value chain provide input for their design (Raynolds *et al*. 2007) (**More…27**).

Certification schemes also apply to timber. In terms of forest management, the Forest Stewardship Council (FSC) is the most common standard. In LAC, the number of square kilometres with a sustainable forest management plan under FSC has increased from 32 000 in 2002 to 128 000 in 2011 (**Figure 2.4.14**), mostly in South America. Although there is an increasing trend in sustainable forest management, the area certified only represents about 0.3 per cent of the region's managed forests. (FSC 2015.)

Moratoria

These are extreme actions undertaken by actors in the supply chain, together with NGOs or consumer groups, designed to restrict production or purchases from places where environmental or social conditions are highly detrimental and where no sustainable alternative can be foreseen. Examples of these are the soy and cattle moratoria signed by companies, NGOs and the government in the Brazilian Amazon.

Cultivation in the Brazilian Amazon has been associated with large environmental impacts such as the conversion of native vegetation to intensive agriculture and the displacement of cattle ranching into the Amazon biome (Macedo *et al*. 2012). Because of the large environmental impacts and NGO pressure, members of the Brazilian Association of Vegetable Oil Industries (ABIOVE) and the National Association of Cereal Exporters (ANEC) signed a moratorium, a voluntary agreement for not purchasing soybeans produced in areas deforested after 24 July 2006. The moratorium has been renewed until May 2016; it has been very successful in arresting deforestation in the Amazon biome. A similar instrument has been put in place for beef, with similar results.

Conservation of natural ecosystems: protected areas

The establishment of protected areas is the most common response to stop the transformation of natural ecosystems. According to the UNEP World Conservation Monitoring Centre, 24 per cent of the land area in Latin America and the Caribbean is protected (UNEP-WCMC 2015a). The growing percentage of land under protected areas is good news for the region, but it needs to be accompanied by proper management plans.

Private initiatives of protected area creation did show an increasing trend, for example Colombia has 83 private reserves in the Andes associated with the *Asociación Red de Reservas Naturales de la Sociedad Civil* A major process is underway in Chile, where the private Conservation Land Trust purchased many parcels of land for private reserves. In Brazil, there are 784 private reserves of natural heritage (RPPN is the acronyms in Portuguese) included in the National Register of Protected Areas. The reserve owners are organized into public associations, which form the National Confederation of RPPN Owners (http://www.rppnweb.com/). Several countries, including Brazil, Colombia and Peru, have formally included reserves with different governance systems and ownership, including those managed by local governments and communal and private reserves incorporated into national protected area systems for harmonized management.

Better overall awareness of the value of natural ecosystems has resulted in more support for conservation measures. Many local governments, aware of the relationship between nature conservation and local water management, have increased the amount of municipal and provincial reserves.

The clear delineation of property rights may also reduce ecosystem loss. In many countries of the region land titling for indigenous communities has reduced ecosystem transformation. (Buntaine *et al*. 2015; Barsimantov and Kendall 2012). For example, indigenous common-property institutions and indigenous defence of homeland have been powerful factors in protecting the forests of Nicaragua's Atlantic coast (Stocks *et al*. 2007). In the same according to this study, colonists deforest more per person than the Bosawas indigenous communities. This example illustrates that, when land rights are clear, they serve as an incentive to manage resources more sustainably.

Local governance and empowerment

Emancipation movements among the indigenous population, which began in the 1980s–1990s, and collaboration with long-standing social development programmes has resulted in successful examples of local development, with much more sustainable agricultural practices governed by the local population.

The changing role of the State

The inclusion of innovative environmental management policies that involve the private sector and international actors does not in any way diminish the key role of national governments. On the contrary it needs to be strengthened to be able to fulfil its role with a new set of policies and instruments. Some of the main areas to strengthen are:

1. Clarify and formalize property rights, ensuring that indigenous, traditional and communal rights are properly enforced and that future land-use expansion into these territories is done following due diligence and the full participation and informed consent of the affected communities.
2. Supplement private instruments, through technology development and transfer, to ensure their scalability. The potential of sylvo-pastoral systems for sparing land in valuable ecosystems cannot be overestimated, but it needs strong public support for the provision of public goods, especially to smallholders, for which there is not a market.
3. Exercise effective monitoring of large corporations to ensure that they exercise control over their supply chain, complying with their environmental commitments,

human and land rights. The region has demonstrated leadership in the adoption of more sustainable practices in export-oriented value chains. Making those practices widely available for domestic and export-oriented crops is possible, but needs strong leadership and financial commitment to make the transition feasible, especially for smallholders.

4. Ensure that all cadastral information containing the geo-referenced registry of all properties in the countries are up to date (reflecting the true distribution of land property), publicly available and accessible, and used for monitoring and tracing environmental compliance.

Land-use management in an uncertain future

Agricultural expansion is expected to continue, as the region holds one of the largest land reserves suited for agriculture, and remains tightly linked to global markets. Although this expansion can bring important economic benefits in the form of employment, foreign currency flows, investment in technology and infrastructure, among others, it also poses several risks. As some provisioning ecosystem services (such as food, fibre and energy) are prioritized in this new land configuration, others, such as hydrological and climatic regulation and soil fertility, may be compromised.

There is no 'silver bullet' for designing and implementing sustainable management practices. Each biophysical and socio-economic context is different, and how local, national and international conditions articulate in a specific location is unique. However, planners, policy makers and land managers might benefit from taking into account the following characteristics:

- There are many illegal and informal activities in the region that exacerbate land degradation and threaten the sustainability of land management and its productivity. Informal land ownership may lead to degradation. People active in illegal activities are usually aware of the nature of their conduct and disregard the negative impacts on other stakeholders. Detrimental land management strategies need to have stronger enforcement to eliminate or reduce their impacts. Education of land managers as well as the communication of good practices (including transferable indigenous knowledge) is desirable.
- Intensifying management strategies where they can be sustainable is critical. This means using land more efficiently and restoring ecosystems. By using land according to its potential, the transformation of natural habitats can be slowed. Rather than extending activities into natural areas, advantage should be taken of the full potential of lands already being used.
- Sustainability means taking into consideration spatial and temporal links as well as limits. There are certain thresholds – biophysical, social and economic. When these thresholds are crossed, land degradation occurs.
- Some strategies are mutually exclusive. Social, economic and environmental trade-offs and also pay for ecosystem service (PES) must be carefully considered in identifying the most appropriate option.
- For agriculture and animal husbandry, strategies may involve intensification of production (producing more in the same amount of land) or extensification (bringing more land into production).

Coffee plantation, Boquete, Panama.

Credit: UNEP/Francesco Gaetani

- Land management strategies need to consider how different scales affect each other. At the plot level, the surrounding larger area must also be taken into account. A specific plot of land within a landscape depends on social and ecological processes taking place in that landscape (and even outside it).

2.5 Biodiversity

2.5.1 Overview and main messages

The countries of Latin America and the Caribbean support a rich biological diversity, which accounts for 60 to 70 percent of all known life on Earth. The wide diversity of

Key Messages: Biodiversity

The biodiversity of the region continues to be threatened, putting many ecosystems and species at risk. Land use change continues to be the greatest threat, but other pressures such as pollution, overharvesting, climate change, unsustainable tourism, and alien invasive species continue to exacerbate already stressed systems.

The establishment and expansion of the region's urban areas (many of which lack adequate planning) and the growth of infrastructure are, in many cases, coinciding with biodiversity hotspots.

Unsustainable patterns of production and consumption and global demand for food and raw materials continue to place growing pressures on the region's ecosystems. The expansion of the agricultural frontier continues to be one of the greatest threats to the region's natural systems.

Data has shown that although the rate of conversion of natural systems has begun to slow, the overall rate of loss of ecosystems remains high. Pockets of success in increasing forested areas such as in the Caribbean, halting the rate of forest loss across the entire region and protecting threatened species continue to be masked by deterioration in many other aspects of biodiversity.

In the case of species, what is of particular concern is that where losses continue to occur, the rate at which they are happening is, more often than not, increasing. The continued loss of LAC's biodiversity is set to have far reaching consequences. Not only will the loss of biodiversity have direct consequences for the economic and social well-being of the 630 million inhabitants of the region; but impacts will be felt globally.

The region has demonstrated leadership and shown success in meeting some of the targets under the Millennium Development Goal 7, and in advancing towards meeting the Aichi Biodiversity Targets.

Between 1990 and 2014 the total terrestrial area under protection in the region increased from 8.8 per cent to 23.4 per cent. At the national level, successful interventions have included the development of new or improved legislation, mobilization of additional resources for biodiversity protection, enhanced dialogue among the stakeholders in biodiversity governance, and the implementation of a variety of policy support tools.

The lack of policy-relevant data and information on biodiversity is an important issue which hinders management efforts (**More…28**).

ecosystems in LAC provides critical services to support economic development and ensure a good quality of life. Approximately one quarter of the tropical forests in the world are found in LAC, and they contribute significantly to the regulation of global climate by providing services such as carbon sequestration and climate regulation. The region also provides large areas of arable land that support agriculture to meet both regional and global food demands. The ecosystems of the region provide opportunities for other important economic and social activities such as tourism and fisheries; and watersheds continue to play an important role in providing water and energy (derived from hydroelectric means). Biodiversity is of critical importance to the many local and indigenous communities found throughout LAC, providing a source of livelihoods and in many cases, shaping their cultures and identity.

There is a need for the region to identify its most urgent data requirements and to make the most effective use of regional and international collaboration opportunities such as those offered by the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES). Fostering greater public-private partnerships can also serve as a useful approach to support research agendas.

Mainstreaming biodiversity and ecosystem services into sectoral and cross-sectoral strategies, plans and programmes must become a top priority for the region. The recently adopted SDGs offer an opportunity to reconsider approaches and strategies; and these efforts can be supported by the wise application of important policy tools such as valuation, natural capital accounting and strategic environmental assessments.

2.5.2 Pressures

Land use change

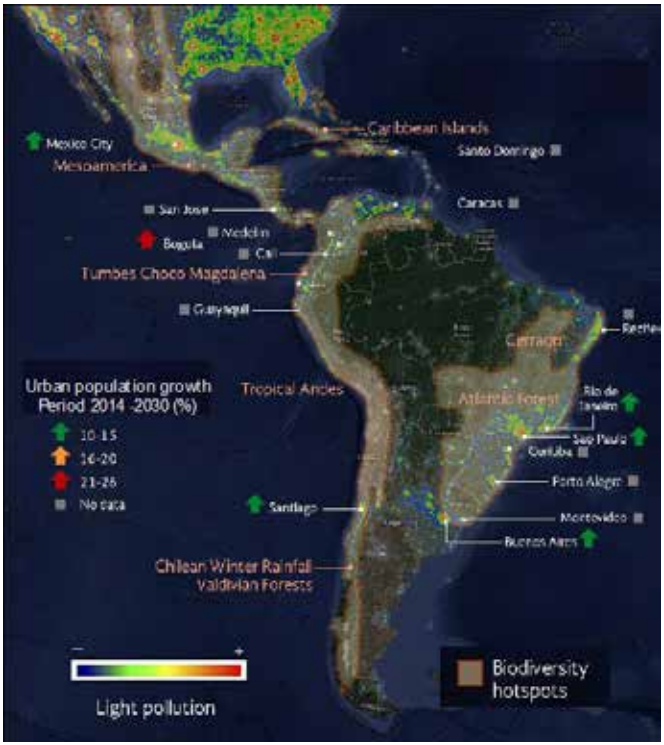
Land-use change, including degradation and fragmentation of natural habitats, remains the most important threat to biodiversity in the region (See Section 2.4). The conversion of natural habitats to agriculture and pastureland is considered the most important land use threat to biodiversity in LAC; and the areas facing highest threat include the Atlantic coastal forests and savannah ecosystems (Magrin *et al*. 2014). Expansions of certain crops such as sugar cane, soybean and coffee plantations, as well as the rearing of livestock, are some of the agricultural activities that are of greatest concern. It has been reported that the rate of loss of natural ecosystems on account of agriculture has slowed in the past decade, but the total area being converted every year in LAC remains high, and is expected to continue this way given the current patterns of land use (Aguiar *et al*. 1996).

Particular concern for biodiversity also arises because of the patterns of urbanization seen in the region. In 2015, about 80 per cent of LAC's population lived in urban areas, which is the highest apportionment seen in the world (UNECLAC 2015b). The majority of LAC's urban agglomerations with more than 1 million people are in South America (43), followed by Mesoamerica (19) and the Caribbean (4) (UNDESA 2014); and many of these are sprawling over biodiversity hotspots.

Megacities in the Atlantic Forest eco-region in Brazil (for example, Sao Paulo and Rio de Janeiro), those in coastal Mesoamerica e.g. San Jose and Mexico City (CBD 2012), and urban areas in the Mediterranean-like ecosystems in Chile are growing within areas considered important for biodiversity (Miloslavich *et al*. 2010). To illustrate this point, light pollution in LAC (**Figure 2.5.1**) could serve as a useful indirect indicator of the pressure that urbanization exerts on natural environments within biodiversity hotspots.

In addition to the infringement on biodiversity hotspots, the growth of human settlements, tourism services and associated infrastructure in the region also continues to drive the transformation of coastal and marine ecosystems. Population growth in coastal areas has been rapid in LAC; between 1945 and 2014, the population in coastal cities with more than 100 000 inhabitants increased by 778 per cent (de Andres and Barragan 2015) (**Table 2.5.1**). In 2014, 420 cities with more than 100 000 inhabitants were settled within 100 kilometres of the coastline, some of them in marine and

Figure 2.5.1: Light pollution, urban population growth and biodiversity hotspots in Latin America and the Caribbean.



Source: Digital Globe 2010 and UNDESA 2014

terrestrial areas which are important for biodiversity, such as Rio de Janeiro, Recife and Sao Paulo, in Brazil (de Andres and Barragan 2015).

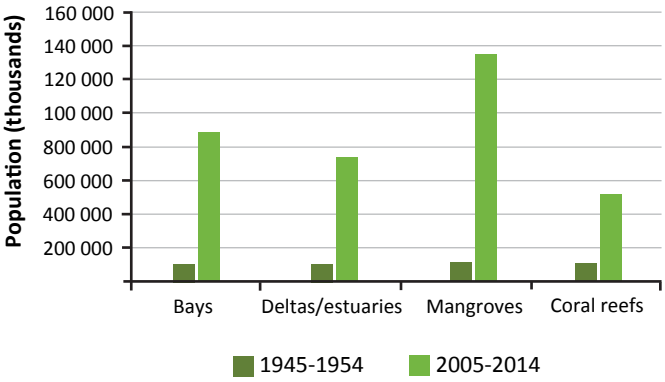
Between 1945 and 2014, the population living in cities near mangrove ecosystems in LAC increased to 122.5 million people (or by 1 114 per cent) – the largest increase when compared with other coastal ecosystems in the region (de Andres and Barragan 2015) (**Figure 2.5.2**).

Table 2.5.1: LAC's population ('000) living in coastal cities (within 100 kilometres of the shore) with more than 100 000 inhabitants, 1945-2014.

Period	Number of coastal cities	population
1945-1954	42	20 487
1955-1964	74	33 148
1965-1974	122	53 474
1975-1984	163	811 69
1985-1994	247	111 138
1995-2004	358	153 921
2005-2014	420	179 828

Source: de Andres and Barragan 2015

Figure 2.5.2: Changes in population living in coastal cities near bays, deltas or estuaries, mangroves and coral reefs in LAC, 1945-2014.



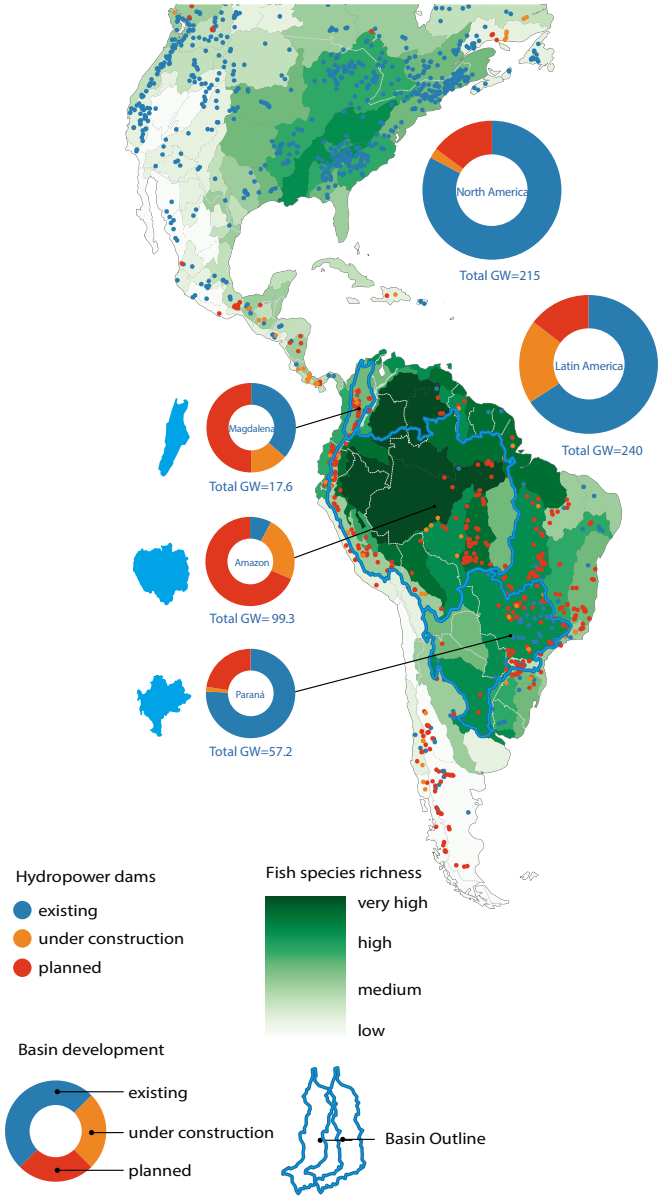
Note: Figures are the population living in coastal cities with more than 100 000 inhabitants and within 100 kilometres of the shore.

Source: de Andres and Barragan 2015

Dam construction

LAC has an important network of hydropower infrastructure, which is also used for water storage. The Paraná, Magdalena and Amazon basins are the most developed with dam

Figure 2.5.3: Existing, under construction, and planned dams in LAC.



Source: Opperman *et al.* 2015

infrastructure (Opperman *et al.* 2015). In the Amazon basin, there are about 150 hydropower stations in operation, of all sizes, as well as a large number of small dykes in minor waterways, located primarily in the Brazilian Amazon, Ecuador, Peru, Bolivia and the Guianas. Until 2010, about 288 000 kilometres of the Amazon had not been affected by dams, but projects planned and in process could reduce this by 62 per cent (Opperman *et al.* 2015). It has been noted that the Amazon and La Plata basins will, in the future, be the basins with the most hydropower projects in the region; and from a biodiversity perspective, these areas correspond with ecosystems rich in fish and other fresh-water species, thus posing a threat to fish species diversity (Zarfl *et al.* 2014, **Figure 2.5.3**)

Pollution

It is estimated that 96 700 million m^3 of water is affected by nitrogen-related pollution every year in the LAC region (Mekkonen *et al.* 2015). The main sources of this pollution are crop production (46 per cent), domestic water (37 per cent), industrial production (17 per cent) and production for exports (7 per cent). It is reported that 3 crops - maize, sugarcane and wheat - account collectively for 52 per cent of freshwater pollution from crop production in the region (Mekkonen *et al.* 2015).

Pesticide pollution by agriculture represents an important pressure to the regional biodiversity. Particular concern arises by its effect on natural and managed pollinators. Although there are no large losses of pollinators reported in the region, increasing agricultural intensification could pose a significant risk to pollinators in the future (van der Valk *et al.* 2013). Besides its ecological impacts, economical losses could be relevant: in Brazil, annual commodities dependent from pollinators can reach EUR 7 000 million (van der Valk *et al.* 2013).

The extractive industries (mining; and oil and gas) are another source of pollution in LAC, and these can have adverse impacts on biodiversity (Maconachie 2015). Such impacts can include removal of habitats to disruption of

food chains and species composition (Miranda *et al*. 2003). In this manner, oil development in the Amazon has been reported to result in pollution of waterways (Finer *et al*. 2013; Mulligan *et al*. 2013), and Section 2.2 on freshwater provides information on the impacts of mining on water quality across LAC.

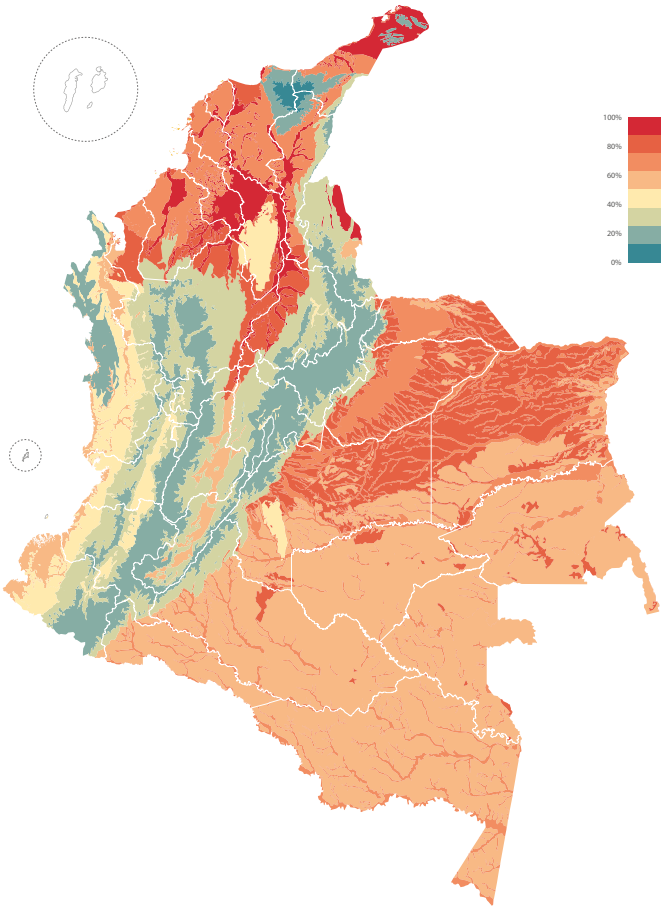
Climate change

Climate change also places a strong pressure on biodiversity (IPCC 2014a), especially by changing the bioclimatic envelopes determining the distribution and abundance of species. The region has suffered in the last century important climatic changes accompanied by an increasing frequency of extreme events, particularly those associated with the ENSO phenomenon.

In the Andes, for example, observed changes in circulation patterns responsible for producing and moving water vapour could be responsible for some reductions in populations of mountain flora and fauna (Vergara 2009). In the marine realm, climate change is affecting Caribbean coral reefs, basically by the increase in sea surface temperature. This condition acting synergistically with coastal activities with negative environmental effects (such as sediment runoff, pollution, destructive fishing practices and unsustainable touristic activities) could make the coral reef situation even worse (UNEP-WCMC 2015b). Ocean acidification, a condition with impacts on the physiology and behaviour of marine organisms (e.g. coral and molluscs) could also have negative impacts in regional marine environments, specifically in the Caribbean.

Projected effects on species distribution could be dramatic in some cases (**More...29**). A recent analysis on 1922 species of vertebrates and vascular plants in Colombia shows that 80 per cent of the modelled species inhabiting lowland ecosystems will face drastic changes in their areas of geographic distribution under various climatic scenarios for 2050 (Velásquez-Tibatá 2014). This is simply because projected changes in temperature and rainfall will cover very large areas of land, making it more difficult for species to adapt or migrate. In contrast, the same analyses show that, for species inhabiting mountain ecosystems, there will be more opportunities to follow the changes in their climatic

Figure 2.5.4: Distribution of the average percentages of species that could lose their current geographic range in 2050 under five climate change scenarios.



Note: This analysis considers 1922 species of vertebrates and vascular plants. Orange to red colours mean that those areas will not be suitable for 50 to 100 per cent of the species currently present there.

Source: adapted from Velásquez-Tibatá 2014

envelopes; even so, up to 40 per cent of the studied species restricted to mountain habitats could be exposed to local extinctions due to climate change (**Figure 2.5.4**).

It is important to take into account that these analyses do not consider synergistic effects with other pressures such as deforestation or overharvesting, making the situation even worse. For example, a similar analysis of the effects of climate change on the distribution of 25 highly invasive plant species in Colombia (Bello *et al*. 2014), showed that the potential area of distribution of 66 per cent of these species will increase under all the climatic scenarios examined for 2050, adding more stress to native species and making it more difficult to restore degraded habitats.

Overharvesting

The world´s consumption of fish products grew by about 94 per cent between 1960 and 2012 (FAO 2014a). This demand has been concentrated in high-income countries, mainly Europe and Asia (Salas *et al*. 2011). LAC has responded to this demand and has become a leading exporter of fish and other fisheries products (FAO 2014a). The region accounts for approximately 24 per cent of global fisheries catch (Pérez-Ramírez *et al*. 2015). In 2012, Peru, Chile and Mexico were among the 18 largest producers of marine capture fisheries in the world with about 11 per cent of the total (FAO 2014a).

Wood extraction Logging is an important economic activity in the region that places pressure on forested ecosystems (Finer *et al*. 2014). Data from FAO indicate that 504 million m^3 of roundwood was produced in LAC in 2014 (FAO 2015c) and this volume has been growing over the last decade. Certain species of global importance, such as mahogany, are also being lost from natural systems across the region at alarming rates (WWF 2015a).

No estimates for the hunting of wild animals are available for LAC as a whole. Bushmeat provides a crucial source of protein where other protein alternatives are scarce or expensive (Swamy & Vasquez Pinedo 2014). In South America has been estimated that between 5 to 8 million people regularly rely on bushmeat as a protein source (Rushton *et al*. 2005), both in rural as in urban areas (for example, in the borders of Brazil, Colombia and Peru, see van Vliet *et al*. 2015). Besides the ecological impacts that bushmeat overharvesting can have in natural populations, also there are serious health concerns because a high percentage of emerging infectious diseases in humans come from the consumption of wildlife (Cawthorn and Hoffman 2014).

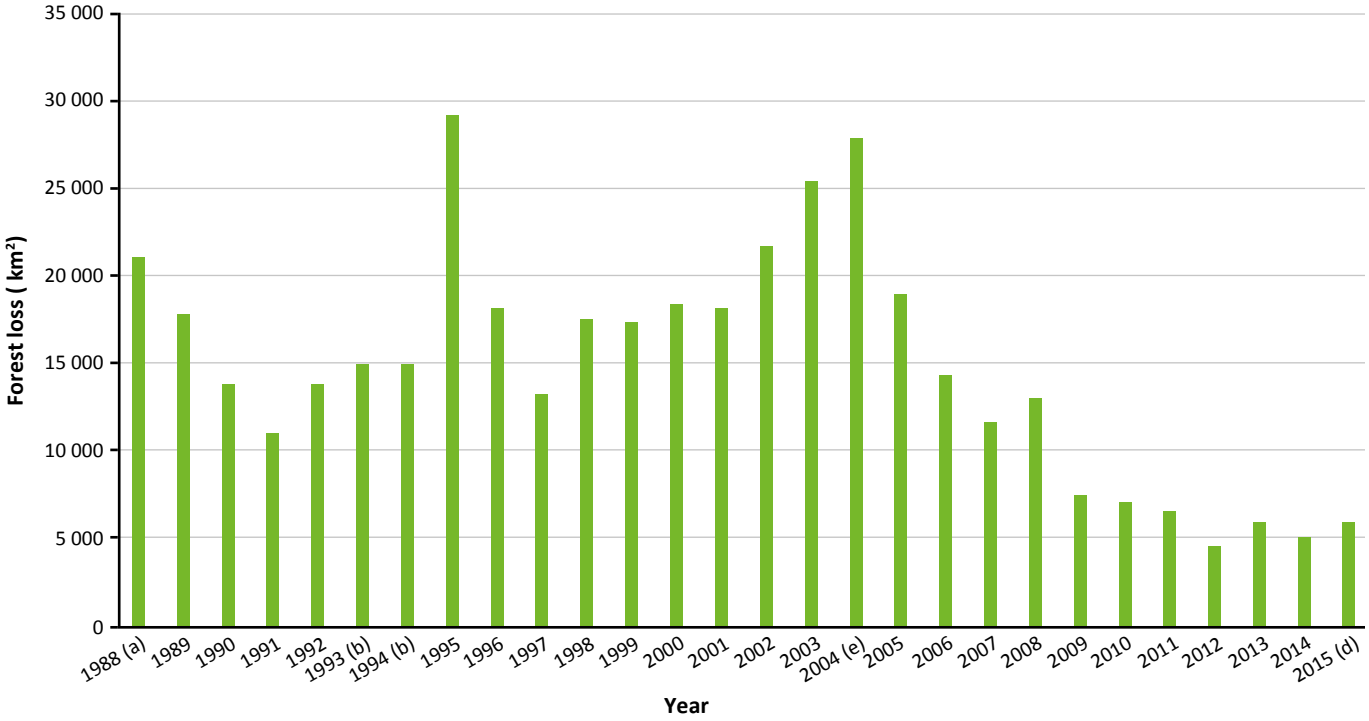
Invasive Alien Species

Invasive alien species (IAS) are considered one of the most important threats to biodiversity worldwide, and islands are especially vulnerable to their effects (CBD 2016). In LAC, factors responsible for the introduction of invasive species (such as travel, trade, and tourism) are growing in parallel with their contribution to national economies. Climate change could facilitate future invasions and establishment of IAS in many ecosystems across the entire region. By affecting the biodiversity of the region, alien invasive species can have knock-on effects on issues such as human health, food security and local and national economies (CBD 2016).

Emerging infectious diseases

Emerging infectious diseases have been recently recognised as a serious threat to biodiversity. Because of its effects on regional fauna, the most relevant is chytridiomycosis caused by the fungus *Batrachochytrium dendrobatidis*, which affects amphibians. In 2008, it was estimated that *chytridiomycosis* caused declines in 42 per cent of global amphibian species and threatened as many as 32 per cent with extinction (IUCN 2008). *Chytridiomycosis* has been related to infections in amphibian species across the entire LAC region, which is a very serious problem given the high diversity and level of endemism of this group in LAC (Swei *et al*. 2011; Weldon *et al*. 2004).

Figure 2.5.5: Deforestation rates in Brazilian Amazon, 1988-2015.



Note: a) measured between 1977 and 1988; b) measured between 1993 and 1994; c) consolidated annual rates; d) estimated rate; and e) beginning of PPCDAm.

Source: PRODES 2015

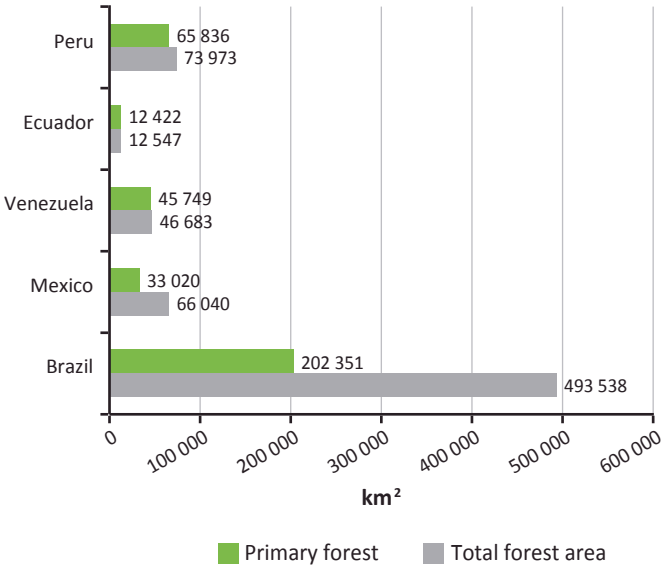
2.5.3 State and Trends

Terrestrial ecosystems

The LAC region still boasts a significant proportion of natural terrestrial ecosystems. In 2015, LAC's forests covered about 9 355 000 square kilometres, which was 91% of total forest cover in 1990. Further, in 2015 LAC's forests accounted for 23.4 per cent of the total forested area worldwide (**Figure 2.5.5**). Although the regional deforestation rate has been reduced, LAC is still losing about 2.18 million hectares of its forests annually (FAO 2015c).

Brazil is the country most affected by deforestation in Latin America and the Caribbean. In 2004, the Brazilian Amazonia reached a peak of 27 800 square kilometres of forests transformed to a different land-use. However, since the launch of the Brazilian Program to Prevent and Combat Deforestation in Amazon (PPCDAm) in 2004, rapid reductions in deforestation rates were achieved. In 2015, deforestation rate reached 5 800 square kilometres per year in Brazil, which represents a reduction of about 80 per cent with respect to the 2004 baseline (**Figure 2.5.5**; PRODES 2015).

Figure 2.5.6: Primary forests in five mega-diverse countries in LAC.



Source: FAO 2015c

Forested areas are recovering in other sub-regions; in the Caribbean for the period 2010 to 2015 forests expanded at a rate of 900 square kilometres per year, mainly as a result of the abandonment of agricultural lands, as in the case of Puerto Rico, Dominican Republic, Jamaica, and Cuba (Álvarez-Berríos *et al*. 2013).

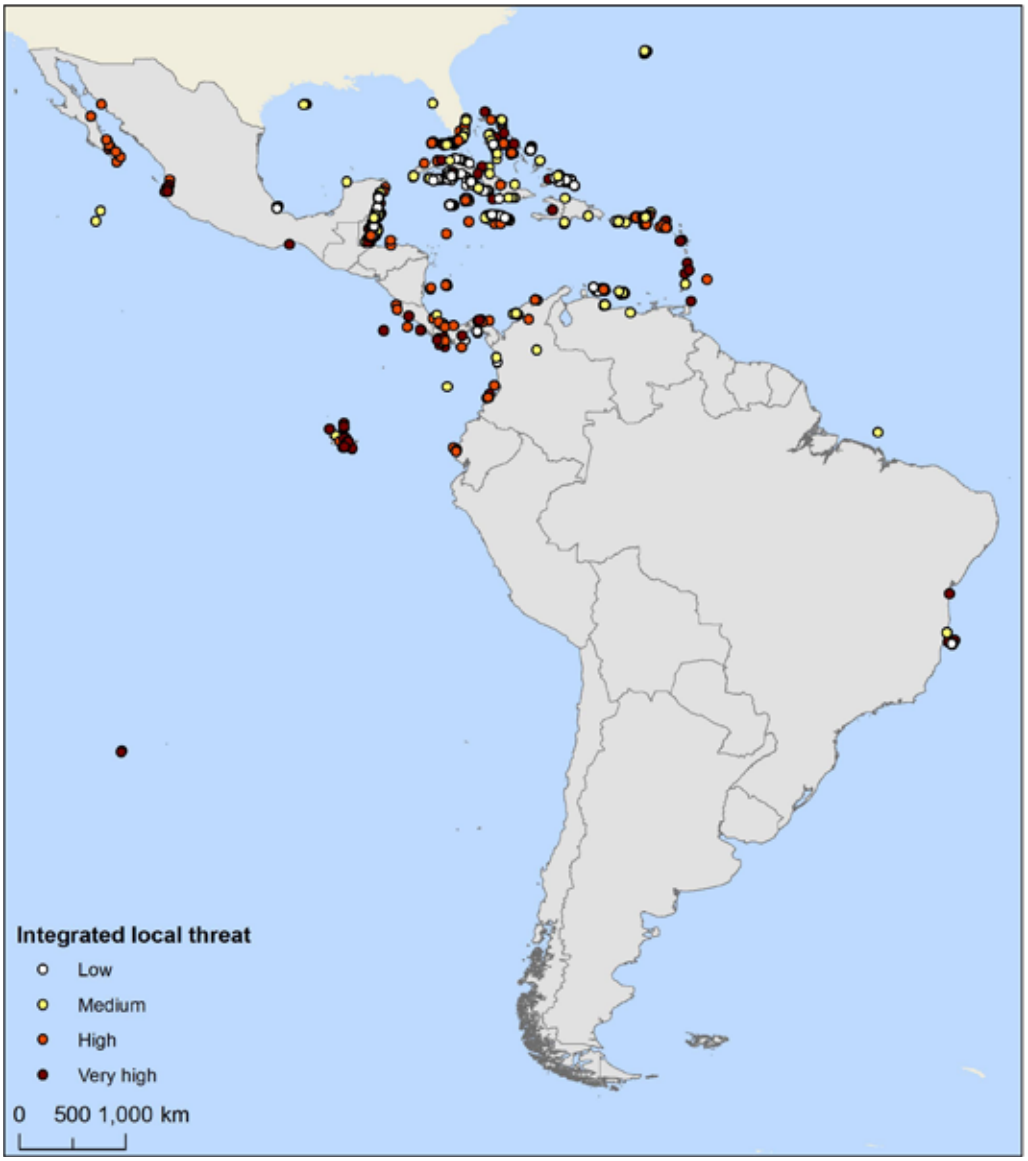
The state of the forests influences their capacity to support biodiversity - primary forests often boast a higher number of species than secondary forests (Barlow *et al*. 2007). In 2015, 41 per cent Brazil's forests were primary (16 per cent of global primary forests); Mexico 50 per cent; and Peru, Venezuela and Ecuador reported values about 89, 98 and 99 per cent respectively (FAO 2015c) (**Figure 2.5.6**). Countries with lower proportions of primary forests in 2015 were El Salvador (2 per cent), Argentina (6 per cent) and Grenada (12 per cent).

Andean *páramos* are important ecosystems from a biodiversity perspective. Approximately 60 per cent of their species are endemic. They are also major suppliers of water for cities (e.g. Quito, Bogota and Cali), agriculture, industries, and for hydropower in the higher Andes (Buytaert *et al*. 2007). Over the past three decades, these ecosystems have been transformed and fragmented (Fearnside 2013). In 2008, the *páramo* covered 60 per cent of its original extent in its northern range (Cuesta and De Bievre 2008).

Temperate grasslands outside the Andean region are some of the richest grasslands in the world (Baldi *et al*. 2008; Miñarro *et al*. 2008). In the *pampas* and *campos*, up to 550 species of grasses have been described. However, the expansion of the agriculture frontier is causing habitat loss and fragmentation (Miñarro *et al*. 2008); in 2008, only about 30 per cent of original Argentine pampas still covered the region. The Brazilian *Cerrado*, covering about 24 percent of Brazil's land area, is a woodland savannah ecosystem which boasts high biodiversity (Solbrig *et al*. 1996). It is the second largest eco-region in LAC, and holds about 5 per cent of global biodiversity, but this ecosystem has been undergoing transformation. By 2008, it had lost about 47.84 per cent of its original range of 2.04 million square kilometres (MMA-Brazil 2015b). For details about grassland transformation in the region see Section 2.4 Land.

Thirty-one per cent of LAC's population lives in drylands, which cover about 25 per cent of the region (UNCCD 2002). These areas, which include hyper-arid and arid deserts and sub-humid forests, are dominated by biodiversity-rich ecosystems. About 1.2 million of square kilometres of drylands are desertified in LAC, it is, about 18.8 per cent of regional drylands (Zika and Erb 2009). Besides its social and economic impacts, many affected areas in the region coincide with areas relevant for their biodiversity (e.g. Mexican and Peruvian drylands and sub-humid forests). More details on land degradation can be found in Section 2.4.

Figure 2.5.7: Coral reefs classified by integrated local threats (2014).



Source: map produced by UNEP-WCMC using data from Reef Base 2014. Reef locations are based on 500 meter resolution gridded data reflecting shallow, tropical coral reefs of the world. Organizations contributing to the data and development of the map include the Institute for Marine Remote Sensing, University of South Florida (IMaRS/USF), Institut de Recherche pour le Développement (IRD), UNEP-WCMC, The World Fish Center, and WRI. The composite data set was compiled from multiple sources, incorporating products from the Millennium Coral Reef Mapping Project prepared by IMaRS/USF and IRD

Coastal and marine ecosystems

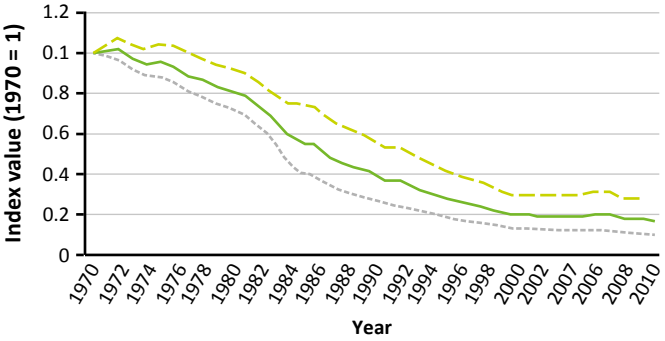
The coral reefs of the Caribbean continue to show signs of decline and degradation. It has been documented that most of the reefs in the region (over 75 per cent) are facing serious threat (Burke *et al.* 2011) (**Figure 2.5.7**). A study by Jackson *et al.* (2014), based on 88 sample points, found average coral cover declined in the Caribbean from 34.8 per cent to 16.3 per cent between 1970 and 2011.

A recent evaluation on the condition of the Mesoamerican Reef (the largest barrier reef in the northern hemisphere and the second largest barrier reef in the world) has indicated signs of improvement (Kramer *et al.* 2015) (**Figure 2.5.8**) Before 2006, the Mesoamerican reef was seriously affected by events of coral bleaching and hurricanes (Wilkinson 2008). However, between 2006 and 2014, the Reef Health Index improved slightly (from 2.3 to 2.8; values approaching 5 denote healthy reefs), due to increases in coral cover and the biomass of commercial fish species.

According to the Global Forest Resource Assessment 2015 (FAO 2015c) currently there are about 46 000 square kilometres of mangrove forests in LAC region. Most is found in coast of the Amazon countries, where Brazil accounts for about 70 per cent or the mangrove area in the sub-region. In Mesoamerica, most mangroves are found in Mexico, and in the Caribbean, Cuba is the country with most mangrove forests. All three sub-regions show a slight increase of mangrove forest area, due to both a natural increase and a more accurate recent estimate. However, it has also been reported that along the Atlantic and Pacific coasts of Mesoamerica, as many as 40 per cent of mangroves species are threatened with extinction (Polidoro *et al.* 2010).

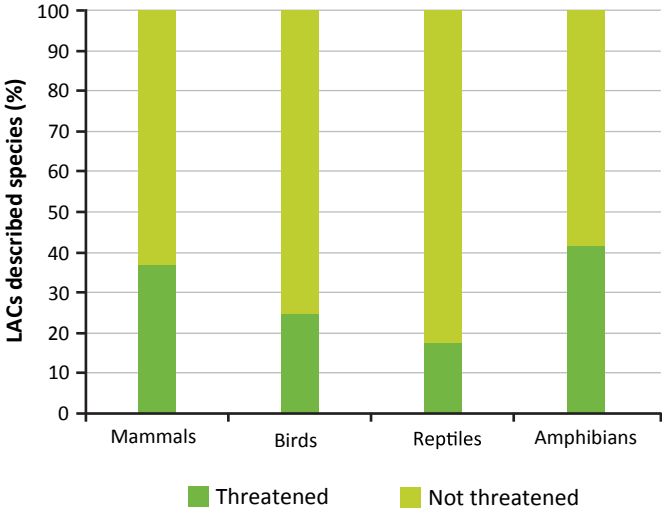
With respect to fisheries, available data indicate that the Pacific fisheries, which are characterised by considerable oscillations, show no major changes in the state of fishing of stocks (FAO 2014a). In the Southwest Atlantic about 55 per cent of the monitored fish stocks are at biologically unsustainable levels, and 45 per cent within biologically

Figure 2.5.8: Neotropical Living Planet Index 1970-2010. Dashed lines represent confidence limits.



Source: McRae *et al.* 2014

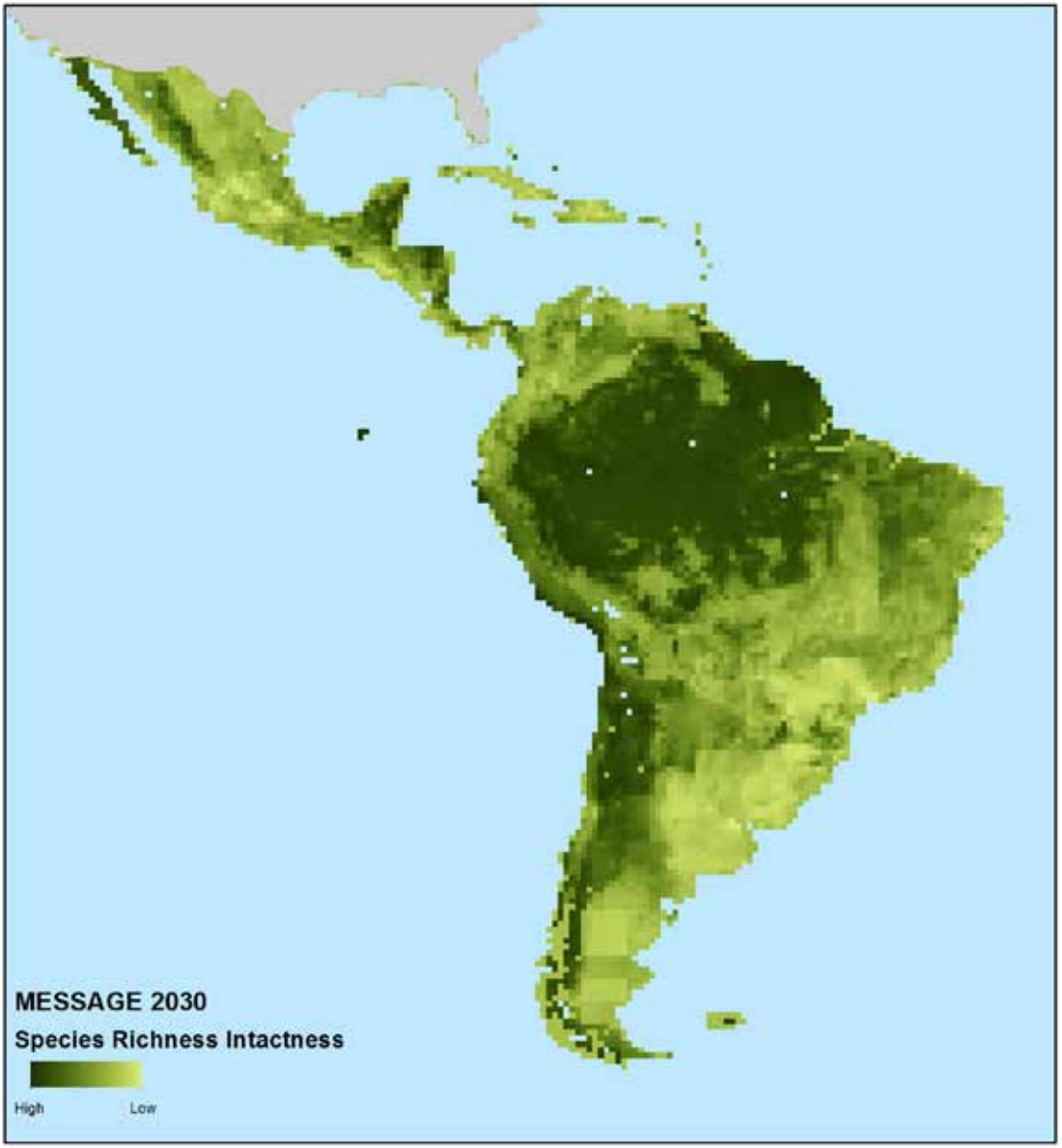
Figure 2.5.9: LAC's threatened species after IUCN, 2015.



Source: IUCN 2015

sustainable limits (FAO 2014a). In the case of the Caribbean fisheries, trends show overall declines in fish stocks (FAO 2014a). Overfishing has been reported as one of the most

Figure 2.5.10: Intactness of the species richness assemblage in the LAC region as measured using the PREDICTS database and modelling framework.



Source: Newbold *et al.* 2015

important threats to Caribbean reefs, affecting up to 70 per cent of these ecosystems (Burke *et al*. 2011).

Threatened species

According to the *Living Planet Index*, between 1970 and 2010, the size of vertebrate populations in the Neotropics decreased by 83 per cent; this is the highest figure observed in any region around the world (**Figure 2.5.9**; McRae *et al*. 2014). The main pressures driving reductions in species are pollution, invasive alien species, habitat loss and climate change (WWF 2014).

Based on the latest data published in the Red List of threatened species by the International Union for Conservation of Nature (IUCN), approximately 10 831 species in LAC are considered at risk (IUCN 2015). This figure is probably an underestimate because of gaps in information about many species. For example, at least 42 per cent of LAC´s amphibian species, 37 per cent of mammal species, 25 per cent of bird species and 18 per cent of reptile species are threatened (**Figure 2.5.9**).

Modelling indicates that while the Amazon forest has retained a large proportion of its original species diversity, other ecosystems have lost significant diversity (**Figure 2.5.10**) (Newbold *et al*. 2015).

Invasive Alien Species

Although knowledge about Invasive Alien Species has been growing in the LAC region, there are still a number of gaps in the data. There are a few national lists with some still in preparation. The list of invasive species for the Caribbean, produced more than a decade ago, reported 416 species, many already present on the mainland (Kairo and Ali 2003). In Mexico, 213 invasive species have been reported in terrestrial ecosystems, 93 in freshwater and 71 in coastal environments (Mexico- SEMARNAT 2015). In Colombia and Argentina, 581 and 600 species have been classified as invasive respectively (FAO 2015d).

In the terrestrial realm, some examples of dangerous IAS established in some LAC countries are the yellow crazy ant *(Anoplolepis gracilipes)*, the chytrid frog fungi *(Batrachochytrium dendrobatidis)*, the cannibal snail *(Euglandina rosea)*, and the small Indian mongoose *(Herpestes auropunctatus)*. For freshwater and marine ecosystems have been registered the zebra mussel *(Dreissena polymorpha)*, the European green crab *(Carcinus maenas)*, the water hiacynth *(Eichhornia crassipes)* and the common pleco *(Hypostomus plecostomus)*, among others (ISSG 2015).

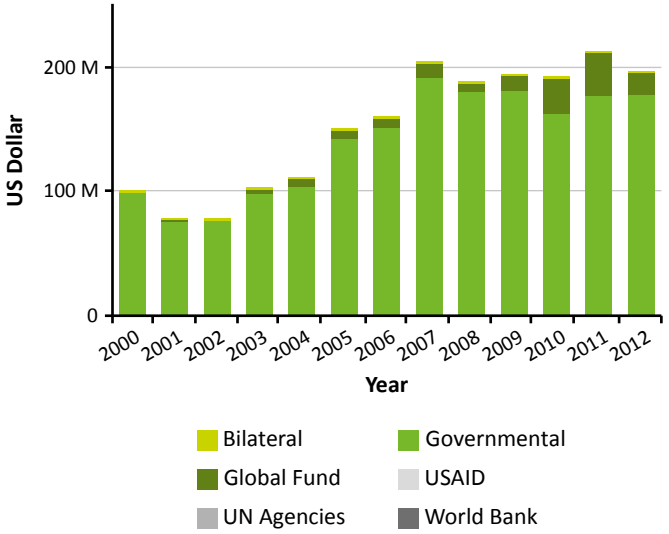
Marine ecosystems in the Caribbean have recently been affected by the invasion of lionfish. Through accidental and/or intentional release into the Atlantic, lionfish have become established in coral reefs in Bermuda, Florida, the Gulf of Mexico, the Caribbean islands, Mesoamerica, and northern South America.

Genetic diversity

Although the current information in the region is not sufficient to accurately assess the state of the genetic diversity of cultivated species, national reports to FAO´s State of World´s Plant Genetic Resources (FAO 2016) indicate significant problems of genetic erosion of crops and their wild relatives in the region.

The adoption of improved crop varieties by farmers is perhaps the most relevant factor causing genetic erosion in the region. For a long time it has been thought that use of improved varieties may result in increasing yields and gains for farmers, which under some circumstances could not be entirely true. In Mexico, the loss of local varieties of maize (currently 59 races of maize and its relative teosinte have been described in this country), is driven by improved varieties: about 70 per cent of the area sown with maize in the States with greatest production uses improved maize seeds (Molina and Córdova 2006; Berthaud and Gepts 2004). In Chile, Chiloé´s farmers prefer commercial improved potatoes to traditional varieties: before the introduction of new varieties the local communities grown between 800 and 1 000 potato varieties; currently just about 270 varieties are

Figure 2.5.11: Funding for treatment and prevention of malaria in Latin America and the Caribbean (USD Million) period 2000-2012.



Note: Data not available for 2000-2012 for Haiti, since 2005 for Suriname and 2006-2008 for Venezuela.

Source: OPS 2013

reproduced in the island (Seguel y Agüero 2008). In Costa Rica, four wild species of common bean (genus *Phaseolus*) are threatened in non-indigenous areas by the same process (MAG 2008).

Forest species in LAC have also been affected by genetic erosion. In general, land use change, overharvesting of timber products and logging are the main factors behind this process in the region. In Ecuador, intensive exploitation of timber products has resulted in genetic erosion in tagua *(Phytelephas aequatoriales)*, cedro colorado *(Ocotea caracasana)* and the royal palm *(Ynesa colenda)* (Tapia *et al.* 2008). The extraction of *Araucaria araucana* in Argentina, combined with overgrazing and forest degradation, have promoted the loss of genetic variability (Clausen *et al.* 2008).

2.5.4 Impacts

The biodiversity in LAC supports economies and cultures of the region in a variety of ways; and it underpins the livelihoods and identities of many of the local and indigenous communities found throughout the region.

The loss of forested area reduces the potential to extract local environmental goods and services; and can therefore result in the loss of economic revenues and future jobs. In LAC, about one fifth of the total rural population derives livelihoods from forest resources to support their sustenance (Pacheco *et al.* 2011).

Forest loss reduces carbon sequestration services, and consequently contributes to climate change. In the Amazon, as a result of the efforts of Brazil to reduce deforestation rates, emission rates have decreased since 2005. However, in the non-Brazilian Amazon an opposite trend in deforestation and carbon emission has been observed (Song *et al.* 2014). Some studies suggest that future deforestation in the region could have a significant impact on atmospheric composition because remnant forests have higher biomass than previously cleared ones (Song *et al.* 2014).

Negative impacts on human health derived from forest loss have been suggested in the literature; some studies show a relationship between deforestation and the incidence of several infectious diseases such as malaria, dengue, Chagas disease, leishmaniosis and Hantavirus (Guerra *et al.* 2006; Vittor *et al.* 2009) (**More...30**). In the case of malaria (about 469 000 cases with 108 deaths in 2012), the resources mobilized for treatment and prevention between 2000 and 2012 ranged between USD 77 million and USD 211 million annually, representing a large portion of public spending (**Figure 2.5.11**; OPS 2013). Although not all malaria infections and all costs associated with them can be directly attributed to the loss of the forest ecosystem, the potential link between forest loss and the spread of malaria should not be discounted.

Cloud forests transformation can promote shortages in water provision. In some cases, water shortages can affect large urban agglomerations which depend on this ecosystem service. The cloud forests in La Tigra National Park in Honduras sustain a constant water flow throughout the year to 850 000 people in Tegucigalpa (it is, 40 per cent of the water supply in 2000; IUCN and WWF, 2000).

Forests are the safest and cheapest option for minimizing the hazards of landslides and floods, which can be catastrophic given the strength of climatic events in the region. In some circumstances, cleared lands are more susceptible to landslides, and this can result in significant losses and injuries to humans. In 2014, about 68000 people were displaced by massive floods in the Bolivian Amazon, as the result of heavy rainfalls and large-scale deforestation in the Peruvian and Bolivian Andes (Macedo and Costello 2015).

Besides the serious social impacts they generate in rural communities, degraded lands have had serious impacts on national economies. In Costa Rica, some estimates suggests costs ranging from about 5 to 13.3 per cent of annual value-added in agriculture; in Mexico, total cost for degraded land has been estimated about 5 to 6 per cent of NDP (Berry *et al*. 2003).

Water pollution, in combination with other factors, can reduce water availability. On Lake Atitlan in Guatemala, recent seasonal blooms of blue green algae (Cyanobacteria) covered up to 4 500 hectares of the surface, as result of excessive phosphorus runoff from crop fields in the basin and the detergent used to wash clothes on the shoreline. As a result, provision of freshwater and other ecosystems services was interrupted (UNEP 2010b). These and other factors have very negative impacts on wetlands, which are a very important ecosystem across the region (**More...31**).

Pollution due to mining also has health consequences for people. In Suriname, several marine and inland fisheries showed mercury contamination resulting from small-scale gold extraction (Mol *et al*. 2001). Similar findings exist for the Amazon basin (Beltran-Pedreiros *et al*. 2011). In French Guiana, 79 per cent of children living along the Marowijne River have abnormally high hair mercury levels caused by consumption of contaminated freshwater fish (Cordier *et al*. 1998).

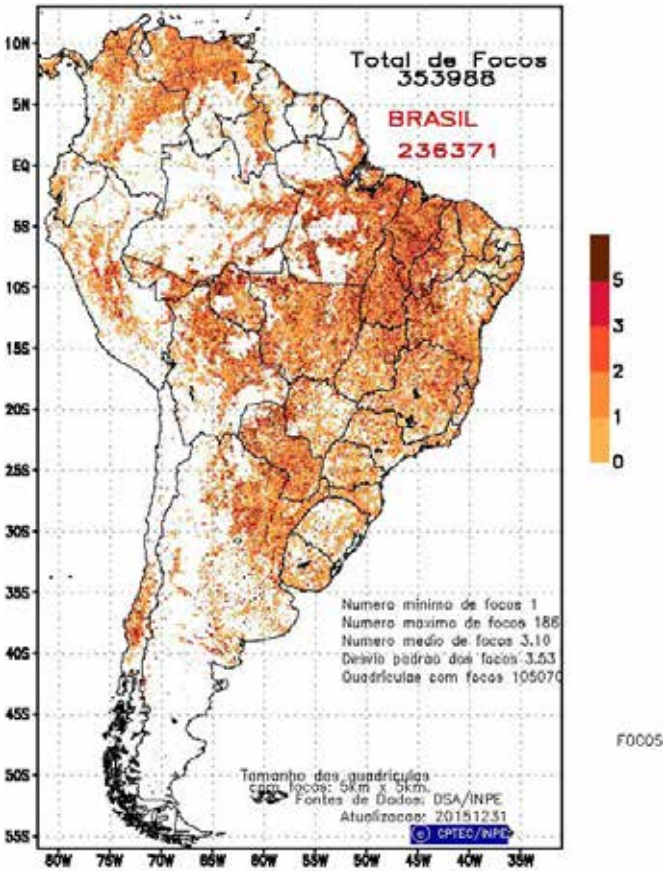
The destruction of mangroves in LAC has negative consequences for small fishermen and local communities (Van Lavieren *et al*. 2012). In some countries, the loss of mangroves has decreased the availability of shrimp larvae, which is vital to the LAC's shrimp aquaculture industry (Tobey *et al*. 1998). When shrimp production decreases the gains of local people and small industries can be seriously affected.

Overfishing can have negative social and economic effects. The decline of fish stocks represents the loss of goods and employment for many coastal communities. One important fishery in the region, the Argentinean hake *(Merluccius hubbsi)* is at very high risk. In the past 20 years the biomass of this species fell by 70 per cent. The Hake fishery generates 60 per cent of employment in the fishing sector (FVSA 2008), therefore the potential collapse of this resource can have wide-ranging impacts.

Marine pollution is a significant issue in the Caribbean region, damaging valuable natural resources and affecting the quality of life of local people and visitors, impacting national economies and jeopardizing the sustainability of the entire region (UNEP 2009). The loss of biodiversity reduces the aesthetic value of marine environments, specifically coral reefs, which usually causes declines in the demand for tourism-related services.

The case of the lionfish in the Caribbean is a good example of potential impacts of invasive species. This species has contributed to the decline of commercially important species of fish, including some species relevant to local consumption (Gómez Lozano *et al*. 2015). Introduction of the Nile tilapia (*Oreochromis niloticus*) in some freshwater bodies in Nicaragua has caused a 50 per cent decline in total biomass catch (Wise *et al*. 2007).

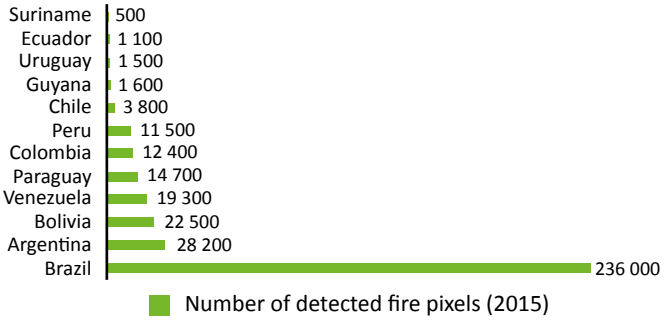
Figure 2.5.12: South America's spatial distribution of fire pixels in 2015 as observed by the early-afternoon daily MODIS coverage of the NASA-AQUA satellite.



Note: The size of each pixel corresponds to 1 km² and fire size detected per pixel varies from a few dozens of square meters to 1 square kilometre.

Source: MMA-Brazil 2015

Figure 2.5.13: Number of fire pixels in 2015 in South America as detected by NASA MODIS-AQUA satellite.



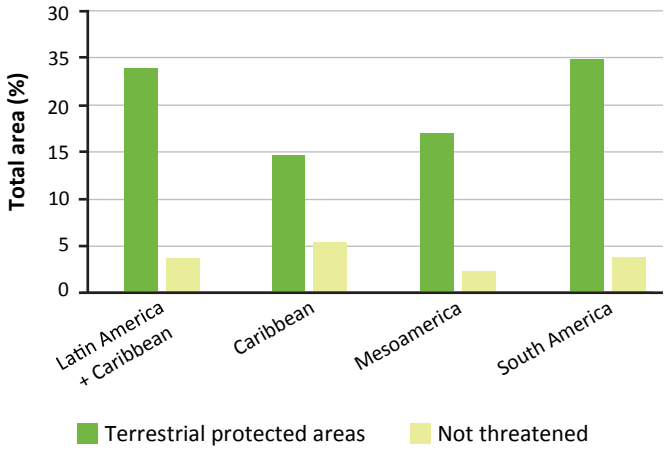
Source: INPE 2015a

Extreme events derived from climate change, such as long droughts, may cause severe wildfires with irreversible consequences for biodiversity. The burning of vegetation is a common feature in the region, either in degraded ecosystems or in natural forests, where fire can be used for deforestation, agricultural practices, pasture renewal, manual sugar-cane cropping, etc. (Silveira *et al*. 2015). The quality and consistency of reliable data on burnt area for the region is an issue since the methodologies currently used to assess the extensions of fire scars are largely based on satellite imagery obtained from different sensors and processing methodologies. **Figure 2.5.12** presents the spatial distribution of fire pixels detected in the region for the relatively dry year 2015 using the daily early-afternoon MODIS images of the NASA-AQUA satellite processed by the Fire Monitoring Program of Brazilian National Space Institute (MMA-Brazil 2015).

Estimates of burned area for Brazil in the last decade presented by INPE (**Figure 2.5.13**) range from 2 millions square kilometres (~20% of its territory) in 2015, to 0.9 million square kilometres in the relatively wet year of 2009. Savannas (Cerrado) is the more affected biome in Brazil, followed by Amazonia Caatinga (semi-arid shrubland), Atlantic vegetation of Pantanal (wetlands) and Pampas (southern prairies) (MMA-Brazil 2015).

Increasing temperatures and changes in rainfall patterns will also have an effect on the Andean glaciers (see Section 2.3). As a consequence, observed changes have been already detected through the drying-up of some Andean wetlands which could have important impacts on water and power

Figure 2.5.14: Protected areas in LAC per sub-region, 2015.



Source: UNEP-WCMC 2015b

supply and the displacement of current agriculture zones and planting patterns (Vergara 2009). Alterations in other important ecosystems such as the region's forests and savannah lands can also be expected on account of climate change (Malhi *et al.* 2009; Betts *et al.* 2008) (**More...32**).

2.5.5 Responses

Terrestrial Ecosystems Responses

Over recent decades, a wide range of options has been implemented in LAC to promote conservation and the sustainable use of biodiversity. Protected areas (PA) are common instruments in public policy for *in situ* conservation of biodiversity. In 2015, 4.87 million square kilometres of terrestrial ecosystems were protected in LAC (24 per cent its territory, UNEP-WCMC 2015b). South American terrestrial PA covered about 90.6 per cent of the total, followed by Mesoamerica (8.7 per cent) and the Caribbean (0.7 per cent, see **Figures 2.5.14** and **2.5.15**). In fact, 74% of all new protected areas worldwide between 2003 and 2009 were established in Brazil (Jenkins and Joppa 2009)

Besides establishing PAs with clear guidelines within state institutions, several countries in the region have sought alternative sources of sustainable funding, such as formal budgets from central governments and the establishment of conservation trust funds with private institutions entrusted with conservation programmes. Governments budgets allocated to PA in LAC are insufficient: on average, LAC countries allocate just 1 per cent of national environmental budgets to PA, which covers about 54 per cent of the total operating costs[20] (World Bank 2012a).

The Ramsar Convention has been a relevant framework for the conservation of freshwater ecosystems. The Convention provides the framework for national action and international cooperation for the conservation and rational use of wetlands of international relevance and its resources. In 2015, LAC had 239 Ramsar sites in inland areas, covering 4 650 000 square kilometres. The countries with the most Ramsar sites are Mexico (91 sites; 715 000 square kilometres), followed by Argentina (21 sites; 534 823 square kilometres), Peru (13 sites; 678 404 square kilometres), Ecuador (14 sites; 26 600 square kilometres), Brazil (13 sites; 72 698 square kilometres), and Bolivia (13 sites; 1 480 000 square kilometres) (data from Ramsar Convention 2015, see **Figure 2.5.16**).

The establishment of biological corridors ensure continuity to the ecological processes of ecosystems. The Mesoamerican Biological Corridor established in 1997 includes eight countries: Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama and Mexico and aims to connect protected areas of Central and North America as well as developing low-impact projects that seek to promote productive alternatives with local communities (CONABIO 2015) (**Figure 2.5.17**).

Payment for Ecosystem Services (PES) schemes seek to reward the owners of areas with natural ecosystems for their conservation efforts (see also Section 2.4). In Mexico,

20 Defined as the funding required to operate key conservation programs and basic requirements to sustain the functions of ecosystems in the PA.

Figure 2.5.15: Protected Areas in LAC, 2015.

Note: IUCN Protected Areas Categories Ia = Strict Nature Reserve; Ib = Wilderness Area; II = National Park; III = Natural Monument or Feature; IV = Habitat/ Species Management Area; V = Protected Landscape/ Seascape; VI = Protected area with sustainable use of natural resources

Source: UNEP-WCMC 2015b

Figure 2.5.16: Ramsar sites in LAC (2015).

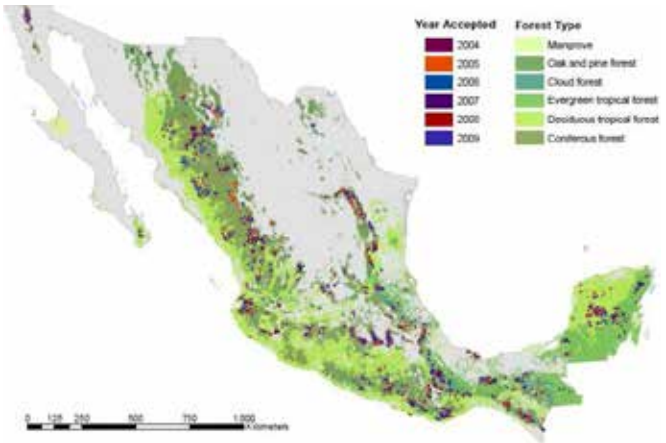
Source: Ramsar Convention 2015

Figure 2.5.17: Mesoamerican Biological Corridor (2015)

Source: UNEP-WCMC 2015a

the National Forestry Commission (CONAFOR) launched two initiatives: in 2003 the Hydrological Environmental Services Program (PSAH, in Spanish) and the Environmental Services Program for Carbon Sequestration, Biodiversity Conservation and Agroforestry Systems (PSA-CABSA, in Spanish) in 2004. Between 2003 and 2011 CONAFOR paid some USD 450 million to protect 26 000 square kilometres (Alix-Garcia and Wolff 2014), about 5 per cent of Mexico's forested area (**Figure 2.5.18**). Although PES objectives related to conservation and poverty alleviation have been discussed, in the Mexican case they seem to achieve both objectives (Alix-Garcia and Wolff 2014). The Mexican case study has highlighted how PES can help to address both conservation issues and poverty alleviation simultaneously (Alix-Garcia and Wolff 2014). Another interesting example national level is that of Peru, which in June 2014 approved the Law 30215 on ecosystem services; this Law regulates the retribution to ecosystem services arising from voluntary agreements in order to contribute to the conservation, recovery and sustainable use of ecosystems.

Figure 2.5.18: Areas of Payment for Ecosystem Services Programmes in Mexico, 2004-2009.



Source: Alix-Garcia and Wolff 2014

REDD+ is an example of a PES scheme based on payments for conservation and enhancement of forest carbon stocks. It seeks to support developing countries in reducing GHG emissions and enhancing forest carbon sinks as a key mitigation strategy. However, some obstacles have been identified for its implementation in LAC: lack of specific and adequate financial resources; strength of macroeconomic and sectoral policies; lack of inter-sectoral support for socio-economic development; lack of clarity on issues such as carbon ownership, land and benefit distribution; lack of representativeness of forest managers, especially in indigenous communities and in areas of decision and management; and lack of capacities (Sanhueza and Antonissen 2014). Notwithstanding, there are also some other remarkable examples of successful national and sub-regional initiatives mechanisms implemented in LAC such as the Amazon Fund and the Brazilian Rural and Environmental Registry (CAR). The Amazon Fund is the largest dedicated fund supporting efforts to reduce emissions from deforestation and degradation in the Amazon, the world's largest tropical forest with invaluable biodiversity. The purpose of the Amazon Fund is to provide an incentive for Brazil and other tropical-forested developing countries to continue and increase voluntary reductions of GHG emission from forest deforestation and degradation, as proposed by the Brazilian delegation to the 12th Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC) in Nairobi, Kenya, 2006. The Fund has demonstrated that developing country institutions can meet high standards of fiduciary governance and operational transparency (Forstater *et al.* 2013).

Sustainable Forest Management (SFM) promotes the management of forests using techniques that maintain biodiversity, productivity, regeneration capacity and ecosystem services. Although SFM has already been implemented in several LAC countries, some evidence suggests controversial effects on biodiversity. For example, in the Brazilian Amazon, low-impact logging seems to have important effects on mammals and reptiles (Azevedo-Ramos *et al.* 2006). In contrast, moderate negative effects on

some species of birds have been observed for SFM in Bolivia (Kuijk *et al*. 2009). It is very important therefore to highlight the need for further studies on the biodiversity impacts and benefits derived from the SFM approach.

Preserving genetic diversity in LAC

Genetic diversity can be conserved *in situ* in the wild or in crop fields, or *ex situ* in gene banks, which are maintained at the local and national level by governments, universities, botanical gardens, NGOs, private sector, farmers and others in the private and public sectors. In LAC, the efforts to maintain genetic diversity of many relevant crop species including forage species, ornamental, and forests species, have been remarkable. In the past ten year, several countries in the region have carried out important germ plasma collection missions. In total about 10 000 accessions were reported for South America (with remarkable efforts by Argentina with about 7 000 accessions) and 2 600 in Mesoamerica (FAO 2010b).

The most important gene bank collections in LAC include: the Centro Internacional de *Mejoramiento de Trigo y Maíz* (CIMMYT) in Mexico; the *Centro Internacional de la Papa* (CIP) in Peru; the *Centro Agronómico Tropical de Investigación y Enseñanza* (CATIE) in Costa Rica; the Centro Internacional de Agriculura Tropical (CIAT) in Colombia; the Embrapa Centre for Biotechnology and Genetic Resources (Embrapa-CENARGEN) in Brazil; the West Indies Central Sugarcane Breeding Station (WICSBS); and the International Cocoa Gene bank in Trinidad and Tobago (ICGT) at the University of the West Indies. Some of these are holders of the largest *ex situ* collections of selected crops. The total number of accessions in some is significant: 327 932 accessions of maize in the CIMMYT; 261 963 accessions for beans in the CIAT; and 35 478 accessions of sweet potato in the CIP (FAO 2010b).

The conservation of genetic diversity in wild species is closely linked to the conservation of wild populations. In this regard, measures to protect ecosystems and species may benefit the conservation of genetic diversity. In the case of crop varieties, the success of programmes oriented to the conservation of genetic diversity must take into account the farmers involved in agricultural activities, and traditions of indigenous communities (**More…33**).

One of the most remarkable actions in the region to preserve genetic diversity *in situ* is the *Parque de la Papa* (Potato Park), which was established in the Cusco region (Peru) between *quechuas* communities and NGOs with international financing. This initiative is a pioneer of *in situ* conservation of genetic diversity. The initiative stems from the Peruvian laws (Ley Perú 27 811 and 28 216) and the International Treaty on Plant Genetic Resources (FAO 2009), which encourages indigenous property rights based on traditional knowledge and technologies.

In terms of legislation and national policies, it is worth highlighting Brazil´s Law No. 13 123 of May 20, 2015 on "Access and Benefits Sharing of Genetic Resources and Associated Traditional Knowledge". This Law regulates access to components of the genetic heritage, protection of and access to related traditional knowledge and the fair and equitable sharing of benefits for the conservation and sustainable use of Brazilian biodiversity. Although it is too early to assess the effectiveness of this law, particularly concerning the protection of Indigenous and traditional peoples' rights, it is clear that this law will facilitate and promote academic research and fair use of biodiversity not possible in the past (Welch 2015). In many LAC countries regulations on Living Modified Organisms exist (**More…34**).

See references for Chapter 2.

Credit: UNEP/Andrea Salinas ▶

CHAPTER 3

Environmental Policies, Goals and Objectives: A review of policy responses and transformative policy in Latin America and the Caribbean

Within each GEO-6 Regional Assessment there is an evaluation of the extent of the policy response on environmental issues in each region. In the previous chapter, an overview of the specific responses in the region for each of the major environmental themes (air, water, land and biodiversity) are presented, as an integral component of the DPSIR framework analysis. In addition to assessing the extent of the policy response there is a need to assess the effectiveness of the policy response, or in other words, how the Response element changes the Pressures, State or Impact within the DPSIR framework. This assessment of policy effectiveness is conducted in this chapter by:

- Evaluating the policy progress made on key regional priority areas;
- Reviewing particular policy success stories; and
- Assessing the enabling conditions for achieving successful environmental policies.

This approach highlights that the policy response is not an endpoint — rather the effectiveness of policies must be continually evaluated and adjusted to strengthen their transformative capacity. This becomes critical in a historic moment demanding urgent, holistic and effective actions to address the multiple environmental issues and challenges in the region.

3.1 Main Messages

- Just like the diverse tapestry of cultures, histories, political and development pathways is so evident across the region, so too is how the many different approaches of how societies in the region interact with their natural environment and resources have evolved. This is evidenced in the spectrum of regional, national and sub-national environmental policy approaches that dictate environmental governance. Policies generally respond in a sectoral manner where management for land, water, air, chemicals, waste, urban and rural planning, biodiversity and natural resources are addressed. To varied extents, the policy landscape continues to evolve, offering great opportunities to share successful policy approaches across multiple levels and scales.
- Many policy regimes are evolving, for example, from highly federalized 'spoke-and-hub' decision making to involving more state participatory approaches, as in Brazil, and from fragmented governance to greater centralized co-ordination of regulatory resources in the Caribbean. Enabling tools, such as the polluter pays and precautionary principles, equity, participatory and community-based approaches, are being advocated in greater degrees, but arguably the outcomes and successes depend on the national context.
- Many options exist for transforming the policy landscape ranging from clean and greening energy options, greater emphasis on the large ocean resources as a new economic frontier, to more integrated water, land and sanitation policies that place land zones, watershed management, land rights and civil society engagement and inclusion at their centres. There is a general recognition in LAC that poverty reduces the quality of life, increases mortality, reduces opportunities to access education and maintain good health, overharvest live natural resources, thereby retarding economic progress and intergenerational equity. However the development of strategic intervention which is driven by the Sustainable Development Goals (SDGs) and the accompanying targets pushes the region to enhance environment policies and investments with greater impact on sustainable development.
- The onus in the region is to map its growth and development pathway for the next decade. In doing so, many options exist such as continuing in a business-as-usual mode or transforming to a sustainable mode. Whichever model is used, there will be trade-offs, losses and gains, but a progressive agenda would require the region's national, federal and state governments to play a collective role, and at the centre of this progressive thinking must be the future we want, which is overwhelmingly grounded in the principles of sustainable development.

◄ Credit: Shutterstock/ Vitaly Titov

3.2 A Transformative Policy Agenda

Transforming societies in Latin America and the Caribbean (LAC) requires strategic policy interventions to promote and encourage positive change. Transformative policy is not based solely on developing new policies but rather on reorienting existing frameworks and platforms to achieve the targets in the SDGs and others, such as the SAMOA Pathway. By pulling the right levers at the most critical intervention points, we may well enhance efficiency and the effectiveness of outcomes. Many of the cross-cutting issues the region faces, such as climate change and disaster risk reduction, require a transformative approach, which maximizes policy coverage in resource management, encourages vertical and lateral scaling, and integrates use of innovative tools and scientific information. The environmental dimension of the SDGs present a welcome challenge to the environmental policy approaches in LAC, stressing the importance of meeting environmental goals and targets that will in turn transform society. While the SDGs are interlinked and require progress in all to achieve the desired impact of sustainable development, the following approaches address the policy transformations envisioned to achieve the environmental dimension of the SDGs which will promote/achieve other goals, such as reducing inequality, among others. This more holistic analysis presented here builds upon the assessment of specific responses covered in the previous chapter.

3.2.1 Towards clean water and sanitation

Over the past decade, governments in the region provided wider access to safe potable water, particularly for socially vulnerable groups such as women and children, a priority (UNECLAC 2015a). Nonetheless, despite this recognition, water is not generally managed in an integrated way, with wastage evident from extraction through to production and consumption in many of the governance systems in LAC (da Rocha 2015). Further, water usage and access is seen as a 'public good' and generally relies on public funding, which may face resource constraints in undertaking effective management (Barbier 2015). The pricing of water and water privatization remains a controversial issue in most of the region (Mulreany *et al.* 2006).

While current water policies consider access, many other areas, such as integrated watershed management, pollution prevention and contamination, are often left to other parts of the government to address, but with little synergy and connectivity. In other instances, for example Small Island Developing States (SIDS), the reliance on surface water in a changing climate makes reliable water supply a challenge and countries are already rationing water to their populations, e.g. Saint Lucia. Therefore, policies in LAC need to be realigned with these realities taken into consideration. This realignment must also consider the implementation of water legislation, and strengthen weak water institutions and regulatory agencies.

View of the Uros Islands on Lake Titicaca, Peru.

Credit: Shutterstock/ TravelMediaProductions

More integrated policies, which consider water from source to sink, will enable the sector to meet the targets of reliable water access to its citizens. Increased usage of grey and wastewater for sectors such as agriculture requires greater advocacy. In addition, a more integrated approach to physical planning is required, where building permissions must be linked to onsite infrastructure for water capture and storage.

This type of adaptive policy can reduce the burden caused by water unavailability, especially in SIDS. Policy transformation should consider options to ensure water security, which includes community to national level incentives for greater use of drip irrigation; rainwater harvesting; water recycling; water conservation; water purification; desalination and well water use. National considerations must include water governance through private ownership where appropriate, to improve efficiency and promote community-based partnerships, and encourage water treaties to respond to transboundary issues, especially in Latin America.

Access to sanitation is still a challenge in LAC; according to the 2015 WHO/UNICEF Joint Monitoring Program (JMP) report (UNICEF and WHO 2015), 83 per cent of the region's population has access to improved sanitation, which is skewed toward greater coverage in the urban or peri-urban areas. Eighty-six per cent, or coverage of 11 million inhabitants, have access to sanitation in the region. However, rural coverage still lags behind with 55 million rural households having no access to modern sanitation. The challenge lies in policies that do not cater for the speed of urban change and increasing population growth. Collected waste in many instances is not treated, and wastewater management is significantly low in the region (Ramirez-Sanchez *et al*. 2015). This demonstrates that the policy approaches to sanitation and wastewater are outpaced by industrial development, settlement realities and migration patterns (**More…35**).

There is some evidence that the sanitation sector is being modernized, and its legal operating framework is improving in some countries e.g. Paraguay (IDB 2015). Adoption of integrated sewerage management is becoming evident in Brazil, Argentina, Chile, Honduras, Nicaragua, Peru, Uruguay and Venezuela for example. However, deficiencies in governance and the required participatory mechanisms are still major challenges. While access to modern sanitation is important, treatment of waste should be considered simultaneously to reduce the environmental impacts of pollution and contamination on the surrounding areas. While regulatory structures that support water pollution control are in place, especially at federal and district levels, there is a low success rate, mainly because of low levels of compliance and enforcement. In addition, many governments are still struggling to make sanitation a business, leaving it severely underfunded with little push on resource mobilization and technological investments, thereby compromising delivery (Cox and Borkey 2015). Innovative financing, such as industrial discharge permits, are not very evident in the region (Aguilar-Barajas *et al*. 2015).

Therefore, progress in sanitation to meet the required goals of access will require more emphasis on investment capital, stronger public/private partnerships, enhanced capacity in chemicals and waste management, such as for those substances listed in the key international conventions of Basel, Rotterdam and Stockholm among others, updated systems to function more efficiently, and more innovative ways of using by-products. Inclusion and promotion of more stringent regulation for industrial and household discharges are short-term measures which can shift the approach on wastewater and sanitation in the region (Masson *et al*. 2013).

3.2.2 Towards zero hunger

Latin America is one of the world's main food producers and ranks among the lowest in the world regarding hunger (FAO 2014b and FAO 2015f). Yet there are 37 million people in LAC still without adequate access to food. Meeting regional food demands and maintaining exports will require, in part, a re-examination of the region's current approach to agricultural production (which is one of the four pillars of food security and nutrition, as shown in **Figure 3.2.1**). Poverty alleviation measures can be also very effective, as demonstrated by the '*Fome Zero*' initiative in Brazil.

In an environmental context, the heavy demand on Meso and South America to feed populations and meet food export demands has led to extensive monoculture agriculture which utilises a large percentage of hectares of land and includes crop types that require intensive farming systems including high fertilizer consumption. This, over time, can promote soil loss; therefore sustainable land management and

Figure 3.2.1: The pillars of food security, which must operate in parallel and in synergy to alleviate and respond to food security in Latin America and the Caribbean.

Source: FAO 2014b

practices must be part the agricultural agenda. However, there is growing evidence of a shift, although relatively slow, of greater emphasis on conservation agriculture. This technique supports a large cohort of social, economic and environmental benefits (**More…36**) and there are many examples such as in Brazil, Costa Rica and El Salvador (FAO 2001). Therefore, a recommended transformation will be to encourage the incorporation of conservation agriculture in the integrated policy prescriptions in the region.

In addition, in the current system of agriculture, there are key policy trade-offs that some countries may have to address. Among these are the energy-food nexus where increased emphasis on biofuel production competes with food crops for water and land. Investing in agricultural waste as a source of biofuel, agro-ecological land-use zoning, and prioritizing biofuel production using marginal agricultural lands, could contribute to minimising the necessary trade-offs. There is also the food-water nexus (see Section 2.2) since agricultural activities use a significant amount of water by relying on irrigation in semi-arid zones. This is required if Latin America is to maintain its output to support global food demand. Land zoning is important to reduce the conflicts with biodiversity protection, deforestation and water scarcity. Fisheries is a critical source of food for many communities in LAC. The adoption of good practices such as local cooperatives can ensure a sustainable food supply (**More…37**).

In Latin America, but more urgently for the Caribbean SIDS, mainstreaming climate change adaptation into farming systems to deal with growing drought-like conditions and erratic rainfall patterns is a major issue. Farming systems in SIDS must consider the inclusion of better horticultural practices and systems for water storage. Adapting to climate change will be essential for building resilience and managing risks to water, energy and food security from changing rainfall patterns, more frequent and intense extreme events, and rising temperatures. While the region's countries have different levels of exposure, vulnerability and capacity to adapt to climate change, food production is particularly at risk. Climate change concerns must be included in agricultural–food security considerations. Such inclusion may need greater investment in this sector, but the potential returns could make the sector more profitable in the medium to long term (Truitt Nakata and Zeigler 2014).

While the value chain is evidently required to transform food security and nutrition in the region, access to food, caused by the major driver of poverty, should be considered as well (see discussion on poverty below).

Wind turbines against a beautiful sunset in the central lowlands of Panama.

Credit: Shutterstock/Gualberto Becerra

3.2.3 Towards affordable and clean energy

The utilization of energy in LAC is dependent on geography, but generally Latin America harnesses its energy needs from a matrix of energy sources including fossil fuels, hydroelectricity and other forms of renewables. Some of the world's largest natural gas reserves are found in Latin America, including Venezuela and Colombia, while others, such as Guyana and Suriname, are aggressively pursuing exploration. In contrast, the Caribbean SIDS rely on imported fossil fuels to fulfil their energy needs. In the Caribbean region, costs of power generation are consistently high – typically USD 390 per MWh across the region (IDB 2014).

Access to electricity in the region is currently 95 per cent (IDB 2014). However, despite this achievement, according to IDB (2014), there are still 30 million people without access, and addressing this deficiency will require planning and coordination. Meeting 100 per cent will mean providing connection services to the most rural and inaccessible areas, which will require larger investments and innovative solutions. Many untapped sources of renewable energy remain in the region, including marine renewables, geothermal, and greater uptake of photovoltaics in electrification. Greater emphasis on renewable energy will also make the region more self-sufficient, especially for countries that are net importers. While the option for renewables is present for development, one of the concerns is reliability and consistency (van der Zwaan *et al*. 2015). This will need to be addressed and perhaps a mixture of sources can reduce this challenge.

Greater uptake of renewable energy sources would require policies that promote investment in renewables with the accompanying technology changes to allow the transition and uptake of renewable sources into the national grid.

This development, and further expansion to meet the energy needs and the projected demands in LAC, must be underpinned by favourable regulatory environments and long-term political frameworks to encourage clean energy deployment. Consistent and credible long-term energy policies that are integrated with emphasis on both targets and incentives are a strong signal for private investment (Mundaca 2013). This must be accompanied by an investment environment that is deemed fair, transparent, accountable, and reasonable.

Regional examples of well-designed policies include the Programme of Incentives for Alternative Electricity Sources (PROINFA) in Brazil (Dutra and Szklo 2008), Chile's energy market liberalization, Nicaragua's tax exemptions for renewable energy equipment, Uruguay's tendering system, Peru's utility regulation prioritizing renewable energy sources, Mexico's target of a 35 per cent renewable energy share in overall power production by 2024, and Eastern Caribbean countries providing tax incentives for photovoltaic installation in homes.

Attracting investment in the energy sector will require reducing the barriers to entry, especially in countries with vertical integrated monopolies such as those in the Caribbean islands (Timilsina and Shah 2016). In contrast, Mesoamerica and South America have a more liberalized policy in the form of wholesale power market accompanied by grid access.

Evidence has shown that the absence of adequate access to the grid makes even the liberal policies unable to attract investment in the renewable sector (Sovacool 2015).

Regional financial institutions have yet to adapt fully to the unique financing requirements of some clean energy projects. Capacity building and training in the renewable energy value chain can support greater uptake. Adoption of net metering has created markets for renewable energy in countries that have adopted them and should be up-scaled in the region.

A sustainable and self-sufficient LAC region would require long-term policy decisions to develop energy value chains, by reducing dependency. The region already has examples of complete clean energy value chains for biofuels, biomass, waste and hydropower. Solar, wind, and geothermal also have near-complete value chains, but gaps exist, for example, there is no manufacturing of wind energy equipment and a lack of geothermal maintenance service providers. Argentina, Brazil, Chile and Mexico have the most complete clean energy value chains in the region (Pueyo 2013). For smaller economies, it is practical to focus on the creation of regional markets and creating 'test beds' for technology development that suit the geographical context of the region.

3.2.4 Towards industry, innovation and infrastructure

Developing sustainable and resilient infrastructure, including regional and trans-border infrastructure with a focus on equitable access, is important in a region experiencing population growth, migration and urbanization. For example, energy-related infrastructure and an expansion of the electricity grid is necessary to provide energy access to urban and rural areas, and a sustainable water infrastructure will improve lives by providing access to water and helping to manage scarce resources in a sustainable manner.

To promote sustainable industrialization, governments must frame the markets in the right way to help economies to grow, improve environmental stewardship, and combat climate change. Successful industrial development requires the right policies and sufficient investment. Industrial policies in the region are designed either to increase competitiveness or to support the creation of new sectors. Many LAC countries are exploring greater multilateral cooperation and partnership to increase the competitiveness of existing sectors (Taffet 2012).

LAC countries must also explore ways to enter new clean sectors. Setting up investment funds and development boards have been effective policies in countries such as Brazil and Costa Rica (Watts *et al*. 2015). A critical policy intervention across much of the region has to do with implementation of public procurement rules that can create market demand and foster innovation. But to support the shift towards clean industrialization, there is the need for skills that will help countries move up the global value chain. In spite of improvements, developing a skilled workforce is a major concern (Azevedo *et al*. 2013; World Economic Forum 2015).

Development policies that promote small and medium enterprises (SMEs), especially in the new sector of social entrepreneurship, must focus on sustainable financing and micro-credits. Failure of SME creation efforts so far have been due to their inability to integrate into existing value chains and markets.

A policy of support for eco-entrepreneurship through the creation of networks of business incubators is one potential response. Governments must pursue financial policies based on venture capital to assist eco-entrepreneurs who have innovative ideas but lack the support required to start up an economic activity (**More…38**). In this way, and with the collaboration of universities and training institutions, these SME activities can be quickly scaled up to shift the industrial model towards clean activities.

Apart from developing new industries and shifting away from the natural resource- and extractive-intensive bases of LAC economies, there is also a need to review policies that are required to clean up the pollution and environmental deterioration that exist. Policies that incentivize the implementation of new pollution-prevention technologies are required in traditionally pollution-intensive industries (Shah *et al*. 2016). Greater adoption of clean and environmentally sound technologies and industrial processes, by all countries, must be in accordance with their respective capabilities. Where capacities are low, policies that open the way for bilateral and multilateral cooperation and technology transfer are required.

Research and development (R&D) investment by governments and the private sector in LAC remains among the lowest in the world. To build resilient societies, the region must aim for policies that enhance scientific research, upgrade technological capabilities, encourage innovation, and increase the number of R&D workers. While more open policies of international cooperation are to be encouraged, this must be clearly coupled with policies that ensure that local expertise and domestic technological innovation potential is enhanced and allowed to develop, also reducing dependence on foreign technology and suppliers (Medina 2014). The policy option of developing green business and industrial zones or green export processing zones is gaining popularity but few examples exist of where it has spurred growth through the right mix of financing mechanisms, regulatory incentives and business support. However, where properly constituted, this mechanism can attract new green businesses, encourage existing manufacturers to raise environmental standards and provide an avenue for long term environmental progress (Shah and Rivera 2007) (**More...39**).

3.2.5 Towards sustainable cities and communities

LAC is characterised by high levels of urbanization and persistent urban growth. Urbanization in the region is also accompanied by high levels of poverty and slums dwelling. As described in Section 2.4, many of the region's urban centres have been developing or expanding in areas that are considered biodiversity hotspots (CBD 2012). This has consequences for sustaining the region's natural capital. Further a UNEP (2011a) study on resource decoupling suggests that Latin American cities are expected to move to high domestic material consumption typologies with rising incomes. This increased material flow into cities places additional burdens on power consumption for appliances and technology and results in increased waste disposal from retail products and municipal waste streams. The increase in road transport, combined with a high level of toxic emissions, has also contributed to polluted cities.

Urbanization is both a result and a driver of growth, opportunities and demand for labour. The rush of people into and the growth of economic activities in cities in the region often take place with little or no proactive planning. This manifests as negative externalities such as pollution, congestion, infrastructural overload and degradation, and slums (Galiani 2015). In the SIDS, the problems are the same, but urban centres are situated in the coastal areas and major additional pressures are the effects of climate change, including sea level rise.

View of the green coast from Miraflores town.

Credit: Shutterstock/Christian Vinces

As the region continues to explore options to deal with the consequences of continued urbanization, policies must target optimizing the benefits of cities, while minimizing or altogether avoiding their negative externalities. Realizing the goal of sustainable living in cities will require robust policies that are integrated and act as a master plan supported by data and information acquisition for evidence–based decision making (Becerra *et al.* 2013). There must be seamless coordination of land use planning, energy, sanitation, transport and housing planning to monitor all aspects of urban sustainability, and attempts at sectoral policies will continue to add to the problems being experienced. The policy approach must allow for the tracing of the pathways of resource consumption and waste generation. This information can be used to track the various synergies among the various city activities (industries, transportation, among others), planning new infrastructure investment or reconfiguring existing ones, and prioritizing institutional investments. However, success will require complimentary legal regimes that empower city planning (**More…40**).

Strengthening the science-policy interface is particularly important for coordinated urban and city planning, moving from the use of traditional statistics at aggregate spatial levels to working with geographic information system data banks and indicators capable of addressing smaller areas (Krausemann *et al.* 2014). New tools, such as material flow analyses, life cycle analyses, costing and management, and social multi-criteria evaluation, will also play a role in constructing a sustainable future. Improved data availability can help identify pathways for improving the allocation of investment in infrastructure, the regulation and use of resources, and the sustainable management of chemicals and waste.

Having well-planned and managed cities directly improves the well-being of communities and the environment while saving on costs related to accidents, health hazards, time resources, and longevity of physical capital investment. Governments in LAC have long-term policies to assist the urban poor, through the provision of state housing and social protection such as cash transfer programmes, health care, waste collection, and sanitation. However, the often critical components of stemming environmental deterioration, increasing green areas, pollution control and addressing resource inefficiencies that accompany reaching the limits of city capacities, have not been addressed through systematic integration of ecosystem approaches in policy.

One of the most pressing challenges in and around urban areas is informal housing and preventing slum formation. This, however, requires costly public investment and cross-cutting policies and actions that are difficult to implement (Bouillon 2012).

Integrated policies must also provide alternative transport models, including investing in bicycle lanes and car sharing systems, and in public transit systems to ease congestion and provide cleaner forms of transport. Such investment is essential for tackling environmental issues, given that the largest contribution of pollution in most cities is from transport emissions.

3.2.6 Towards climate action

Effective climate change policies at the regional level will depend on the level of transboundary cooperation between countries and the deployment of economic incentive instruments (**More…41**). Policy priorities for the region have to include cooperation in designing climate change policies and standardizing carbon prices (Lucena *et al.* 2015). At the XX Meeting of the Forum of Ministers of the Environment of LAC, it was decided to establish a regional cooperation platform on climate change to increase dialogue and exchange experiences on climate public policy, climate action, financing and other means of implementation, including transfer of climate technologies and capacity building to promote regional cooperation.

The other critical intervention point remains inadequate implementation. Policies that promote clean technologies and facilitate more diversified low-carbon economies

will, over time, greatly improve environmental quality. Climate policies in the region appear to suffer from a lack of implementation, and are often undermined by the energy sector or by mining legislation (Chadwick *et al*. 2013). To make the Intended Nationally Determined Contributions (INDCs) a success, governments need to better integrate energy and climate objectives such as fossil fuel subsidy reform and the promotion of public transport (Blechinger and Shah 2011) .

The key challenge at present is that most of the policy-driven adaptation practices are disaster responses rather than policies that actively reduce risks and address the factors that make poorer groups vulnerable. Particularly in the context of adaptation, policy development needs to be adjusted to the challenges of growing urbanization by increasing green urban areas connecting with ecosystems by ecological corridors and restoring degraded ecosystems. Focus must also be placed on the high-risk coastal communities of the Caribbean that will be affected by sea level rise and extreme weather events. Within the region, there are large groups of low-income populations living in risk-prone areas and dangerous sites, such as floodplains, because these are the only sites for them to occupy that are within reach of income-earning opportunities (**More…42 and 43**).

Climate adaptation policies also have to be cross-cutting to address nexus issues. For example, Northern Chile, the Brazilian North-East, Northern Mexico and other arid and semi-arid regions will face particular problems of water shortages related to climatic change. Many water basins are expected to experience lower levels of precipitation, which will ultimately reduce the availability of freshwater (Lynch 2012).

In the context of climate mitigation policies, while the region accounts for only 5 per cent of global GHG emissions, many countries have been leading the formulation of global mitigation strategies. For example, in 2012, Mexico enacted a climate change law that calls for a 50 per cent reduction in GHG emissions relative to 2000 levels by 2050 and has submitted a National Determined Contribution (NDC) pledging a 22 per cent decrease from business-as-usual emission levels by 2030. Other countries, including Colombia, the Dominican Republic, Trinidad and Tobago, are following along the same lines.

There are two policy areas that could both advance Latin American climate change mitigation goals and support economic growth: reducing energy subsidies and improving energy efficiency (Martinez *et al*. 2015). Energy subsidies are generally created to help support the poor, but they are less efficient than direct transfers or tax credits and often provide the greatest benefit to the affluent, the biggest energy consumers (Arrigada 2015). Removing subsidies that eat into government budgets and contribute to inefficient energy use would allow states to redirect scarce resources to other priorities, promote more efficient energy use, and make alternative energy sources more competitive (Radomes and Arango 2015).

Better energy-efficiency policies can also support both economic recovery and climate change mitigation by helping to decouple emissions from economic growth. Many countries are already implementing substantial energy efficiency programmes. Uruguay, for example, has passed a major initiative that aims to reduce annual energy consumption by 5 per cent per year by 2024 (Sousa *et al*. 2013). The reductions would come mainly from the residential sector, especially through greater use of solar water heaters and high-efficiency wood stoves, and from the transportation sector through more electric and hybrid vehicles. Argentina has also implemented many energy efficiency programmes, including the National Program for the Rational Use of Energy and Energy Efficiency, which provide economic incentives to reduce energy consumption (Nasirov and Silva 2014).

3.2.7 Toward sustainable governance for life below water

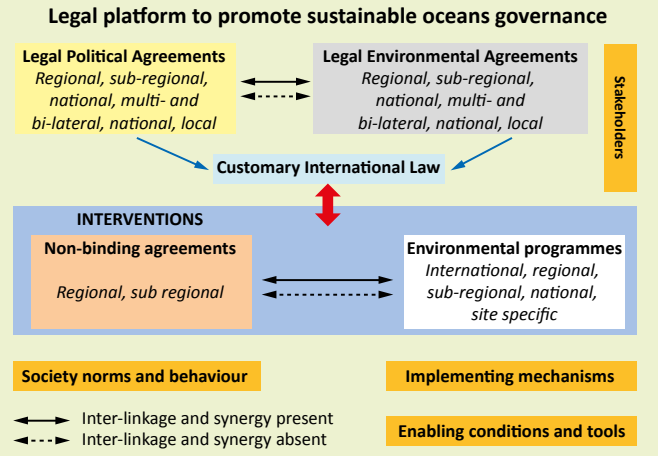
The oceanic jurisdiction of LAC encompasses large areas covered by the United Nations Convention on Law of the Sea (UNCLOS) or customary international law. In particular, when the SIDS delineate their maritime boundaries, their marine area will be many times larger than their land area (for example Saint Vincent and the Grenadines' marine area is 90 times its terrestrial area). The oceans possess many resources that support human well-being in the form of fisheries, minerals and ecosystem services (see Section 2.4). While these are traditional sectors, there is a growing recognition that the oceans can provide greater economic returns. There must therefore be a paradigm shift that promotes a change from sectoral to integrated management, within a framework that considers all sectors. Sustainable ocean governance has emerged as a concept that provides an effective intersecting platform to monetize ocean resources while sustainably managing them.

Promoting sustainable ocean governance, both in the exclusive economic zones (EEZs) and in areas beyond national jurisdiction (ABNJ), requires holistic thinking. Such a transformative approach to ocean management will allow more effective and iterative management because the relationships/links between economic development, sustainable resource consumption and protection will be better articulated.

Most recently, the Ministers of Environment of LAC called for greater recognition and action on ocean acidification, overfishing and preservation of marine biodiversity. Regional efforts are to be enhanced to combat illegal, unreported and unregulated fishing through more regional cooperation and strengthening of national capacities to eliminate illegal fishing activities.

This transformative approach of bringing ocean activities under a framework is developing greater coherence in pollution control and ecosystem-based management inclusive of resources. This allows the LAC region, and

Figure 3.2.2: A conceptual framework of ocean governance.



Source: Singh 2008

especially the SIDS, to regard the oceans as the last untapped frontier for their economic progression and the improvement of human well-being.

Figure 3.2.2 shows the various legal agreements that provide the legal basis/right to govern and the interventions show the various instruments which support the core. Both the legal core of governance and interventions are effected by a large number of implementing mechanisms facilitated by various institutions and stakeholders. These take into account societal norms and behaviours (**More...44 and 45**).

3.2.8 Towards sustainable governance for life on land

LAC is characterised by a wide range of ecosystems, ranging from dense tropical forest and grasslands to estuaries and wetlands (see Sections 2.3 and 2.4). These ecosystems provide many services, for example in the form of food and housing. The pressures from population growth and demographic shifts, agricultural intensification to meet

food demands, and logging, have led to deforestation and a decrease in forest cover (Section 2.3). This affects biodiversity and critical habitats, impacts food security, hinders the availability of the global carbon budget and reduces the services provided by forests to support human well-being (Section 2.4).

The land-water nexus that underpins hydropower generation, agricultural production and natural resource extractive expansion is under increasing pressure from climate change and growing populations. Recent water crises such as the severe 2014 drought in Brazil's economic heartland in the south-east of the country, have brought trade-offs between water, energy and food to the fore. For the region to meet the SDGs and UNFCCC climate agreement, nexus-oriented policies across land and freshwater will be a prerequisite for success. Not as an emergency response to solve crises as they occur, but as an established approach to address challenges and opportunities to food security, human health and ecosystem resilience.

Many policies have evolved to promote land management, and efforts to create integration across various sectors in land management planning are evident, but only in pockets. In other instances, policies regarding land are narrow in focus, for example housing and settlements are considered but the enabling tools such as land tenure and water management are addressed in separate policies, with little convergence. This poor integration is resulting in continued silo approaches.

The situation regarding land resource management therefore requires a paradigm shift to transform to a modality in which land and its accompanying resources are managed in a more integrated fashion. This would require policies that give meaningful recognition to land governance, land management and resource protection and management, with the strategic aim of reducing the effect of land-based activities on freshwater systems, promotion of more sustainable forest husbandry, greater emphasis on management of protected areas, and more national auditing and accounting of the value of biodiversity, centred around improved well-being for citizens (**More...46**). Further, policy transformation must place emphasis on the legal regimes that promote land rights, entrenched in an effective land tenure system which supports accountability, considers and mainstreams disaster risk management, and promotes holistic land zoning. This can promote sustainable land management, thereby addressing the land-water-food security nexus in LAC as enshrined in SDG 15.

3.2.9 Sustainable consumption and production

Policy frameworks must continue strengthening national and regional scientific, technological and innovative capacity to move towards more sustainable patterns of consumption. Incentive policies and education should be coupled to promote the adoption of sustainable lifestyles (UNEP 2015).

SCP requires more active participation of the productive and service sectors, both SMEs and large enterprises, in the implementation of best practices. Key to this effort are agreements for international cooperation to provide technical assistance and funding for initiatives involving implementation of SCP in the region, including those which have as an objective the transfer and dissemination of technology, capacity building and innovation in the context of equity and common and differentiated responsibilities. Inviting countries and other relevant actors to promote mechanisms for South-South cooperation is also important.

National action plans on SCP could be aligned with the national development plans, sustainable development national strategies or other similar policy instruments and their objectives. Mainstreaming SCP into decision making and national plans, policies and/or strategies is vital in order to shift consumption and production patterns of the countries in the region. For example, sustainable public procurement is a powerful tool to modify sustainable consumption and production patterns and to promote sustainable markets.

While SCP has to be mainstreamed across product and service sectors ranging from infrastructure to tourism, the food production sector provides a clear example of where sustainability gains can be made through streamlined SCP approaches. Responding to this challenge, the regional governments at the XIX Meeting of the Forum, of Ministers of Environment for LAC held in March 2014, called to promote sustainable food production, supply and distribution systems in order to guarantee food security. The objectives of SCP reforms are to satisfy the growing demand for food, in terms of quantity, quality and diversity, by an increase in productivity and production, while reducing the overall environmental impact of food production and consumption. This includes reducing food losses and food waste, taking into account the national context and policies. It is important to promote sustainable food production systems that implement resilient agricultural practices that increase productivity and production while ensuring biodiversity, water and soil conservation and protection, and climate change adaptation.

The promotion of sustainable lifestyles has also been identified as a regional priority. This should take into consideration the inclusion of the different approaches, visions, models and instruments to achieve sustainable development - such as *'el buen vivir'* and *'vivir bien'*, respecting the indigenous traditional wisdom and knowledge, and living in harmony with nature (UNEP 2015a). Education is an important element to achieve a permanent change in the habits and behaviours of societies. Efforts to mainstream education for sustainable development and SCP are key to achieve sustainable lifestyles. Policies must particularly address youth, tomorrow's decision makers and consumers, especially in the urban environment, who are defining future consumption patterns. Information is a deciding factor for consumers in their purchasing decisions. Countries therefore have to ramp up policy support for tools such as eco-labels, voluntary standards, marketing claims and life cycle approaches which provide information on the impacts of goods and services over their lifetime.

Since so much of the SCP effort is cross-sectoral, national and regional coordination requires frameworks designed to enhance inter-agency and intra agency communication and collaboration. Governments must also seek to engage the private sector in the implementation of SCP policies and initiatives, paying particular attention to the needs of SMEs. Other important strategies requiring further support and development are mainstreaming the SCP approach in the financial institutions to facilitate SCP related investments and projects; and strengthening partnerships with other stakeholders such as academia, NGOs, labour organizations and research centres.

3.2.10 Poverty and inequality in the context of the SDGs

LAC is characterised by emerging economies where the social and economic policies are aligned to increasing economic growth. The aim is to improve the well-being of the population through interventions to reduce inequalities and poverty. Such development trajectory is highly advocated because LAC has one of the highest levels of inequality in the world (SDG 10) with a large percentage of the population living in poverty (SDG 1). In Latin America in 2012, one in five Latin Americans are classified as chronic poor, representing more than 130 million people (World Bank 2015). Poverty is being driven by factors such as monetary income, non-income elements and employment, in addition to external global factors such as market volatility, trade and resources consumption.

The economic growth in Latin America in the last decade has allowed over 70 million people to move out of poverty, but into a 'vulnerable class', meaning that any system fluctuations can trigger them back into poverty. The Caribbean region also has high level of inequality and poverty coupled with high rates of youth unemployment. However, like in Latin America the policy push toward poverty reduction is evident.

Given the poverty resource use relationship, the policies described in this chapter, can support poverty alleviation because it strengthens the governance in resource management, frames policies which places greater emphasis on citizens' empowerment into policy making, prescribe greater green and blue sustainable growth which considers the environment and natural resources in both terrestrial and marine environment, all as an integral part of economic growth in LAC. This will strengthen the economic resilience which can propel the movement of the vulnerable group into a more middle class society. Undertaking more integrated approaches to issues such as water and sanitation use and management and governance of land, can contribute to the alleviation of the 'non income' poverty challenges leading to improved human well-being such as through reduction of water borne diseases, among others. These policies also support a greater emphasis on community-based resource management and encourage a shift to economic diversification such as greater emphasis on the blue economy which, if harnessed effectively can support economic livelihoods and trigger new forms of economic growth especially in countries with large ocean areas under jurisdiction.

LAC has a high exposure rate to natural disasters and the poor and vulnerable tend to reside in hazardous locations with therefore greater exposure. In all the policies advocated in support of achieving the SDGs, disaster risk reduction and management must be mainstreamed as well as climate change consideration. Upscaling the incorporation of insurance mechanisms which must include catastrophic risk in environment and resource management are required.

Poverty reduction can only be achieved when inequality is addressed by ensuring that prosperity and economic progress is shared. The recognition in LAC that poverty reduces quality of life, increases mortality, retards economic progress and debilitates inter-generational equity evident. The development of strategic interventions driven by the SDGs and the accompanying targets can push the region to greater impact in sustainable development by creating more opportunities for improving lives through innovation, cooperation, partnerships (SDG 17) and effective resource use.

Placing the citizen at the centre of policymakers' considerations, not just as target, but also as agent of change will witness more policy development and design services that respond to individuals' needs and are relevant to their circumstances. Concepts such 'co-creation' and 'co-production' have emerged to describe this systematic pursuit of sustained collaboration between government agencies, non-government organisations, communities and individual citizens. In LAC there is already a steady shift to public participation and inclusiveness. As this is encouraged and further mainstreamed in every area and over time, this will become far more evident in the region.

The SDGs form an inclusive pathway promoting sustainable development based on the interconnected environment, social and economic pillars. They ultimately aim at transforming the population landscape by improving the well-being of society. The suggested policy interventions in the preceding chapter for LAC offer pathways to achieve the goals and can be adapted to suit the targeted scale, which can be federal, state, national or regional. The intention is to transform the policy landscape through environmental mainstreaming to meet the goals in LAC. The recommended options, with a focus on the environmental dimension, will support the economic and social cultural dimensions with the strategic aim of supporting the goal of reducing poverty, improving education, health and nourishment to promote human well-being, support gender equality, and encourage partnership.

See references for Chapter 3.

CHAPTER 4

Latin America and the Caribbean in 2015: Towards sustainability

The DPSIR situation analysis presented in previous chapters forms the basis of the environmental outlooks for Latin America and the Caribbean explored in this chapter. The chapter takes into consideration the sustainability pathways as defined by the recent developments at the international level in late 2015, namely the adoption of the Sustainable Development Goals and the COP 21 Paris Agreement. It also considers the current driving forces and regional megatrends, in an attempt to model and describe some of the potential outcomes and trajectories of change under different scenarios. Finally, the chapter offers some insights in the environmental outlooks for the region, and some of the societal choices needed to move towards a sustainable future.

4.1 Main Messages

- Latin America and the Caribbean is home to a significant portion of the planet's natural wealth. The future of the region's economies, as well as the ability of LAC countries to fight poverty and reverse inequality, depends heavily on the region's natural capital, and the ability of governments to effectively manage it.
- There are a number of critical driving forces that will shape the future of the region. Climate change is a major concern for LAC countries because of the anticipated impacts on access to water, food production, health, land use, and physical and natural capital. Unsustainable patterns of production and consumption are also placing increasing pressures on resources such as land, water and biodiversity. Demographic changes that drive urbanization and other forms of human settlements are also important driving forces that place growing demands on basic services such as health, water, energy, housing, natural ecosystems and the management of chemicals and waste. Lack of attention to these drivers can have far reaching environmental and socio-economic consequences.
- In this chapter, three possible pathways or scenarios for LAC are presented with a 35 year outlook from 2015:- i) '*Economy prevails*'; ii) *'Policy trade-offs'*, and; iii) '*Towards a sustainability agenda*'. These scenarios have been developed with strong consideration of the 2030 Agenda for Sustainable Development; and they focus on the environmental drivers of greatest concern.
- The scenarios highlight that the outlook for LAC will not be optimal if economic considerations are always prioritised over environmental protection. There is a need to decouple economic growth from resources consumption, and adapt to changes in lifestyle that reflect greater sustainability in the way that natural capital is produced and consumed.
- The scenarios also emphasize that, although LAC is likely to continue to be the region with lowest carbon content of any regional energy mix through 2050, current patterns of economic development will result in increased carbon emissions in the region. There is therefore a need for countries to seek ways to better green their economies, and reduce their dependence on fossil fuels.
- The region also has to ensure that it can adapt to future environmental changes by building the resilience of its ecosystems so that their services are protected. Proper investment in ecological infrastructure will likely play an important role in lowering the vulnerability of the region's populations to future environmental and socio-economic shocks.
- Meaningful change in the social and economic landscape of the region towards greater sustainability will require stronger governance and enforcement of policies able to take into account future risks and uncertainties, as well as an increase in social behaviours and actions that seek to protect and value natural capital.

4.2 Setting the Scene

People, Planet, Peace, Prosperity and Partnerships (i.e. the 5 P's) are the central issues of the 2030 Agenda for Sustainable Development around which the opportunities to achieve a life of dignity for all, including future generations, in harmony with nature are addressed. The recognition of the need to achieve greater and inclusive prosperity, within the Earth's life support system, puts environmental issues in a central place as never before.

◄ Credit: Shutterstock/ Tati Nova photo Mexico

Previous chapters of this report have reported on, and highlighted changes in the environmental landscape in LAC that have both positive and negative implications not only for the region and its socio-economic development, but also for the world as a whole. Environmental management in LAC is complex and challenging – this fact remains clear. The diversity of nations, cultures, economies, biodiversity and environmental conditions found within the region make it difficult to propose solutions that will meet the needs of all, especially given the uncertainty of future trends in economy, society and environmental pressures.

Chapter 3 has proposed a range of policies, approaches and tools that governments of the region may wish to consider as they move forward, both individually and collectively, in managing the region's environmental assets. This chapter of the report complements Chapter 3 by looking ahead, and analysing three possible scenarios for LAC. The three scenarios take into account current environmental and socio-economic trends, including drivers; and trends in policy and other responses at the regional and sub-regional scales.

The SDGs have been used as a framework for framing the analysis, and the scenarios therefore reflect the concept, spirit and tone related to the sustainability agenda that is evident throughout much of the previous chapters of this report. It should be noted however that not all 17 SDGs are fully included in the modelling and presentation of scenarios. Although the interconnectedness of the 17 SDGs is fully recognised, the complexity that arises in trying to tackle all issues in an exercise such as this will make it ineffectual. As such, special emphasis is placed on the environmental dimension of the SDGs, and where practical and relevant, the implications for others are highlighted.

The regional scenarios presented in this chapter have not been constructed from ground zero. Previous GEO reports have performed analyses and presented scenarios both at the regional and global scales. The scenarios in this regional report build on previous GEO reports (**Table 4.2.1**), and it takes into account new learning in the development of scenarios and modelling.

4.3 Driving forces, megatrends and key uncertainties

4.3.1 Driving forces and megatrends

LAC is a dynamic, complex and fast-paced region; and its economies, cultures and natural wealth are all inextricably tied to the global landscape. Examining future trends in almost every aspect of the environment thus calls for an

Table 4.2.1: Basic background for the outlooks.

Global GEO-3 (2002)	GEO LAC 2 (2003)	Global GEO-4 (2007)	GEO LAC 3 (2010)	Global GEO-5 (2012)	GEO LAC 4 (2016)
Markets first	Unregulated market	Markets first	Relegated sustainability	Conventional outlooks	Economy prevails
Policy first	Reforms	Policy first	Sustainability reforms	----	Policy trade off
Security first	----	Security first	Unsustainability and increased conflict	----	----
Sustainability first	Great transitions	Sustainability first	Transition to sustainability	Sustainability outlooks	Toward a sustainability agenda

Source: UNEP 2002; UNEP 2003; UNEP 2010a; UNEP 2012b

examination of the economic, social and environmental trends that are occurring at larger scales.

Global environmental problems are driven by a number of deep-seated and probably long-lasting trends. If these trends, world economic tendencies, population growth and ageing, skill-based technological change, globalization, and increasing environmental pressures, persist, they will have a profound effect on human well-being and its relationship with the environment. Each of these trends by itself raises difficult policy challenges but it is the interactions between them that will create the greatest dilemmas for policy makers. The scenarios outlined here describe how these trends may evolve but this should not be interpreted as a forecast. Rather they are meant to serve as a description of how different development pathways can generate new policy challenges, both at a national and international level.

Economic interdependence between and amongst LAC countries is likely to increase. Increased trade integration with a wider set of actors will also increase the mobility of already high-skilled labour as well as corporate investment. Increasing economic interdependence will require international cooperation in providing global public goods such as basic research, technology transfer and financial assistance. Effective cooperation could boost R&D, allowing coordinated action to curb carbon dioxide emissions and limit damage to growth and well-being.

Despite the decline in absolute regional poverty and shrinking income gaps across countries, the growing importance of skill-based technological progress for growth and rising demand for higher skills can lead to continued polarization of wage distribution within countries. With unchanged redistributive policies, significant increases in inequality will continue, back-lashing on growth, especially if economic opportunities available to vulnerable groups are reduced.

With unchanged or ineffective emission reduction policies, rising economic damage from environmental degradation on account of climate change is likely to hamper growth. By 2050, GHG emissions will have doubled compared to 2010, and environmental damage, stemming for example from lower agriculture productivity and rising sea levels, may lower regional GDP. There could also be increasing health costs and productivity losses related to local pollution in many countries. The risk of catastrophic environmental events will increase, and the increase in concentrations of GHGs in the atmosphere will continue, and, potentially more seriously, environmental damage will continue to occur beyond 2050.

Climate change is a crucial challenge for the LAC region. It has various harmful effects not limited to melting of regional glaciers, change in seasons, occurrence of new diseases, frequent floods, and change in overall weather scenarios.

LAC policy makers will have to face further extinction of species and habitats and the loss of biodiversity. Ecosystems that took millions of years to evolve are in danger when many species populations decline dramatically. The balance of natural processes, such as pollination, is crucial to the survival of ecosystems and human activity. The destruction of coral reefs remains a very important challenge in the various oceans surrounding the region.

The region's forests are natural sinks of carbon dioxide and produce oxygen as well as help to regulate temperature and rainfall. Covering 30 per cent of the land, forests will face potential challenges from future infrastructure development and demand for food, shelter and clothes from the growing populations. Reforestation programmes will have to complement demand from the residential, agricultural, industrial and commercial sectors.

Health issues also pose huge challenges to the region. Current environmental problems represent many risks to human and animal health. Dirty water is one of the biggest health risks and poses threats to the quality of life and public health. Runoff to rivers can contain toxins, other chemicals and disease-carrying organisms. Air pollutants can also cause respiratory diseases such as asthma and cardio-

vascular problems. High temperatures encourage the spread of infectious diseases, including dengue.

4.3.2 Key uncertainties

The three scenarios have been built around main drivers and megatrends summarised above, and the evolution of key uncertainties. The basic dimensions of uncertainties in GEO-4 (UNEP 2007) are used as a methodological basis in accordance with the situation in LAC. This analysis includes five basic dimensions:

A. Institutional and socio-political framework;
B. Population trends;
C. Economy and markets;
D. Science and technology; and
E. Value systems.

Key uncertainties under these dimensions were assumed (**More…47**).

4.4 Scenarios for Latin America and the Caribbean

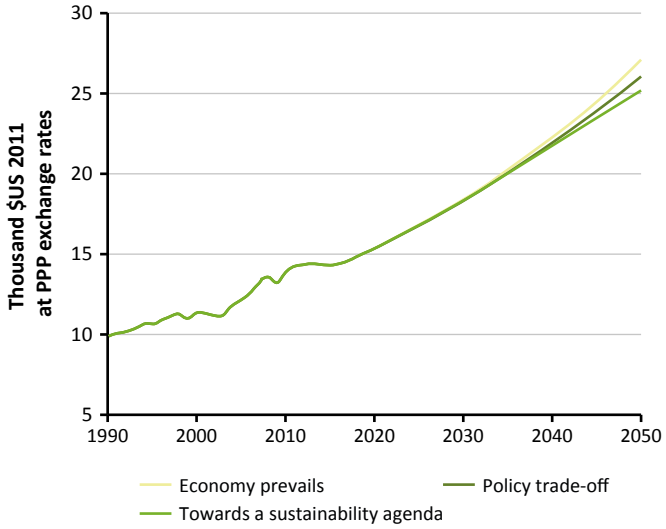
Guided by the theme of GEO-6 'Healthy Planet, Healthy People', the scenarios for LAC that are presented in this section focus on a few key indicators that continue to be at the center of the environment-development discourse in the region. Taking into account the impacts that various socio-economic drivers are having on the natural wealth of LAC countries (economic growth, population growth, urbanization and patterns of production and consumption), as presented in Chapter 1, the scenarios consider the future implications of selected development pathways based on how social, economic and environmental considerations are prioritized. The intention is to provide an opportunity to examine options for improving the health of the natural environment in LAC, while at the same time ensuring that human well-being is secured into the future. The supplementary information provides the technical background of the modelling carried out to support the analyses presented in this section (**More…48**).

4.4.1 Economy prevails

Looking back from 2050, the neo-liberal paradigm and unregulated markets seem to have been the main drivers in this outlook. Over the period 2015 to 2050, the economic structure of the region showed little change, continuing to give priority to primary or natural resource-intensive industries, mainly in South America; screw-driver-assembly manufacturing activities, especially in Mexico and Mesoamerica; and sand-and-sea all-inclusive type resorts in the Caribbean (UNECLAC 2014; De la Torre *et al.* 2013). By 2025, LAC still had the same percentage of world GDP as in 2015 (about 7 per cent) (BID 2014). The regional GDP per person at purchasing power parity increased from USD 13 790 in 2010 to more than USD 16 700 in 2025, and USD 26 980 in 2050 – a 96 per cent increase over the period 2010-2050 (**Figure 4.4.1**). As was expected, the increase in GDP per person in the other outlooks tends to increase at a lower rate.

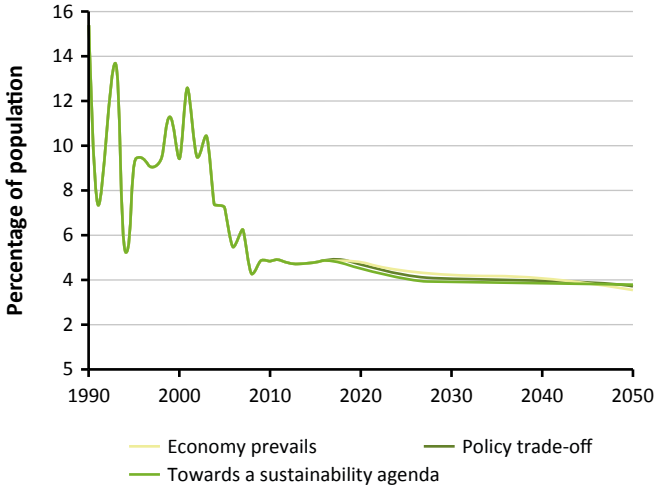
Remittance flows continued to increase, eventually surpassing official development assistance (ODA) and foreign direct investment (FDI), mainly in Mesoamerica and some Caribbean countries (UNECLAC 2015b). However, regional foreign debt remained high, with Brazil, Mexico and Argentina accounting for about two-thirds of the total. Foreign technology penetration increased and LAC reduced their capacity for research and innovation. Intellectual property associated with genetic resources and traditional knowledge was included in the market economy under conditions that favoured multinationals (Rios and Mora 2014). Social control had been reinforced, and an increasing social tension, also related to the lack of respect of basic human rights that had been observed in the region. The commercialization of social services (World Bank 2005) increased steadily. Inequity and extreme poverty continued even though some were misled by statistics which showed that the percentage of the population living on an income of

Figure 4.4.1: GDP per person growth in the three scenarios.



Source: IFM 2015

Figure 4.4.2: Population living on less than USD 1.25 in the three scenarios.



Source: IFM 2015

less than USD1.25 per day reduced from about from 4.9 per cent in 2010 to 3.7 per cent in 2050 - a 25 per cent reduction over the period (**Figure 4.4.2**).

Population growth had slowed mainly because of population aging and reduced birth rate (UNECLAC 2011). By 2050 the LAC population reached around 777 million (8.89 per cent of the world population) (UNPD 2006; CELADE 2014) (see **Figure 4.4.3**), representing an almost 25 per cent increase since 2015. Migratory pressures, both within and outside the region, increased due to the deterioration in social conditions, with different sub-regional patterns.

Urbanization expanded uncontrollably, rising to about 87 per cent by 2050 with urban growth taking place not in the central areas but expanding into the suburbs. Growing corruption, institutional weakness and lack of financial resources negatively impacted on governments' capacity to implement policies.

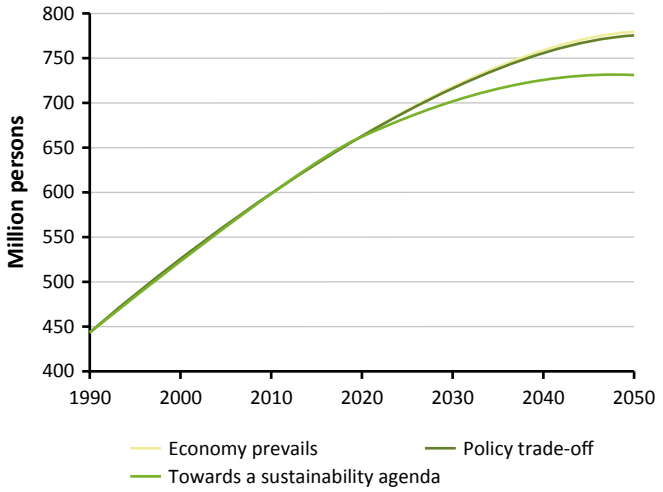
Furthermore, three urban mega-corridors[21] consolidated:

- In Brazil, the mega-corridor of Rio de Janeiro-Sao Paulo-country areas harbours 44 million inhabitants along 511 kilometres. 57 per cent of the GDP of Brazil is created in this territory.
- In Mexico, the mega-corridor Toluca - Mexico - Puebla with 32 million inhabitants in an area of 198 kilometres generates 40 per cent of the GDP.
- In Argentina, the mega-corridor Buenos Aires - Rosario – Córdoba, along 710 kilometres, with 21 million inhabitants produces 49 per cent of GDP of the country.

Regional environmental degradation and pressure on natural resources continued to grow because of unsustainable forms of production and consumption. Despite existing legislation, land degradation continued as crop and grazing

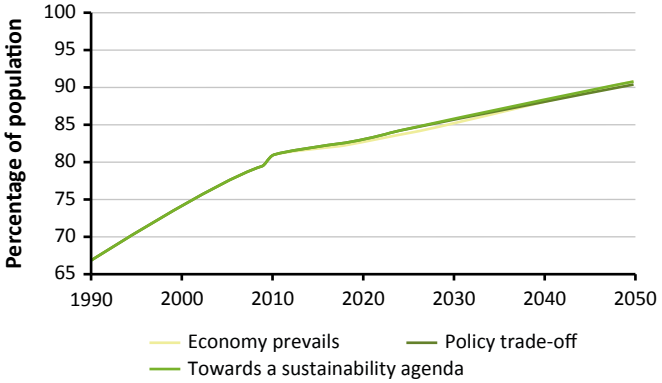
21 BID (2014) defines mega-corridors as two or more cities interconnected into a distance of over 60 kilometres.

Figure 4.4.3: Population growth in the three scenarios.



Source: IFM 2015

Figure 4.4.4: Population with access to improved sanitation in the three scenarios.



Source: IFM 2015

land increased to 4.9 square kilometres by 2050 (Place and Meybeck 2013). Pan-tropical forest loss increased slowly for decades and even accelerated in the 2040s as areas of high forest cover in Latin America that are currently experiencing little deforestation come under greater threat (Busch and Engelmann 2015), leading to further habitat loss and fragmentation. Urban air pollution had significant impacts on human health, especially in megacities. Waste generation per person also grew as a consequence of urbanization.

Quality and quantity of surface and ground water diminished as strong economic growth led to increased water demand, and this put further pressure on water resources. Economic growth facilitated the design and construction of wastewater treatment plants, increasing the number of people with access to modern sanitation by about 10 per cent between 2010 and 2050 (**Figure 4.4.4**).

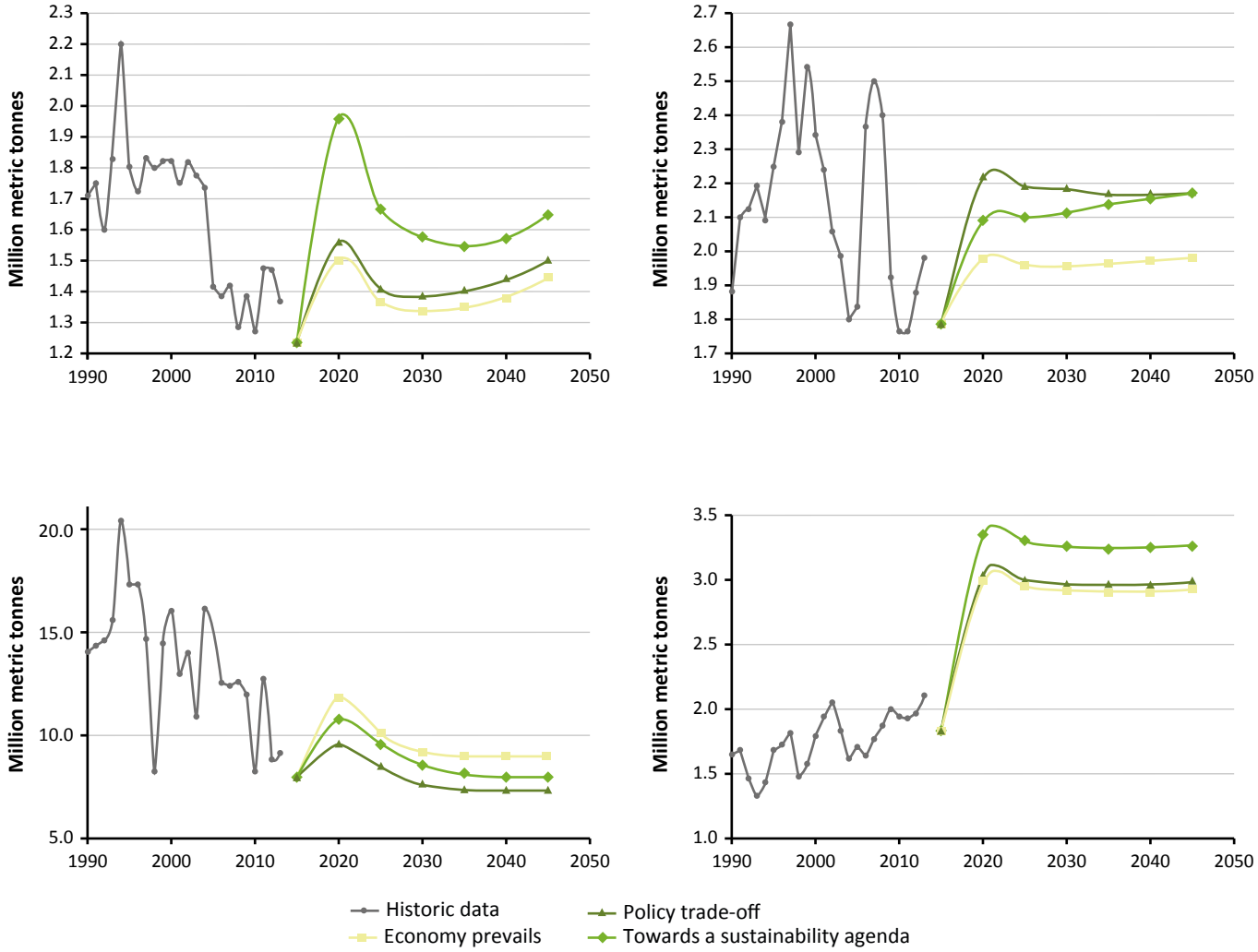
Even up to 2050 LAC is still facing difficulties in meeting SDG 14: *Conserve and sustainably use the oceans, seas and marine resources for sustainable development.* This in spite of fish landings increasing initially by up to 28 per cent before levelling off along both the Atlantic (FAO 31 & 41 zones) and Pacific coasts (FAO 77 & 87 zones) (**Figure 4.4.5**)

The increase in the biomass of fish landings, however, masked a significant decline in ecosystem health as indicated by the large declines in the fisheries depletion index (**Figure 4.4.6**).

With regard to SDG 13: T*ake urgent action to combat climate change and its impacts,* vulnerability to climate change in LAC increased, with very limited response capacity, particularly in the small island developing states (SIDS) and low-lying coastal states in Mesoamerica and South America (IPCC 2014b). LAC per person GHG emissions in the Economy Prevails outlook, consistent with Representative Concentration Pathway 8.5 Watt per square metre (RCP 8), grew from around 0.46 billion tonnes of carbon dioxide in 2000 to about 1.46 billion tonnes in 2050 (**Figure 4.4.7**).

Significant impacts of projected climate change and sea level rise were expected for the analysed period in Latin American coastal areas. Also, tropical glaciers were more affected, with water scarcity as a result causing major conflict. Air pollution increased, although several standards

Figure 4.4.5: Fish landings in FAO zones 31, 41, 77, and 87 in the three outlooks (historic data: 1990-2014).

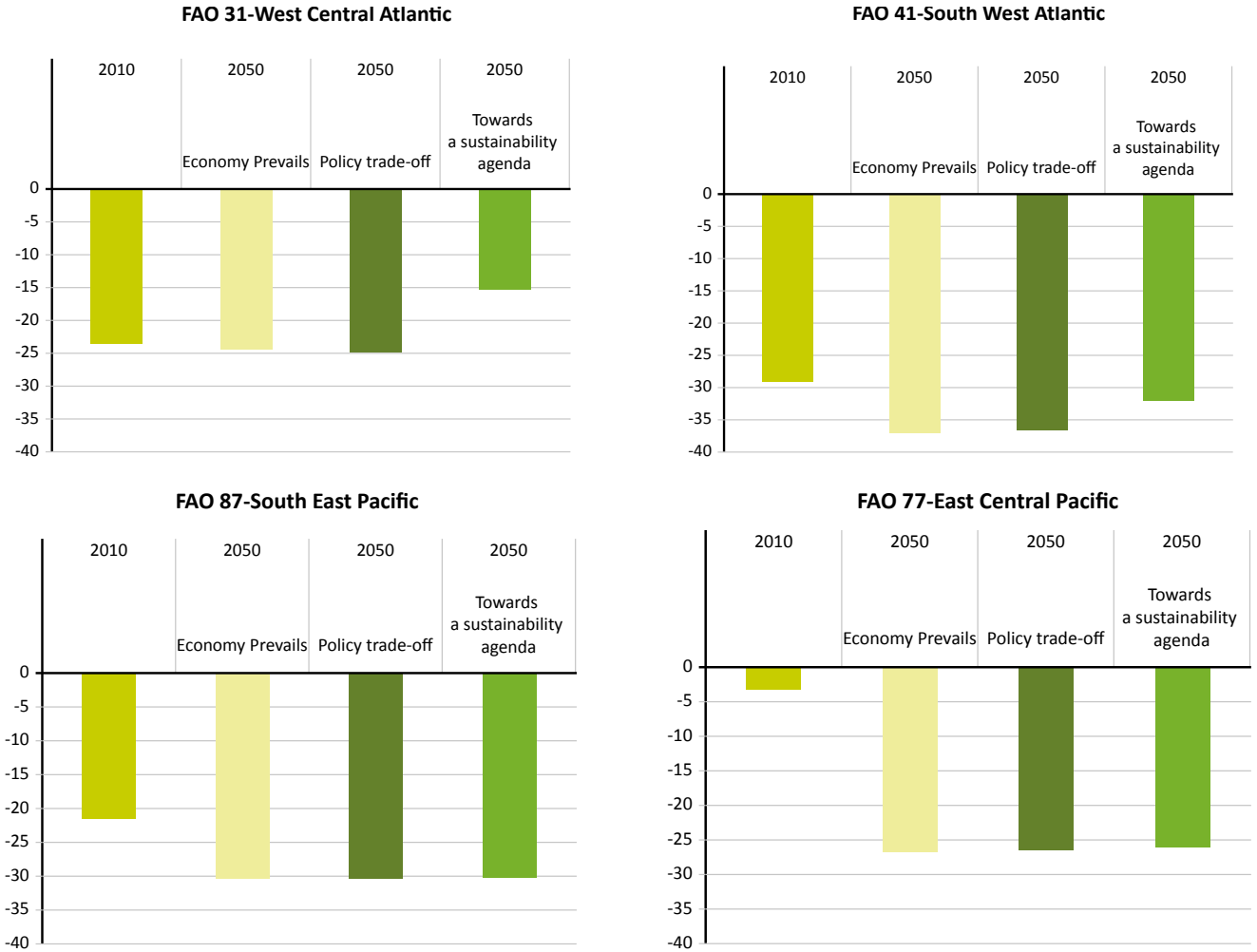


Source: Prepared by Jacqueline Alder (FAO) using the EcoOcean model from the University of British Columbia

and market mechanisms tended to further reduce and control the emissions in some critical areas such as Mexico City, Santiago, and São Paulo.

The region emitted nearly seven gigatonnes of carbon dioxide equivalent in 2050, when LAC per person emissions reached 9.3 tonnes of carbon dioxide equivalent. But despite the significant increase in projected energy emissions in the business-as-usual trajectory, LAC still had the lowest carbon

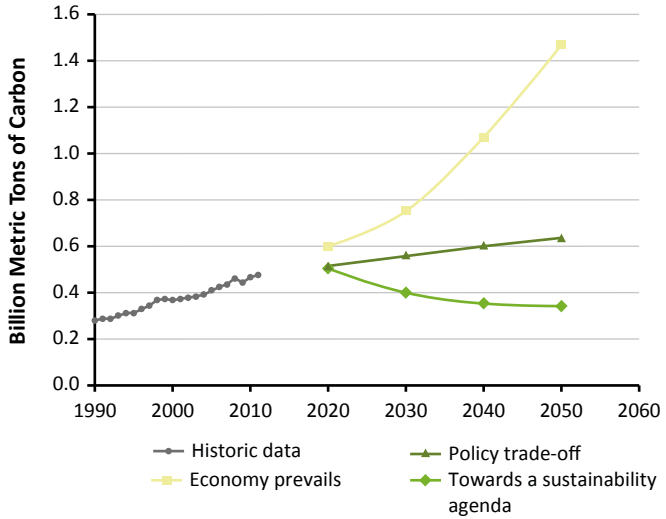
Figure 4.4.6: Fish Depletion Index for LAC FAO regions in the three outlooks.



Source: Prepared by Jacqueline Alder (FAO) using the EcoOcean model from the University of British Columbia

content of any regional energy mix through 2050. Meeting global climate stabilization goals of 2 tonnes per capita (tpc) by 2050 cost LAC approximately USD 100 billion per year, with an average abatement cost of less than USD 20 per tonne of carbon dioxide equivalent (Vergara *et al.* 2013). One example of negative impacts of climate change was seen on key crops which were significant for LAC and played a major role in the global food supply chain (Fernandez *et al.* 2012). These impacts reduced the value of annual agricultural exports in the region by USD 32/54 billion by 2050. Impacts of this magnitude, particularly in the context of a tight global food supply-demand balance, triggered other consequences,

Figure 4.4.7: Carbon dioxide emissions in LAC in the three scenarios (1990-2014).



Source: IFM 2015

including food market speculation and threats to food security. By 2040 the suitability of the agricultural lands in LAC had substantially changed compared to 2014 (**Figure 4.4.8**).

Challenges

The '*Economy prevails'* outlook tends to maximise economic growth at the expense of social and environmental objectives. This approach is reactive in terms of policy responses. Consequently, economic growth instability increases, as does vulnerability to unforeseen events. Policy options in this outlook emphasize privatization of public services and attempts to internalize environmental and social externalities into the costs of production through market tools.

4.4.2 Policy trade-offs

In this scenario, new policies and regulations are introduced to partially mitigate the adverse impacts of more than two decades of neo-liberal practices. Regional economic structure gradually shifts towards more value-added products and service activities. Until 2025 not much difference in GDP per person is experienced compared to the '*Economy prevails'* outlook, but by 2050 GDP per person reaches USD 25 980 (**Figure 4.4.1**), a small decrease.

In this scenario, population growth slows, urbanization stabilizes and emigration pressures reduce. The LAC population reaches around 774.4 million, a value close to that expected in the '*Economy prevails'* scenario. Policies are introduced to deal with the progressive aging of the population. Urbanization tends to be less chaotic. Institutional structures and policies improve, and democracy is promoted. Advances in environmental protection are achieved, especially in reducing urban pollution, although problems related to the management of natural resources persist.

Better income distribution policies are implemented and social expenditures increase in most of the region. This trend allows governments to partially achieve the SDGs in crucial areas such as education, health and poverty eradication. For example, female secondary education increases steadily to over 80 per cent (Alves *et al.* 2013). Following some of the main ideas proposed by Lutz *et al.* (2008), in many LAC countries, the previously uneducated half of the adult population now has primary education and a possible new SDG effort adds widespread secondary education. Additional investment in secondary education provides a huge boost to economic growth. Regional integration is enhanced through several sub-regional agreements and organizations. Regional initiatives for energy cooperation, including on the promotion of renewable sources, are encouraged. As a

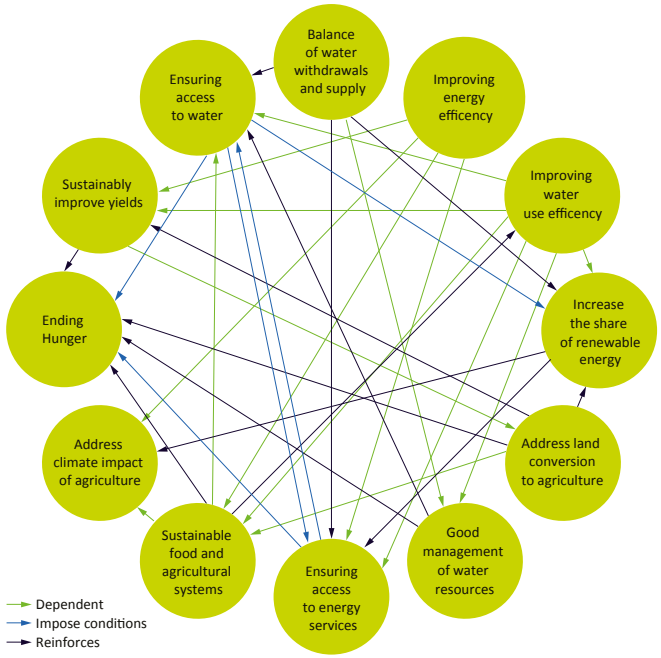
Figure 4.4.8: Future Agriculture Suitability 2011-2040.

Map made by UNEP-WCMC based on the GLUES database (Zabel *et al.* 2014)

result of these initiatives, new development corridors are established.[22]

The water-energy-food nexus (**Figure 4.4.9**) introduces a new model for actions across different sectors. In a region under pressure because of climate change and growing demands from a larger population, understanding these interdependencies is critical for achieving longer-term economic, environmental and social goals.

Figure 4.4.9: The food-energy-water nexus: interlinkages among SDG targets.



Source: Weitz *et al.* 2014

22 The future development corridor layer was created from various reports (see table below) and provides an indication of the location of planned/potential future transport infrastructure. Data and maps were compiled from different sources in the grey literature and, where GIS data were unavailable, digitized and overlaid on a 0.5 degree (~50km X 50km) grid.

This scenario assumes that regional initiatives for solving conflicts in shared watersheds emerge, particularly in South America (**More…49**). Together with an increase in living standards comes a substantial expansion in the water services delivered to households and businesses. The water demand of industry is also increased due to an expansion of industrial output. However, increases in water withdrawals are tempered by investments in new water-saving technologies, which lead to an improvement in water use efficiency. Hence, the number of people living in river basins with severe water stress grow. People living in these river basins are eventually able to cope better with water scarcity because of various top-down policy interventions, such as the establishment of national early warning systems for droughts, and better national coordination of water supply development. To protect natural waters, the capacity of wastewater treatment is substantially expanded. Although great efforts are made to protect aquatic ecosystems, significant quantities of untreated wastewater are still discharged into surface waters and result in deterioration of water quality in many areas.

A moderate reduction in the rates of land degradation, deforestation and habitat fragmentation is achieved due to improved regulations and enforcement mechanisms, but other driving forces such as climate change and infrastructure continue to affect natural resources (**More…50**).

Coastal development, leading to higher vulnerability to climate change, increases, especially in the wider Caribbean, even though governments make significant efforts to increase adaptive capacity. New initiatives, including economic instruments and regulations, to face urban pollution and management of solid waste, are introduced, mainly in areas with low environmental standards. As a consequence, significant air pollution and water contamination reductions are registered in targeted urban areas. As seen in **Figure 4.4.7**, total carbon dioxide emissions increase, but to a much lesser extent than in the '*Economy prevails*' scenario.

Figure 4.4.10: Future fields of oil and gas.[23]

Map made by UNEP-WCMC based on IHS (2014) data

23 The exploited oil and gas fields' layer was created from the proportion of each 50km x 50km grid cell covered by exploited oil and gas fields. This was based on data from the IRIS21 industry database from IHS Global Insight (IHS 2014). All fields not categorized as unexploited were categorized as exploited (i.e., those with a status of 'Producing', 'Developing', 'No data', 'Intermittent prod', 'Abd aft imprvd recov' 'Abd aft enhcned recov', 'Temporarily shut-in').

Challenges

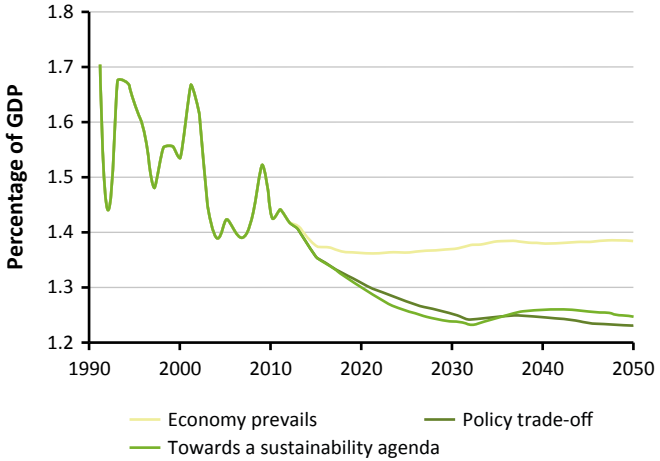
The *'Policy trade-offs'* scenario promotes greater transparency, policy effectiveness, and institutional coordination. However, environmental sustainability, even while a policy objective, remains a secondary priority for governments. This approach focuses on large-scale problems at the global and national level and is not well integrated with issues relevant at the local level. In general, policy implementation tends to be slow. In a context of persistent market competition, some regulatory efforts are discouraged due to the high transaction costs of regulation. Policy options in this outlook advocate an improvement in assessing environmental and social problems through better screening and monitoring, both geographically and thematically.

4.4.3 Towards a sustainability agenda

This scenario assumes the implementation of policies to promote sustainable approaches to agricultural practices, rather than market signals, more conscientious tourism, and a more participative and coordinated strategy for energy trade. By 2050 LAC accounts for USD 25 150 GDP per person, which implies more sustainable economic growth.

Regional initiatives towards energy cooperation, including regional and bilateral agreements for developing renewable sources are strengthened. Foreign debt diminishes to manageable levels and greater socio-economic integration emerges. There are steady cost reductions in some areas such as military expenditure (**Figure 4.4.11**), and this makes more resources available for social and environmental activities. Better use of science and technology occurs in priority areas. Governments prioritise applied R&D investment, with significant advances in policy implementation based on science. Equity in technology transfer is strongly encouraged. Innovation is prioritized according to local and regional needs with appropriated technologies. There is strong South-South cooperation in science and technology, with some South

Figure 4.4.11: Military expenditure in the three scenarios.



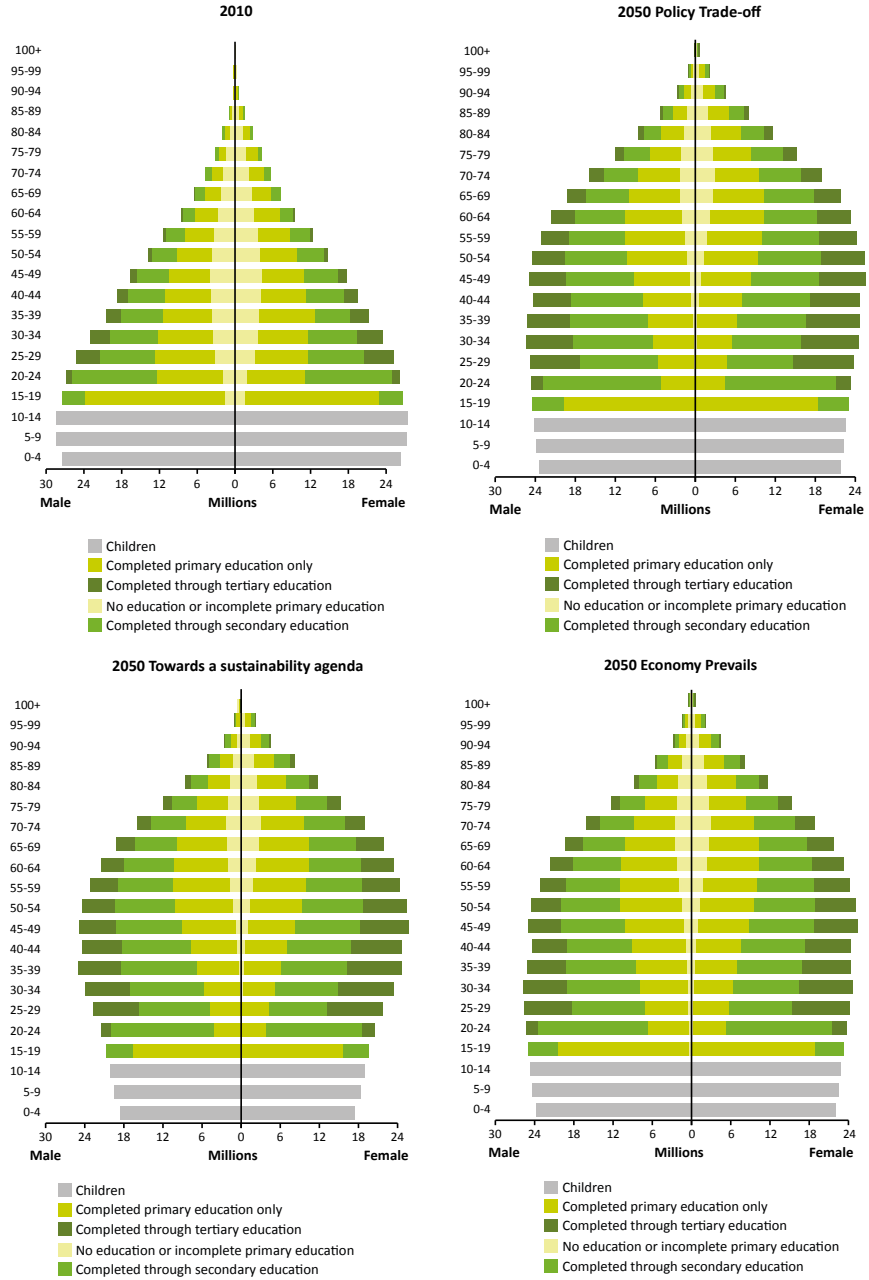
Source: IFM 2015

American countries such as Brazil, Argentina and Venezuela playing leading roles.

In this outlook, basic needs satisfaction increases, without endangering the preservation of natural resources. In their efforts to move towards greater sustainability, the countries of the region promote greater equality and social cohesion, and facilitate effective public-private partnerships, factors that make the costs associated with policy less onerous to governments.

This development model permits the coexistence of rural and urban living. Geographical differences in income still exist, with the lowest income per person in Mesoamerica and the Andean region. However, there is a radical change in income distribution patterns due to significant increases in social expenditure; and income equity reaches the highest level in history. In 2015 most of the countries in the region have already attained the MDGs, except the nations with the lowest Human Development Index (HDI) scores, including Guatemala, Haiti and Honduras. Sound national policies and international assistance help to fill the remaining gaps by 2050. The reduction of the informal sector and contraction

Figure 4.4.12: LAC education pyramid.



Source: IFM 2015

of extreme poverty are significant. There is also a significant decrease in the population living on an income of less than USD 1.25 per day, as shown in **Figure 4.4.2**.

Respect for human rights is guaranteed. Women are increasingly integrated into economic, social and political processes. Female enrolment in primary education increases from 92.9 per cent in 2010 to almost 100 per cent in 2050, while female enrolment in secondary education increases from 81.9 per cent in 2010 to 93.5 per cent in 2050 (**Figure 4.4.12**). It is well established that an increased share of women with primary and tertiary education cause a significant decrease in child bearing, leading to a decrease in LAC population. This results in a demographic transition and the beginning of a developed country type inverted pyramid.

Migration tends to be a matter of choice, rather than necessity. City development is based on long-term planning, with different visions for each city. Urban policies are diversified and urbanization continues, mainly in medium and small cities.

A more balanced structure is reached for decision making with political parties becoming more representative of all social interests. Wider participation and better coordination between national and local governments is prioritised. Access and transparency to public information increases. Civil associations are represented in formulating environmental policies. Noticeable changes in consumption patterns, as well as significant advances in the solution of priority environmental problems, happen. After a rapid increase between 2000 and 2005, total equivalent carbon dioxide emissions stabilises between 2005 and 2035, and then decreases below the 2010 level by 2050 (**Figure 4.4.7**).

Although conflicts related to strategic natural resources persist, for freshwater, hydrocarbons and biodiversity in border areas of South America, governments have effective capacity to prevent and manage these. Effective mechanisms and joint programmes are adopted to guarantee fair and equitable access and management of shared resources. Local governments and business groups also launch campaigns to encourage water-saving action and work together to stimulate investment in technology for reducing water use. These and other efforts slow the growth in water withdrawals despite growth in both the population and the economy.

Mechanisms to rehabilitate and rebuild affected and polluted ecosystems and areas are implemented. A protected area system is in place that is effective and representative of key ecosystems and species of the region, stopping the loss and fragmentation of key habitats. A well-established network of regional genetic banks develops as part of a global network. There is progressive replacement of agrochemicals by organic substances and biological controls, supported by biotechnological development. New mechanisms are introduced to effectively protect property of local traditional knowledge, with a leading role for some South American countries, to regulate access to genetic resources in a fair and equitable way, and to significantly reduce bio-piracy. Systems for integrated ecosystem information, traditional knowledge, protected areas and economic well-being are optimized for ecosystem services delivery. A common agenda for sustainable development in mega-diverse countries is agreed.

Challenges

In '*Towards a sustainability agenda',* it is possible to stabilise economic growth while significantly improving equity and environmental quality through proactive and comprehensive policies. The overall increase in human well-being and ecosystem health is likely to outweigh the initial cost of social and environmental investment, resulting in positive feedback for long-term economic growth. However, in some areas, this outlook may result in a slowing of technological intensity, as well as a shift towards local-level issues. In this case, policy options tend to prioritize the emphasis on building and keeping a social consensus through education and institutional strength.

4.5 The Outlook for Latin America and the Caribbean

The balanced integration of sustainable economic growth, social protection and justice, and environmental stewardship is reflected in the SDGs. The supplementary information includes an overview of the implementation of the SDGs under the three different scenarios (**More…51**).

The emerging picture from the current report is that the road ahead for LAC in terms of the management of its natural assets will neither be straightforward, nor will it be without its challenges. The sustainable development agenda landscape, because of its very interconnected nature, is complex (**Figure 4.5.1**), yet these very connections offer opportunities for the region's governments to identify key policy entry points and responses that will allow very specific

Figure 4.5.1: Environmental sustainability for SDGs.

Source: UNEP 2016

actions with multiplier effects (and consequently multiple benefits for the relationships between environment and society).

In the context of the evidence provided by this report, and in light of efforts already underway/ planned within the region to attend to environmental challenges, there are a few important issues that governments and other stakeholders may wish to consider.

Firstly, governments will likely need to find innovative solutions to allow for the decoupling of economic growth and resource consumption. This will be critical for attending to many of the persistent anthropogenic activities that are driving environmental change. Current patterns of development, including production and consumption, are, in many cases, unsustainable and with future anticipated increases in population size, it will be necessary to ensure that needs can be met with minimal damage to the natural environment. Reducing dependence on fossil fuels, and diversifying energy sources, will also be important for countries of the region.

The scenarios indicate that focusing on measures that ensure greater sustainability will not compromise economies or human well-being in adverse ways. Though some trade-offs may be necessary, issues such as poverty and health may be better managed where emphasis is placed on effectively managing environmental assets. Many governments of the region have engaged in some aspect of 'green economics' or 'green growth' and there are emerging strategies amongst countries to ensure a coordinated approach. Efforts such as these should be promoted and supported.

Governments of the region also likely need to invest in ecosystem-based resilience in order to reduce vulnerability and increase adaptation. Better investments in ecological infrastructure and implementation of measures to reduce pollution and other environmental pressures will help to safeguard some of the region's precious ecosystems and their services. This is especially important in the context of adapting to a changing climate, which is anticipated to have widespread and adverse impacts in the region.

The use of a range of policy support tools, mechanisms and approaches should help to boost regional success in addressing environmental changes and meeting the SDGs. Some of these include education and communication; the development of strategic partnerships especially within the region, but also beyond; innovation; investments in research; proper monitoring and evaluation; effective implementation of policies and enforcement of laws; adequate financing, and placing focus on capacity building.

See references for Chapter 4.

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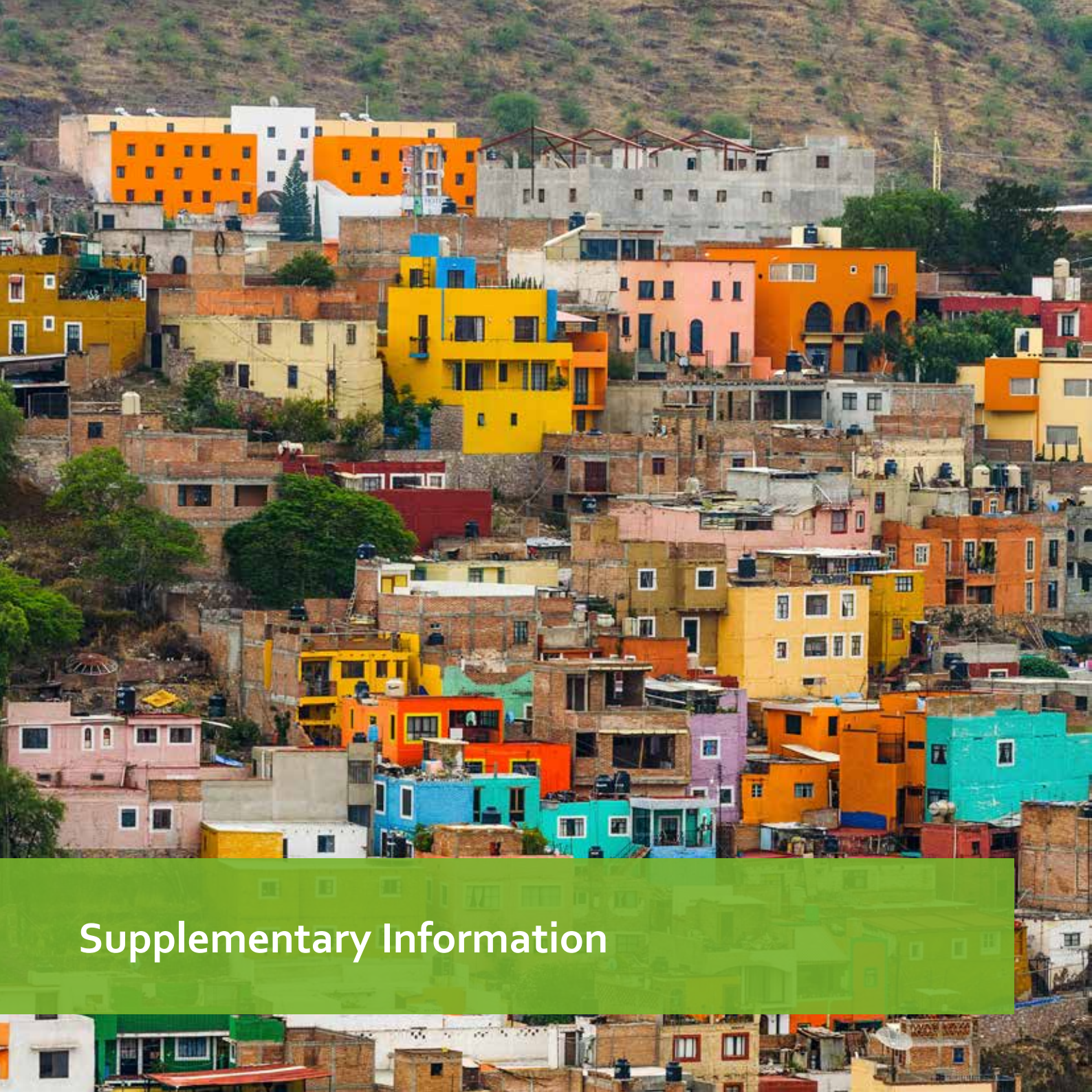

Supplementary Information

Additional information and to read **More...**:

1. Selected commodities exported by Latin America and the Caribbean expressed as percentage of merchandise exports (2010 and 2014)

Country Name	Ores and metals exports (% of merchandise exports)			Fuel exports (% of merchandise exports)			Food exports (% of merchandise exports)			Manufactures exports (% of merchandise exports)		
	2010	2014	change %	2010	2014	change %	2010	2014	change %	2010	2014	change %
Antigua and Barbuda	1.78	17.53	15.76	0.00	0.00	0.00	50.65	25.67	-24.99	47.57	17.45	-30.12
Argentina	4.42	3.38	-1.04	8.13	4.75	-3.37	51.12	55.87	4.75	33.19	32.14	-1.05
Bahamas, The	11.04	9.53	-1.51	0.00	0.00	0.00	25.15	20.12	-5.02	63.35	70.07	6.72
Barbados	1.20	1.26	0.05	0.02	9.43	9.40	32.87	33.44	0.57	63.98	53.99	-9.99
Belize	0.00	0.20	0.20	36.15	16.66	-19.49	60.86	63.91	3.05	1.38	1.53	0.15
Bolivia	33.34	22.18	-11.16	43.88	57.82	13.94	15.27	15.94	0.67	6.42	3.57	-2.85
Brazil	17.79	14.39	-3.39	10.14	9.25	-0.89	31.08	35.39	4.32	37.06	34.80	-2.26
Chile	64.57	56.38	-8.20	0.86	0.85	-0.01	16.86	22.45	5.59	12.64	14.12	1.47
Colombia	1.64	1.00	-0.65	60.40	67.53	7.13	11.90	10.92	-0.97	22.51	17.65	-4.86
Costa Rica	1.15			0.58			34.73	34.46 (a)	-0.27	60.87	61.86 (a)	0.99
Dominica	6.70			0.05			27.13	13.74 (b)	-13.39	65.99	73.97(b)	7.98
Dominican Republic	3.69	3.74	0.06	0.11	6.78	6.67	27.53	26.55	-0.98	67.71	62.13	-5.58
Ecuador	0.63	1.46	0.83	55.28	53.10	-2.18	30.01	35.31	5.30	9.84	6.17	-3.67
El Salvador	1.74	1.55	-0.19	2.99	2.58	-0.41	17.82	19.14	1.32	72.79	75.75	2.97
Guatemala	6.49	8.37	1.89	4.54	6.56	2.02	42.07	42.40	0.34	42.68	39.23	-3.45
Guyana	22.51	18.89	-3.63	0.00	0.00	0.00	64.79	69.11	4.32	7.20	7.04	-0.16
Honduras	6.37	4.04	-2.32	8.56	0.05	-8.52	57.26	54.91	-2.35	25.28	39.69	14.41
Jamaica	12.03	11.59	-0.44	22.69	22.29	-0.40	24.62	18.28	-6.34	40.37	43.51	3.14
Mexico	2.99	2.87	-0.12	14.04	10.65	-3.39	6.06	6.39	0.34	76.02	78.74	2.72
Nicaragua	2.00	0.88	-1.12	1.37	0.34	-1.04	88.21	51.48	-36.73	7.15	46.33	39.18
Panama	11.45	11.40	-0.05	0.31	0.16	-0.15	72.59	67.52	-5.08	13.19	14.56	1.37
Paraguay	0.56	0.82	0.25	30.55	22.75	-7.80	59.38	65.35	5.97	7.44	9.49	2.05
Peru	53.26	45.78		11.92	14.48	2.56	19.82	23.60	3.78	13.69	14.71	1.02
St. Kitts and Nevis	0.13			0.00			11.53			87.23		

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Country Name	Ores and metals exports (% of merchandise exports)			Fuel exports (% of merchandise exports)			Food exports (% of merchandise exports)			Manufactures exports (% of merchandise exports)		
	2010	2014	change %	2010	2014	change %	2010	2014	change %	2010	2014	change %
St. Lucia		9.62			0.23			37.02			45.56	45.56
St. Vincent and the Grenadines	1.93			0.00			82.34			15.71		
Suriname	0.26	0.34	0.09	13.02	10.63	-2.38	2.38	3.32	0.94	1.91	2.65	0.74
Trinidad and Tobago	0.31			66.12			2.52			31.02		
Uruguay	0.26	0.29	0.03	3.16	1.13	-2.03	61.93	65.29	3.37	25.98	23.72	-2.26
Venezuela, RB	2.07			93.42	97.67 (a)	4.25	0.19			4.29		
LAC (all income levels)	12.15	11.71	-0.44	22.23	12.25	-9.98	18.64	22.84	4.19	44.63	49.68	5.05

Note: (a) 2013: (b) 2012

Source: World Bank 2015

2. Types of goods and services exported by Latin America and the Caribbean (2010 and 2014)

Country Name	High-technology exports (% of manufactured exports)			ICT goods exports (% of total goods exports)			International tourism, receipts (% of total exports)			Insurance and financial services (% of service exports, BoP)		
	2010	2014	change %	2010	2014	change %	2010	2014	change %	2010	2014	change %
Antigua and Barbuda	0.00	0.00	0.00	2.16	2.23	0.07	56.89			3.88		
Argentina	7.50	6.68	-0.83	0.11	0.23	0.12	6.90	6.08	-0.82	0.17	1.06	0.89
Bahamas, The	0.00	0.00	0.00	0.16	0.62	0.46	67.55	66.06	-1.49			
Barbados	12.13	16.44	4.31	1.51	0.77	-0.73	51.91	42.76 (a)	-9.16	4.37		
Belize		0.00			0.06		31.82	35.09	3.26	2.00	0.62	-1.38
Bolivia	8.40	8.07	-0.32	0.00			4.96	5.45	0.50	9.49	10.14	0.65
Brazil	11.21	10.61	-0.59	1.01	0.39	-0.61	2.55	2.80	0.24	7.88	4.62	-3.26
Chile	5.49	6.17	0.68	0.37	0.50	0.13	2.94	3.62	0.67	6.87	7.33	0.46
Colombia	5.06	7.71	2.66	0.15	0.18	0.03	7.50	7.65	0.15	1.09	1.03	-0.06

Country Name	High-technology exports (% of manufactured exports)			ICT goods exports (% of total goods exports)			International tourism, receipts (% of total exports)			Insurance and financial services (% of service exports, BoP)		
	2010	2014	change %	2010	2014	change %	2010	2014	change %	2010	2014	change %
Costa Rica	39.97			19.91			17.74	18.52	0.78	0.28	1.23	0.95
Dominica	0.01		-0.01	2.45			54.00			1.94		
Dominican Republic	2.35	3.73	1.38	1.98	1.01	-0.97	33.72	33.23	-0.49	1.11	1.72	0.62
Ecuador	8.43	4.76	-3.67	0.12	0.05	-0.07	4.01	5.14	1.13		4.09	
El Salvador	5.79	4.76	-1.03	0.33	0.39	0.06	13.00	19.83	6.83	2.15	2.93	0.78
Grenada							60.95			2.91		
Guatemala	5.68	4.96	-0.72	0.88	0.24	-0.64	12.76	11.32	-1.44	1.83	1.64	-0.19
Guyana	0.19	0.22	0.03	0.06	0.09	0.03	7.06	5.86	-1.20	10.95	13.81	2.86
Haiti							37.68	34.92	-2.76			
Honduras	2.58	2.42	-0.16	0.15	0.17	0.02	12.69	9.73	-2.96	1.19	0.72	-0.46
Jamaica	0.57	0.56	-0.01	0.39	0.29	-0.10	52.32	51.80	-0.52	1.51	0.52	-0.99
Mexico	16.94	15.99	-0.95	20.17	16.03	-4.14	4.02	3.96	-0.06	12.02	16.85	4.84
Nicaragua	4.81	0.39	-4.43	0.14	0.08	-0.06	9.31	8.88	-0.43	0.46	0.40	-0.06
Panama	0.83	0.20	-0.63	9.60			13.72	21.04	7.31	9.14	6.21	-2.93
Paraguay	6.59	6.13	-0.46	0.08	0.14	0.06	2.19	2.26	0.07	3.79	3.07	-0.72
Peru	6.59	3.85	-2.74	0.08	0.10	0.02	6.37	8.50	2.13	6.87	10.77	3.90
St. Kitts and Nevis	1.30			19.27			43.24			1.47		
St. Lucia		5.19	5.19		11.65	11.65	50.75			1.84		
St. Vincent and the Grenadines	0.16			1.35			46.95			2.22		
Suriname	12.14	20.75	8.61	0.08	0.05	-0.03	2.97	4.38	1.41	0.90	3.39	2.49
Trinidad and Tobago	0.10			0.05			5.21			15.95		
Uruguay	6.59	7.93	1.34	0.05	0.10	0.06	15.57	13.61	-1.96	4.77	4.64	-0.13
Venezuela, RB	5.05			0.02			1.17	1.02 (a)	-0.16	0.11		
LAC (all income levels)	10.60	10.90	0.30	8.15	7.15	-1.00	5.67	6.21	0.54	5.68	5.84	0.16

Note: (a) 2013: (b) 2012

Source: World Bank 2015

3. Major regional platforms for collaboration on environment and sustainable development

Grouping	Composition	Scope and objectives
Association of Caribbean States (ACS)	Antigua and Barbuda, Barbados, Belize, Colombia. Costa Rica, Cuba, Dominica, Dominican Republic, el Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, the Bahamas, Trinidad and Tobago, Venezuela. Associate Members: Aruba, Curacao, France on behalf of (French Guiana, Saint Bartholomew and Saint Martin), Guadeloupe, Martinique, Saint Maarten and The Netherlands on behalf of (Bonaire, Saba, and Saint Eustatius).	The primary purpose of the ACS is to be an organization for "***consultation, cooperation and concerted action***" for its member countries. The ACS Membership has identified five focal areas for attention, three of which are of critical importance for environmental management. These areas include a) the preservation and conservation of the Caribbean Sea, b) Sustainable Tourism, d) Disasters Risk Reduction.
Caribbean Community (CARICOM)	**Member Countries:** Antigua and Barbuda, The Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, Saint Lucia, St. Kitts and Nevis, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago. **Associate Members:** Anguilla, Bermuda, British Virgin Islands, Cayman Islands, Turks and Caicos Islands	The **Treaty of Chaguaramas** established the Caribbean Community and Common Market, later known as CARICOM. The community focuses on issues related to foreign policy coordination, functional cooperation, and economic integration, particularly those related to trade arrangements. As it relates to environment, there are several articles within the Revised Treaty of Chaguaramas including topics such as natural resource management, fisheries, forestry and environmental protection. CARICOM also has several expert institutions dealing with disaster management, climate change, fisheries management, environmental health and hydrology.
The Community of Latin American and Caribbean States (CELAC)	Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, Ecuador, El Salvador, Granada, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Dominican Republic, St. Lucia, St. Kitts and Nevis, St. Vincent and Grenadines, Trinidad and Tobago. Uruguay and Venezuela.	This is an intergovernmental mechanism, which includes the thirty-three countries in Latin America and the Caribbean. It is a regional forum for decision making in support of regional integration programmes. The CELAC has identified work programmes on environment, energy and disaster risk reduction.

Grouping	Composition	Scope and objectives
The Caribbean Development and Cooperation Committee of the United Nations Economic Commission for Latin America and the Caribbean (UNECLAC-CDCC)	**Member Countries:** Antigua and Barbuda, The Bahamas, Barbados, Belize, Cuba, Dominica, Dominican Republic, Grenada, Guyana, Haiti, Jamaica, St. Kitts and Nevis, Saint Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago. **Associate Member Countries:** Anguilla, Aruba, British Virgin Islands, Cayman Islands, Montserrat, Puerto Rico, Turks and Caicos Islands, United States Virgin Islands.	The mission of the UNECLAC-CDCC is to find solutions to the development challenges facing the Caribbean "by conducting research and analysis and providing sound policy advice and technical assistance to Caribbean Governments, focused on growth with equity and recognition of the region's vulnerability". UNECLAC-CDCC secretariat conducts research; provides technical advice to governments, upon request; organizes intergovernmental and expert group meetings; helps to formulate and articulate a regional perspective within global forums; and introduces global concerns at the regional and sub regional levels. Relevant areas of focus include statistics, science and technology, and sustainable development, with operational activities extending to include assessment of the socio-economic impacts of natural disasters. UNECLAC Sub regional Headquarters for the Caribbean also functions as secretariat for the Programme of Action for the Sustainable Development of Small Island Developing States (SIDS POA).
MERCOSUR MERCOSUL. Mercado Común del Sur, Mercado Comum do Sul	Argentina, Brazil, Paraguay, Uruguay. Venezuela (pending ratification). Associate members: Bolivia, Chile, Colombia, Ecuador and Peru.	This Union, established in March 1991 by Argentina, Brazil, Paraguay and Uruguay by the Treaty of Asuncion, carries out a number of critical activities relevant to environmental governance including: 1. Provision of mechanisms for public participation in the original Protocol of Ouro Preto; 2. Environment and trade links exist through various legal mechanisms and resolutions addressing issues such as pesticides, energy policies and transport of hazardous products. 3. One of the Technical Working Groups of Mercosur specifically addresses the environment through a new protocol to be added to the Treaty. It will address issues such as increased co-operation on shared ecosystems, environmental monitoring, environmental information systems, and certification processes. Protected areas, conservation and sustainable use of natural resources, including biological diversity as well as provisions for protecting health and quality of life, social participation and regional co-operation are also included in the protocol.

Grouping	Composition	Scope and objectives
Red Iberoamericana de Oficinas de Cambio Climático (RIOCC)	Argentina , Bolivia, Brazil , Chile, Colombia, Costa Rica, Cuba , Ecuador, El Salvador, Spain, Guatemala, Honduras, México, Nicaragua, Panamá, Paraguay, Peru, Portugal, Dominican Republic, Uruguay, Venezuela.	Created in 2004 as a decision by the Environment Ministries Forum with the objective to maintain permanent dialogue, to identify and align priorities, challenges and experiences on climate change in the region. The objectives of this platform include: promotion and implementation of the UNFCCC decisions, contribute to the alignment of the region in international negotiations, build technical capacities and contribute to technology transfer, promote the mainstreaming of climate change into national policies, promote awareness raising, education and collaboration between the public and private sector on climate change issues.
Organization of American States (OAS)	Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, United States of America, Uruguay, Venezuela (Bolivarian Republic of), Barbados, Trinidad and Tobago, Jamaica, Grenada, Suriname, Dominica , Saint Lucia, Antigua and Barbuda, Saint Vincent and the Grenadines, The Bahamas, Canada.	The OAS is regarded as the world's oldest regional organization and constitutes the main political, juridical, and social governmental forum in the Hemisphere. The Organization uses a four-pronged approach to effectively implement its essential purposes, based on its main pillars: democracy, human rights, security, and development. As it relates to environment, the OAS provides support to its member states in the design and implementation of policies and projects to integrate environmental priorities into poverty alleviation and socio-economic development goals. The OAS facilitates this work through its Department of Sustainable Development. This department is responsible for ensuring the implementation of Summit Mandates on Environment and Natural Resources Management and Climate Change. There are also specific work programmes on Integrated Water Resources Management; Energy and Climate Change Mitigation; Natural Hazards and Climate Change Adaptation; Biodiversity; Environmental Law, Policy and Good Governance
Organisation of Eastern Caribbean States (OECS)	Anguilla, Antigua and Barbuda, the British Virgin Islands, Dominica, Grenada, Martinique, Montserrat, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines.	OECS is a sub-regional grouping that facilitates regional cooperation in a number of sectors, including education, environment, and health; it is also working towards Economic Union. The Environment and Sustainable Development Unit of OECS (OECS-ESDU) within the OECS Secretariat is responsible for the provision of natural resource and environmental management support to OECS member states. The OECS-ESDU is currently implementing programmes in a number of areas including disaster risk reduction, biodiversity management, energy, climate change, sustainable oceans governance, communication and public awareness, coastal and marine resources management, environmental planning, watershed management and waste management.

4. Major development banks in Latin America and the Caribbean

Institution	Role in Regional environmental Governance
The Inter-American Development Bank (IADB)	This bank emerged in 1959, and is a leading source of development financing for Latin America and the Caribbean. In addition to loans, the bank provides, grants, and technical assistance to countries working to reduce poverty and inequality, improve health and education, and advance infrastructure. The overarching aim of the bank through its interventions is to achieve development in a sustainable, climate-friendly way. Included among the goals of the bank is "*addressing climate change, renewable energy and environmental sustainability*". Also, in providing finance for major projects with potential significant impacts on the environment or on society, the bank requires the preparation of Environmental (and Social) Impact Assessments (EIAs). These EIAs are made available to affected populations and local NGOs by the borrower. In the past five years the bank provided approximately USD 3 200 million of financing to projects in the region dealing specifically with the environment and natural disasters, energy, and water and sanitation.
The Caribbean Development Bank (CDB)	The CDB has as its objective "to fully incorporate natural capital, climate change and natural disaster risk management into sustainable economic development planning in Latin America and the Caribbean". The Bank's current focal areas include: Strengthening and fostering environmental governance and policy; Innovating in public and private financing investment opportunities; Assisting countries in the design and implementation of sustainable development plans that include natural capital, disaster risk management and climate change impact consideration; Providing environmental and social safeguards for all countries' projects and plans. The Bank aims to ensure, through its lending policies, that environmental disaster/hazard risk and climate change are integrated into decision making and planning to reduce the vulnerability and increase the resilience of regional infrastructure in borrowing countries.
The Latin American Bank of Development (CAF)	The CAF offers support to the Latin American countries in order to "*enhance the environmental investment, migrate towards low carbon economies, and optimize their capacity for responding to the international strategy for the construction of sustainable development", through "the generation of strategies, specific programs, concrete initiatives, and innovative financial schemes.*" CAF incorporates an environmental perspective in its activities, aimed at: "The responsible management of the shared ecosystems and natural resources of regional and international importance, as well as the harmonization of the environmental policies in Latin America; The capitalization of opportunities and the management of risks and impacts generated by the physical integration; The conservation of the natural heritage and the continuity of the functional relations of the ecosystems that guarantee life."

5. Criteria pollutants

Criteria Pollutants are particle pollution (often referred to as particulate matter), ground-level ozone, carbon monoxide, sulphur oxides and nitrogen oxides. These pollutants can harm human health and the environment, and cause property damage. Of the six pollutants, particle pollution and ground-level ozone are the most widespread health threats. These commonly found air pollutants (also known as criteria pollutants) are found all over Latin America and the Caribbean.

Particulate matter, also known as particle pollution or PM, is a complex mixture of extremely small particles and liquid droplets. The size of particles is directly linked to their potential for causing health problems. Particles that are 10 micrometres in diameter or smaller (PM_{10}) are particularly harmful and generally pass through the throat and nose and enter the lungs. Once inhaled, these particles can affect the heart and lungs and cause serious health effects and also lead to premature death.

Ground-level **ozone** is not emitted directly into the air, but is created by chemical reactions between oxides of nitrogen (NO_x) and volatile organic compounds (VOC) in the presence of sunlight. Breathing ozone can trigger a variety of health problems, particularly for children, the elderly, and people of all ages who have lung diseases such as asthma. Ground-level ozone can also have harmful effects on sensitive vegetation and ecosystems.

Carbon monoxide (CO) is a colourless, odourless gas emitted from combustion processes. Particularly in urban areas, the majority of CO emissions to ambient air come from mobile sources. CO can cause harmful health effects by reducing oxygen delivery to the body's organs (like the heart and brain) and tissues. At extremely high levels, CO can cause death.

Nitrogen dioxide (NO_2) is one of a group of highly reactive gases known as oxides of nitrogen, or nitrogen oxides (NO_x). NO_2 forms quickly from emissions from cars, trucks and buses, power plants, and off-road equipment. In addition to contributing to the formation of ground-level ozone and fine particle pollution, NO_2 is linked with a number of adverse effects on the respiratory system.

Sulphur dioxide (SO_2) is one of a group of highly reactive gases known as oxides of sulphur. The largest sources of SO2 emissions are from fossil fuel combustion at power plants and other industrial facilities, industrial processes such as extracting metal from ore, and the burning of high sulphur-containing fuels by locomotives, large ships, and non-road equipment. SO_2 is linked with a number of adverse effects on the respiratory system or heart disease.

6. Greenhouse gases

Many chemical compounds present in Earth's atmosphere behave as greenhouse gases. These are gases that allow direct sunlight to reach the Earth's surface unimpeded. As the shortwave energy heats the surface, longer-wave energy (heat) is reradiated to the atmosphere. Greenhouse gases absorb this energy, thereby allowing less heat to escape back to space, and trapping it in the lower atmosphere. Each of these gases can remain in the atmosphere for different amounts of time, ranging from a few to thousands of years. Some gases are more effective than others at making the planet warmer. For each greenhouse gas, a Global Warming Potential (GWP) has been calculated to reflect how long it remains in the atmosphere, and how strongly it absorbs energy. Gases with a higher GWP absorb more energy than gases with a lower GWP, and thus contribute more to warming the Earth.

Carbon dioxide (CO_2): Carbon dioxide enters the atmosphere from burning fossil fuels, solid waste, trees and wood products, and as a result of certain chemical reactions. It is removed from the atmosphere (or sequestered) when it is absorbed by plants as part of the biological carbon cycle.

Methane (CH_4): Methane is emitted during the production and transport of coal, natural gas, and oil. Other emissions result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.

Nitrous oxide (N_2O): Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.

Fluorinated gases (e.g. hydrofluorocarbons, perfluorocarbons and hydrofluoroethers): Are sometimes used as substitutes for stratospheric ozone-depleting substances, they are typically emitted in smaller quantities, but because they are potent greenhouse gases, they are sometimes referred to as High Global Warming Potential gases (High GWP gases).

Toxic air pollutants are those known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, damage to the immune system, and neurological, reproductive (e.g., reduced fertility), developmental, respiratory and other health problems. The adverse environmental effects are well known. Examples are benzene, which is found in gasoline, perchloroethylene, which is emitted from some dry-cleaning facilities, methylene chloride, which is used as a solvent and paint stripper by a number of industries, dioxin, asbestos, toluene, and metals such as cadmium, mercury, chromium, and lead compounds.

Most air toxics originate from human-made sources, including mobile sources (e.g., cars, trucks, buses) and stationary sources (e.g., factories, refineries, power plants), and indoor sources (e.g., some building materials and cleaning solvents). Some air toxics are released from natural sources such as volcanic eruptions and forest fires.

Some toxic air pollutants such as mercury can deposit onto soils or surface waters, where they are taken up by plants and ingested by animals and eventually magnified up through the food chain.

7. Total emissions of carbon dioxide in 2006 and 2011 (kilo tonnes per year) in LAC countries (columns 2 and 3 respectively); percentage increase (decrease) in total emissions (kilo tonnes) of carbon dioxide in the same period (column 4); percentage increase (decrease) in emissions (tonnes) of carbon dioxide per person (2011 vs 2006, column 7); and percentage increase (decrease) in emissions of carbon dioxide (kg CO_2/PPP GDP) per unit of GDP (2011 vs 2006, column 10).

Country	Total CO_2 emissions (kt)		+/- (%)	CO_2 emissions (kg per PPP $ of GDP)		+/- (%)	CO2 emissions (t per capita)		+/- (%)
	2006	2011		2006	2011		2006	2011	
Antigua and Barbuda	425.372	513.38	20.69	5.10	5.82	14.28	0.23	0.29	26.01
Argentina	174237.505	190034.941	9.07	4.47	4.67	4.41	0.19	0.23	18.55
Bahamas, The	1521.805	1906.84	25.30	4.53	5.21	14.80	0.34	0.36	6.07
Barbados	1371.458	1565.809	14.17	4.99	5.56	11.38	0.15	0.11	-26.11
Belize	432.706	550.05	27.12	1.55	1.74	12.13	0.20	0.21	5.20
Bolivia	14730.339	16120.132	9.43	1.55	1.56	0.88	0.36	0.29	-20.06
Brazil	347668.27	439412.943	26.39	1.85	2.23	20.74	0.16	0.15	-6.57
Chile	64814.225	79408.885	22.52	3.93	4.59	16.83	0.25	0.23	-10.50
Colombia	62940.388	72423.25	15.07	1.44	1.54	7.15	0.16	0.14	-15.31
Costa Rica	7099.312	7843.713	10.49	1.62	1.66	2.44	0.15	0.13	-15.78
Cuba	27407.158	35921.932	31.07	2.43	3.19	31.36	0.17	0.17	0.87

Country	Total CO_2 emissions (kt)		+/- (%)	CO_2 emissions (kg per PPP $ of GDP)		+/- (%)	CO_2 emissions (t per capita)		+/- (%)
	2006	2011		2006	2011		2006	2011	
Dominica	110.01	124.678	13.33	1.56	1.75	12.20	0.18	0.17	-8.59
Dominican Republic	19710.125	21888.323	11.05	2.08	2.16	3.74	0.24	0.19	-18.96
Ecuador	28859.29	35727.581	23.80	2.06	2.34	13.87	0.25	0.24	-6.92
El Salvador	6846.289	6684.941	-2.36	1.12	1.07	-4.85	0.17	0.15	-15.10
Grenada	231.021	253.023	9.52	2.24	2.41	7.63	0.21	0.21	0.20
Guatemala	12526.472	11257.69	-10.13	0.96	0.77	-20.59	0.16	0.11	-30.26
Guyana	1290.784	1782.162	38.07	1.69	2.25	33.61	0.38	0.39	2.12
Haiti	2112.192	2211.201	4.69	0.22	0.22	-2.03	0.16	0.14	-10.32
Honduras	7007.637	8412.098	20.04	1.00	1.08	8.63	0.26	0.25	-5.29
Jamaica	12020.426	7755.705	-35.48	4.53	2.87	-36.60	0.55	0.34	-38.59
Mexico	445291.144	466548.743	4.77	3.97	3.91	-1.59	0.30	0.25	-18.97
Nicaragua	4466.406	4899.112	9.69	0.81	0.83	2.63	0.23	0.20	-12.79
Panama	7370.67	9666.212	31.14	2.15	2.58	20.21	0.20	0.16	-19.32
Paraguay	3986.029	5298.815	32.93	0.66	0.81	21.64	0.12	0.11	-3.99
Peru	35063.854	53068.824	51.35	1.25	1.79	43.25	0.17	0.17	0.53
St. Kitts and Nevis	234.688	267.691	14.06	4.71	5.05	7.28	0.42	0.24	-42.66
St. Lucia	366.7	407.037	11.00	2.19	2.27	3.81	0.23	0.25	5.23
St. Vincent and the Grenadines	220.02	238.355	8.33	2.02	2.18	7.89	0.22	0.22	-1.81
Suriname	2449.556	1910.507	-22.01	4.85	3.61	-25.62	0.22	0.22	0.56
Trinidad and Tobago	46431.554	49574.173	6.77	35.62	37.19	4.40	1.35	1.29	-4.03
Uruguay	6648.271	7774.04	16.93	2.00	2.30	15.09	0.16	0.13	-20.48
Venezuela, RB	169514.409	188817.497	11.39	6.23	6.40	2.67	0.42	0.38	-10.12
Caribbean	119170.166	131040.245	9.96	73.21	76.95	5.11	4.72	4.23	-10.29
Mesoamerica	491040.636	515862.559	5.05	13.18	13.63	3.44	1.68	1.45	-13.49
South America	958865.495	1141606.773	19.06	69.82	73.68	5.52	4.41	4.17	-5.42
Total LAC	1515406.085	1730270.283	14.18	117.36	123.58	5.31	8.98	8.10	-9.84

Note: the emissions reported are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.

Source: World Bank 2015.

8. Latin America and the Caribbean, Intended Nationally Determined Contributions

Country	Brief summary of the INDCs for selected countries
Paraguay	20% reduction in emissions by 2030. - unconditional target: 10% reduction by 2030 along with a conditional 10% reduction by 2030
Honduras	A 15% reduction in emissions by 2030, compared to business-as-usual levels, conditional upon international support. Will also reforest a million hectares of forest by 2030. Includes section on adaptation.
Guatemala	An unconditional 11.2% emissions cut in 2030, relative to business-as-usual projections, or a conditional 22.6% reduction. Notes that climate-related loss and damage over the past 16 years totals US $3500 million. Includes section on adaptation.
Costa Rica	Reconfirms its aspiration to become carbon neutral by 2021. In terms of total greenhouse gas emissions, pledges to reduce emissions by 44% by 2030 compared to business-as-usual levels, equivalent to a 25% reduction compared to 2012 levels. Requires international support to implement. Includes section on adaptation.
Haiti	A 26% reduction in emissions by 2030, relative to business-as-usual levels. Of this, 5% will be achieved unconditionally, while the remainder is subject to international support. Includes section on adaptation.
Barbados	A 44% economy-wide emissions cut in 2030, compared to business-as-usual. Its interim goal of 37% in 2025 is equivalent to a 21% cut relative to 2008 level. Includes section on adaptation. Implementation requires financial support.
Chile	An unconditional 30% reduction in emissions per unit of GDP by 2030, compared to 2007 levels, or a 35–45% reduction conditional on international support. The intensity target covers all sectors except land use and forestry. Includes separate targets on sustainable forest management and reforestation. Includes section on adaptation.
Dominica	An 18% emissions cut by 2020, compared to 2014 levels, with cuts of 39% by 2025 and 45% by 2030 from the same baseline. Includes section on climate risks and adaptation.
Uruguay	Expects to become a net carbon dioxide sink by 2030. An unconditional 25% cut in emissions per unit of GDP by 2030, compared to 1990 levels, or a 40% cut conditional on international support. Other sector targets include scaling up emission removals through land and forestry, while reducing the emission intensity of power production, beef and waste. Includes section on adaptation.
Guyana	Up to 52 million tonnes of carbon dioxide equivalent of mitigation and a 20% share of total energy from renewables by 2025, conditional on provision of adequate resources. Unconditional elements are not associated with quantified outcomes. The pledge covers carbon dioxide from forestry and energy. Conditional elements and adaptation needs will cost an estimated USD 4 495 million.
Brazil	A 37% reduction in emissions by 2025, compared to 2005 levels, with a further indicative target of a 43% reduction in emissions by 2030. Contains sections on adaptation and means of implementation, including south-south initiatives. A comprehensive and up to date overview of the expected emissions of greenhouse gases in Brazil is available in MCT 2014.
Peru	An unconditional 20% reduction in emissions by 2030, compared to business-as-usual. A 30 % reduction is offered conditional on international funding. This would equate to a 22% increase compared to 2010 emissions. Includes section on adaptation. Also sets out Peru's position on the Paris agreement.

Country	Brief summary of the INDCs for selected countries
Colombia	A 20-30% reduction in greenhouse gas emissions by 2030, compared to business-as-usual. The lower end is unconditional whereas the top end of ambition is subject to the provision of international support. Colombia will also consider communicating a target for 2025, depending on the outcome of the Paris talks.
Dominican Republic	A 25% reduction in emissions compared to 2010 levels by 2030, conditional upon favourable and predictable support, climate finance mechanisms and corrections to the failures of existing market mechanisms. Includes a five-year review of target. Includes sections on loss and damage, finance, technology, capacity building and youth, and gender.
Trinidad and Tobago	By 2030, an unconditional 30 % reduction in business-as-usual carbon dioxide, methane and nitrous oxide emissions from transport, power and industry. A conditional 45% reduction is also on the table.
Mexico	Unconditional 25% reduction in greenhouse gases and short lived climate pollutants from a business-as-usual scenario by 2030, which would rise to 40% subject to the outcome of a global climate deal. For the unconditional pledge, this means peaking net emissions by 2026 and reducing emission intensity per unit of GDP by around 40% from 2013 to 2030.

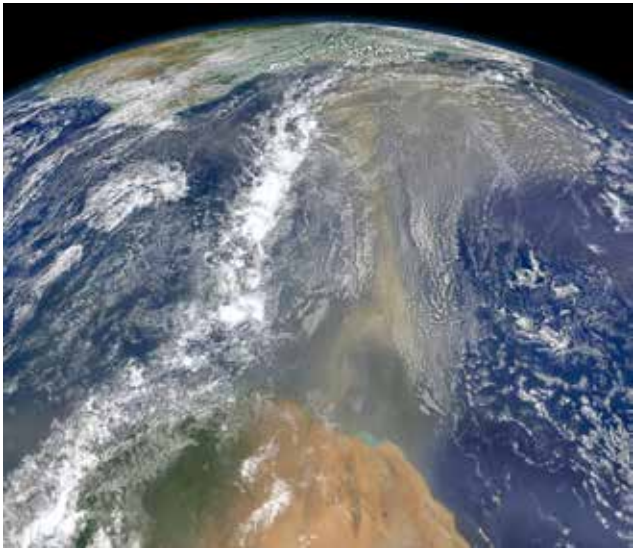
9. Transboundary air pollution

Transboundary pollution issues have barely been addressed in the region, but the recent reports from the Global Monitoring Plan of the Stockholm Convention may help understanding of the complex problem of transboundary air pollution within and between regions. Intercontinental transport of dust may have long-distance impacts, for example Saharan dust in the Caribbean islands, where links between dust and childhood asthma in Trinidad have been already documented (Gyan *et al.* 2005).

African dust clouds are regularly carried across the Atlantic Ocean by the North Atlantic trade winds to the Caribbean, the southern states of the USA and the South American mainland. These clouds bring millions of tonnes of dust to these regions – 20 million tonnes of dust particles are estimated to arrive in the Caribbean each year (Schlatter 1995). Most dust particles are less than 1 micrometre in diameter and could potentially reach the smallest of human airways. Small particles of dust, metals and toxic chemical pollutants are moving through the air, across the oceans, and between continents.

A piece of Africa – actually many very small pieces – began to arrive in the Americas in June 2014. On June 23, a lengthy river of dust from western Africa began to push across the Atlantic Ocean on easterly winds. A week later, the influx of dust was affecting air quality as far away as the south-eastern USA.

Saharan dust heading west towards South America and the Gulf of Mexico, 25 June 2015



Source: NASA 2015

This composite image, made with data from the Visible Infrared Imaging Radiometer Suite (VIIRS) on Suomi NPP, shows dust heading west toward South America and the Gulf of Mexico on June 25, 2014. The dust flowed roughly parallel to a line of clouds in the inter-tropical convergence zone, an area near the equator where the trade winds come together and rain and clouds are common. In imagery captured by the Moderate Resolution Imaging Spectro radiometer (MODIS), the dust appeared to be streaming from Mauritania, Senegal, and Western Sahara, though some of it may have originated in countries farther to the east.

Saharan dust has a range of impacts on ecosystems downwind. Each year, dust events like the one pictured here deliver about 40 million tonnes of dust from the Sahara to the Amazon River Basin. The minerals in the dust replenish nutrients in rainforest soils, which are continually depleted by drenching, tropical rains. Research focused on peat soils in the Everglades show that African dust has also been arriving regularly in South Florida for thousands of years.

In some instances, the impacts are harmful. Saharan dust, for example, can have a negative impact on air quality in the Americas, and scientists have linked African dust to outbreaks of certain types of toxic algal blooms in the Gulf of Mexico and southern Florida.

10. Air quality issue in LAC

Mining

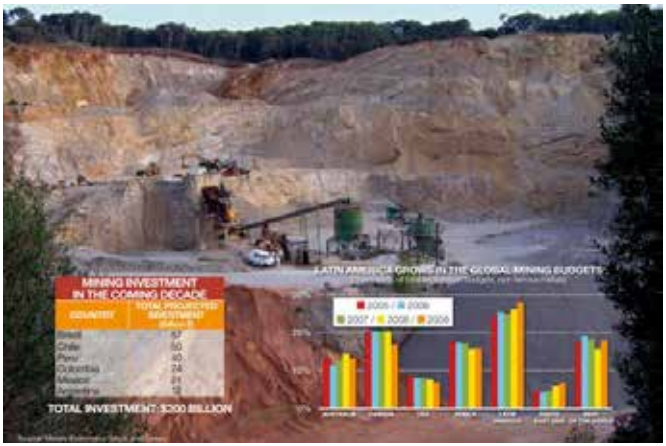
Mining activities in Latin America have been growing in the past two decades. These activities raise many issues related to mining and air pollution throughout the region. One example is mercury releases to the atmosphere from artisanal gold mining.

Virtually all countries in Latin America have artisanal mining activities, with gold being the most mined mineral (Veiga 2002). The total amount of gold produced by artisanal mining in the region during the 1990s is estimated at up to 188 tonnes per year, by more than 1 million artisanal miners. Mercury amalgamation is the preferred method used by these gold miners: when retorts are not used, up to 50 per cent of the mercury used in the process can be released to the atmosphere (Veiga 2002).

In a study conducted in a gold mining area of Colombia (Cordy *et al.* 2011), urban air mercury levels ranged from 300 nanograms of mercury per cubic metre (background) to 1 million nanograms per cubic metre (inside gold shops) with 10 000 nanograms of mercury per cubic metre being common in residential areas. The World Health Organization's standard for public exposure is 1000 nanograms per cubic metre. The total mercury release/emissions to the Colombian environment can be as high as 150 tonnes a year, giving this country the first position as the world's largest mercury polluter per person from artisanal gold mining.

Some other issues are related to particulate matter contamination from coal mining and releases of sulphur and nitrogen oxides from copper smelters in Chile and Peru, causing acidification in adjacent agricultural areas.

Latin America and the Caribbean, metal reserves as a percentage of world reserves, 2000–2012



Source: MPA 2011

Currently, the region provides 45 per cent of global copper production, 50 per cent of silver, 26 per cent of molybdenum, 21 per cent of zinc and 20 per cent of gold. As a result, Latin America attracts 25 per cent of global investment in mining.

Radon

Radon is a chemically inert, naturally occurring radioactive gas. It is produced from radium in the decay chain of uranium, an element found in varying amounts in all rocks and soil all over the world. An increased risk of lung cancer is the main health hazard from high radon exposure. This has been substantiated in many studies of uranium miners.

South America, arithmetic mean radon level in SA (Becquerel per cubic metre) year 2007

Source: Zielinski *et al.* 2008

Lead

Lead is a non-essential trace element, whose toxic properties affect human and environmental health as a neurotoxic contaminant. Mining is one of the main sources of lead entering the atmosphere, followed by leaded gasoline used in transport. Based on data gathered in an ice core from the Illimani (Aymara) Mountain in the Bolivian Andes, Eichler *et al.* (2012) demonstrated that atmospheric lead emissions from road traffic exceed the levels released by historical metallurgy over the last two millennia. Leaded gasoline has been phased out in the region, which has resulted in lower levels of lead in air during recent years.

Indoor air pollution

Burning solid fuels produces extremely high levels of indoor air pollution: typical 24-hour concentrations of PM10 in biomass-using homes in Latin America and the Caribbean are 300–3 000 micrograms per cubic metre, with peaks during cooking to as high as 10 000 micrograms per cubic metre. For comparison, the US Environmental Protection Agency

Video: Using solid fuel for cooking is a serious issue in Latin America and the Caribbean

Source: Children International (https://www.youtube.com/watch?v=0B1ETlTyD90)

(EPA) has set the standard for annual mean PM10 levels in outdoor air at 50 micrograms per cubic metre; while the annual mean PM10 limit agreed by the European Union is 40 micrograms per cubic metre. As cooking takes place every day of the year, most people using solid fuels are exposed to levels of small particles many times higher than accepted annual limits for indoor air pollution. The more time people spend in these highly polluted environments, the more dramatic the consequences for health. Women and children are most at risk from harmful indoor air pollution.

11. Installed hydropower capacity in gigawatt (GW) in 2014

Country	GW installed	% in LAC	% Global
Argentina	9.08	5.6	0.9
Bolivia	0.5	0.3	0.0
Brazil	89.3	54.9	8.6
Chile	6.4	3.9	0.6
Colombia	10.8	6.6	1.0
Costa Rica	1.75	1.1	0.2
Cuba	0.1	0.1	0.0
Dominican Republic	0.5	0.3	0.0
Ecuador	2.2	1.4	0.2
El Salvador	0.5	0.3	0.0
Guatemala	1.0	0.6	0.1
Haiti	0.1	0.1	0.0
Honduras	0.6	0.4	0.1
Nicaragua	0.1	0.1	0.0
Mexico	12.4	7.6	1.2
Paraguay	8.8	5.4	0.9
Panama	1.6	1.0	0.2
Uruguay	1.5	0.9	0.1
Suriname	0.2	0.1	0.0
Venezuela	15.14	9.3	1.5
Total LAC	162.61	100.0	15.7
Total world	1036.0	-	-

Source: IHA 2015.

12. Latin America and the Caribbean, number and use of operational dams and reservoirs

Country	Multiple uses	Irrigation	Water supply	Flood control	Hydroelectricity	Navigation	Recreation	Pollution control	Livestock rearing	Other
Antigua and Barbuda	1	8	9	0	0	0	0	0	8	0
Belize	2	0	0	0	2	0	0	0	0	0
Costa Rica	3	0	0	0	8	0	0	0	0	0
Cuba	36	88	50	0	0	0	7	0	2	2
Dominican Republic	10	3	0	0	7	0	0	0	0	1
El Salvador	0	0	0	0	4	0	0	0	0	0
Grenada	0	0	4	0	0	0	0	0	0	0
Guatemala	1	0	0	0	21	0	0	0	0	0
Haiti	2	0	0	0	1	0	0	0	0	0
Honduras	4	1	4	7	0	0	0	0	0	0
Jamaica	0	0	2	0	0	0	0	0	0	0
Nicaragua	2	0	0	0	21	0	0	0	0	0
Panama	4	0	0	0	10	0	0	0	0	0
St. Lucia	0	0	1	0	0	0	0	0	0	0
Trinidad and Tobago	0	0	4	0	0	0	0	0	0	2
Mexico	49	37	4	3	8	0	0	0	0	0
Argentina	64	0	3	7	10	0	17	0	0	0
Bolivia	7	205	50	0	9	0	5	0	0	10
Brazil	-	-			60	-	-	-	-	-
Chile	14	8	2	0	3	0	0	0	0	0
Colombia	8	0	1	0	28	0	1	0	0	0
Ecuador	7	0	1	0	3	0	0	0	0	0
Guyana	3	1	0	0	0	0	0	0	0	0
Paraguay	3	0	0	0	2	0	0	0	0	0
Peru	9	24	0	0	31	0	0	0	0	0
Suriname	0	0	0	0	1	0	0	0	0	0
Uruguay	8	>400	4	0	3	0	0	0	0	14
Venezuela	49	7	33	0	8	0	1	0	0	0

Source: FAO 2015a. The reported numbers are only for operational dams bigger than 10 million cubic metres

13. Manzanilla flooding event – nature's balancing acts

In November 2014 a portion of the main access road along the eastern coast of Trinidad was totally destroyed after incessant torrential rains. Initially, the incident was thought to be due to coastal erosion and climate change was the culprit. However, after investigation, it was found that the flooding was from the adjacent swamp.

Flooding at the Manzanilla beach (Trinidad and Tobago)

Credits: IereEye 2015

Flooding from the swamp was not considered a high threat, so measures may not have been taken to alleviate this type of occurrence. In this instance the continuous and prolonged rainfall caused the swamp to exceed its hydrological carrying capacity. Since the flow was obstructed by the roadway, the water made a path of its own, through the roadway, resulting in its collapse. As the water continued to flow it cut channels through the roadway and eventually to the sea, leaving destruction of property and infrastructure in its path.

This serves as a lesson. The Manzanilla beach has always been visibly affected by coastal erosion so protective structures are in place to protect the road from erosion; there was never a thought that the road would be threatened from the swamp. This shows that marine and adjacent freshwater systems should be more integrated in development planning.

14. Snow and ice: more than a pretty picture

The Andes cover a latitudinal range of 46°, from Venezuela in the north (10°N), to Cape Horn in the south (56°S) and are divided into several cordilleras, encompassing seven South American countries. In line with the global glacier trend, which can be attributed mainly to global warming, a generalized glacier recession has been occurring in the Andes since the end of the Little Ice Age in around 1850, and accelerated ice loss in recent years has been reported along the Andes.

The glaciers in the Central Tropical Andes (10°–20°S) and in the North-Central Southern Andes (25°–35°S) play a central role in water resources, depending on several factors, two of the main ones being the glaciation coverage within the basin and the distance of rivers downstream from the glaciers. The regulating effect of glaciers on stream runoff will decrease rapidly as deglaciation in the Andes proceeds. In addition to atmospheric warming, glacier loss in the Andes will probably be further accelerated by drier conditions in the Central Tropical and in the North-Central Southern Andes, as projected by general circulation models of the Intergovernmental Panel on Climate Change (IPCC) in 2013 and 2014.

Video: Chile: Natural Laboratory. Glaciers and phytoremediation plants (in Spanish)

https://www.youtube. com/watch?v=a_uoafvsury

15. Impacts of recent climatic events in LAC

Extreme events in the Caribbean

On some of the smaller islands of the Caribbean and in rural communities rainwater harvesting is used to meet domestic demand. Thus the timing of a drought determines water availability, with surface water (fed by rainfall and runoff) being affected earlier than groundwater. In 2010, several countries of the Caribbean had to face drought conditions that led to significantly lower than normal flows. For instance, the island of Carriacou, part of Grenada, which relies exclusively on rainwater for its water needs, had to have water tankered to the island as water production in the country was reduced by 30 per cent. (Cashman 2014). In Antigua, the main supply reservoir that meets 22 per cent of water demand was empty by March 2010. In Barbados, water levels in aquifers and production boreholes reached extremely low levels, leading to the implementation of Stage 1 of the National Drought Management Plan: a voluntary stage where citizens are encouraged to employ conservation measures.

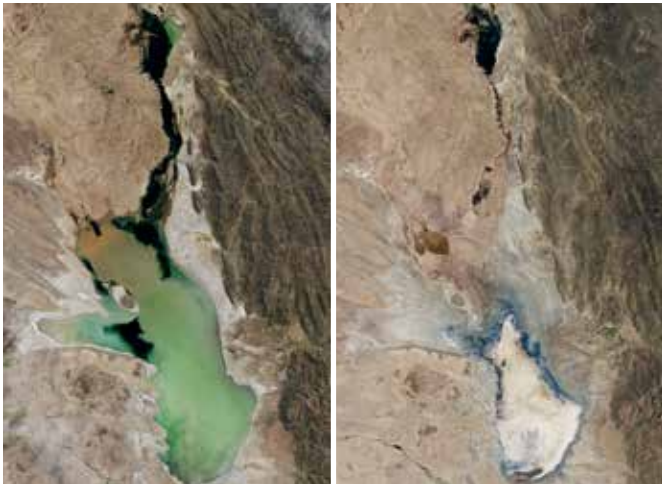
Drought adds to the periodic hurricane season that hit the Caribbean islands. Since 2010, around 30 tropical storms crossed the region and left more than US $1641 million of total damage (CRED 2015). Tropical storm Erika was one of the more devastating, costing Dominica 20 deaths and half of its annual GDP (AP 2015).

Lake Poopó, Bolivia

During the wet season (December – March) rainfall recharges Bolivia's second largest lake directly via increased inflow from the Desaguadero River. But in late 2015 into 2016 Lake Poopó, an important fishing resource, dried up (BBC world 2015). Many reasons may have caused this disaster. Climate change affecting the normal volume fluctuations of the lake, mineral sediments deposited from the surrounded mines, indiscriminate diversion of water for agriculture and waste dumping.

The lake is part of the Titicaca – Poopó – Uyuni hydrological system, located in the high flat plain of western Bolivia. This binational basin (shared with Peru) regulates the cold

Lake Poopó in April 2013 (left) and January 2016 (right)



Source: USGS 2015

weather of the region and is also highly sensitive to climatic changes. The last time the lake dried up was in 1994 it took several years for water to return and even longer for the ecosystems to recover.

The management plan for the Poopó basin was elaborated in 2014, but it might have been too late to stop the lake degradation. If no enforcement of current legislation is put in place, and if the management plan remains unfunded, lake Poopó might not come back to life.

Magdalena River, Colombia

The Magdalena and Cauca are the two major rivers of Colombia accounting for:

- 24% of national territory (269 129 km^2)
- 77% of Colombia´s population (32.5 million)
- 80% of GDP through oil transportation, agriculture and hydropower
- 50% of national continental fisheries

In January 2016, due to the effects of El Niño, the river levels went quickly down leaving only 30 centimetres of depth (more than one meter below normal levels), impossible conditions for navigation. While some are optimistic of the river´s recuperation if reforestation takes place, the transportation sector only is losing 4.5 million dollars monthly (Nature Conservancy 2016).

16. Hydropower: At the mercy of the elements

Like Brazil, Colombia, Peru and many other Latin American countries, Costa Rica gets most of its energy—about 80 percent—from hydroelectric plants. The reliance on hydropower puts countries at the mercy of hydrological variability as rainfall is the key to hydropower.

In 2014, Costa Ricadeclared a state of emergency (Dyer 2014) in the northwest of the country because of an El Niño-related drought, and hydropower contribution to the country's electric grid dropped, forcing the utility to switch on diesel generators. But at the beginning of 2015 Costa Rica was able to generate 100% of its electricity from renewable energy, mainly from hydropower and geothermal plants (Wade 2015). The heavy rains allowed four of the hydroelectric dams to run above their usual capacity thus the country did not need to supplement with fossil-fuel generators.

Any form of renewable energy is largely dependent on climate, therefore investing in more than one energy source can have beneficial outcomes. Uruguay, for example, has no known oil reserves and is gaining almost 95% of its energy through renewable resources (Aradas 2014). Increasing its resilience to climatic changes and investing in diverse renewable sources has ensured that the country was not severely impacted by the reduced rainfall experienced in the region in 2015. Wind farms such as Peralta now feed into hydropower plants so that dams can maintain their reservoirs longer after rainy seasons and users are not negatively affected.

Uruguays energy revolution.

Credit: Anahí Aradas

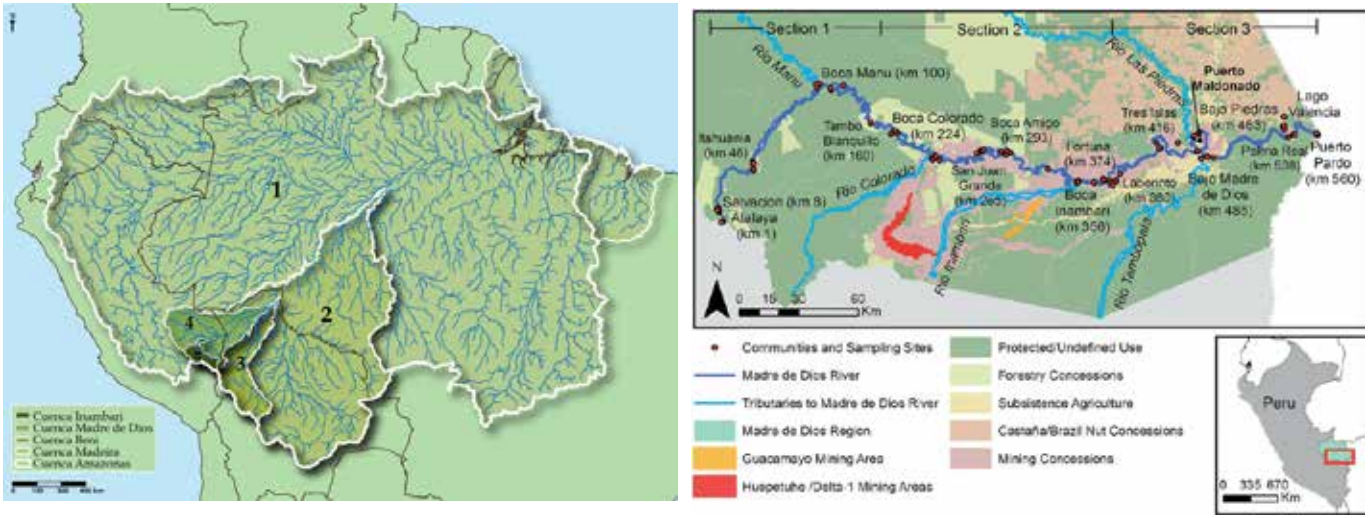
17. Artisanal gold mining, river contamination, health and food security

The Madre de Dios river basin (Peru, Bolivia and Brazil) is one of the rich Amazonian areas where "gold washing" is practiced. Artisanal and illegal miners separate gold from ore by creating an amalgam of equal parts of mercury and gold which is heated and rinsed with river water. The vaporized Hg eventually settles in soil and the sediment of lakes, rivers, and oceans and is transformed into methylmercury (MeHg). In bodies of water MeHg enters the food chain as it is absorbed by phytoplankton, which are ingested by zooplankton and fish. Mercury is accumulated in these organisms and because humans eat fish regularly, its toxic effects (in the skin and the central and peripheral nervous system specially) could be observed by Ashe (2012) in the Peruvian province of Madre de Dios.

The province owes its name to the Madre de Dios River, which crosses the borders with Bolivia and Brazil and is an important effluent to the Amazon River. The basin is not only rich in gold but also in biodiversity and water resources.

The Peruvian Government has put in place different programmes to monitor and control informal gold mining and recently ratified the Minamata Convention on Mercury. Most of the gold produced in Latin America and the Caribbean comes from Peru, which is also the 6th top producer worldwide with 4870 million ounces in 2013. Artisanal mining is estimated to account for 10.16 percent of that production and illegal mining has been escalating since 2005 together with gold prices (Sánchez Castro-Moreno 2015).

Location and main tributaries of the Madre de Dios river, between Peru, Bolivia and Brazil



Source: Inambari 2016

18. Increasing access to potable drinking water in Ceará, Brazil

THE PROBLEM: approximately 20 million people or two thirds of the rural population of Brazil have no access to basic services such as safe drinking water and sanitation. The National Health Foundation reported in 2009 only 32.8% of the rural population were connected to a drinking water supply system and the connection to sewerage systems was 22 per cent. Little progress has been made in improving this situation in Brazil, not only as a result of limited funding and political will, but also due to: the decreasing rural population (in the 1940's 68.8% of the total population was in rural areas compared to only 15.6% in 2010); the rural population sparseness in a vast territory; a non-existent widely accepted model to provide public service by the governments (probably because the different sizes of the rural communities require tailored solutions); and there is no economical scale to provide public services. Even though, there are many different initiatives by local, state or federal governments. For instance, in the Ministry of Environment there is the Program "Água Doce", which provides technical assistance to the rural communities in the Semi-arid region of Brazil by drilling wells, implementing treatment of the brackish water through membranes and training the local community to operate the service.

ACTION TAKEN: the State of Ceará implemented an integrated rural water supply and sanitation system (SISAR), which consists of a federation of community associations specifically created to self-manage the local systems, with technical support from the State's Water and Sanitation Company (CAGECE). Each SISAR unit is legally constituted as a private non-profit civil association that manages the rural water supply and sanitation systems operated by affiliated community associations. It administers its own funds, which are received either from the government or from private donors, and other revenues including money charged for its services.

MAJOR PRE-REQUISITE FOR SUCCESS: this system, which achieves self-sustainability, is difficult to implement in communities with fewer than 50 families.

RESULT: User participation is the most important factor in developing sustainability, while participatory mechanisms, such as this, lead to more investment in the supply of water and sanitation in rural areas and greater commitment from the public sector in providing management and increasing access. The partnership between CAGECE and SISAR has led to increased social responsibility by contributing to environmental preservation.

Source: GWP (2015). Global Water Partnership, Brazil: An innovative management model for rural water supply and sanitation in Ceará State (#411). Available at: http://www.gwp.org/en/ToolBox/CASE-STUDIES/Americas--Caribbean/Brazil-An-innovative-management-model-for-rural-water-supply-and-sanitation-in-Ceara-State-411/ Accessed in October 2015.

19. Adopt a River Programme - Trinidad and Tobago

The Adopt a River Programme, the first of its kind in the Caribbean, is an initiative that brings communities and corporate entities together for the improvement of watersheds throughout Trinidad and Tobago in a sustainable, holistic and coordinated manner.

The programme began in 2013 with one adopter, the Water and Sewerage Authority (WASA), adopting the Guanapo watershed. The community identified the leachate from the Guanapo landfill and heavy siltation from the quarries as the major sources of pollution to the river.

In an effort to inspire water champions, the community was trained in water-quality testing to collect monthly samples from the Guanapo River using a basic testing kit. This was the first successfully completed project under the programme and provided the first water-quality dataset

from a community for the Authority. This initiative created a ripple effect of positives in the community.

The University of the West Indies (UWI) won a grant to support the monitoring of the river and characterize the ecological impact of the Guanapo landfill. The university then engaged the landfill management agency, the Solid Waste Management Company Limited (SWMCOL), to solve the landfill pollution issues whilst the monitoring was ongoing so that at the end of the project, when the quality and impacts of the landfill were reported, the solutions had already been implemented.

In order to solve the issue of the silt runoff from quarries, the quarry operators were engaged to maintain the Heights of Guanapo Road, as well as their settling ponds, so as to reduce the siltation of the Guanapo River.

The first Adopt a River Project in Guanapo saw social, economic and environmental benefits which included an improvement in the river's water quality.

Since 2013, the Adopt a River Programme has been expanded to 23 adopters across 13 watersheds. Most of the projects focus on community-based water-quality testing as an educational tool for raising local awareness on water related issues.

20. Embedding the water-energy-food nexus within the SDGs

Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture	Goal 6. Ensure availability and sustainable management of water and sanitation for all	Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all
2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round	6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all	7.1 By 2030, ensure universal access to affordable, reliable and modern energy services
2.2 By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women, and older persons	6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	
	6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	7.2 By 2030, increase substantially the share of renewable energy in the global energy mix

Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture	Goal 6. Ensure availability and sustainable management of water and sanitation for all	Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all
2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment	6.4 By 2030, substantially increase water use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	7.3 By 2030, double the global rate of improvement in energy efficiency
2a. Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries	6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate	7a By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil fuel technology, and promote investment in energy infrastructure and clean energy technology
2.5 By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed	6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	
	6a. By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies	7b. By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, SIDS and landlocked developing countries, in accordance with their respective programmes of support

Source: UN 2015.

21. Mangroves in the land – ocean interface

A critical factor for the wellbeing of mangrove ecosystems is the availability of freshwater. Although mangroves are found in both humid and arid climates, in LAC, mangrove structural development and growth rates are far greater in humid equatorial areas with plentiful rainfall, preferably distributed relatively evenly during the year (Kjerfve 1990; Blasco 1984; Snedaker 1984). Notable exceptions are the northern coast of Peru, portions of the Caribbean coasts of Colombia and Venezuela, the coast of Ceará in Brazil and most of the smaller islands in the Caribbean, where the most extensive and best developed mangrove systems are in regions with ample freshwater. Rainfall by itself apparently does not limit the growth of mangrove wetlands, as these exist in arid as well as wet climates (Galloway 1982). However, rainfall does serve an important role as a primary control in leaching residual salts from mangrove soils, and thus acts to reduce soil salinity. In arid areas or regions with a strongly seasonal rainfall pattern, a barren salt flat often develops as a rim landward of the mangroves. (Kjerfve 1990). Other factors being equal, coasts with a great tidal range can be expected to have more extensive mangrove wetlands because of a greater potential for tidal flooding. Such conditions are encountered along the humid Pacific coast of Colombia with spring tides reaching 3.9 metres, and also along the humid coasts of northern Brazil where semidiurnal spring tides exceed 7 metres. On the other hand, in the inner part of Baja California, Mexico, where the climate is arid, mangroves are poorly developed in spite of daily tides with a range of more than 7 metres. In contrast, all of the Gulf of Mexico and the Caribbean Sea is microtidal, sometimes diurnal and sometimes mixed, with a range of less than 0.5 metres (Kjerfve 1981). Here, the tide is of little consequence in terms of affecting mangrove distribution.

With the flow of water to the mangroves comes a steady supply of nutrients from the surrounding land. The organic silts and sediments settle and, warmed by the sun, provide ideal conditions for the growth of microscopic plants and animals, the base of aquatic food chains. The abundance of food materials leads to some mangroves being one of the most productive systems on Earth. The contribution of plant material to regulate climate and water source is one reason to consider and protect mangroves since the movement of water from the Earth to the sea to the air and back to the Earth is fundamental in the water cycle. Evaporation occurs with higher temperatures, where mangroves ecosystems are located. On one side, mangroves can absorb the water through their leaves or roots through groundwater, and they also lose water vapour through their leaves into the atmosphere. As the water vapour in the atmosphere increases, clouds are formed and eventually water droplets form causing rain events to occur in other areas, this means that evaporated water, after being condensed, falls into rivers and streams and eventually into the ocean where the water cycle begins again.

There is growing concern about the state of mangroves in LAC.

In several countries, mangroves are being cut and replaced by other biological or engineered structures, such as large scale mariculture (shrimp farming) in Ecuador, Brazil and Central America, tourism in Mexico, Central America and South Eastern Brazil, and harbours and industrial complexes almost everywhere (Lugo 2002; Lacerda *et al.* 1993, MMA-Brazil 2010). According to a recent GEF Project report "Conservaçao e uso sustentável efetivo de ecossistemas manguezais no Brasil" (ICMBio e IBAMA, 2014) Brazil still has 1 398 966 hectares of mangroves, 76% of them inside reserves.

22. Water quality in beaches in touristic destinations

Marine water pollution can have negative effects on coastal ecosystems and on human health. Regarding the latter, the most common problems are related to bathing in contaminated waters, which lead to gastrointestinal illness, skin rush and eye and ear infections.

In Mexico, marine water quality standards are established by a series of official norms. Among different parameters,

pathogens, particularly faecal coliforms and enterococci (commonly associated with municipal wastewater), are analyzed given their capacity to generate infectious diseases (Larrea-Murrell *et al.* 2013; James 1979 in Wong and Barrera 1996).

The "Integrated Programme for Clean Beaches" and the National Information System on Water Quality at Mexican Beaches started to monitor bacteriological quality in 2003. The Ministries of Marina, Environment and Natural Resources, Health and Tourism participate in this initiative that includes 17 coastal States. According to WHO´s criteria, samples with values higher than 200 enterococci per 100 millilitres show water quality not recommended for bathing.

In 2003, 226 beaches in 35 touristic destinations were monitored; in 2015, this increased to 267 beaches in 62 tourist destinations, with 364 monitoring sites. In general, water quality has shown acceptable values in the majority of locations (97.8% in the first trimester of 2015, see Figure below). Results are publicly available at http://www.gob.mx/semarnat/articulos/programa-playas-limpias.

Water quality at selected beaches in Mexican touristic destinations

Source: COFEPRIS *et al.* 2015; CONAGUA 2014

In Brazil, reports on water quality in beaches are under responsibility of the State Environment Agencies. They are based on random sampling and analysis of beach water related with their faecal coliform content. Research on beach water quality for bathing shows a great daily variability as a result of factors such as ocean and marine currents, rainfall, urban sewage and the amount of people present at the beach at the time of sample collection (Inmetro 2016).

There is no official site for statistics about the suitability of beaches for bathing in the main cities situated in the Brazilian coastal area. Particular initiatives show water quality status of around 500 beaches in the Atlantic Brazilian Coastal zone, during summer. However, it is supposed that only a small number of people use this kind of information to make their choice for holidays and vacation places.

23. Chile: Native forest substitution by plantations

The export of natural resources is one of the pillars of Chile's economy. The forestry industry is currently the third most important exporting activity in the country, and its main markets are the US, China and Japan (INFOR 2014). Chile's main source of timber is government-subsidized forest plantations with fast-growing exotic species (*Pinus radiata and Eucalyptus* spp.) (Altamirano *et al.* 2013; Lara *et al.* 2012; Altamirano and Lara 2010; Aguayo *et al.* 2009). Forest plantations currently cover approximately 25 thousand square kilometres of the country (INFOR 2014). They have been established in former agricultural areas, but have also replaced native forests (Miranda *et al.* 2015; Zamorano-Elgueta *et al.* 2015; Altamirano *et al.* 2013; Lara *et al.* 2012; Altamirano and Lara 2010; Aguayo *et al.* 2009; Echeverría *et al.* 2006).

Chile's native forests represent more than 50 per cent of the southern hemisphere's temperate forests (Donoso 1993). The country's native temperate forests have a large number of endemic species that are threatened by human activities, making them a conservation priority (Brooks *et*

al. 2006; Myers *et al.* 2000). The main causes of forest loss and fragmentation are the expansion of the agricultural frontier, and since the 1970s conversion into plantation forests (Zamorano-Elgueta *et al.* 2015; Miranda *et al.* 2015; Altamirano *et al.* 2013; Lara *et al.* 2012; Altamirano and Lara 2010; Aguayo *et al.* 2009; Echeverria *et al.* 2006). Plantation forests are the dominant land use in some regions of Chile, homogenizing many landscapes (Miranda *et al.* 2015). The majority of the remaining native forest patches are located in inaccessible areas of the Chilean Andes (Lara *et al.* 2012; CONAF-CONAMA-BIRF 1999).

Research carried out in southern Chile (35°33′ – 40°16′ S) describes and analyses these forest substitution processes over the past 40 years (Miranda *et al.* 2015; Zamorano-Elgueta *et al.* 2015; Altamirano *et al.* 2013; Lara *et al.* 2012; Altamirano and Lara 2010; Aguayo *et al.* 2009; Echeverria *et al.* 2006). More than 2 500 square kilometres of native forests have been converted into forest plantations. From 1993 until 2013, nearly 1 500 square kilometres of native forests were substituted by forest plantations in the area between 33°53′ S and 43°44′ S (CONAF 2015). Forest monitoring in three regions in southern Chile (37°35′ S– 41°03′ S) indicates that, for the same period, 60 per cent of the native forest loss was the result of forest plantation. (CONAF, 2015) (see Figure below). Although the loss of native forest in the region monitored has decreased in recent years, from 2006 to 2013 forest plantation still accounted for nearly 50 per cent of native forest loss.

In recent years, large logging companies have adopted Forest Stewardship Council (FSC) certification programmes. FSC guidelines require the implementation of ecological restoration, and one of the first steps is the identification and quantification of native forest loss. (Universidad de Concepción 2013, 2014; Universidad Austral de Chile 2012a, 2012b, 2013; WWF, 2011). Logging companies estimate that, since 1994, 250 square kilometres of native forest and 215 square kilometres of degraded native forest have been converted to forest plantations (Universidad de Concepción 2013, 2014; Universidad Austral de Chile 2012, 2013; WWF 2011).

24. Sustainable land management in St. Vincent and the Grenadines

Background

St. Vincent and the Grenadines in the Eastern Caribbean, a member of the Organization of Eastern Caribbean States (OECS) and the Caribbean Community (CARICOM), is categorized as a Small Island Developing State (SIDS). It is a multiple-island nation consisting of approximately 32 islands and cays and has a total land area of approximately 389 square kilometres and a population of 108 065 people.

Advantages of sustainable land management

Sustainable management strategies are very important to St. Vincent and the Grenadines as they ensure long-term development and environmental conservation. They are crucial to minimizing land degradation, rehabilitating degraded areas and ensuring the optimal use of land resources for the benefit of current and future generations. The multiple benefits of the country's land include: agricultural production, biodiversity conservation, forest and vegetation maintenance, water quality and sustainability, soil health and supporting human life. However, human development and resource exploitation practices create the greatest threat to achieving sustainability of the land.

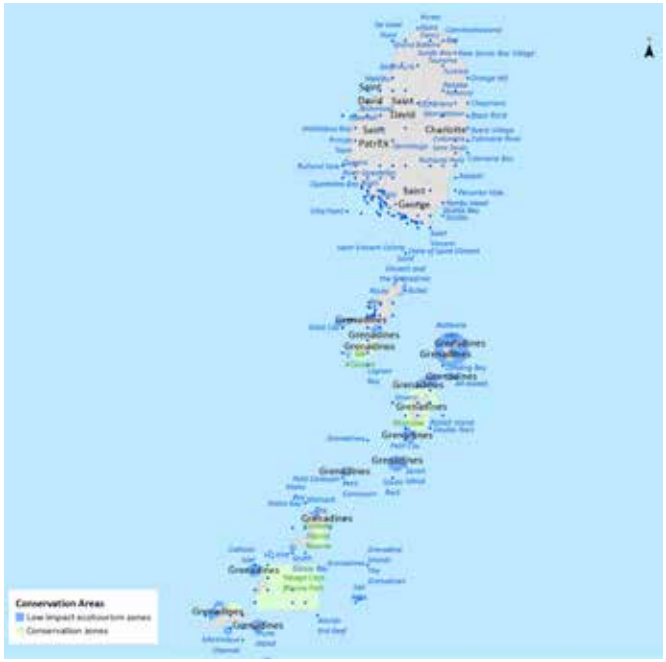
Challenges, and difficulties of setting up strategies

St. Vincent and the Grenadines, with a developing economy, makes increasing demands on limited land space and natural resources. Conflicting objectives of intensified economic and social development, while maintaining and enhancing the ecological function challenges sustainability. Some of the challenges and difficulties are:

Piecemeal approach to management

Sustainable land management has not been at the forefront of activities because approaches to tackle resource management have been segmented. Sustainable

St. Vincent and the Grenadines



Source: Grenadines Marine Resource Space-use Information System (MarSIS), 2013

land management has been associated mainly with the agricultural sector as it is there that the direct relation between land and production is critical.

Unsustainable agriculture and the impact of deforestation

Economically, tourism and the service sectors have replaced agriculture. Historically, St. Vincent was a leader in soil conservation, using grass barriers and contour drains and ploughing on the steep slopes to support agricultural production. However, the expansion of agriculture has resulted in deforestation and the loss of traditional soil conservation practices. With the introduction of and dependence on bananas, soil conservation practices were grossly reduced. Bananas, with their shallow root system

North Leeward, St. Vincent and the Grenadines

Credit: Andrew Simmons

and intensive weed management regimes, have resulted in increased soil erosion.

Ineffective land tenure system and land-use competition

A large proportion of land is owned by private owners or government, and is either rented or worked through loose leasehold arrangements. Problems arise when agricultural land is urbanized and farmers have to move to marginal lands, often in forested areas.

Poverty leads to increase in marijuana production in forested areas

Unemployment and a lack of livelihood alternatives have increased poverty for over a third of the population. This problem is compounded by the increasing difficulties in the global economy, and invasive species and their effects on the banana industry. It is estimated that more than 1 500 farmers plant marijuana (*Cannabis sativa*) to support their families. Marijuana is grown after deforesting watershed areas where the land is steep, increasing the erosion potential.

Contour farming at Peters Hope

Credit: Andrew Simmons

Tourism and other development in the Grenadines

The smaller Grenadine islands experience erosion due to the drier climate, intensive agriculture and animal farming. Coastal land is used for the expansion of tourism infrastructure.

Housing, squatting, and infra-structural development

A changing and growing economy requires the expansion of infrastructure and housing. More than 80 per cent of the population and 90 per cent of the developments to sustain such a population are located within a narrow belt along the coast. This results in the loss of protective coastal vegetation that function as ecosystems as well as for climate regulation. Squatting on publicly owned land is a serious problem in St. Vincent and the Grenadines. Up to 16 000 squatter families live on land deemed unsuitable for agriculture (Sylvester 2002). This illegal process leads to deforestation and hampers reforestation efforts.

Limited institutional capacity and legal framework

Different ministries deal with environmental issues in a fragmented way. There is no national policy for the establishment of a responsible agency for sustainable development. A weak legal framework makes enactment and enforcement of appropriate laws difficult.

Successes in sustainable land management

After the strong impacts of the 2013 Christmas Eve storm, people´s environmental awareness has increased. NGOs and government agencies are making efforts to increase the population's understanding of the links between economic development and protection of the environment as a strategy to manage natural resources in a more sustainable manner.

Policy strengthening and coordination

There is a range of committees responsible for coordinating activities under the various United Nations conventions. Although the committees have not functioned effectively, their work resulted in building synergies among stakeholders, resulting in greater coordination of activities and programmes. Partner agencies effectively share information on sustainable development and livelihoods and address other development challenges.

Collaboration with community-based organisations and civil society

The government is working with community-based groups to develop community parks and protected areas as a strategy to enhance and preserve the ecological value of the country and involve the community in the management of natural resources. The aim of this initiative is to ensure that 20 per cent of the country is covered by forest and a network of community parks. The government has created a National Parks Authority to lead in this area of work. A major strength of this initiative is the leadership provided by community-based organisations and civil society.

The National Land Titling and Land Registration Project (NLTRP)

The need to properly manage, share and store data to enhance land administration and management prompted the creation of the NLTRP government policy. The following Cabinet recommendations were successfully implemented: a) creation of a Land Registry Department separate from the existing registries; b) re-organization of the Land and Surveys Department; and c) giving the Physical Planning Unit more legal recognition and an improved status.

Building capacity of stakeholder organisations

Sustainable land management initiatives have contributed to building capacities within the individual stakeholder agencies, including Registry and Lands and Surveys Departments, and the Physical Planning Division.

Sustainable Land Policy

A Sustainable Land Policy draft is under review before it is endorsed by Cabinet. The Policy offers the opportunity for a profound transformation of Vincentian society through optimal use and management of land resources for a prosperous mixed economy, concentrating on agriculture, fisheries, tourism and other services that use land, greater social equity, and conservation and enhancement of the environment for current and future generations.

Reforming land use in the German Gutter, Troumaca

The increasing demand for land for housing and farming has increased impacts in German Gutter (drainage, dumping, clearing of teak) making it vulnerable to continued erosion and slippage. This project is increasing public education outreach in the area for:

- *Increasing the community's involvement in environmental management*
- *Production of a land-use map of the German Gutter area*
- *Control of drainage into the area to reduce soil erosion.*

Soil conservation measures in the Montreal area

The Forestry Department developed the Montreal area on Crown Lands, formerly settled by squatters, who have been relocated. This area is within the watershed that supplies drinking water to most of the south-eastern communities of St Vincent. These gentle sloping lands provide rich fertile soils for farming. However, they have suffered significant land degradation over time as the crops grown demand a high use of agrochemicals and there has been very little in terms of soil conservation measures. A combination of government initiatives has successfully resulted in a reduction in soil degradation and has demonstrated the benefits to the local population. The project is also developing maps of activities, vegetation, land ownership and water for use in the sustainable management of the area.

25. Jatropha cultivation in Cuba

Although land degradation continues to affect the LAC region, there have been efforts to restore degraded lands through improved management practices. *Jatropha curcas L.*, a shrub native to the tropical dry areas of Central America and Mexico, is being adopted as an agroforestry system in many parts of the world. This plant produces a fruit that can produce biodiesel, and, at the same time, contribute to recovery of degraded soils by reducing water erosion and improving fertility. Experiments in India indicate that the soils of a 30-month-old plantation have improved in terms soil structure, aggregate stability and soil organic matter. The improvement of these characteristics will increase the water infiltration capacity, therefore reducing runoff and water erosion (Ogunwole *et al.* 2008).

Plantations of *Jathropa curcas L.* have been expanding in Cuba. Besides the production of biodiesel, this crop also offers the potential for developing new products (i.e. soap, lubricants, fertilizers) as well as providing a source of renewable energy (the plant's oil) in rural areas that can improve the quality of life of the rural population (Sotolongo

et al. 2007). In 2012, a new biodiesel plant in Guantanamo province began operation with a capacity to produce 30 000 gallons per year, and the island expected to expand the cultivation of this crop (Kotrba 2012). Besides the production of renewable energy, this agroforestry system has many environmental benefits such as the increase in forest area and a potential habitat for biodiversity, soil recovery by reducing wind and water erosion and an improvement of soil fertility (Sotolongo *et al.* 2007).

26. Ecological restoration

Ecological restoration (ER), the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed (SER 2004), is a rapidly growing field, advancing both in theory and practice and gaining momentum in global policy fora (Murcia *et al.* 2015). Ecological restoration is emerging as a mechanism for restoring natural and social capital and leveraging change across social and political spectra in Latin American countries (Aguilar-Barajas *et al.* 2015). In recent years, governments around the world have undertaken various national and international commitments such as:

The Hyderabad Call of the UN Convention on Biological Diversity: its goal is to restore 15 per cent of all degraded ecosystems on Earth by 2020; the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) with Objective 3(b)(i) of land degradation and restoration (Aguilar *et al.* 2015); the 20x20 Initiative, whose objective is to bring 200 000 square kilometres of degraded land in Latin America and the Caribbean into restoration by 2020, including large-scale restoration goals such as 32 000 square kilometres in Peru, 1 million in Colombia, and 5 000 in Chile and Ecuador (WRI 2014).

CIFOR (2015) has recently recognized the need for restoration at large spatial scales, for example at least 200 million hectares of degraded land in Latin America and the Caribbean. Scaling up ecological restoration brings new challenges, such as strengthening governance for relevant decision-making, capacity building for different stakeholders, and including robust indicators for monitoring.

27. Examples of certification and verification schemes in Latin America and the Caribbean

Coffee. By 2012, about 40 per cent of global production was compatible with voluntary standards, amounting to 3.3 million tonnes out of 8.2 million produced[1]. Although only 25 per cent of this is sold in the market as compliant with the certification/verification system, adoption of better practices is significant and Latin America leads this effort. The region represents about 60 per cent of the global coffee market but its share of the certified market ranges from 66 per cent in the organic market to 77 per cent of the Rainforest Alliance and Fair Trade certified markets[2]

Cacao. In 2012, the certified production of cacao at the global level reached 22 per cent of global production but only 10 per cent of global trade. Although Latin America accounts for less than a quarter of global trade, the region dominates the organic market (94 per cent of sales) led by the Dominican Republic and Ecuador. Latin America also has 48 per cent of the market of fair trade certified cacao (Potts *et al.* 2014).

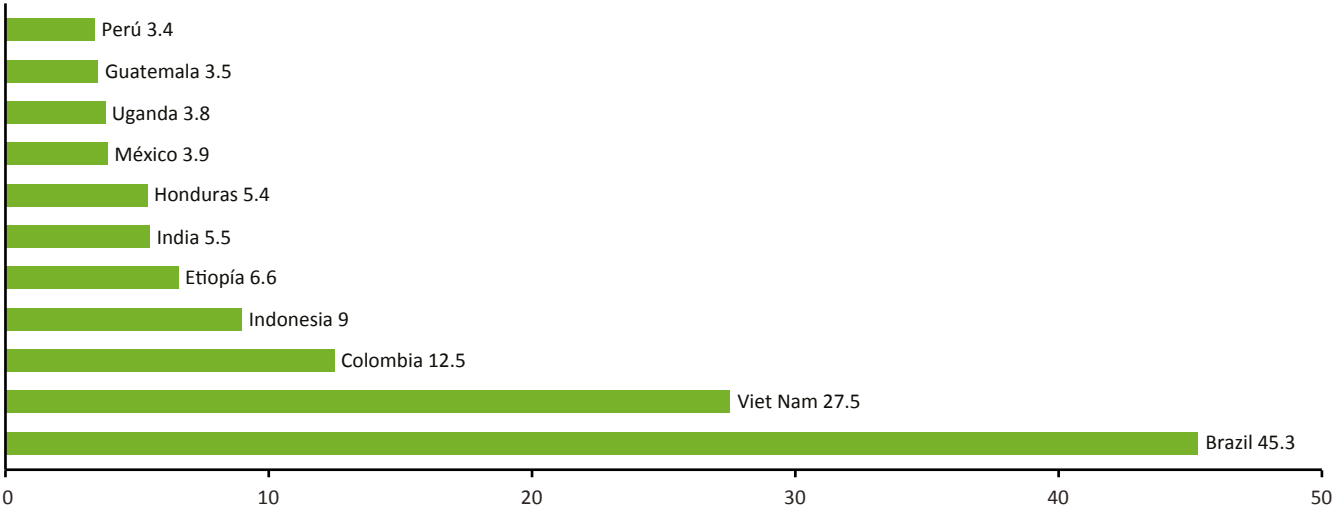
Bananas. Nearly 2.7 million tonnes of certified bananas are produced every year, more than 88 per cent of which are exported. Although the market for certified bananas is only 15 per cent of global trade, Latin America is again the biggest participant in this differentiated market, representing 100 per cent of fair trade certified sales (Potts at al. 2014).

Sugar cane. Only 3 per cent of global production and 1 per cent of global trade in sugar is certified as compliant with good agricultural practices. Bonsucro, a Brazilian standard for sustainable sugar production, is the certification system

1 This includes both certified and verified production

2 (http://www.theguardian.com/lifeandstyle/2004/nov/24/foodanddrink.shopping1).

Six out of the eleven major global producers of coffee are countries from LAC. Data 2014-2015 (Millions of 60 kilogram bags)



Source: ICO 2015

with the largest share of the market, but its adoption has been confined within the country (Potts at al. 2014).

Palm oil. Certification for palm oil has been the result of the multi-stakeholder Roundtable on Sustainable Palm Oil (RSPO) (see above). This initiative, which set out to tackle tropical deforestation derived from palm oil expansion, defined a standard for sustainable production that has been adopted mainly in Indonesia and Malaysia, the largest producers. Today, about 15 per cent of global trade is certified as conforming to the RSPO standard. Latin America's participation in this trade is only 3 per cent, led by Brazil and Colombia. The low adoption of certification on the continent can be at least partially explained by public policies that have provided incentives for biofuel production and local consumption (through gasoline mandates), and have decoupled the local market from international trends (Potts at al. 2014).

28. Challenges for Biodiversity e-Infrastructures in Latin America and the Caribbean

Increased developments in information and communication technologies (ICTs) are a fundamental asset in building and sharing knowledge, information, and data needed to achieve the goals stated within the strategic plan for biodiversity 2011-2020 and the Aichi Biodiversity Targets (CBD Decision Cop10 X/2[3]).

Early developments of on-line biodiversity information systems in the 1990s caught momentum with the discussions on the establishment of the Global Biodiversity Information Facility (GBIF) at the OECD Mega Science Forum (1999). GBIF was launched in 2001 to address "*the need to link these informatics resources (and the people who use them) into a synergistic, interoperable whole that makes biological informatics a mega science endeavor.*" GBIF shares over 570

3 See https://www.cbd.int/decision/cop/?id=12268

million occurrence records that document evidence of a named organism in nature. Biodiversity e-infrastructures in LAC that are providing local data to GBIF include:

Argentina - Sistema Nacional de Datos Biológicos (SNDB). Ministerio de Ciencia, Tecnología e Innovación Productiva (MCTIP);

Brazil - Sistema de Informação sobre a Biodiversidade Brasileira (SiBBr). Ministério de Ciência, Tecnologia e Inovação (MCTI);

Chile GBIF Chile. Ministerio de Medio Ambiente (MMA);

Colombia - Sistema de Información sobre Biodiversidad de Colombia (SiB Colombia). Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (IAvH);

Costa Rica - Costa Rica Biodiversity Facility (CRBio). Instituto Nacional de Biodiversidad (INBio);

Mexico - Sistema de Información sobre Biodiversidad de México (SNIB). Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (Conabio);

Peru - GBIF Peru. Ministerio del Ambiente (MINAM);

Uruguay - GBIF Uruguay. Museo Nacional de Historia Natural (MNHN).

An important advance made in Brazil, in order to integrate federal biodiversity scientific data and support policy implementation was the launch, in 2015, of the Portal da Biodiversidade, hosted in Instituto Chico Mendes de Conservação da Biodiversidade - ICMBIO, an agency of Brazilian Environment Ministry (https://portaldabiodiversidade.icmbio.gov.br/portal/).

ICTs are changing the way in which knowledge is produced. As well as disciplinary, institutional, and peer-reviewed research, knowledge production increasingly involves actors from different disciplines, institutions, countries, and cultures, and is often part of public discussions (Nowotny *et al.* 2001; Gibbons *et al.* 1994). Therefore, e-infrastructures are not only responsible for addressing the full cycle of data management, providing interoperability between different data systems and disciplines (GRDI 2020 2010), but also in providing a platform for collaboration.

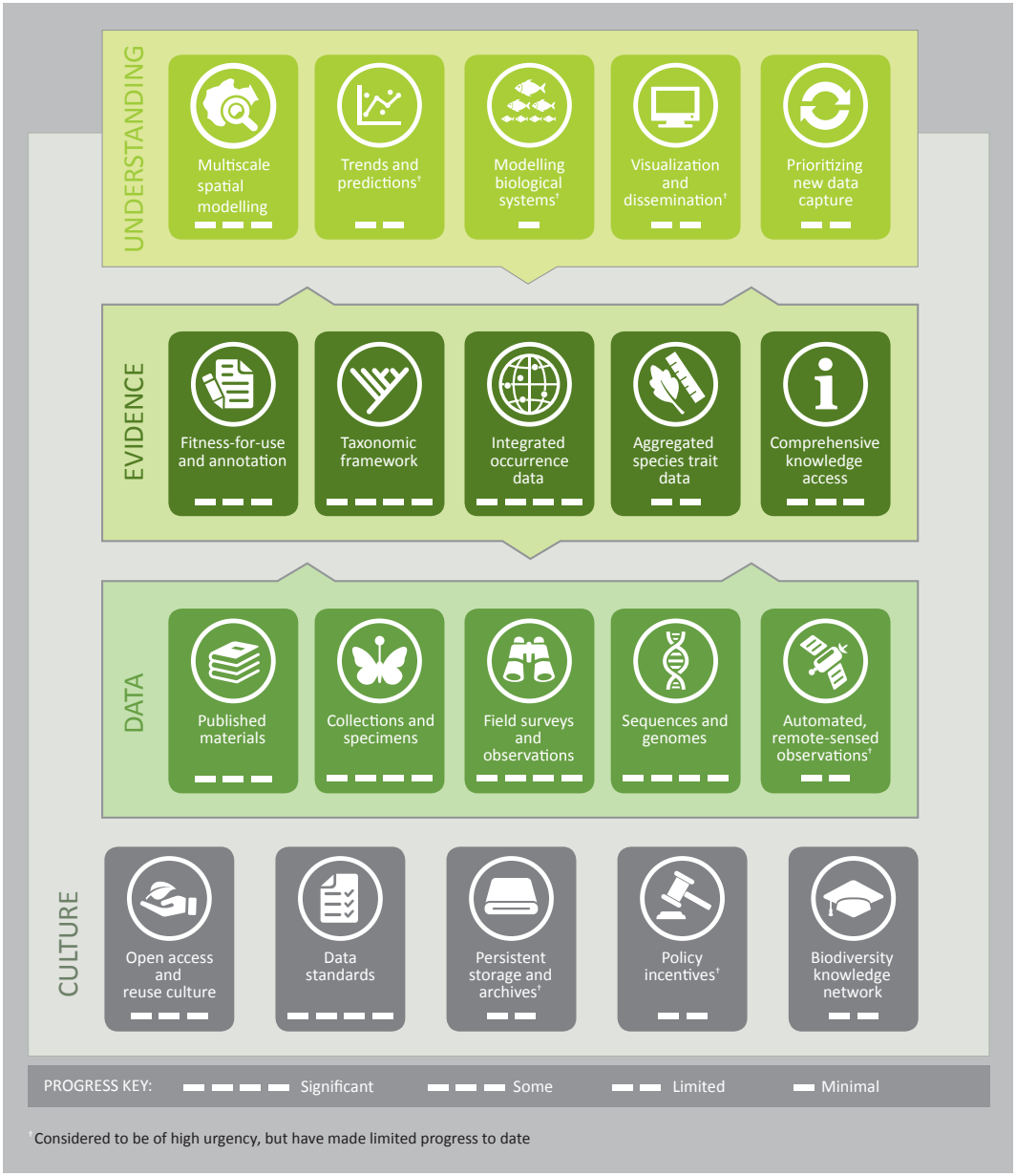
A framework for a much deeper understanding of the world's biodiversity proposed by the Global Biodiversity Informatics Outlook (GBIO) is described in *Delivering Biodiversity Knowledge in the Information Age* (Hobern *et al.* 2013). This framework presents four interconnected focus areas: Culture, Data, Evidence, and Understanding, and breaks them down into individual components (See Figure).

As well as using accepted standards and protocols, e-infrastructures must provide services to enable the use and reuse of data by other e-infrastructures in different contexts and for different purposes. Data and tools must be of value for policy and decision-making at all scales, from local to global, and to monitor the outcome of such policies and decisions by society.

Consistent and measurable indicators have an important role in improving the effectiveness of policies. Important global biodiversity indicators exist, but were insufficient to measure biodiversity loss for the 2010 Biodiversity Target (see at: https://www.cbd.int/2010-target/). Essential biodiversity variables (EBVs) were proposed by the Group on Earth Observations Biodiversity Observation Network (GEO BON) to identify a minimum set of essential measurements that are required for studying, monitoring and reporting biodiversity and ecosystem change (Pereira, *et al.* 2013). Global Infrastructures for Supporting Biodiversity research (GLOBIS-B)[4] focuses on multi-lateral cooperation of biodiversity research infrastructures worldwide. Their goal is to identify the required primary data, analysis tools, methodologies and legal and technical bottlenecks to develop an agenda for research and infrastructure development to compute EBVs (Kissling *et al.* 2015).

4 See http://www.globis-b.eu

The Global Biodiversity Informatics Outlook (GBIO) Framework



Source: Hobern *et al.* 2013

Another important focus must be municipalities. An important initiative is *ICLEI Local Governments for Sustainability,* a network of more than 1 000 cities, towns and metropolises committed to building a sustainable future. E-infrastructures must enable the flow of scientific data into these systems.

As well as different scales (from local to global) and publics (scientists, educators, policy makers and society), other challenges that apply to networks and e-infrastructures include governance and financial sustainability. Many e-infrastructures are a result of networks (institutions and people) and are project-based. Their continuity must be secured which requires new long-term policies (Canhos *et al.* 2015).

29. Climate change impacts on biodiversity – distribution of species

It is difficult to foresee future biome changes in simple terms. The glacial – interglacial vegetation changes in LAC appear to have resulted in a contraction of the Amazon forest biome and the extension of the savanna in glacial epochs when temperatures dropped and the climate was drier than today (Graham 2011). The potential 'savannization' of the Amazon forest biome under future climate scenarios has been the focus of recent studies (Salazar *et al.* 2007), and is most likely to occur with increasing precipitation seasonality, however, the prediction of changes in precipitation is notoriously difficult for its large spatio-temporal variation. What the composition or structure of any new biome or ecosystem that might develop in response to climate drivers has been viewed by two radically different ways: (1) simple biome shifts along with the shifts in climate space that today corresponds to the distribution of biomes, and therefore in the long run represents a climate – biome equilibrium, and (2) by the concept based on evidence of paleo-vegetation studies of past climates of 'communities with no modern analogues' (Jackson and Overpeck 2000; IPCC 2007). The predicted change in (bio)climate can be traced by comparing today's climatic variables with that of the future based on CMIP5 results spatially downscaled by WorldClim (http://worldclim.org/CMIP5). An assumption of equivalency in the biological composition of a new equivalent climate space is likely to be rarely met during rapid climate change, such as reported for the period following the last glacial maximum and for the Holocene maximum (Birks and Willis 2008) as plant species vary in their reproductive and dispersal capacity and they are likely to lag behind changes in bioclimatic variables that define their climate niches. This is likely to lead to spatial changes in the composition of plant communities, leading to the formation in some cases of new 'communities' of extant species whose realized niches do not overlap today and consequently they do not occur in the same 'communities' (IPCC 2007). The contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007). pointed out the importance of novel warmer climates are likely to arise by 2100 AD in the tropics, based on some of the IPCC scenarios, for future biological assemblages. Taking into account spatially variable shifts in precipitation patterns already observed (Magrin *et al.* 2014), there is a possibility of species, for the above-cited reasons related to reproduction and dispersal, forming new communities in the future with no contemporary analogue. These changes are important for local and regional biodiversity, ecological functioning of communities and for biodiversity conservation (Araújo *et al.* 2011).

30. Human rabies in LAC likely linked to mining and land use change

In 2005, human rabies transmitted by vampire bats reached new heights in Latin America. Fifty-five human cases were reported in several outbreaks, 41 in the Brazilian Amazon. Peru and Brazil had the highest number of reported cases between 1975 and 2006. Between 1980 and 1990 outbreaks were reported in Peru with more than 20 cases. By comparing data from field studies conducted in Brazil in 2005 with those of the previous decade, it was suggested that similar situations regarding bat bite at the local level were occurring (Schneider *et al.* 2009).

In the case of rabies in the Amazon region, some possible risks have been considered, such as gold prospecting, land-use change, land clearing and other changes induced by human activities. Thus more research is needed to clarify causality in rabies outbreaks. Monitoring should be complemented by an exchange of information between health and agricultural sectors, including cases of rabies and bat bites in humans and animals. All this information may anticipate possible events and propose successful interventions before the beginning of an outbreak (Schneider *et al.* 2009). In order to understand the role of environmental change in the appearance of diseases involving vectors, an integrated approach based on biological, ecological, anthropological and sociological aspects should be developed.

Human rabies in Brazil

Since 2006, cases of human rabies transmitted by animals in Brazil have declined dramatically. Among the officially confirmed cases, 18 cases were for dog transmission, only 6 cases of transmission by bats, two of which by vampire bats, five cases confirmed by transmission primates, especially in north-eastern Brazil, where marmosets are pets. From 2006 until the first half of 2015, there were no cases of human rabies in the Brazilian Amazon, 3 cases were reported in the north-eastern region and 3 in the Midwest region and no cases in southern Brazil (MS 2015).

Although cases of human rabies have fallen in the last 10 years in Brazil, exposure is possible considering the number of confirmed cases in wild and domestic animals in the various regions. In 2014, 38 notifications were confirmed in animals in the Amazon, 139 in the Northeast, 541 in the southeast, 90 in the Midwest and 243 in southern Brazil. Among the confirmed cases, most occurred in livestock (cattle = 744 cases and horses = 111 cases), but the rabies virus has been confirmed in 139 non-vampire bats and 11 vampire bats and three primates, 10 crab-eating fox and even 19 other animals (MS 2015).

Governmental efforts have been undertaken with the vaccination coverage in effect reducing the canine and feline rabies, especially in urban centres. However, in remote areas where access to information is rare, rabies in other animals is common and health care is far, the risks are great, considering the number of bats bites in people (MS 2015a). Seeking to expand wildlife diseases and zoonosis monitoring capabilities in remote areas, Fiocruz (Oswaldo Cruz Foundation) and LNCC (National Scientific Computing Laboratory) developed the "Information System on Wildlife Health" (SISS-Geo). Using citizen science and a researcher's network, animals are recorded by anyone in the field and computational modelling generates alerts. SISS-Geo is available free on mobile and web (www.biodiversidade.fiocruz.ciss.br). The photographic record, the description of the condition of the animals, local environmental data and georeferenced location by GPS without internet access or telephone, identifies the occurrence of animals with no loss of data, essential for confirmation of the alert by the competent authorities. The application is in use by traditional communities in the Extractive Reserve of Tapajós-Arapiuns, in Pará, and in the south of Bahia, in the Atlantic Forest area.

31. An overview about the ecosystem services of wetlands in Latin America and the Caribbean

Despite wetlands being recognized as key ecosystems due to the high amount of ecosystem services that they provide to society, they are among the most threatened ecosystems in the world. Recent studies indicate that wetlands cover about 30 per cent of the territory of tropical South America (Junk *et al.* 2013; Ricaurte *et al.* 2012) and show that there is a wide variety of coastal, inland and artificial wetland types in LAC.

In LAC, wetlands are present in daily life through the various provisioning, regulating and cultural ecosystem services. They are the main source of water for human consumption and industrial purposes. Rivers, lakes and lagoons provide food for people, and fisheries and aquaculture constitute the principal economic activity of many local communities. Large flooded forests and savannas reduce and delay flooding and are important for agriculture. Andean lakes and peatlands play an important role in the climate and atmospheric regulation. Mangroves, lagoons, riverine

aquatic beds and oxbow lakes are critical habitats for species spawning, nursery and foraging. All wetlands are unique sites for tourism and recreational activities and in some cases represent areas of high spiritual value.

In LAC some evaluations of ecosystem services have been performed on wetlands at the national level in Colombia (Ricaurte *et al.* 2014) and at the regional scale in the Paraná-Paraguay River (Benzaquéna 2013) and Paz River between El Salvador and Guatemala (Gallo and Rodriguez 2010). In general, it has been established that provisioning services such as water supply and food, and regulating services, are the most important services from a local stakeholder perspective.

Challenges for reconciling human development and wetland conservation in LAC

Major wetland ecosystem services prioritized in assessments on ecosystem services in LAC

Water regulation
Habitat for species
Water purification
Disturbance regulation
Climate regulation
Water supply
Fishing
Existence value and species conservation
Cultural identity and sense of belonging
Traditional ecological knowledge

Colombia

Water supply
Food control
Water purification
Habitat for species
Recreation and tourism
Forage plant species
Flowering plants with beekeeping value
Groundwater recharge
Coastal and hydric erosion control
Sediments retention and organic matter
Transport

Parana-Paraguay River

Fishing
Water supply
Firewood and timber
Habitat for species
Hydrological regulation
Water purification
Regulation of extreme events
Soil formation
Recreational

Paz River

Most wetlands in LAC have a pronounced seasonality, so any protection strategy must include their delimitation based on the areas flooded during the highest water level and, for the tropical region, it must include the highest water level of La Niña years. Hydrological and land cover data therefore needs to be monitored in order to increase ecosystem-based adaptation capacity to climate change.

Governmental development plans may include wetlands as strategic ecosystems. Legal enforcement of existing environmental laws is also needed at different spatial scales, taking into account that five of the major wetland complexes in the world are in South America: Amazon, Orinoco, Pantanal, La Plata and Cauca-Magdalena systems.

The Pantanal is considered as the sixth largest wetland in the world (Keddy *et al.* 2009). With about 138 000 -160 000 square kilometres in the upper Paraná basin in Bolivia, 867 Brazil and Paraguay, its biological richness is unique: about 4 700 species, 3 500 plants, 325 fish, 53 amphibians, 98 reptiles, 656 birds and 159 mammals (WWF 2013). The ecosystem services provided in Nhecolandia, in the Mato Grosso do Sul state (Brazil), is around US $15 500 million, of which two thirds corresponds to water provision and regulation of disturbances (Seidl and Moraes 2000). The Pantanal is considered one of the best-preserved ecosystems in South America, with 83 per cent of its original range of distribution, according to data from the Deforestation Satellite Monitoring Project of Brazilian Biomes (IBAMA 2012). Nevertheless, high parts of the basin of the Paraná have already lost 60 per cent of their natural vegetation, which could have important consequences for the ecosystem. The conservation of the Pantanal is partly due to periodic floods covering a vast portion of this ecosystem each year. Nevertheless, about 5 000 square kilometres of flooding forests (13 per cent of its original extent) were deforested in the last century (Seidl *et al.* 2001). Until 2004, 44 per cent of the area had signs of degradation by human activities and impacts on wildlife (Alho 2008). Other pressures on this ecosystem are water pollution, infrastructure development, settlement, non-regulated tourism and invasive species (Alho 2011).

The rate of growth of populations, and mega-industrial agriculture, mining and development projects, increase the vulnerability of wetlands. This implies the need to strengthen environmental-political dialogue and build capacity for greater local empowerment in decision making.

32. Climate change related impacts on major ecosystem types in LAC

The tropical Andes. Tovar *et al.* (2013) defined the current potential distribution of seven biomes by the correlation between climatic and topographic variables and the potential current mapped distribution of montane land cover types. To predict 'biome climate space responses' the authors compared the position and extent of the potential biomes with projections based on an ensemble of eight global climate models for the periods 2010–2039 and 2040–2069.

Glaciers and periglacial areas, *páramo,* humid puna and evergreen montane forest appeared to have their lower elevation distribution boundary displaced uphill, while results for seasonally dry tropical montane forest, montane shrubland and xeric pre-puna indicated a downslope expansion. Today's upper boundary appeared at higher elevation for almost all biomes by 2070. Although there were losses projected for several biomes, the overall results suggested that between 75% and 83% of the current tropical Andes would remain stable in terms of climate space of today's potential biomes, depending on the emission scenario and time horizon modelled

Observed and hypothesized ecosystem responses to changes in climatic factors in the tropical Andes were compiled for the main ecosystem types by (Anderson *et al.* 2011). A variety of impacts reported included species range and cultivation extensions uphill, physico-chemical changes to soil, changes in the hydrological regime, and extreme meteorological, climatic and hydrologic events. These were projected to lead to changes in ecosystem services:

- Changes in water-related ecosystem services;

- Shifts in services related to agricultural production;
- Decreased down-slope stability and safety;
- Impaired contribution of Andean ecosystems to climate regulation;
- Climate change-induced shifts in species distribution and abundance -> biodiversity-related ecosystem services;
- Feedback reinforcing between climate change, its impacts on ecosystems and their service provision potential, and human use of resources (Herzog *et al.* 2011).

Tropical lowland forest and savannah. An earlier assessment of changes in tropical forest and savannah extent (Salazar *et al.* 2007) suggested that the tropical forest biome would reduce from the area of its current potential extent by 3 per cent for the period 2020 - 2029, 9 per cent for 2050 - 2059 and 18% for 2090 - 2099 under the IPCC A2 emission scenario (using values based on an agreement of 75 per cent among 15 climate models). The corresponding increase in savannah would be most pronounced in south-eastern Amazonia.

There are large uncertainties with regard to the degree of forest conversion to other land use types (Ometto *et al.* 2013) and the implied impacts it might have on climate (Lima *et al.* 2014; Vera *et al.* 2006), especially precipitation, and, in turn, on ecosystem structure and functioning within and outside Amazonia. The full impacts of climate change, potentially reinforced by further forest conversion to pasture and crop production in Amazonia remains the subject of debate as far as the figures are concerned, but not the trend of decrease in mean precipitation and increase in temperature (Ometto *et al.* 2013). How these factors will reconfigure the extent, structure and functioning of the various ecosystems of the Amazon basin will continue to be one of the focal topics in research in biosphere-atmosphere interactions, landscape ecology, and biogeography.

Mediterranean. An increase in temperature and decrease in precipitation is projected by the end of the 21st century with likely changes in the distribution of the sclerophyllous thorny shrubland and woodland in Mediterranean Chile (Bambach *et al.* 2013). Ecological niche models, which were fitted and used to produce projections, suggested that the highest reduction in suitable environment would occur along the coastline; little change was forecast for native ecosystems of the Andes.

Marine ecosystems. In the marine realm, climate change is considered an important threat to Caribbean coral reefs. The impact still varies throughout the Caribbean, however, as temperature increases are not uniform, and some coral species appear to be better able to adapt to increasing temperatures than others (Gardner *et al.* 2015). It has been reported by Mumby *et al.* (2014) that although rising sea surface temperatures have not yet had a significant impact on Caribbean coral reefs, if current trends continue, widespread losses of corals can be expected in the future.

33. The guardians of native stingless bees important for pollination services in Yucatan, Mexico

Xunan kab is the name that the Maya people give to the stingless bee *Melipona beecheii*[5]. There is a relationship between these insects and the Maya culture that has existed for centuries and includes religious and productive matters. This species has been cultivated since the proto-classic period (about 50 BC to about 300 AC) according to recent archaeological studies in Guatemala (Źrałka *et al.* 2014). Nogueira (1997) called this activity Meliponiculture.

The honey of these bees is a very important alimentary and medicinal resource, as well as a ritual, since it is part of relevant ceremonies, mixed with certain species of plants and constitutes sacaj and báalche, the most important ritual beverages for this culture (González-Acereto 2012).

5 According to González Acereto (2012), it is also called Koolel-Kab or Pool-Kab depending on the region.

From the ecological point of view, *M. beecheii* and 17 other species of native stingless bees in the Yucatan peninsula are essential for ecosystem health as they are excellent pollinators of native flora as well as of cultivars of commercial importance.

It is through the Melipona-Mayas relation that the mutual dependence and geographical co-existence that exists between the biological and cultural diversities can be appreciated: biocultural diversity (Nietschmann 1992; Maffi 2005). Contemporary Maya knowledge includes biological, ethological and ecological characteristics of the bees that have sustained the meliponiculture for generations. The Maya people provide care to the bees as they keep their predators away, protect them from extreme climate events such as hurricanes and drought, and enhance their populations, as they know how to divide the colonies.

The Maya are therefore the bees' guardians, and it is thanks to their care that it is possible to have the populations of M. beecheii in the state in which they are nowadays, considering the destruction that their habitat has suffered and the expansion of Africanized bees (Cairns *et al.* 2005). Quezada-Euán *et al.* (2001) documented that there were no more wild nests of *M. beecheii, M. yucatanica y Scaptotrigona pectoralis* in the central part of Yucatán where the henequen (*Agave fourcroydes*) plantations only allowed the survival of the populations confined to meliponaries.

34. Living Modified Organisms in LAC

Living Modified Organisms[6] (LMOs) may have important benefits and potential negative effects on conservation and sustainable use of biodiversity. In this regard, the Cartagena Protocol on Biosafety works in accordance with the precautionary approach contained in Principle 15 of the Rio Declaration on Environment and Development, to ensure an adequate level of protection in the field of the safe transfer, handling and use of LMOs resulting from modern biotechnology. This international treaty was ratified by 18 countries in LAC; however, only one country, Mexico, ratified the Nagoya–Kuala Lumpur Supplementary Protocol to the Cartagena Protocol; it is aiming to contribute to the conservation and sustainable use of biological diversity, also taking into account risks to human health by providing international rules and procedures in the field of liability and redress relating to LMOs.

The leading countries in biotech crops in LAC are Brazil and Argentina. In 2014, Brazil sowed 42.2 million hectares of biotech crops, which represented a growth of 5 per cent from 2013. For the past five years, Brazil has been the engine of the growth of biotech crops globally and it is expected that it can close the gap with the United States, the most important producer in the world (James 2014). In 2014 Argentina occupied the second place with 243 000 square kilometres of biotech crops, followed by Paraguay (39 000 square kilometres) and Uruguay (16 000 square kilometres, James 2014). In contrast, Peru, Venezuela, Ecuador and Bolivia are against LMOs. The Peruvian case includes a moratorium until December 2021; till then, no LMO crops are allowed for biosafety studies. In this context, it is essential to improve the mechanism of risk assessment and take special consideration to preserve native genetic diversity in countries hosting centres of origin.

35. The Matanza - Riachuelo River Basin in Argentina, promoting governance

SITUATION ANALYSIS: The Matanza - Riachuelo River forms the southern boundary of the city of Buenos Aires. The river basin currently houses 3 000–4 000 different industrial sites, generating roughly 25 per cent of the country's GDP. Today, of the roughly 3.5–5 million people living within the

6 A Living Modified Organism (LMO) is defined in the Cartagena Protocol on Biosafety as any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology. The Protocol also defines the terms 'living organism' and 'modern biotechnology' (see Article 3). In everyday usage LMOs are usually considered to be the same as GMOs (Genetically Modified Organisms), but definitions and interpretations of the term GMO vary widely (CBD 2012).

Matanza - Riachuelo basin – approximately 10 per cent of the country's total population and over a quarter of the Greater Buenos Aires population – 1.2 million live below the poverty line and 500 000 live in villas, the Argentine term for slums. This has resulted in pollution due to lack of modern sanitation facilities (McKinney 2012).

PROGRESS MADE: In 2009, a comprehensive sanitation plan (PISA) was developed to respond to the sanitation issue. It was an integrated plan which considers:

- An institutional mechanism, a governance structure, developed in the form of the River Basin Authority to enhance coordination;
- Integrated management where it promotes recovery and preservation of the quality of surface water and groundwater including a design for the watershed;
- Social and economic considerations within the environmental context – where spatial impact action towards balanced growth, integrated, sustainable management was considered, including wastes disposal;
- Legal governance through which laws were developed to enforce compliance;
- Community engagement which mainstreams public participation in decision making

IMPACT: Progress is being made and pollution is being dealt with in a more comprehensive manner, with greater engagement and more effective management of both the water and sanitation in the basin.

MAJOR PRE-REQUISITE FOR SUCCESS: Strong partnership, an integrated approach and sound legal governance.

36. Increasing Food Security in Costa Rica's Indigenous Populations

THE PROBLEM: According to the 2000 Costa Rica census, indigenous peoples make up 1.7 per cent (64000) of the population (INEC 2015). There are eight recognized indigenous groups: Huetar, Chorotega, Teribe, Brunka, Guaymí, Bribri, Cabecar, and Maleku. They live in 24 reserves set into law in 1977. The government established these territories, where indigenous people already inhabited the land which is rich in forests, rivers, and animals, with potential for agriculture, hunting, fishing, and gathering plants for various uses, as well as clean water in rivers and streams (Chacón Castro 2002). Although tourism and export agriculture production are the top contributors to GDP in Costa Rica (CIA 2015), the main livelihood of the indigenous is semi-subsistence agriculture (subsistence production coupled with some income-generating activities and food purchases). Agricultural interventions have historically focused almost exclusively on traditional Latin American crops and practices (coffee, banana, sugar, rice, beans, and corn). The typical high-yielding varieties of these crops require more intensive production than native crops and do not necessarily yield well in the regions where indigenous people live. Not only are the rainfall, soil types, and overall climate in indigenous reservations quite different from the lowlands where the main cash crops are usually grown, but high-yielding varieties usually require intensive inputs that are not accessible to indigenous people. Points of sale of improved seed, fertilizers, and pesticides are often far away, and purchasing those items is beyond the means of the poorest farmers. Furthermore, there are legal barriers to credit in the reservations, as a centre for Indian rights explains: "*Indigenous peoples in Costa Rica cannot obtain agricultural credit because the lands belong to the community and there is no legal formula for providing guarantees on communal properties*" (Schulting 2007).

ACTION TAKEN: The Ministry of Agriculture agency in Limón and Buenos Aires, a neighbouring canton in southern Costa Rica with a high indigenous population, has outlined strategies to improve food security for the indigenous people. The plan cites an absence of agricultural projects as a cause of poverty, migration, and food insecurity. The agency proposes projects that include goat and cow production, vegetable gardens for home use, irrigation systems for dry seasons, and focusing on interventions for home production. The home production suggested, however, proposes adaptation of indigenous land so that mainstream crops can

be productive, that is, so that crops with high water needs can grow and animals will have ample pasture to graze. The native species were not given much attention, but market access and poor soil conditions were considered.

MAJOR PRE-REQUISITE FOR SUCCESS: involvement of the stakeholders, in this case the indigenous population including women, greater awareness and representation in the political process, government support to improve access to market and make available agricultural materials and extension services to the indigenous process.

RESULT: While this policy is still being implemented, the impacts are already showing increased food security for a marginalised community. This increases the health and nutrition of the communities and provides an income. This demonstrates that considering the pillars of food security in tandem can alleviate the challenges of food security. (Herforth 2013)

37. Local cooperative management of fisheries

The impacts of coastal degradation on food security can be reduced through local cooperative management of fisheries (FAO 2014) when capacity building and technology are strengthened. Good practice includes the definition of capture fields, releasing young individuals and eggs to allow reproduction, and the use of improved fishing gear. Some cooperatives in the region have also developed the capacity for primary processing, which adds value to their production.

Many of the Caribbean coasts are frequently hit by tropical storms, which bring the hydrological regime to extremes, with socio-economic consequences known as disasters. Regulations and land-use planning can help to protect the coast, infrastructure and lives. Measures like seagrass restoration and the establishment of fisheries, beach protection and recreational areas can reduce the impact of storms on the coasts, as proved by the management activities in the southern coast of Haiti (Horsford and Lay 2012).

38. City of Knowledge, Panama

The City of Knowledge's mission is to be an international platform for knowledge management to promote sustainable development and the competitive advantages of Panama. Just a few minutes from downtown Panama City, City of Knowledge is strategically located across from the Panama Canal. Some 120 hectares and more than 200 buildings of what was once the Fort Clayton US military base are now home to a booming international community established for the purpose of business, academic, scientific, and humanistic collaboration. The objective is human and sustainable development based on knowledge.

City of Knowledge is a management platform that focuses on boosting the innovative and competitive capacities of the users who share the campus. Integration, dynamic networking, and joint efforts facilitate the transference of knowledge. This allows an unusual concentration of innovative firms, international organizations focused on development and academic and research institutions, resulting in a lively and successfully collaborative community. In order to strengthen these dynamics, City of Knowledge provides access to a series of benefits and services aimed at the needs of its users.

Credit: Shutterstock/ pattyphotoart

The process of transferring the Canal and the surrounding military and civilian areas from the US to Panama ended in 2000. This led to an awareness of the need to convert some of these spaces, previously dedicated to military use, into areas aimed at human development with a particular emphasis on contributing to the improved quality of life for Panamanians. This became the focus of the City of Knowledge Foundation (FCDS) from its creation in 1995. Four years later, the FCDS symbolically received the key as the first user of Clayton from the President of the Republic. Historically Panama has been a gathering point. The country offers a high level of financial, commercial and juridical security within the region, which allows foreign investment and an internationally-recognized positive business climate. The City of Knowledge's role is framed within this context of innovation and sustainable development. Panama's geographic position has turned it into a strategic node for communications and transportation for the world's economy. In addition to the Canal, this node includes modern ports on both oceans, complemented by logistics services and an air hub that connects the country to the rest of the planet.

Source: City of Knowledge Foundation, Panama City, Panama
http://ciudaddelsaber.org/en/foundation

39. Industry, Innovation, and Infrastructure: The Central American Electrical Interconnection System (SIEPAC) is open for business

Electricity integration in Central America is now a reality, operating commercially and providing electricity to countries' national grids when they experience shortages. In 2015, the regulatory framework of the Central American Regional Electricity Market (MER) entered into effect, providing the impetus for regional exchanges of electricity and stimulating private investment in the sector. Thanks to SIEPAC, Panama was able to recover from an energy crisis that had arisen in May 2015 as a result of a prolonged drought that reduced the levels of reservoirs at hydroelectric dams, reducing generating capacity. Panama was able to import electricity transmitted across the SIEPAC network from El Salvador, Honduras and Nicaragua. The amount of electricity imported was equivalent to the average monthly consumption of 100 000 families, demonstrating the importance and reliability of a network that encompasses 1 800 km and has an installed capacity of 300 MW.

The activation of SIEPAC and MER and the consolidation of this one-of-a-kind transmission network comes as a result of much hard work by countries in the region that can now count on robust electricity infrastructure extending from Guatemala to Panama, complemented by a connection to Mexico, and in the future to Colombia. More advances will now occur, enabling the development of larger and more efficient regional generation projects, while also facilitating the preparation of a larger number of renewable energy projects, thus contributing to a diversification of the regional energy matrix. This is historic, mainly for the private sector, for energy projects that are regional in scope and that feature the use of renewables as cleaner sources, adding up to tangible benefits for households and business throughout the region. (IDB 2013, 2014)

40. Buenos Aires: setting an example with public buildings

In 2008, Buenos Aires, the capital city of Argentina, launched a programme that aimed to dramatically reduce energy consumption in 100 public buildings. The Energy Efficiency Programme in Public Buildings project targeted energy reductions of 20 per cent from 2007 levels by the end of 2012, and was expected to eliminate 5 000 tonnes of carbon emissions. Officials started small but intend to expand rapidly. By early 2014 they had thoroughly audited five buildings (two offices, two hospitals and a school) and developed individually-tailored energy-reduction plans for each. The first audit, for example, examined energy use in the office used by Argentina's Environmental Protection Agency, which supported the programme. The audit found a potential to reduce overall energy consumption by 30 per cent, including reducing the energy consumed by computers by 55 per cent. The audits were used as best-practice examples to extend

the programme to 31 more buildings over the course of 2010. In late 2009 the city government bolstered the programme by mandating the appointment of an energy manager to monitor consumption in every government building.

Officials started with city buildings because they are often large, and can achieve substantial savings quickly. They also set an example for the private sector. The city's environmental department has started work on legislation that will impose energy efficiency measures on private-sector buildings. Another of the programme's goals is to create energy-efficiency guides for households, businesses and industry.

Source: Latin American Green City Index, Assessing the environmental performance of Latin America's major cities. A research project conducted by the Economist Intelligence Unit, sponsored by Siemens, 2014.

41. The Regional Assessment of Short Lived Climate Pollutants in Latin America and the Caribbean

The scientific community has increasingly addressed the reciprocal interaction between climate change and air quality for many years (Bollen *et al.*, 2010; Isaksen *et al.*, 2009; Ramanathan and Feng 2009; Kinney, 2008; Jacobson, 2002; Ramanathan *et al.*, 2001; Ramanathan & Feng, 2009). Because of their relatively short life in the atmosphere and high radiative forcing, substances such as methane, black carbon, tropospheric ozone and many hydrofluorocarbons (HFCs) have been categorized as short-lived climate forcers (UNEP 2011; Shoemaker *et al.* 2013). Since black carbon, tropospheric ozone and methane affect air quality, these substances have also been called short-lived climate pollutants.

Several authors have stressed the relevance of integrated approaches for climate change, air quality, health and energy security policies (Jacobson, 2002; Younger *et al.*, 2008; Ramanathan & Carmichael, 2008; Isaksen *et al.*, 2009; Ramanathan & Feng 2009; Wallack & Ramanathan, 2009; Bollen *et al.*, 2010; McCollum *et al.*, 2011; Anenberg *et al.*, 2012). Furthermore, Shindell *et al.* (2012), have identified fourteen mitigation measures targeting methane and black carbon emissions, including some related to activities from the oil and gas sector. If the defined fourteen measures are fully implemented and undertaken along with substantial carbon dioxide emission reductions, the authors found a high probability of limiting global mean temperature increase below the 2ºC level (see figure 1); while also realising important co-benefits in terms of human health, crop production and ecosystems conservation (UNEP and WMO, 2011).

The Climate and Clean Air Coalition, as a global political response to these scientific findings, was launched in 2012 and decided to support a major integrated assessment of SLCPs which is currently being undertaken across the LAC region to support and provide a framework for national action, underpin regional co-operation on SLCP mitigation, and provide a regional focus for engagement with policy makers, scientists, technical experts, and other key stakeholders.

The report, which will be launched in 2016, includes a review of the available data on SLCP and Criteria Pollutants for the region. In order to assess the emissions, the LAC region was subdivided into13 countries and groups of countries. The estimates included in the regional assessment of SLCP constitute the first comprehensive inventory for the whole region for all sectors and substances at a detailed level. The importance of different sources of methane emissions varies by country but, overall, agriculture (mostly from ruminant livestock), fossil fuel (coal, oil and gas production and distribution) and waste are estimated to be the sources of more than 95 per cent of LAC methane emissions. Products of incomplete combustion typically include primary particles (dominated by Organic Carbon and Black Carbon (BC)), volatile organic compounds and carbon monoxide); the main sources are cooking and heating stoves burning solid fuels, open burning of agricultural waste, transport, and small industrial sources, particularly brick kilns and coke ovens.

These sources produce about 90 % of BC emissions for LAC, excluding forests fires.

As atmospheric policies are developed, the region will need to continue building shared and agreed information bases on which common regional policies can be developed and common positions agreed. It is expected, building on the existing UNEP assessments, that the undergoing integrated regional assessment will allow a detailed discussion at regional and sub-regional scales of opportunities and barriers to policy implementation in support of successful policy and planning in LAC.

42. Caribbean Catastrophic Risk Insurance Facility (CCRIF)

The Caribbean Catastrophic Risk Insurance Facility (CCRIF) offers insurance products that have provided coverage for hurricanes (tropical cyclones) and earthquakes since 2007 and began offering coverage for excess rainfall in June 2013 (CCRIF 2014). Products for countries now include hurricane coverage, earthquake coverage, and excess rainfall coverage. Two more insurance products are being developed: the Livelihood Shock Absorber is intended to provide low-income people with an amount of money within a short period of time that would allow them to rebuild their farm/small enterprise and/or livelihood after an extreme weather event; and the Loan Portfolio Cover is intended to provide portfolio-level protection against default for lender institutions such as development banks and credit unions which have significant portfolios of individual and small business loans exposed to weather risks, for example a development bank or credit union with a significant agricultural lending portfolio (CCRIF 2015).

The Climate Risk Adaptation and Insurance in the Caribbean programme seeks to help vulnerable people adapt to extreme weather events. The programme will design and implement products that combine risk reduction and insurance for low-income groups such as small farmers and day labourers in the region. The products target medium-level weather extremes (specifically, excess rainfall and high winds), which are projected to increase in frequency and intensity with climate change. Thus, the programme will protect the livelihoods of small farmers and day labourers who are affected by a hurricane or a flood by offering micro-insurance and other risk transfer solutions linked with disaster risk reduction and risk management.

Source: Caribbean Catastrophic Risk Insurance Facility website. http://www.ccrif.org.

43. Caribbean Climate Online Risk and Adaptation Tool (CCORAL)

The Caribbean Climate Online Risk and Adaptation Tool (CCORAL), is a web-based tool designed to help decision makers in the Caribbean integrate climate resilience into their decision making and planning processes.

CCORAL was developed by the Caribbean Community Climate Change Centre (CCCCC), with support from the Climate and Development Knowledge Network (CDKN), based on a thorough consultation process involving significant inputs from across the region. Critical inputs were provided by Government Ministries in the four CCORAL pilot countries: Barbados, Belize, Jamaica and Suriname. The new online support tool is an important step towards increasing the climate resilience of the region.

For decision-makers in the Caribbean, the impacts of climate change are all too apparent. In recent years the region has suffered from climate-related extreme weather events such as hurricanes and flooding and other climate-driven changes such as sea level rise and ocean warming. From infrastructure projects, to town planning, to fisheries management, to tourism development, the question of how to continue to prosper in the face of climate change is a primary concern for policy-makers in the region. Integrating considerations of climate risk into the decision-making processes for legislators, planners, policy makers and project leaders is a considerable challenge. With the launch of CCORAL, the

region has taken a significant step towards enabling decision makers to understand climate risks to current and planned activities and take action to increase their resilience. Specific guidance is provided on how to address climate impacts in the context of legislation, national planning, strategy, policy, programmes, projects, and budgets.

CCORAL is an online, open-source tool http://ccoral.caribbeanclimate.bz/.

Source: http://cdkn.org/project/the-caribbean-climate-online-risk-and-adaptation-tool-ccoral/

44. Promoting sustainable ocean governance in the Organisation of Eastern Caribbean States

SITUATION ANALYSIS: the Organisation of Eastern Caribbean States (OECS) is an economic sub-region in the Caribbean with 10 Member States, all SIDS, which have similar challenges, for example marine pollution. The Revised Treaty of Basseterre establishing the economic union stipulates, in Article 4(0), inter alia, that the Union shall pursue common policy for oceans. In addition, all the member states ratified the United Nations Convention on the Law of the Sea (UNCLOS). In 2013, the highest decision-making body of the Union, the Authority, approved and adopted the Eastern Caribbean Regional Ocean Policy (ECROP) to promote a common approach to ocean governance in all the member states, further mandating each of them to develop their national policy to support the regional one. The competency for the implementation of the oceans programme, including ECROP, was given to the Commission for the OECS. ECROP has priorities and a number of goals of which many are in synergy with the SDGs.

PROGRESS MADE: in 2014, implementation began and a structure for research was developed to support a stronger science-policy interface: a marine research strategy, a code of conduct for responsible marine research, a data platform to support greater access to information and guidelines for marine standards, and established an ocean governance team comprising of one nominated representative from each member state, who supports the connectivity and articulates needs on behalf of the member state. Many projects with regional and national impacts have been developed, together with, currently, five National Ocean Policies.

IMPACT: prior to the implementation of ECROP, oceans were managed in an ad-hoc fashion, within a number of policies which deal mostly with conservation but to which few resources are leveraged, all within national jurisdictions with little bi- or multi-lateral cooperation. Now, member states are including ocean economy in their development models and many countries are also pleading for greater conservation efforts, for example the Caribbean Challenge Initiative which aims to bring 20 per cent of the coastal area under conservation.

MAJOR PRE-REQUISITE FOR SUCCESS: political will was the major driver, with sound governance structures for multilateral environmental agreements and political diplomatic agreements, policies, effective institutional structures and cooperation, and science-policy interfacing to encourage greater understanding of the oceans and seas.

MAJOR IMPEDIMENTS: Due to economic challenges in member states and a low level of funds earmarked for oceans, a sustainable financing mechanism is required to expedite gains.

Source: http://www.gwp.org/en/ToolBox/CASE-STUDIES/Americas--Caribbean/Brazil-An-innovative-management-model-for-rural-water-supply-and-sanitation-in-Ceara-State-411

45. The Ramsar Regional Initiative for the Integral Management and Wise Use of Mangroves and Coral Reefs

The initiative aims to develop a regional strategy and action plan for the conservation, management and wise use of mangroves and coral reefs in the region. It will put regional cooperation mechanisms in place to promote the sustainable use of mangroves and coral reefs, through an exchange of knowledge and lessons learned. Local communities living near mangrove ecosystems are encouraged to participate in the initiative, as well as other social, territorial and institutional stakeholders, including private-sector partners. This initiative was approved by the Ramsar Standing Committee (SC40) in May 2009 and the Standing Committee (SC41). The following Contracting Parties are members of the initiative: Brazil, Costa Rica, Cuba, El Salvador, Guatemala, Mexico, Peru, Ecuador, Colombia, Nicaragua, Honduras, Dominican Republic Panama and Venezuela. The International Organization Partners of the Ramsar Convention – BirdLife International, the International Union for the Conservation of Nature (IUCN, Wetlands International) and World Wide Fund for Nature (WWF) – and other international organizations working for the protection of mangroves and coral reefs were also invited to participate. The main objectives are:

1. to promote the generation and exchange of knowledge on the current status of conservation of mangroves and coral reefs in member countries, through inventories and ecosystem studies;
2. to strengthen capacity and develop a regional approach to the conservation and wise use of mangroves and coral reefs;
3. to promote the review, adaptation and harmonization of the legal framework, including national policies, to guarantee the protection and conservation of mangroves, coral reefs and associated wetlands;
4. to manage mangroves, coral reefs and associated wetlands effectively by adopting an integrated watershed approach, including measures of adaptation and mitigation to climate change;
5) to develop and strengthen communication, education, public awareness and participation (CEPA) in member countries to increase the visibility and awareness of mangroves, coral reefs and associated wetlands;
6) to encourage, strengthen and disseminate basic and applied research, including traditional knowledge, socio-economic studies on mangroves, coral reefs and associated wetlands.

46. Biodiversity protection and livelihoods through the biological corridor in Haiti and Dominican Republic

THE PROBLEM: the pressure that biological resources are suffering due to natural factors is compounded by human action and, on occasion, their uncontrolled use of ecosystems. The fragility of the ecosystem richness has been aggravated in recent years due to the poverty in which the inhabitants of the area live, and due to the lack of resources made available to provide alternative livelihoods to those communities. Significantly, the corridor area is characterized by a high number of inhabitants per square kilometre, compounding the destructive effect of human activity on the local biodiversity.

ACTION TAKEN: The Caribbean Biological Corridor (UNEP-EC 2012) encourages and facilitates collaboration between the participating countries through the establishment of a network of protected areas; the creation of livelihood options as a means of contributing to poverty alleviation; human-resource development; and the establishment of a regional institutional mechanism for the planning and management of shared resources between Haiti and the Dominican Republic.

MAJOR PRE-REQUISITE FOR SUCCESS: in transboundary arrangements such as the biological corridor, there must be partnership and the leveraging of resources. This was achieved through the establishment of the regional institutional mechanism by Haiti and the Dominican Republic.

Video: Coral Reef Restoration Program

https://www.youtube.com/watch?v=3DwtFJLdxLw

RESULT: A number of technical teams have been formed with experts from the participating countries, facilitating the exchange of knowledge institutional ties. One important output of this initiative is the facilitation of dialogue on the sustainable management of national and transboundary natural resources. The countries were able to integrate an ecosystem management approach into development and planning processes and established a cooperative multinational platform for the sustainable use and conservation of biodiversity through environmental rehabilitation and the development of alternative livelihood options.

47. Key uncertainties considered for the three proposed scenarios for LAC

A. Institutional and socio-political frameworks			
Key uncertainties	**Scenario 1: Economy prevails**	**Scenario 2: Policy trade-offs**	**Scenario 3: Towards a sustainability agenda**
What is the level and what is the nature of the partnerships established with different stakeholders in the countries (governments, private sector and other civil society organizations)?	Low: private sector leads the economy. Government role is weak and relations with civil society develop mainly under the pressures for solving specific problems.	Low: greater integration efforts among different stakeholders, but agreements are not always implemented, especially on social and environmental issues.	High: great dynamism between governments and private sector to define sustainable investments. Legal instruments and economic incentives for private sector and communities relations are well used.
What is the level and what is the nature of partnerships between countries?	Low. The level of cooperation in managing environmental regional problems remains low.	High. Cooperation among countries in environmental policies improves. Regional action plans are developed to face environmental challenges. Free-trade agreements signed include important environmental provisions.	High: new integration modalities are more equitable and go beyond economy/ trade spheres integrating economic, social and environmental agendas.

A. Institutional and socio-political frameworks			
What is the power relationship between the government, the private sector and civil society?	Not balanced: the private sector interests are prioritized.	Not balanced: the private sector interests continue to be prioritized, but there is an increasing government intervention according environmental challenges and social pressures.	Balanced: legal instruments and economic incentives promote more balanced relationships among stakeholders.
What is the level and what is the nature of public participation in management?	Medium; government and private sector are not interested in increasing public participation in policy adoption processes. Awareness of environmental challenges continues to be low.	Medium: some results can be attained in relation to environmental challenges related to global aims and goals. For that, public participation increases.	High: there is an integrated process of different stakeholders in the research, policy adoption and implementation of legal instruments and economic incentives to face environmental challenges.
What is the level and what is the sectoral distribution of government investments?	Medium: the level of investments prioritizes sectors such as energy, transportation, infrastructure, mining and undermines investment on environmental and social dimensions.	Medium: even when there is an increase in environmental and social investments there is still a tendency for mainstreaming economic investments.	High: government and private investments develop in a more coordinated way with greater emphasis on environment (pollution reduction) and social issues (health, education and science and technology).
What degree of integration is there between economic, social and environmental policies?	Low: the integration among economic, social and environmental policies is not developed, although some countries have legal frameworks and instruments that could promote this process.	Medium: the regional consensus towards more integrated economic, social and environmental policies increases, based on global environmental awareness and agreed international instruments and commitments.	High: economic, social and environmental action plans increase, creating a very integrated development agenda.

B. Population trends			
Key uncertainties	**Scenario 1: Economy prevails**	**Scenario 2: Policy trade-offs**	**Scenario 3: Towards a sustainability agenda**
What are the population dynamics?	Limited growth: lower population growth rate with an ageing tendency. Transition from high to low levels of mortality and fertility. Family planning is conditioned by economic pressures and high cost of living.	Limited growth: the proportion of people in potentially productive ages grows steadily relative to the number of people in potentially unproductive (inactive) ages. Slow reduction of fertility rate. Population dynamics goes faster than provision for public services.	Limited growth: nearly all countries in the region enter a transition period from the demographic bonus, posing new challenges for population changes and their effects on social, economic and environmental development.
What is the basic urbanization characteristic?	Uncontrolled expansion: Development of megacities without social services, with greater pressures on available natural resources. Increase in potential conflicts.	Regulated expansion: some urbanization planning begins to be introduced due to the confluence of environmental awareness and economic and financial needs, but the historic tendency to promote the development of cities at the cost of natural resources persists.	Development of green sustainable cities: design and planning of city development considers environmental requirements for living. Planning takes a more equilibrated stance between the goals of economic growth and social and environmental developments.
What is the fundamental trend for migratory flows to US/Europe and within LAC?	High: migratory trends increase both in the region and abroad. These migratory pressures generate crucial restrictions in countries of destination.	Medium: there is a reduced trend of migration to countries outside the region, and an increasing trend within the region.	Low: small migration flows are determined by less economic and social pressures and a more integrated sustainable development agenda. There are high in and out flows for capacity building and technology transfer.

C. Economy and Markets			
Key uncertainties	**Scenario 1: Economy prevails**	**Scenario 2: Policy trade-offs**	**Scenario 3: Towards a sustainability agenda**
What is the degree of market opening?	High: open markets in main sectors of the economy and some regulated markets head towards free trade, but some sectors continue to be negatively affected by trade distortions.	High: open markets in goods and services according to competitiveness level. Even when there is progress in attaining multilateral agreements, there is also a boom in bilateral agreements.	Medium: open markets with the inclusion of some fair-trade elements while others remain regulated. There is a global consensus on conduct codes for transnational enterprises.
How does sectoral specialization behave compared to diversification of the economy?	High specialization: deriving from natural resource availability and socioeconomic fragmentation.	Medium specialization: there is a tendency toward an increased diversification in value-added in goods and services production.	Low specialization: the development path leads the region to a more diversified economic pattern.
What are the dynamics of the informal economy?	High: informal economy increases due to disparities in economic opportunity. Lack of enforcement of regulations exacerbates informality.	Medium: economic growth promotes formal employment and reduces pressures on informal economy. Investment in education and capacity building contribute to this process.	Low: there is a tendency to develop a diversified economy with social and environmental perspectives. Policies and strategies are developed to increase employment and reduced informal economy.
What is the degree of government intervention in the economy?	Low intervention: government intervention is mostly influenced by political pressure groups. Economic efficiency receives all the priority.	Medium intervention: government maintains a regulatory role, promoting partnerships and alliances and contributing to redistribution of income and wealth, to slowly improve equality of opportunity and outcome.	Medium intervention: government develops mechanisms for stakeholder participation and decision making. Government role focuses on innovation, science and technology. Redistribution of income leads to a net welfare gain for society.

D. Science and technology			
Key uncertainties	Scenario 1: Economy prevails	Scenario 2: Policy trade-offs	Scenario 3: Towards a sustainability agenda
What are research and development (R&D) levels, sources and priorities?	Low: contribution of LAC to total research is very low, due to a reduced level of investment in R&D, and a lack of science and technology policies.	Medium: spending on R&D increases. Some governments in the region are now keen to implement policies, favouring innovation.	High: more government and private spending on R&D narrows the gap between rich and poor countries, favouring socio-environmental investments. There is also more adequate institutional structure for fostering innovation.
What are the priorities of energy technologies?	Low: Poorly diversified energy portfolios make economies widely exposed to fluctuating gas and oil prices. Despite the impact of such price volatility on energy security, the LAC region continues to be a net exporter of energy. Meanwhile, energy affordability for their citizens and market actors remains very low. For some countries, main power generation sources are hydrological and biomass resources.	Medium: There is growing global pressure to accelerate the deployment of low-carbon technologies in order to decrease pollution and the depletion of natural resources. Practices, although limited, are introduced to promote energy sustainability.	High: Encouraging innovation on renewable energy technologies based on development of new forms of financing and enabling policy frameworks. Renewables sources such as biomass, waste, geothermal and wind begin to grow rapidly.
What are the trends of technology transfer?	Low: technology transfers inhibit the region's potential to grow and improve its living standards.	High: technology transfer between transnational segments. There are some actions that favour transference in prioritized areas.	High: Collaboration between governments, the private sector and civil society improves, transformation of new knowledge into innovation.
How does the relationship between homogenization and cultural diversity perform?	Low: Cultural homogenization prevails. Development of technology, information and capital transcend geographical boundaries, reshaping relationships among markets, states and citizens.	Medium: Conservation of indigenous cultures becomes as vital for humankind as the conservation of species in ecosystems is to life in general. Some policies start to favour diversity.	High: Increased recognition of the specificity of cultural diversity. Policies and instruments are developed for decision making processes.

E. Values System			
Key uncertainties	Scenario 1: Economy prevails	Scenario 2: Policy trade-offs	Scenario 3: Towards a sustainability agenda
How does the relationship between individuals and community perform?	Low: Predominance of individualism, but collectivity prevails in some vulnerable communities regarding environmental issues.	Low: Collective actions are not sufficiently grounded in environmental management.	Medium: There is an increase in elements of collective interest such as perceived risk, trust in policy decision making, knowledge about integrating strategies of environment, social and economic developments that are positively related to support government policies to face different environmental challenges.
What are the protected areas policies?	Low: Protection of some natural areas important for economic development and particular interest (forests, genetic resources, beaches). Lack of financial resources limits the effectiveness of protection.	Medium: Protected natural areas remain a fundamental interest in all national and international conservation strategies. They allow protection of the world's threatened species that are increasingly recognized as essential providers of ecosystem services and biological resources; key components in climate change mitigation strategies and also as a means for protecting human communities and places of great cultural and spiritual value.	High: Protected natural areas play a leading role in development policies, balancing the relationship between conservation and development. Policies are implemented to promote payments for environmental services, conservation of marine and freshwater protected areas, integration of indigenous people in decision-making and planning processes, and others.

48. Technical background supporting the models used for the GEO LAC scenarios analyses

The LAC scenarios chapter experts group, along with six other regional groups and a global team of expert modellers from WCMC met in Cambridge in July 2015 to start building the GEO LAC-4 scenarios with a multi-scale outlook.

Over the next six months the LAC team worked to further develop the scenarios. Meetings were also held in Panama and Nairobi in 2015 to decide how best to integrate the narrative and the quantitative results. The LAC regional team prepared narrative descriptions of each of the three scenarios by taking the drivers and assumptions of the GEO-3 global scenarios and GEO LAC 2003 scenarios as a starting point. While taking into consideration other regions' and global influences, the group's

objective was to describe the three scenarios from a LAC outlook. In parallel, some advanced state-of-the-art models, described below, were used to develop the quantitative estimates of future environmental change and impacts on human well-being. To check the validity and consistency of the scenarios, the narrative team interacted with the modellers to ensure that the scenarios' quantitative and qualitative components complemented and reinforced each other

The Models

International Futures: (IF) is a large-scale integrated global modelling system (Hughes and Hillebrand 2006). The IF model serves as a thinking tool to analyse long-term country-specific, regional, and global futures across multiple and interacting issue areas. For GEO 6 LAC, IF projected population trends and GDP per capita as well as providing additional information on education and military expenditure.

The IF model uses a standard and generally accepted assumption about national level income distribution; this is adjusted for each country to match historical data on persons living on less than 1 to 2 dollars per day.

EcoOcean: is a model developed by the University of British Columbia Fishery Centre to explore scenarios for the world's oceans (Alder *et al.* 2007). It is based on the well-known Ecopath with Ecosim (EwE) ecological modelling software. EwE uses two main components: Ecopath - a static, mass-balanced snapshot of marine ecosystems, and Ecosim - a time dynamic simulation module for policy exploration based on an Ecopath model. The EcoOcean model was constructed using 43 functional groups common to the world's oceans including FAO's 19 marine statistical areas. The groups were selected with special consideration for exploited fish species but are intended to include all major groups in the oceans. The fish groups are based on size categories and feeding and habitat characteristics. Fishing is the most important driver for the ecosystem model simulations. The five major fishing fleet categories are: demersal, distant water fleet, baitfish tuna (pursed seine), tuna long-line and small pelagic. This classification is used to distinguish different fishing methods based on historical information. For GEO 6 LAC, EcoOcean provided estimates of the Depletion Index for fisheries.

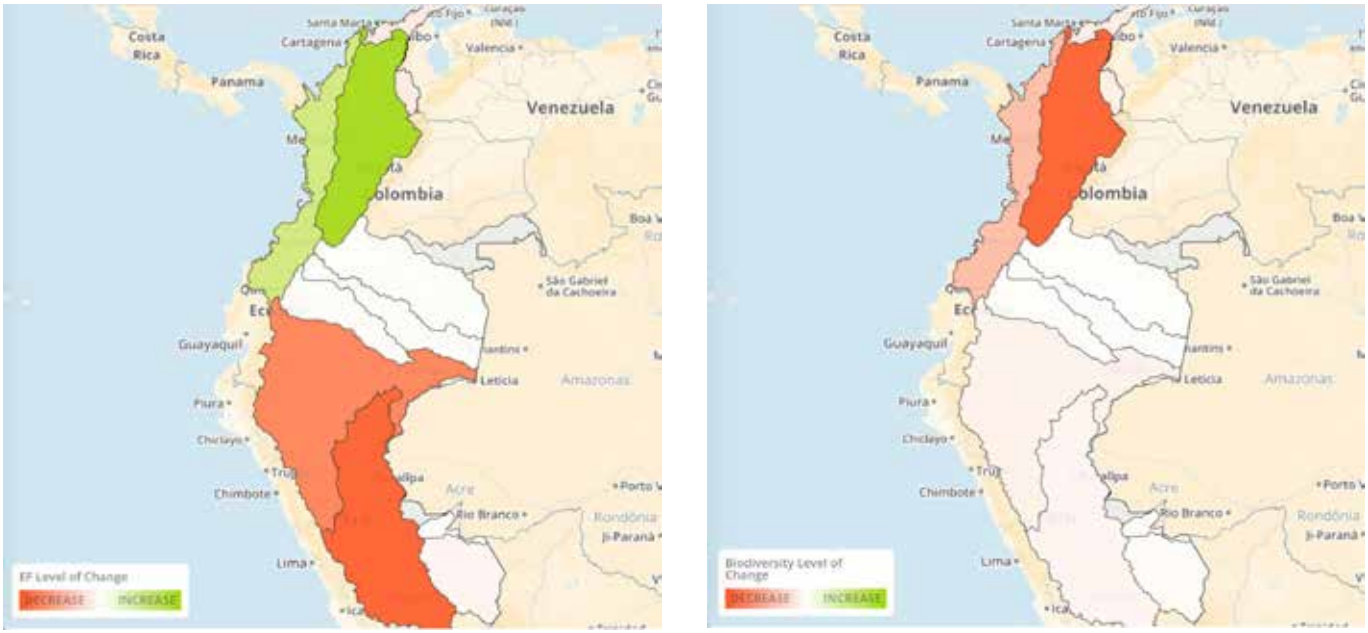
49. Watersheds of the Andean Region

The Watersheds of the Andes region cover large portions of Colombia, Ecuador, Peru and Bolivia, as well as smaller areas of Venezuela, Panama and Brazil. Spanning a huge diversity of ecosystems, from the high-altitude grasslands and cloud forests of the Andes to the tropical forests of the Amazon, the region has a unique geological history and important climate variability, which is largely responsible for the exceptional biodiversity and extremely high endemism. It is also of great importance for the ecosystem services it provides, in particular the water-related services.

Development in the region has been rapid. Commodity-driven land-cover change strongly affects water supply, impacting on the livelihoods of millions of people downstream who depend on water from the Andes. The region also supports a very large number of people beyond the region, with estimates of 100 million people in total benefiting from services provided by the high Andean wetlands. The region has seen growth in international investment, and resulting growth in national economies. Natural resources, in particular minerals and hydrocarbons, are largely behind this economic growth, comprising the top export commodities for all countries except Panama.

The overcoming obstacles scenario developed by UNEP-WCMC (2015), which refers to three countries in the Andean region: Colombia, Ecuador and Peru for the period up to 2050, presents a set of change factors defined and scored in terms of relevance and uncertainty, such as the state's level of political power, markets, consumption patterns and economic development. This outlook reflects many of the preconditions of the trajectory described in GEO's policy trade-off outlook. It runs as follows: the Andean region is in conflict with trends towards decentralization, regulation and sustainability and hence political and economic conflicts. However, by 2050, the Andean Region has become part

Change in ecosystem function provision and change in biodiversity importance between 2015 and 2050 for watersheds in Colombia, Ecuador and Peru based on Overcoming Obstacles Outlook



Note: Change in biodiversity importance is based on IUCN species ranges for amphibians, mammals, and birds in combination with their habitat affiliations and modelled land cover

Source: UNEP-WCMC 2015

of the Pacific Economic Community, with a low-carbon economy, high economic development and specialization, and responsible consumption patterns.

The overcoming obstacles outlook shows a general pattern of decrease, or no change, in biodiversity importance in this sub-region, with watersheds of highest importance being found to the west of the sub-region. Typically these watersheds also suffer greatest declines in biodiversity/biodiversity importance, due to large-scale conversion of natural cover, such as grassland/scrubland, into pasture. However, the effect depends on the specific composition of the natural cover lost, and conversion of grassland to pasture results in increases in the large watershed stretching from the north of Peru into Ecuador and Colombia.

50. Brazil land-use change

Brazil aims to reduce emissions from deforestation and land use as a contribution to climate change mitigation and to conserve the country's rich biodiversity. In its commitment to the UNFCCC made at COP-21, the country pledged to cut its greenhouse gas emissions to 37 per cent below 2005 levels by 2025 and intends to reach a 43 per cent cut by 2030. This is the first time a major developing country has committed to an absolute decrease in emissions.

Brazil's commitment on emissions reduction is supported by evidence-based policy advice. The main support for Brazil's estimates of future emissions from land use change is the GLOBIOM-Brazil model (Camara *et al.* 2015), developed by

Brazilian researchers from INPE (National Institute for Space Research) and IPEA (Institute for Applied Economic Analysis) in cooperation with IIASA (International Institute for Applied System Analysis) and UNEP-WCMC (World Conservation Monitoring Centre). The model simulations project scenarios proposed by Brazil's MMA (Ministry for the Environment).

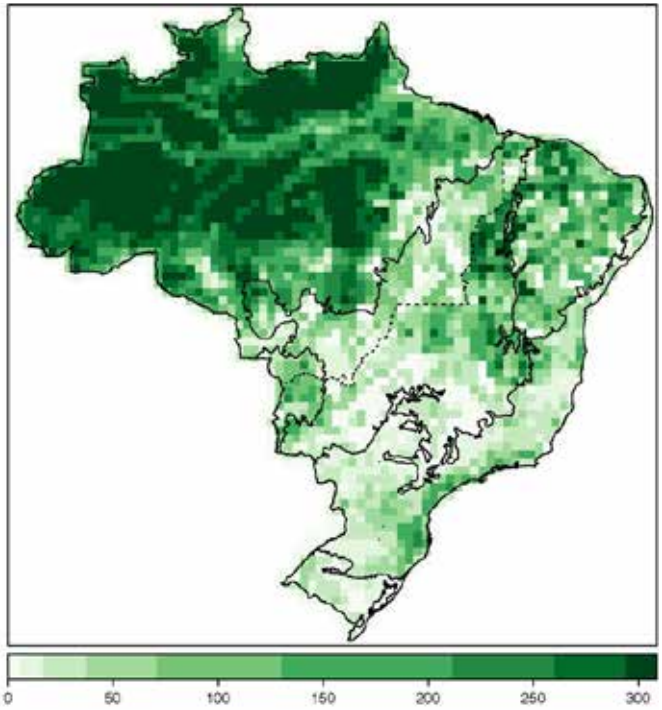
GLOBIOM-Brazil model projections show that full application of Brazil's Forest Code can achieve a compromise between an environmental protection and agricultural production result. The Forest Code allows zero net deforestation in Amazonia, where agricultural production will be dominated by cattle raising. Major cropland expansion occurs in the Cerrado and in Mata Atlântica, using both natural lands and spare land from pasture intensification. Such pressures on natural vegetation suggest that, to avoid significant biodiversity losses in Caatinga and the Cerrado, Brazil needs extra preservation measures in these biomes.

Brazil could become a net carbon sink in the next decades.

Forest regrowth due to implementation of Forest Code rules offsets emissions resulting from legal deforestation in the 2020-2030 decade, reducing the net emissions by 90% compared to 2005. In the 2030-2040 decade, Brazil reaches zero emissions from land use change in the Forest Code scenarios.

Implementing the Forest Code is of key importance to Brazil. To do so, the country faces major challenges. Building a high quality rural environmental cadastre is key to monitoring forest restoration. Brazil needs to set up a monitoring system for the whole country as powerful as the one in place for Amazonia. Legal reserve amnesty should be limited to small farmers, avoiding illicit break-up of large farms. The market for environmental quotas needs to be regulated to avoid leakages and enhance forest conservation. Strong action to avoid illegal deforestation in Amazonia must continue to be enforced. The right incentives for efficient production must be in place, including the Low Carbon Agriculture plan. If Brazil overcomes these challenges, there will be multiple benefits for its citizens, including biodiversity protection, emissions mitigation, and positive institution building.

Projected total forest in Brazil (mature + regrowth) for 2030 in the scenario where the Forest Code is fully enforced. Each grid cell has 2500 square kilometres



Source: www.redd-pac.org

The main reference for the GLOBIOM-Brazil model is the report "Modelling Land Use Change in Brazil: 2000-2050", available at the website: http://www.redd-pac.org.

Besides GLOBIOM-Brazil, other models have investigated the trade-offs between production and protection of land use in Brazil, indicating that the country can expand its agricultural area and productivity without increasing deforestation and complying with the new forest code (Sparovek *et al.* 2012; Soares-Filho *et al.* 2014; Strassburg *et al.* 2014)

51. GEO-LAC Scenarios in the Context of the SDGs

GOAL	SDGs	Main targets	Scenario 1: Economy prevails	Scenario 2: Policy trade-offs	Scenario 3: Towards a sustainability agenda
1	End poverty in all its forms everywhere	1.1 By 2030, eradicate extreme poverty, currently measured as people living on less than US $1.25 a day	Increase assisting interventions. There is a reduction of population under extreme poverty but there is also an increase in inequity.	Global agreements lead to the adoption of policies that improve living conditions, reducing poverty and vulnerability.	Integrated policies and international agreements create sustainable conditions for development.
2	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture	2.3 By 2030, double agricultural production and the incomes of small-scale food producers 2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services.	Productivity of large agriculture industries rise, but small agriculture remains affected by lack of investment and innovation.	Some integration between medium and large agricultural firms starts under governmental policies to securing food production. There is still a tendency to prioritize the interests of big agribusiness.	Integration of small, medium and large agricultural firms under supply-demand chains allows increase of productivity and research and innovation.
3	Ensure healthy lives and promote wellbeing for all at all ages	3.1 By 2030 reduce the global maternal mortality ratio to less than 70 per 100 000 live births	Financial resources go to other sectors of the economy leaving health issues with low budgets, affecting infrastructure requirements and services. Due to the fact that environmental impacts on health are considerable, productivity of workers is affected.	Global development and environmental agreements lead to the implementation of health policies. Financial resources start to be available for health protection.	Policies on health issues promote an increase in productivity of labour. Reduction of pollutants improves well-being.

GOAL	SDGs	Main targets	Scenario 1: Economy prevails	Scenario 2: Policy trade-offs	Scenario 3: Towards a sustainability agenda
4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	4.7 By 2030 ensure that all learners acquire knowledge and skills needed to promote sustainable development, including through education for sustainable development and sustainable lifestyles, human rights, gender equality.	Main financial resources go to production sectors of the economy. Social sectors such as education get low shares of national and subnational budgets. Environmental education not yet included in specific mechanisms.	There is a global consensus about the importance of education for sustainable development that leads to policies that promote inclusive and quality education and capacity building.	Special attention to quality of education is revealed, considering sustainable development, human rights and gender issues. Knowledge and capacity to learn are main aspects of education for the future.
5	Achieve gender equality and empower all women and girls	5.a undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources in accordance with national laws.	SDGs continue to work on MDGs. Attaining gender equality continues to be a problem in the region. Some policies are implemented to improve the situation.	Inclusive gender policies are developed to empower women and girls in different social and economic sectors.	Participation of women in high-level management positions becomes more frequent. Overall participation of women in decision making processes is implemented.

GOAL	SDGs	Main targets	Scenario 1: Economy prevails	Scenario 2: Policy trade-offs	Scenario 3: Towards a sustainability agenda
6	Ensure availability and sustainable management of water and sanitation for all	6.4 by 2030, substantially increase water-use efficiency across all sectors. 6.5 by 2030 implement integrated water resource management at all levels, including through transboundary cooperation as appropriate 6.a by 2030, expand international cooperation and capacity-building support to developing countries in water and sanitation.	Technology and socioeconomic conditions change considerably within and outside the water sector. New policy initiatives such as MDGs and SDG emerge. Severe restriction on water availability is addressed mainly for agricultural and industrial production, leaving potable water availability to the end. There is strong tendency to privatize scarce water resources. There is low public investment for sanitation infrastructure and poor management services. Water and food scarcity weaken critical governance. Fostering conditions for conflicts and extremism.	Water conservation technologies slowly become prevalent and help reduce water use. Water recycling greatly increases the usage of water from industrial and municipal sources, reducing water stress. Improving infrastructure and transforming wastewater from a major health and environmental hazard into a resource of fresh water as an emerging key challenge. Pressure increases as water is exported and free-trade agreements restrict the use of the precautionary principle.	International agreements promote public and private investment and management in sanitation infrastructure. New technologies such as precision farming, nanotechnology, salt-tolerant agriculture, remote sensing for avoiding water leaks, and others are widely spread. Levels of governance that include both bottom-up contributions and top-down interventions are mutually reinforcing and essential for water sector reforms.

GOAL	SDGs	Main targets	Scenario 1: Economy prevails	Scenario 2: Policy trade-offs	Scenario 3: Towards a sustainability agenda
10	Reduce inequality within and among countries	10.1 by 2030 progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average	Income inequality increases. Top earners capture a larger share of the income gains. Technological change in globalization widens the distribution of labour income, but there are variations in policies and institutions that recreate inequality.	There is growing consensus that assessments of economic performance should focus not only on income growth but also take income distribution into account. In pursuing growth and redistribution strategies, policy makers take into account possible complementarities or trade-offs between economic growth and achieving greater sustainability.	There is a reduction in the gap due to partnerships between all stakeholders, policies in education, capacity building, technology and innovation, and the promotion of opportunities. Inequality of opportunity is addressed.

GOAL	SDGs	Main targets	Scenario 1: Economy prevails	Scenario 2: Policy trade-offs	Scenario 3: Towards a sustainability agenda
13	Take urgent action to combat climate change and its impacts, taking note of agreements made by the UNFCCC forum	13.2 integrate climate change measures into national policies, strategies, and planning	Assumes no dramatic changes in policies even taking account of broad policy commitments and plans that have been announced by countries, including national pledges to reduce greenhouse gas emissions and plans to phase out fossil energy subsidies, even if the measures to implement these commitments have yet to be identified.	The 2°C scenario. (2DS) is the focus. The 2DS describes an energy system consistent with an emissions trajectory that recent climate science research indicates would give an 80 per cent chance of limiting average global temperature increase to 2°C. It sets the target of cutting energy-related carbon dioxide emissions by more than half in 2050, compared with 2009, and ensuring that they continue to fall thereafter. Importantly, 2DS acknowledges that transforming the energy sector is vital, but not the sole solution: the goal can only be achieved provided that carbon dioxide and other greenhouse gas emissions from non-energy sectors are also reduced. The 2DS is broadly consistent with the World Energy Outlook 450 Outlook through 2035.	Sets out an energy pathway consistent with the goal of limiting the global increase in temperature to 2°C by limiting concentrations of greenhouse gases in the atmosphere to around 450 parts per million of carbon dioxide equivalent.

GOAL	SDGs	Main targets	Scenario 1: Economy prevails	Scenario 2: Policy trade-offs	Scenario 3: Towards a sustainability agenda
14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development	14.2 by 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration, to achieve healthy and productive oceans 14.5 by 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on best available scientific information 14.7 by 2030 increase the economic benefits to SIDS and LDCs from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism	Oceans, seas and marine resources are increasingly threatened, degraded or destroyed by human activities, reducing/eliminating their ability to provide crucial ecosystem services. Important classes of threats include climate change, marine pollution, unsustainable extraction of marine resources and physical alterations and destruction of marine and coastal habitats and landscapes. The deterioration of coastal and marine ecosystems and habitats is negatively affecting human well-being worldwide.	Good governance, an enabling environment, sustainable land- and marine- based human activities, and adequate measures will be required to reduce the negative anthropogenic impacts on the marine environment, for example due to a more sustainable use of resources, changes in consumption and production patterns, and improved management and control of human activities. Projects and measures should ideally be designed and implemented in an integrated, cross-sectoral and cross-scale manner, in line with the ecosystem approach and involving all stakeholders.	Measures such as the following are implemented : actions to adapt to and mitigate ocean acidification; implementation of a global programme aimed at greater protection and restoration of vital ocean and coastal habitats; strengthen the legal framework to effectively address aquatic invasive species; build green societies in small island developing states: addressing key vulnerabilities, increase efforts for responsible fisheries and aquaculture, regulatory and economic instruments that promote nutrient efficiency and recovery

GOAL	SDGs	Main targets	Scenario 1: Economy prevails	Scenario 2: Policy trade-offs	Scenario 3: Towards a sustainability agenda
15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation, and halt biodiversity loss	15.2 by 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests, and substantially increase afforestation and reforestation globally 15.3 by 2020, combat desertification, and restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land-degradation neutral world 15.4 by 2030 ensure the conservation of mountain ecosystems, including their biodiversity, to enhance their capacity to provide benefits which are essential for sustainable development	Historically conflicting goals for production and the environment remain, especially in agriculture. Long-term productivity of ecosystem functions (land, water and biodiversity) are in danger and increasing productivity (quality, quantity and diversity) of goods and services, and particularly safe and healthy food remains under pressure. Commercial agriculture still is the most important driver of deforestation in the region. Pressures from many international drivers to clear forests increase due to urbanization, increasingly meat-based diets, long-term population trends, growth in developing country regional markets for key commodities, and climate-change adaptation factors.	Understanding of natural resource characteristics of individual ecosystems and ecosystem processes (climate, soils, water, plants and animals) which start to be included in policies and programmes. Land-user-driven and participatory approaches are included in policies for more integrated terrestrial ecosystem management. Environmental functions and services provided by ecosystems are recognized and included in policies.	Sustainable Land Management (SLM) is in place to minimize land degradation, rehabilitate degraded areas and ensure the optimal use of land resources for the benefit of present and future generations. Integrated use of natural resources at ecosystem and farming system levels are in place with multilevel and multi-stakeholder involvement. Opportunities for sustainable utilization of an ecosystem's natural resources to meet peoples' welfare and economic needs (for example, for food, water, fuel, shelter, medicine, income, recreation) are identified and promoted.

GOAL	SDGs	Main targets	Scenario 1: Economy prevails	Scenario 2: Policy trade-offs	Scenario 3: Towards a sustainability agenda
16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	16.7 ensure responsive, inclusive, participatory and representative decision-making at all levels 16.8 broaden and strengthen the participation of developing countries in the institutions of global governance	Over 20 per cent of the world's population continues to live in conflict-affected areas and fragile states. In many of these places, natural resources and their governance play a key negative role in both the conflict and the fragility. In fact, since 1990 at least 18 violent conflicts have been fuelled by the exploitation of natural resources. At the same time, good governance of natural resources can provide a solid platform for post-conflict reconstruction and peace building.	Addressing conflicts where natural resources play an important role is one of the difficult challenges. Opportunities for improved implementation of peacekeeping mandates are developed. Policy focus expands from mainly growth development pathways to poverty eradication and is understood to be a challenge to sustainability by all countries. Ongoing discussions on the 2030 agenda for SD leads to a development framework more universal in nature, with differentiated targets for high-, middle- and low-income countries.	Governments put people, both women and men, at the heart of engagement and adhere to the principles of accountability, non-discrimination, participation, empowerment, transparency and efficiency. Working with state institutions to make them more accountable and responsive is as important as direct support to local communities and civil society organizations. The human rights-based approach and principles of good governance contribute to this focus.

Acronyms and Abbreviations

3Rs	reduce, reuse, recycle
4Rs	reduce, reuse, recycle and re-think
AAL	Average annual loss
ABC	1) atmospheric brown cloud or 2)Agricultura de Baixa Emissão de Carbono (Low Carbon Emission Agriculture), Brazil
ABS	access and benefit sharing
ACC	adaptation to climate change
ACP	Autoridad del Canal de Panamá
ACS	Association of Caribbean States
ACTO	Amazon Cooperation Treaty Organization
AEM	agri-environment measures
AHTEG	Ad Hoc Technical Expert Group
AIDS	acquired immune deficiency syndrome
AMCs	advanced market commitments
ANAM	National Environmental Authority of Panama
AQG	air quality guidelines
ATS	Antarctic Treaty System
AZEs	Alliance for Zero Extension sites
BBOP	Business and Biodiversity Offsets Programme
BC	black carbon
BFP	Bolsa Floresta Programme (State of Amazonas, Brazil)
BPA	bisphenol-A
BRIC	Brazil, Russia, India and China
CAC	command and control
CAN	Andean Community
CAPRADE	Andean Committee for Disaster Awareness and Prevention
CARICOM	Caribbean Common Market
CARIFORUM	Forum of the Caribbean Group of African, Caribbean and Pacific States
CBD	Convention on Biological Diversity (UN)
CBNRM	Community Based Natural Resources Management
CBR	crude birth rate
CCAC	Climate and Clean Air Coalition
CCAD	Central American Commission on Environment and Development
CCCCC	Caribbean Community Climate Change Centre
CDEMA	Caribbean Disaster Emergency Management Agency
CDM	Clean Development Mechanism
CEB	Chief Executive Board for Coordination (UN)
CEC	Commission for Environmental Cooperation (under NAFTA)
CEHI	Caribbean Environmental Health Institute
CEPREDENAC	Centro de Coordinación para la Prevención de los Desastres Naturales en America Central

CFC	chlorofluorocarbon
CFU	community forest unit
CGIAR	Consultative Group on International Agricultural Research
CH_4	methane
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CLRTAP	Convention on Long-range Transboundary Air Pollution
CMC	Chemical Management Center
CMP	Chemicals Management Plan
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CO	carbon monoxide
CO_2	carbon dioxide
CONAVI	Comisión Nacional de Vivienda (Mexico)
COP	conference of the parties
CSA	environmental services certificates
CSCL	Chemical Substance Control Law
CSD	Commission on Sustainable Development
CSO	civil society organisation
CSRP	Sub-regional Fisheries Commission (FAO)
CZMU	Coastal Zone Management Unit (Barbados)
DAC	Development Assistance Committee (OECD)
DALY	disability adjusted life year
DDT	dichlorodiphenyltrichloroethane
DESA	Department of Economic and Social Affairs (UN)
DEWA	Division of Early Warning and Assessment (UNEP)
DPSIR	drivers, pressures, state, impacts, responses
DRR	disaster risk reduction
EA	ecosystem approach
EAF	ecosystem approach to fisheries
EBA	ecosystem based adaptation
EC	European Commission
ECESA	Executive Committee on Economic and Social Affairs (UN)
UNECLAC	Economic Commission for Latin America and the Caribbean of the United Nations
ECROP	Eastern Caribbean Regional Ocean Policy
EE	energy efficiency
EU	European Union
EIA	environmental impact assessment
EM-DAT	Emergency Events Database of the Centre for Research on the Epidemiology of Disasters (CRED)
EMG	Environment Management Group
ENRM	Environmental and Natural Resources Management (World Bank)
ENSO	El Niño Southern Oscilation
EPA	environmental performance assessment
ERMA	Environmental Risk Management Authority

ESA	environmentally sensitive area
ESI	environmental services index
ESS	Earth system science
ETS	emissions trading scheme
EU	European Union
Ex-COPs	Extraordinary Conferences of the Parties to the Basel, Rotterdam and Stockholm Conventions
EWS	early warning system
FAO	Food and Agriculture Organization of the United Nations
FDI	foreign direct investment
FIT	feed-in tariff
FON	Friends of Nature
FONAFIFO	Fondo de Financiamiento Forestal de Costa Rica
FONAG	Fund for the Protection of Water
FSC	Forest Stewardship Council
GAPS	Global Atmospheric Passive Sampling
GATT	General Agreement on Tariffs and Trade
GBIF	Global Biodiversity Information Facility
GCF	Green Climate Fund
GCM	general circulation models
GCP	gross cell product
GDP	gross domestic product
GEF	Global Environment Facility
GEMS	Global Environmental Monitoring System
GEO	Global Environment Outlook
GEOSS	Global Earth Observation System of Systems
GESAMP	Group of Experts on Scientific Aspects of Marine Environmental Protection
GHG	greenhouse gas
GIS	geographical information systems
GLASOD	Global Assessment of Human-Induced Soil Degradation
GM	Global Mechanism
GMO	genetically modified organism
GMP	Global Monitoring Plan
GNP	gross national product
GPA	Global Programme of Action for the Protection of the Marine Environment from Land-based Activities
GPCP	Global Precipitation Climatology Project
GPI	genuine progress indicator
GPW	Gridded Population of the World
GUPES	Global University Partnership on Environment and Sustainability
GW	gigawatt
GWP	1) Global Water Partnership, or 2) global warming potential
GWSP	Global Water System Project
HAB	harmful algal blooms

HCFC	hydrochlorofluorocarbon
HCH	hexachlorocyclohexane
HDI	Human Development Index
HFA	Hyogo Framework for Action
HFCs	hydrofluorocarbons
HIV	human immunodeficiency virus
HLCP	High Level Committee on Policy
HLIAP	High-Level Intergovernmental Advisory Panel
HS	Harmonized System
HTAP	hemispheric transport of air pollution
HWS	human water security
IAEG	Inter-agency and Expert Group
IATTC	Inter-American Tropical Tuna Commission
IBA	important bird area
ICARM	integrated coastal and river management
ICCA	indigenous and community-conserved areas
ICE	International Court for the Environment
ICHRP	International Council on Human Rights Policy
ICLEI	Local Governments for Sustainability
ICLZT	integrated rotating crops, livestock production and zero-tillage operations
ICRISAT	International Crop Research Institute for the Semi-Arid Tropics
ICT	information and communication technology
ICZM	integrated coastal zone management
IDB	Inter-American Development Bank
IEA	1) International Energy Agency, or 2) integrated environmental assessment
ILAC	Latin American and the Caribbean Initiative for Sustainable Development
ILBM	integrated lake basin management
ILC	indigenous and local communities
ILEC	International Lake Environment Committee
ILM	1) integrated land management, or 2) indigenous land management
ILO	International Labour Organization
IMO	International Maritime Organization
IMPACT	International Model for Policy Analysis of Agricultural Commodities and Trade
INBO	International Network of Basin Organizations
INPE	Instituto Nacional de Pesquisas Espaciais
INVERMAR	Invertec Pesquera Mar de Chiloé
IOC	Intergovernmental Oceanographic Commission of UNESCO
IOMC	Inter-organizational Programme for the Sound Management of Chemicals
IP	intellectual property
IPA	indigenous protected area
IPA CIS	Inter-Parliamentary Assembly of the Commonwealth of Independent States
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

IPCC	Intergovernmental Panel on Climate Change
IPR	intellectual property rights
IPSRM	International Panel for Sustainable Resource Management
IRP	integrated resource planning
ISDR	International Strategy for Disaster Reduction
ISEW	Index of Sustainable Economic Welfare International
ITPGRFA	Treaty on Plant Genetic Resources for Food and Agriculture
ITF	International Transport Forum
IUCN	International Union for Conservation of Nature
IWA	International Water Association
IWM	integrated watershed planning and management
IWRM	integrated water resources management
JPOI	Johannesburg Plan of Implementation
JPoI	Joint Plan of Implementation
JRC	European Commission Joint Research Centre
kBOE	thousand barrels of oil equivalent
LAC	Latin America and the Caribbean
LECZ	low elevation coastal zone
LEZ	low emission zone
LIFDC	low-income food deficit countries
LME	large marine ecosystem
LPG	liquefied petroleum gas
LRTAP	long-range transboundary air pollution
MA	Millennium Ecosystem Assessment
MARPOL	International Convention for the Prevention of Pollution From Ships
M&E	monitoring and evaluation
MDG	Millennium Development Goals
MDTF	Multi-Donor Trust Funds (UN)
MEA	multilateral environmental agreement
MERCOSUR	Mercado Común del Sur
MINAM	Ministerio del Ambiente del Perú
MPA	marine protected area
MSC	Marine Stewardship Council
MSW	municipal solid waste
N_2O	nitrous oxide
NAFA	National Forest Authority
NAMA	nationally appropriate mitigation actions
NBSAP	national biodiversity strategies and action plans
NGO	non-governmental organization
NH_3	ammonia
NH_X	ammonia and ammonium
NO_2	nitrogen dioxide

NO_x	nitrogen oxides
NMVOCs	non-methane volatile organic compounds
O_3	ozone
OAS	Organization of American States
OCP	organochlorine pesticides
ODA	official development assistance
ODS	ozone-depleting substance
OECD	Organisation for Economic Co-operation and Development
OECS	Organization of Eastern Caribbean States
OP	obsolete pesticide
PAEC	Programa Cubano de Ahorro Energético
PAH	polycyclic aromatic hydrocarbons
PBDE	polybrominated diphenyl ethers
PCB	polychlorinated biphenyls
PCT	polychlorinated terphenyls
PES	payment for ecosystem services
PM	particulate matter
$PM_{2.5}$	particulate matter with a diameter of 2.5 micrometres (0.0025 millimetre) or less
PM_{10}	particulate matter with a diameter of 10 micrometres (0.01 millimetre) or less
POP	persistent organic pollutants
PPCDAm	Action Plan for Protection and Control of Deforestation in the Amazon
PPP	purchasing power parity
PROCEL	Programa Nacional de Conservação de energia eléctrica (National Electrical Conservation Programme) (Brazil)
Produsa	Programa de Produção Sustentável do Agronegócio (Programme for a Sustainable Production in Agriculture), Brazil
PSP	paralytic shellfish poisoning
PTC	production tax credit
PUF	polyurethane foam
QSAR	quantitative structure-activity relationships
R&D	research and development
RB	Bolivarian Republic
RCP	representative concentration pathways
RE	renewable energy
REC	renewable energy credits
REDD	Reducing Emissions from Deforestation and Forest Degradation
REFIT	renewable energy feed-in-tariff
REIN	Regional Environmental Information Network
REMP	renewable energy master plan
RES	renewable energy systems
RPBR	Río Plátano Biosphere Reserve (Honduras)
RPPN	Reserva Particular do Patrimônio Natural (Private Reserve of Natural Heritage), Brazil
RPS	Renewable Portfolio Standard
RSB	Roundtable on Sustainable Biomaterials

RSPO	Roundtable on Sustainable Palm Oil
RTRS	Roundtable on Responsible Soy
RWH	rainwater harvesting
SAICM	Strategic Approach to International Chemicals Management
SCBD	Secretariat of the Convention on Biological Diversity
SCCF	Special Climate Change Trust Fund
SCP	Sustainable consumption and production
SDG	Sustainable Development Goal
SEA	strategic environmental assessment
SEEA	System of Environmental-Economic Accounting
SEMARNAT	Secretaría de Medio Ambiente y Recursos Naturales
SFM	sustainable forest management
SICA	Sistema de la Integración Centroamericana (Central America Integration System)
SIDS	small island developing states
SLCF	short-lived climate forcer
SLCP	Short-lived climate pollutants
SLM	sustainable land management
SME	Small and Medium Enterprises
SOE	state owned enterprises
SoE	state of the environment
SOX	sulphur oxides
SO_2	sulphur dioxide
SPB	sustainability policy banks
STAR	System for the Transparent Allocation of Resources
SST	sea surface temperature
SWF	Sovereign Wealth Funds
TCO	traditional communal lands
TBNRM	transboundary natural resources management
TEAP	Technology and Economic Assessment Panel (the Montreal Protocol)
TEEB	The Economics of Ecosystems and Biodiversity
TEK	traditional ecological knowledge
TEU	twenty-foot-equivalent units
TFCA	transfrontier conservation areas
TK	traditional knowledge
TM	technology mechanism
TMDL	total maximum daily load
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNCED	United Nations Conference on Environment and Development
UNCLOS	United Nations Convention on the Law of the Sea
UNCOMTRADE	United Nations Comtrade Database - International Trade Statistics - Import/Export Data
UNCSD	United Nations Commission on Sustainable Development

UNCTAD	United Nations Conference on Trade and Development
UNDG	United Nations Development Group
UNDP	United Nations Development Programme
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples
UNEA	United Nations Environment Assembly
UNECLAC	United Nation Economic Commission for Latin America and the Caribbean
UNFCCC	United Nations Framework Convention on Climate Change
UNEP	United Nations Environment Programme
UNEP-CEP	United Nations Environment Programme – Caribbean Environment Programme
UNEP-PCFV	United Nations Environment Programme – Partnership for Clean Fuels and Vehicles
UNEP-WCMC	United Nations Environment Programme – World Conservation Monitoring Centre
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNFF	United Nations Forum on Forests
UNISDR	United Nations Office for Disaster Risk Reduction
UN-REDD	United Nations collaborative initiative on Reducing Emissions from Deforestation and forest Degradation in Developing Countries
UNSD	United Nations Statistics Division
UNWTO	United Nations World Tourism Organization
USA	United States of America
UV	ultraviolet
VIA	Vulnerability Impact Assessment
VITEK	vitality of traditional ecological knowledge
VOC	volatile organic compound
vPvB	very persistent and very bioaccumulative
WHC	World Heritage Convention
WHO	World Health Organization
WMO	World Meteorological Organization
WRI	World Resources Institute
WSSD	World Summit on Sustainable Development
WTO	World Trade Organization
WTP	willingness to pay
WUE	water-use efficiency
WWAP	World Water Assessment Programme
WWDR	World Water Development Report
WWF	World Wide Fund for Nature
XAD-2	Styrene divinylbenzene
ZZE	economic and ecological zoning

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Job No: DEW/1966/NA
ISBN: 978-92-807-3546-8