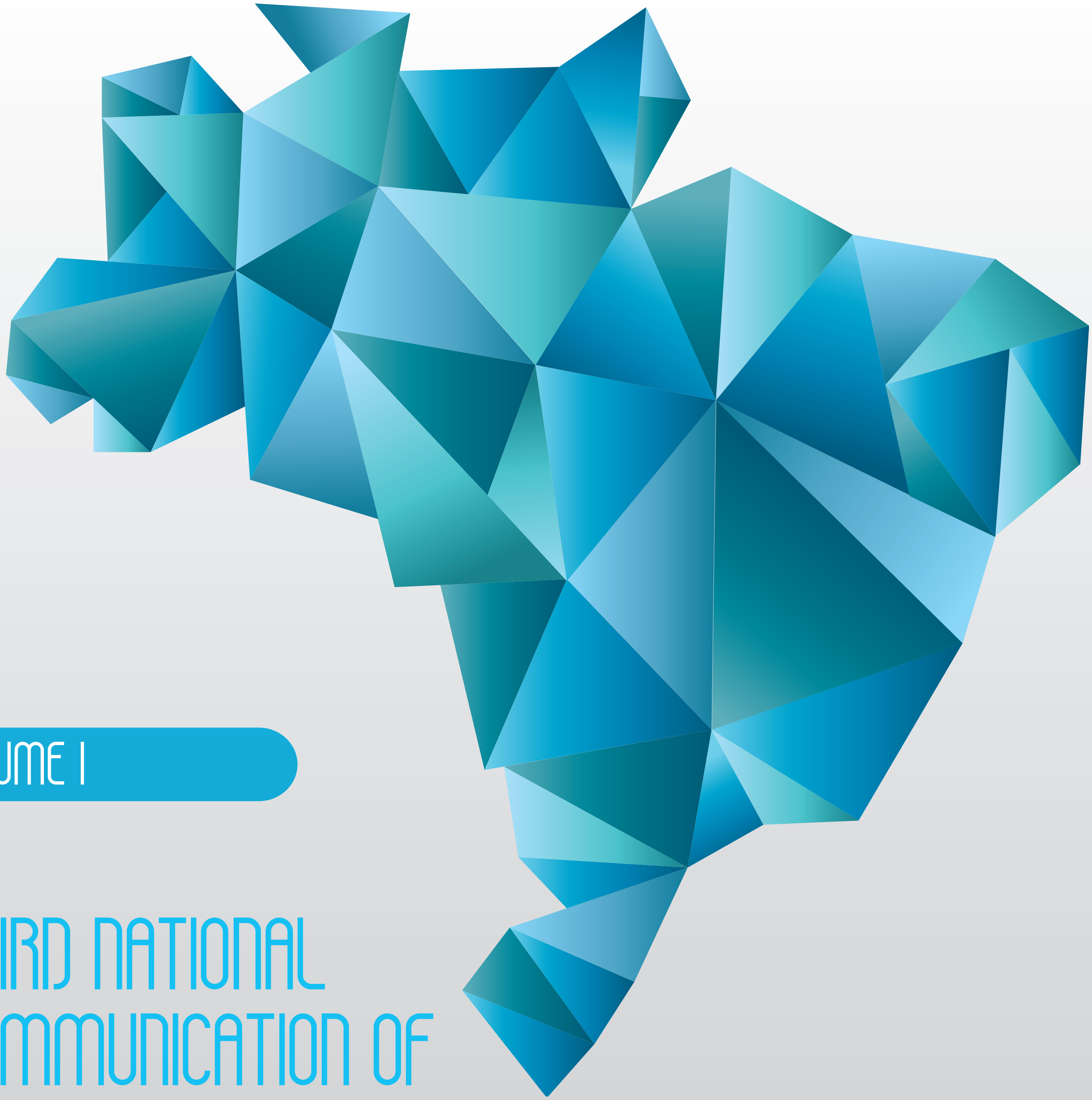

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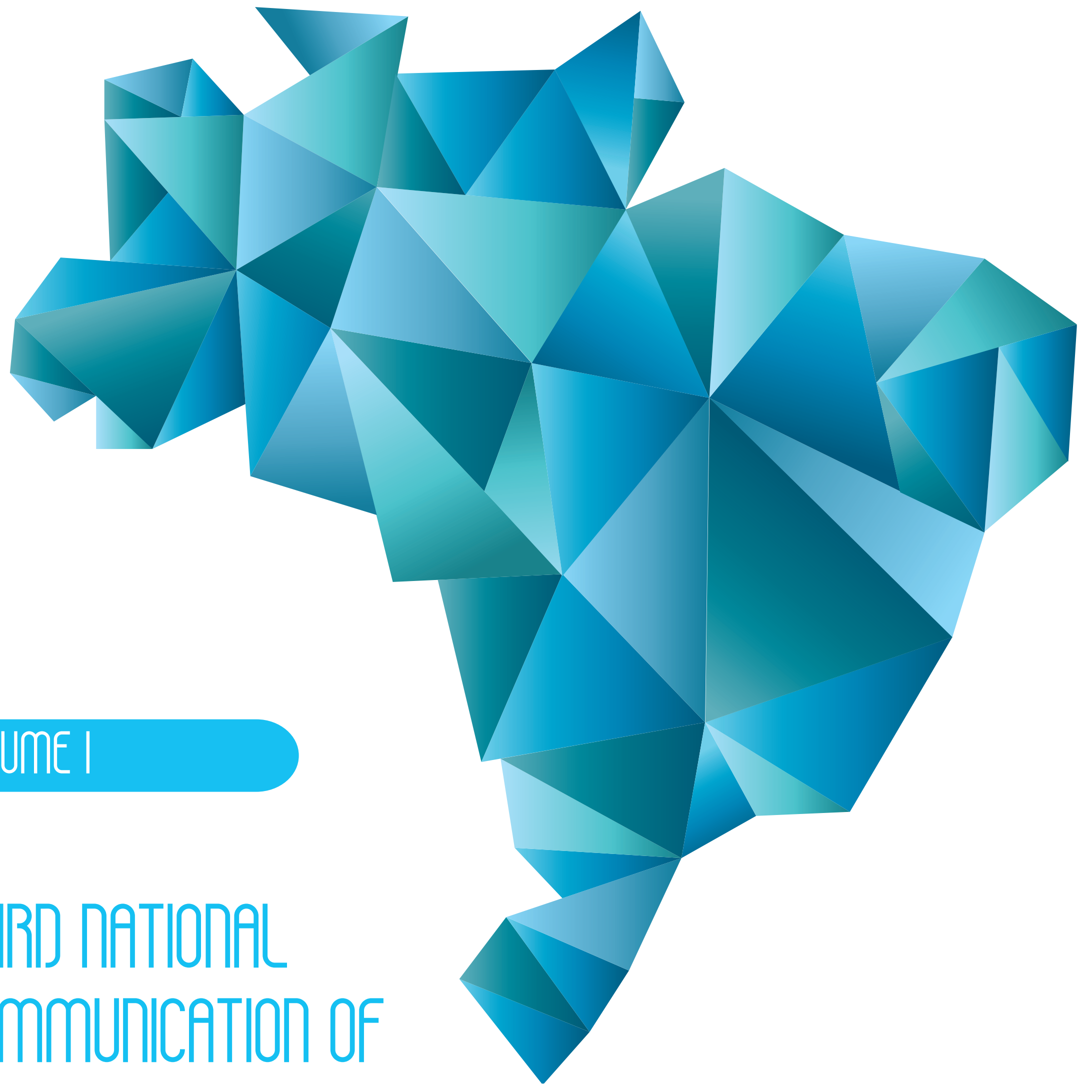
THIRD NATIONAL COMMUNICATION OF BRAZIL TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE



VOLUME I

THIRD NATIONAL COMMUNICATION OF BRAZIL TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

Ministry of Science, Technology and Innovation
Secretariat of Policies and Programs of Research and Development
General Coordination of Global Climate Change
Brasília
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SYMBOLS, ACRONYMS AND ABBREVIATIONS

°C – Celsius degrees

ABAL – Brazilian Aluminum Association *(Associação Brasileira do Alumínio)*

ABC – Brazilian Academy of Sciences *(Academia Brasileira de Ciências)*

ABC – Brazilian Cooperation Agency *(Agência Brasileira de Cooperação)*

ABC – Low-Carbon Agriculture *(Agricultura de Baixo Carbono)*

ABCM – Brazilian Coal Association *(Associação Brasileira do Carvão Mineral)*

ABEGÁS – Brazilian Gas Distribution Companies Association *(Associação Brasileira das Empresas Distribuidoras de Gás Canalizado)*

ABIQUIM – Brazilian Chemical Industry Association *(Associação Brasileira da Indústria Química)*

AC – state of Acre

AIE – International Energy Agency *(Agência Internacional de Energia)*

AL – state of Alagoas

AM – state of Amazonas

ANA – National Waters Agency *(Agência Nacional de Águas)*

AP – state of Amapá

APAs – Environmental Protection Areas *(Áreas de Proteção Ambiental)*

ASD – Areas susceptible to desertification

BA – state of Bahia

BNDES – National Bank for Economic and Social Development (*Banco Nacional de Desenvolvimento Econômico e Social*)

BPC – Continuous Cash Benefit *(Benefício de Prestação Continuada)*

BRACELPA – Brazilian Association of Pulp and Paper *(Associação Brasileira de Celulose e Papel)*

BRICS – acronym for an association of five major emerging national economies: Brazil, Russia, India, China and South Africa

C_2F_6 – hexafluoroethane

C40 – Group of the world's biggest cities united to fight climate change

CBERS – China-Brazil Earth Resources Satellite

CCS – Carbon Capture and Storage

CCST – Earth System Science Center *(Centro de Ciência do Sistema Terrestre)*

CDB – China Development Bank

CDM – Clean Development Mechanism

CE – state of Ceará

CEC – Scenario Elaboration Committee *(Comitê de Elaboração de Cenários)*

Cemaden – National Center for Monitoring and Alerting of Natural Disasters *(Centro Nacional de Monitoramento e Alertas de Desastres Naturais)*

CEMIG – Minas Gerais Electrical Utility *(Centrais Elétricas de Minas Gerais)*

CENPES – Petrobras' Leopoldo Américo Miguez Research and Development Center *(Centro de Pesquisas e Desenvolvimento Leopoldo Américo Miguez)*

CEPAC – Thematic Network for Sequestering Carbon and Climate Change and set up the Carbon Storage Research Center *(Centro de Pesquisas sobre Armazenamento do Carbono)*

CEPEL – Center for Electrical Energy Research *(Centro de Pesquisas de Energia Elétrica)*

Cetesb – Environmental Protection Agency of São Paulo State *(Companhia Ambiental do Estado de São Paulo)*

CF_4 – tetrafluormethane

CGEE – Center for Strategic Studies and Management in Science, Technology and Innovation *(Centro de Gestão e Estudos Estratégicos)*

CGMC – General Coordination of Global Climate Change *(Coordenação Geral de Mudanças Globais de Clima)*

CH_4 – methane

CIDES – Interministerial Commission on Sustainable Development *(Comissão Interministerial para o Desenvolvimento Sustentável)*

CIM – Interministerial Committee on Climate Change *(Comitê Interministerial de Mudança Global do Clima)*

CIMGC – Interministerial Commission on Global Climate Change *(Comissão Interministerial de Mudança Global do Clima)*

cm – centimeter

CMP – Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol

CNPq – Council of Scientific and Technological Development *(Conselho Nacional de Desenvolvimento Científico e Tecnológico)*

CO_2 – carbon dioxide

Conabio – National Council of Biodiversity *(Conselho Nacional de Biodiversidade)*

Conpet – National Program on the Rationalization of the Use of Oil and Natural Gas Products *(Programa Nacional da Racionalização do Uso dos Derivados do Petróleo e do Gás Natural)*

COP – Conference of the Parties

COPPE – Alberto Luiz Coimbra Institute – Graduate School and Research in Engineering at the Federal University of Rio de Janeiro *(Instituto Alberto Luiz Coimbra de Pós-Graduação e Pesquisa em Engenharia – UFRJ)*

CPM – Research and Modeling Committee *(Comitê de Pesquisa e Modelagem)*

CPRM – *Mineral* Resources *Research Company (Companhia de Pesquisa de Recursos Minerais / Serviço Geológico do Brasil)*

CPTEC – INPE's Center for Weather Forecasting and Climate Studies *(Centro de Previsão do Tempo e Estudos Climáticos do INPE)*

CTBE – Center for Bioethanol Science and Technology *(Centro de Ciência e Tecnologia do Bioetanol)*

CTL – *Coal-to-liquid*

CTNC – Climate Technology Center and Network (*Centro de Tecnologia de Clima)*

DBSA – Development Bank of Southern Africa

DEGRAD – Mapping of degraded areas

DETER – Real Time Deforestation Detection System *(Sistema de Detecção de Desmatamento em Tempo Real)*

DF – Federal District

DHN – Navy's Directorate of Hydrography and Navigation *(Diretoria de Hidrografia e Navegação do Ministério da Marinha)*

DNA – Designated National Authority

EEZ – Ecological and Economic Zoning System

Eletrobras – Brazil's Electrical Utility *(Centrais Elétricas do Brasil S.A.)*

Embrapa – Brazilian Agricultural Research Corporation *(Empresa Brasileira de Pesquisa Agropecuária)*

ENSO – El Niño Southern Oscillation phenomenon

EPE – Energy Research Company *(Empresa de Pesquisa Energética)*

ES – state of Espírito Santo

ESFF – River Family Health Teams *(Equipes de saúde da família fluvial)*

ESFR – Riverside Family Health Teams *(Equipes de saúde da família ribeirinha)*

ESGF – Earth System Grid Federation

FAPESP – São Paulo Research Foundation *(Fundação de Amparo à Pesquisa do Estado de São Paulo)*

FBMC – Brazilian Climate Change Forum *(Fórum Brasileiro de Mudanças Climáticas)*

FGV – Getulio Vargas Foundation *(Fundação Getúlio Vargas)*

FIFA – *Fédération Internationale de Football Association* (International Federation of Association Football)

Funbio – Brazilian Biodiversity Fund *(Fundo Brasileiro para a Biodiversidade)*

Funcate – Foundation for Space Science, Technology and Applications *(Fundação de Ciência, Aplicações e Tecnologia Espaciais)*

Funceme – Cearense Meteorology and Water Resources Foundation (Fundação Cearense de Meteorologia e Recursos Hídricos)

GEF – Global Environment Facility

GEOMA – Thematic Network of Environmental Modeling Research of the Amazon *(Rede Temática de Pesquisa em Modelagem Ambiental da Amazônia)*

GHG – greenhouse gas

GIZ – (*Die Deutsche Gesellschaft für Internationale Zusammenarbeit)* – German International Cooperation Agency

GLP – Liquefied Petroleum Gas

GO – state of Goiás

GOALS – Global Ocean-Atmosphere-Land System

GOES – Geostationary Operational Environmental Satellite

GOOS – Global Ocean Observing System

GTL – Gas-to-Liquid

GW – gigawatt

hab – inhabitants

HDI – Human Development Index

HFCs – hydrochlorofluorocarbons

IABr – Brazilian Steel Institute *(Instituto Aço Brasil)*

IAI – Inter-American Institute for Global Change Research

Ibama – Brazilian Institute of Environment and Renewable Natural Resources *(Instituto Brasileiro do Meio Ambiente e Recursos Naturais Renováveis)*

IBGE – Brazilian Institute for Geography and Statistics *(Instituto Brasileiro de Geografia e Estatística)*

ICLEI – Local Governments for Sustainability

ICMBio – Chico Mendes Institute on Biodiversity Conservation *(Instituto Chico Mendes de Conservação da Biodiversidade)*

ICMS – Value Added Tax on Sales and Services *(Imposto sobre Circulação de Mercadorias e Serviços)*

IES Brasil – Economic and Social Implications Project *(Projeto Implicações Econômicas e Sociais)*

INCT – National Institute of Science and Technology *(Instituto Nacional de Ciência e Tecnologia)*

INDC – Intended Nationally Determined Contributions

INMET – National Institute of Meteorology *(Instituto Nacional de Meteorologia)*

INPA – National Institute for Research in Amazonia *(Instituto Nacional de Pesquisa na Amazônia)*

INPC – National Consumer Price Index *(Índice Nacional de Preços ao Consumidor)*

INPE – National Institute for Space Research *(Instituto Nacional de Pesquisas Espaciais)*

IOUSP – Oceanographic Institute of the University of São Paulo *(Instituto Oceanográfico da Universidade de São Paulo)*

IPCC – Intergovernmental Panel on Climate Change

IPEA – Institute of Applied Economic Research *(Instituto de Pesquisa Econômica Aplicada)*

IRENA – International Renewable Energy Agency

ITCZ – Inter Tropical Convergence Zone

JRC – Joint Research Centre

KfW – German development bank

km – kilometer

km^2 – square kilometer

LAMEPE – Laboratory of Meteorology of Pernambuco *(Laboratório de Meteorologia de Pernambuco)*

LANDSAT – Land Remote Sensing Satellite

Landsat / TM – *Landsat Thematic Mapper*

LBA – Large-Scale Biosphere-Atmosphere Experiment in Amazonia

LNG – liquefied natural gas

m – meter

m^3 – cubic meter

m^3/s – cubic meter per second

MA – state of Maranhão

MAPA – *Ministry of Agriculture*, Livestock and Supply *(Ministério da Agricultura, Pecuária e Abastecimento)*

MAPS – Mitigation Action Plans and Scenarios

MBSCG – Brazilian Model of the Global Climate System *(Modelo Brasileiro do Sistema Climático Global)*

MCid – Ministry of Cities *(Ministério das Cidades)*

MCTI – Ministry of Science, Technology and Innovation *(Ministério da Ciência, Tecnologia e Inovação)*

MDG – Millennium Development Goal

MDIC – Ministry of Development, Industry and Foreign Trade *(Ministério do Desenvolvimento, Indústria e Comércio Exterior)*

MDS – Ministry of Social Development and Fight Against Hunger *(Ministério do Desenvolvimento Social e Combate à Fome)*

MEC – Ministry of Education *(Ministério da Educação)*

MERCOSUR – Southern Common Market / *MERCOSUR (Mercado Común del Sur) (Mercado Comum do Sul)*

MF –Ministry of Finance *(Ministério da Fazenda)*

MG – state of Minas Gerais

mm – millimeter

MMA – Ministry of the Environment *(Ministério do Meio Ambiente)*

MME – Ministry of Mines and Energy *(Ministério de Minas e Energia)*

MODIS – Moderate Resolution Imaging Spectroradiometer

MPOG – Ministry of Planning, Budget and Management *(Ministério do Planejamento, Orçamento e Gestão)*

MRE – Ministry of Foreign Affairs *(Ministério das Relações Exteriores)*

MS – state of Mato Grosso do Sul

MT – Ministry of Transportation *(Ministério dos Transportes)*

MT – state of Mato Grosso

MW – megawatt

MWp – megawatt-peak

N – North

N_2O – nitrous oxide

NAFC – Federal Climate Articulation Group *(Núcleo de Articulação Federativa para o Clima)*

NAMAs – Nationally Appropriate Mitigation Actions

NASA – National Aeronautics and Space Administration

NDE – National Designated Entity

NEB – Brazilian Northeastern region

NO – Northwest

PA – state of Pará

PAE – State Action Programs to Fight Desertification *(Programas de Ação Estadual de Combate à Desertificação)*

PAN – National Action Plans *(Planos de Ação Nacional)*

PAs – Protected Areas

PB – state of Paraíba

PE – state of Pernambuco

PI – state of Piauí

PMBC – *Low Carbon* Mining Plan *(Plano de Mineração de Baixa Emissão de Carbono)*

PNAB – National Primary Care Policy *(Política Nacional de Atenção Básica)*

PPP – Purchasing power parity

PR – state of Paraná

PSE – Health at Schools Program *(Programa Saúde na Escola)*

PSF – Family Health Program *(Programa Saúde da Família)*

PSMC Saúde – Health Sectoral Plan for Mitigation and Adaptation to Climate Change *(Plano Setorial da Saúde para Mitigação e Adaptação à Mudança do Clima)*

PSTM – Sectoral Plan of Transport and Urban Mobility for Mitigation and Adaptation to Climate Change *(Plano Setorial de Transporte e Mobilidade Urbana para Mitigação e Adaptação à Mudança do Clima)*

RBMA – National Council of the Atlantic Forest Biosphere Reserve *(Reserva da Biosfera da Mata Atlântica)*

RGP – General Fisheries Register *(Registro Geral da Pesca)*

RJ – state of Rio de Janeiro

RN – state of Rio Grande do Norte

RO – state of Rondônia

RR – state of Roraima

RS – state of Rio Grande do Sul

S – Sul

SACZ – South Atlantic Convergence Zone

SAP – Early Warning System for Drought and Desertification *(Sistema de Alerta Precoce de Secas e Desertificação)*

SC – state of Santa Catarina

SE – state of Sergipe

SENAC – National Service for Commercial Apprenticeship *(Serviço Nacional de Aprendizagem Comercial)*

SENAI – National Service for Industrial Apprenticeship *(Serviço Nacional de Aprendizagem Industrial)*

SEP/PR – Secretariat of Ports *(Secretaria de Portos da Presidência da República)*

SEPED – Secretariat of Policies and Programs of Research and Development *(Secretaria de Políticas e Programas de Pesquisa e Desenvolvimento)*

SEPPIR – Secretariat of Policies for the Promotion of Racial Equality *(Secretaria de Políticas de Promoção da Igualdade Racial)*

SESC – *Social* Service of *Commerce (Serviço Social do Comércio)*

SESI – Brazilian Social Services for Industry *(Serviço Social da Indústria)*

SISMOI – System of Monitoring and Observation of Climate Change Impacts *(Sistema de Monitoramento e Observação de Impactos das Mudanças Climáticas)*

SP – state of São Paulo

SRT – Home Care Services *(Serviços Residenciais Terapêuticos)*

SST – sea surface temperature

SUS – Unified Health System *(Sistema Único de Saúde)*

TEC – Technology Executive Committee

TERRA – Satellite from The Earth Observing System *(Satélite do Sistema de Observação da Terra)*

TNA – Technology Needs Assessment

TNC – Third National Communication

TO – state of Tocantins

TOGA – Tropical Ocean Global Atmosphere

UCS – Union of Concerned Scientists

UEMOA – West African Economic and Monetary Union *(União Econômica e Monetária do Oeste Africano)*

UFPE – Federal University of the state of Pernambuco *(Universidade Federal de Pernambuco)*

UFRGS – Federal University of the state of Rio Grande do Sul *(Universidade Federal do Rio Grande do Sul)*

UFRJ – Federal University of the state of Rio de Janeiro (*Universidade Federal do Rio de Janeiro*)

UnB – University of Brasília *(Universidade de Brasília)*

UNEP – United Nations Environment Programme

UNFCCC – United Nations Framework Convention on Climate Change

UNICA – Sugarcane Industry Union *(União da Indústria de Cana-de-Açúcar)*

UNICEF – United Nations Children’s Fund

US$ – US Dollar

USA – United States of America

USP – University of São Paulo *(Universidade de São Paulo)*

W – West

WiFi – Wireless Fidelity

WMO– World Meteorological Organization

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NATIONAL CIRCUMSTANCES

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NATIONAL CIRCUMSTANCES

1.1. CHARACTERIZATION OF THE TERRITORY

Brazil is located in South America between the parallels 5°16’20” north latitude and 33°45’03” south latitude, and the meridians 34°47’30” and 73°59’32” west of Greenwich. Its geodesic center is located at the coordinates 10°35’ south latitude and 52°40’ west of Greenwich. The eastern limit is the coast of the Atlantic Ocean, and it has several oceanic islands, with a special mention to Fernando de Noronha, Abrolhos and Trindade. To the north, west and south, Brazil borders all South American countries, with the exception of Chile and Ecuador. The Equator and the Tropic of Capricorn cross the country, with most of its lands located in the lower latitudes of the globe, giving it the characteristics of a tropical country.

With an area of 8,515,767.049 km^2, Brazil is the largest country in South America, and the fifth in the world.

The Federative Republic of Brazil is divided into 26 states, 5,570 municipalities and the Federal District, where the capital of the Republic, Brasília, seat of the government and the executive, legislative and judicial branches, is located.

The vastness of Brazil’s territory, in latitude as well as longitude, is home to an extraordinary mosaic of ecosystems, along with extensive climate and topographic diversity. Throughout its history, these characteristics have determined the various forms of human occupation and use of the spaces shaped by the country’s tropical and subtropical nature, which have been categorized, in general terms, as five large geographic regions: North, Northeast, Southeast, South and Central-West (Figure 1.1).

FIGURE 1.1

Brazil's political-administrative division

Caption

State boundary
Country boundary
State capital
Country capital

Region
North
Northeast
Southeast
South
Central West

Source: IBGE[1]

The 2010 Demographic Census showed that the Brazilian population was 190,755,799 inhabitants on the survey reference date. The series of demographic census has shown that the population has experienced successive increases, having grown almost 20 times since the first census in Brazil, in 1872.

Between the last two demographic censuses, i.e., in the 2000/2010 periods, the highest growth rates were observed in the North and Central-West regions, where the migratory flow contributed significantly.

According to data from the 2010 Census, the Southeast region is the country's most populous region, with about 42% of the total inhabitants. The Northeast region is ranked second, with approximately 28%, followed by the South region with 14%, North with 8% and Central-West, which houses only about 7% of the population.

Recently, the increase of almost 23 million urban inhabitants resulted in an increase in the degree of the Brazilian urbanization, which jumped from 81.2% in 2000 to 84.4% in 2010. This increase was caused by the natural growth in urban areas, in addition to the migration to urban areas. The Southeast continues to be Brazil's most urbanized region, with a 92.9% degree of urbanization (IBGE, 2011).

1 *Available at: http://7a12.ibge.gov.br/mapas-7a12/brasil*

Figure 1.2 provides the distribution of the population across the country's territory, and the map shows Brazil's demographic density.

FIGURE 1.2

Demographic Densities in Brazil

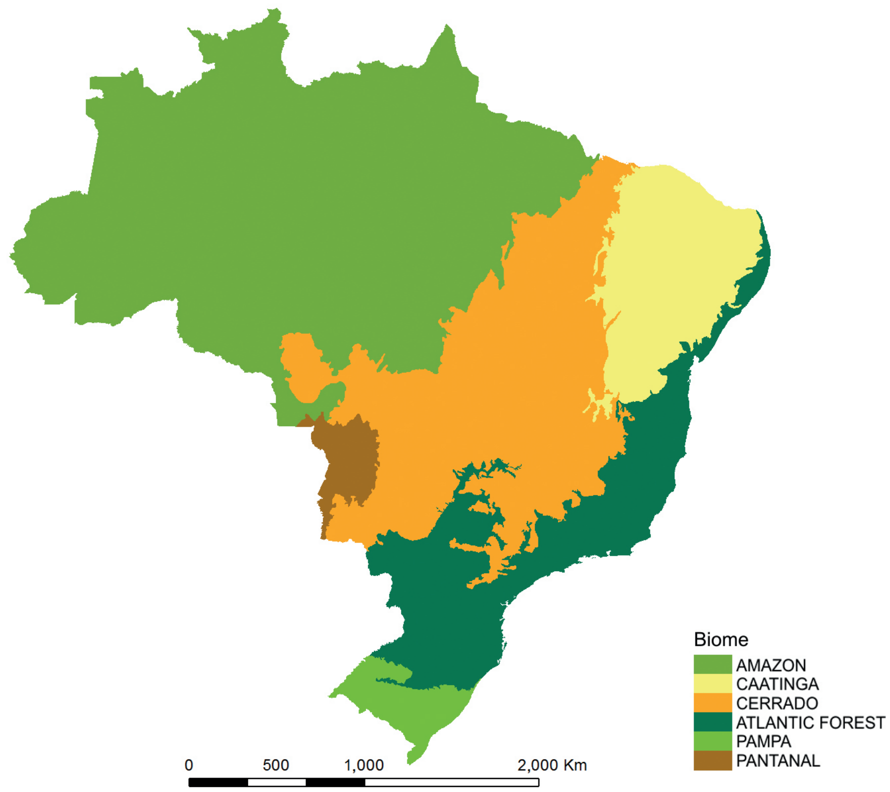
Source: IBGE (2011)

1.1.1. Vegetation and Flora Resources

The Brazilian territory comprises six large biomes, according to the type of predominant vegetation, terrain and/or climatic conditions of the region (Figure 1.3).

FIGURE 1.3

Distribution of Brazilian biomes in the national territory



Source: IBGE (2004)

According to the Vegetation Map of Brazil (refer to the technical annex of Volume III), forest formations occupy most of the national territory, and are constituted by humid and seasonal forests, which appear most commonly in the Amazon and Atlantic Forest.

Savanna formations are predominant in the Cerrado, but they also appear in other regions of the country, including the Amazon. Steppe savannah formations appear mainly in the Northeastern Caatinga. Steppe formations appear mainly in plateau and prairies in the far south area of Brazil, in the Pampa biome. Campinaranas can be found mainly in the Amazon, in the Rio Negro Watershed.

It is worth pointing out that these biomes have peculiar features that combine specific needs and concerns resulting from the negative effects of climate change. The biomes will be described in detail below.

1.1.1.1. Amazon

The Amazon biome is composed of various ecosystems covering a total area of approximately 7 million km^2, more than 60% of which are within the Brazilian territory. Structurally it is composed of the Andes to the west, the Brazilian Shield to the south and the Guyana Shield to the north and by the sedimentation basin to the center, where the major rivers of the region are. In Brazilian territory, the Amazonian ecosystems occupy the states of Acre, Amapá, Amazonas, Pará, Rondônia, Roraima and the states of Maranhão, Tocantins and Mato Grosso.

The Amazon is recognized as the largest existing tropical forest, totaling 1/3 of the tropical rainforest reserves and the largest gene bank on the planet. It is the forest with the highest species richness (MYERS et al., 2000) and a large quantity of biomass, having accumulated in the biomass of its forests the equivalent to 1.5 decades of anthropogenic carbon emissions on a global scale (NEPSTAD, STICKLER and ALMEIDA, 2006; SAATCHI et al., 2007).

The Amazon Watershed is the largest reserve of fresh water in the country. It embraces 73.6% of the national surface water resources. In other words, the average flow rate of the region is almost three times greater than the sum of the flow rates of all other Brazilian river regions (BRASIL, 2006). The Amazon Watershed is considered to be the largest riverine basin in the world, accounting for one sixth of the total fresh water of the rivers discharged into the oceans of the world (JUNK, SOARES and BAYLEY, 2007).

The Amazon climate is typically wet and is exposed to high temperatures. Regarding rainfall, there is a great variation in precipitation and marked variation also in the seasonality of precipitation in this region (GRIMM, 2011). For example, some parts of the south and west of the Amazon may face periods of up to five months with less than 100 mm of rain. The climate dynamics of the atmosphere in the Amazon is established in such a way that this region functions as a distributor of water vapor for the southern region of the South American continent (NOBRE et al., 2009).

The predominant vegetation in the Amazon is the Dense Humid Forest, a type of vegetation typical of humid climates (VELOSO, RANGEL-FILHO and LIMA, 1991). The second most common type of vegetation is the Open Humid Forest, subject to some level of water deficit in the dry season. Three other types of vegetation with representative biodiversity cover minor extensions. They are: the Semi-Deciduous Forests, facing more prolonged droughts; the *campinas* and *campinaranas*, predominant in the Rio Negro Watershed; and the relict savannas, which occupy small areas distributed in various regions of the Amazon.

Nowhere on Earth do more animal and vegetation species exist than in the Amazon, both in terms of species inhabiting the whole region as well as those coexisting in a single location. However, although the Amazon is the region with the greatest biodiversity on the planet, only a fraction of this biodiversity is known.

Findings of studies in Brazil have also shown that an average temperature rise of 3°C to 4°C in the Amazon by 2100 would have a significant impact on the forest, which is not adapted to temperatures above 40°C. It is estimated that the natural vegetation would be replaced by another vegetation similar to the Cerrado, which endures higher temperatures.

In order to enable the buildup and promotion of an effective policy for mitigation and adaptation to climate change in the Amazon, it is crucial to know the duo dynamic of this biome as a source and sink of carbon as well as its response to climate change.

For all the reasons mentioned herein, this region is particularly sensitive to global climate change but it is also potentially determining to climate change itself.

Instruments for nature conservation in the Amazon are ecosystem management, protected areas and the study and preservation of species of fauna and flora. Particularly in relation to the fight and prevention against deforestation, the Brazilian Government employs a number of initiatives, which are consolidated in the Action Plan for the Prevention and Control of Deforestation in the Amazon Region (PPCDAm). In addition, some states of the Amazon have successfully used economic instruments such as Payment for Environmental Services, such as the *Bolsa Floresta* (Forest Conservation Grant). These combined initiatives are an important component to explain the recent drop in the Brazilian deforestation rates.

Such measures to combat deforestation and consequently mitigate greenhouse gas emissions of Brazil will be detailed in Volume II of this National Communication.

1.1.1.2. Atlantic Forest

The Atlantic Forest is the second largest tropical forest in the South-American continent. It is a complex and exuberant set of highly important ecosystems that are home to a significant part of Brazil's biological diversity, recognized both by the national and international scientific communities. It is also one of the most threatened biomes in the world due to prolonged human occupation and destruction of habitats and their various typologies and associated ecosystems. The loss of habitat, fragmentation and forest degradation rank this biome in the 5th position of biodiversity hotspots (MITTERMEIER et al., 2005).

The Atlantic Forest is distributed along the country's Atlantic coast, which stretches across the Northeast to the South of Brazil, reaching sections of Argentina and Paraguay in the Southeast and South. The Atlantic Forest originally encompassed 1,315,460 km² of the Brazilian territory. Its original borders included areas in 17 states, (PI, CE, RN, PE, PB, SE, AL, BA, ES, MG, GO, RJ, MS, SP, PR, SC, and RS), which corresponded to approximately 15% of Brazil. Currently, the region is home to most of the major cities of the country and contains only 12% of its original vegetation cover distributed in small forest fragments (RIBEIRO et al., 2009).

Even though it has been reduced and fragmented, it is estimated that there are about 20,000 plant species (about 35% of the existing species in Brazil) in the Atlantic Forest. This abundance is greater than that of some continents and, therefore, the Atlantic Forest region is a high priority for the conservation of the world's biodiversity.

The predominant climate in the biome is tropical humid. The Atlantic Rainforest comprises, in most part, low and medium elevations (1000 m). In the region of occurrence of these forests, average monthly temperatures of at least 18°C and high precipitation (above 2000 mm annually) predominate and are well distributed throughout the year.

The vegetation of the Atlantic Forest is extremely heterogeneous, being composed mainly of two major types: the Dense Humid Forest or Atlantic Rainforest (east coast) and Semideciduous Seasonal Forest (located inland). In addition there are also other special environments, such as pioneering formations (wetland areas or meadows), sandbanks, mangroves, rupestrian and altitude fields, besides mixed humid forest with araucaria (SCARANO, 2002).

Currently, approximately 70% of the Brazilian population, or 120 million people that, account for 80% of the Gross Domestic Product (GDP) of the country, and live in urban and rural areas with fragments of this biome coverage.

The dynamics of human occupation has escalated over the past three decades, resulting in severe alterations in ecosystems due to the high fragmentation of the habitat and loss of its biodiversity.

Currently sugarcane cultivation, cattle-ranching and plantations of eucalyptus and Pinus occupy significant space in the Atlantic Forest, and form the landscape of both small properties and sparse vegetation (small in size, poorly connected, with a high degree of isolation and high edge effect), as by extremely extensive activities (RIBEIRO NETO, MONTENEGRO and CIRILO, 2011).

On account of high habitat loss and fragmentation, the remaining vegetation suffered drastic modification in relation to the heights, being more concentrated in high altitudes and on reliefs with moderate slope. Only 7.6% of the remaining vegetation was found in more flat areas, and areas with greater slope are among the best-preserved ones, with 33% of the original coverage. This type of result favors, in part, physiognomies such as rupestrian fields and fields of altitudes (RIBEIRO NETO, MONTENEGRO and CIRILO, 2011).

The coverage of protected areas of the Atlantic Forest progressed over the last few years, with the contribution of the Federal, State and, more recently, Municipal Governments and the private sector. However, most of the remaining native vegetation still remains unprotected. Thus, in addition to the investment in the expansion and consolidation of protected areas, the strategies for the conservation of the biodiversity of this region also include innovative forms of incentives for conservation and sustainable use of biodiversity, such as the encouragement of the recovery of degraded areas and the sustainable use of native vegetation, as well as incentive for payment for environmental services provided by the Atlantic Forest. Law No. 11,428/2006 and Decree 6,660/2008 are important instruments for conservation and recovery of the Atlantic Forest. They regulate the use and protection of the native vegetation of the Atlantic Rainforest biome.

The preservation of the remnants of the Atlantic Forest is one of the basic conditions for the maintenance of climate regimes, hydrological cycles and mitigation of the effects of air and water pollution in this region (RIBEIRO et al. 2009).

1.1.1.3. Pampa

Situated in the extreme south of Brazil and also reaching Uruguay and Argentina, the Southern Fields or "Pampas" is the only Brazilian biome restricted only to one Unit of the Federation, the state of Rio Grande do Sul, where it occupies 63% of its area, corresponding to approximately 178,000 km^2 (CSR and IBAMA, 2010). Also in this biome, other known types, such as the fields in the high mountain ranges, are found in transition areas with a predominance of Brazilian pine (*araucárias*). In other areas there are fields similar to savannas profiles.

The Southern Fields feature a flat and wavy relief. The climate in the region of the Pampas is considered as a transition between the subtropical climate in the north, and the temperate climate in the south. The rainiest season coincides with the summer, decreasing during the winter, between the months of April and September. However, the dry season is not severe. In the *Pampeana* Province, the average annual rainfall varies from 1,200 to 1,600 mm/year, with average annual temperatures ranging from 13°C to 17°C. The distribution of rainfall is uniform throughout the year, with some tendency of heaviest rainfall in winter. The monthly average in summer is 120 mm while in winter it reaches 145 mm, with the amount of total annual rainfall for the region getting close to 1,400 mm/year (GRIMM, 2009). The available data show that the southern fields present considerable stocks of carbon in its soils, a process that is favored by low temperatures.

In some regions, grassy fields predominate, forming the main matrix of the biome, with two outstanding formations: clean fields and shrubby fields (VELOSO, RANGEL-FILHO and LIMA, 1991). This field vegetation initially seems to have an apparent uniformity, however, other types of vegetation are also noted, forming mosaics of grassland and isolated fragments of forests (capons), riparian vegetation, slope forests and ironwood formations, shrub formations, *butiazais* (jelly palms), swamps and rocky outcrops. Associated forests are of different sizes and areas and contain elements of deciduous forests, semi-deciduous forests, or humid forests with the occurrence of tree species commonly known as *araucaria* (Brazilian pine) (OVERBECK et al., 2007). Its alluvial forest has countless tree species of commercial interest.

As a set of very old ecosystems, the Southern Fields feature specific flora and fauna and great biodiversity, not yet fully described by science.

The extensive and continuous cattle-ranching became the most important and traditional form of land use in the region and has dominated the economy in subsequent stages of development (OVERBECK et al., 2007). Currently, there has been an intensification of agricultural activities in the region, leading to transformations and the substitution of natural vegetation by exotic species, seasonal crops, such as rice, soybeans, corn and wheat, as well as tree species, with the advent of forestry (SUERTEGARAY and SILVA, 2009). The sheep farming is another activity carried out in the region. Thus, 58,68% of the region of the Southern Fields is occupied by some kind of anthropogenic activity, mostly rural.

The gradual introduction and expansion of monoculture and pasture with exotic species whose management involves the use of fire have led to a rapid deterioration and reclassification of natural landscapes of the Southern Fields. In the Upper Uruguay River and the Medium Plateau, the expansion of soybean and wheat plantation have led to the disappearance of the fields and clearing of woods. These two crops currently occupy virtually the entire area, causing a gradual reduction in soil fertility. This also leads to erosion, compacting and loss of soil organic matter. Estimates of habitat loss reported that approximately 36% of the native vegetation of this biome remained in 2008 (CSR and IBAMA, 2010).

The Pampa is one of the planet's most important areas of temperate fields. In addition to its above-described natural heritage, there is a cultural heritage associated with the biodiversity of the region. In spite of this, in comparison with the other Brazilian biomes, it is the one that has less representativeness with the National System of Protected Areas (SNUC)[2].

1.1.1.4. Pantanal

The Pantanal is a low region, with a flat relief, located in the center of a watershed, where the rivers flood the plain and nourish an intricate drainage system that includes extensive lakes, divergent watercourses and differing areas of runoff and seasonal flood. In 1991, the Interministerial Commission for the Preparation of the United Nations Conference on Environment and Development defined the Pantanal wetlands in the state of Mato Grosso as "the largest continuous flooded plain on the planet". It is also the largest humid continental area in the world. In view of its importance in terms of natural wealth and biodiversity, it was decreed National Heritage by the Constitution of 1988 and Heritage of Humanity and Biosphere Reserve by the United Nations, in 2000.

Its geographic location is of particular importance, since it represents the connection between the Cerrado, in Central Brazil, the Chaco, in Bolivia, and the Amazon region to the North. The Pantanal is the plain physiognomy that composes, with the Plateau and the Chaco, the Upper Paraguay Watershed, the second largest watershed in

2 *This subject will be discussed in more detail in subitem 1.1.1.1 of Volume II of this TNC.*

South America, surpassed only by the Amazon Watershed. Out of an area of approximately 151,313 km², 65% lies in the State of Mato Grosso do Sul and the remaining 35% in the State of Mato Grosso, both in the Central-West region of the country. The population of the Upper Paraguay Watershed is approximately 2.5 million people (ANA, 2012; IBGE, 2011) – out of which 70% live in urban areas.

The Pantanal has a typically humid weather (INMET, 1992), whose main characteristic is the marked change in the water column, that causes the flooding of the plains throughout the year (from October to March), alternately with water outflows (from April to September), where the evapotranspiration is usually greater than the precipitation. Thus, the Pantanal acts as a great reservoir, with a gap of up to five months between water inflows and outflows. The temperatures in the Pantanal are among the most extreme found in Brazil.

Flooding is the most important ecological phenomenon of Pantanal and the pulse is considered a driving force of the flood ecosystem (JUNK and CUNHA, 2005). These periodically flooded environments have high biological productivity, great density and diversity of fauna.

In short, the heterogeneity of the Pantanal determines the existence of various swamplands, which have their own characteristics, with ecological and floristic diversity (CORSINI and GUARIM NETO, 2000). There are several aquatic and semi-aquatic ecosystems that are interdependent to a greater or lesser degree.

In the Pantanal, the main economic activities are agriculture, cattle-ranching, the agro-food-processing industry (beef, sausages, etc.), tourism and fish farming. In the vicinity of the city of Corumba there are also mining centers of manganese and iron and steel (WANTZEN et al., 2008; LIMA 2008). Several charcoal kilns also operate in this biome, which also presents an eucalyptus forestry.

The agricultural frontier expansion process, which mainly occurred after 1970, was the key cause of the demographic growth in Brazil's Central-West region. The population growth process did not affect the wetland plain region, with its land structure based on large properties geared towards cattle-raising in its swampy areas. There was no significant increase in the number or population of wetland cities. However, there was fast urban growth on the plateau.

In 2008, the Ministry of the Environment (MMA) and the Brazilian Institute of the Environment and Renewable Natural Resources (Ibama) signed a cooperation agreement for the implementation of the Program of Monitoring Deforestation in Brazilian Biomes by Satellite, with the support of the United Nations Development Program (UNDP). Consequently, the vegetation cover of the Cerrado, Caatinga, Atlantic Forest, Pampa and Pantanal biomes started to be monitored. Then, non-governmental organizations, with the help of Embrapa, monitored the Upper Paraguay Watershed between the years of 2002 to 2008. It was identified that the plateau suffers a greater impact in relation to the plains, arising from agricultural activities.

As for environmental management, land planning in the Pantanal has been performed by means of an Ecological and Economic Zoning System (EEZ) in the states of Mato Grosso and Mato Grosso do Sul. This action of governance contributes to a better management of soils and pastures, as a way to mitigate the environmental degradation. The establishment of a regulatory framework (Law No. 9,878/2013) by the state of Mato Grosso, which created the State System for Reducing Emissions from Deforestation and Forest Degradation, Conservation, Sustainable Forest Management (REDD+), is also emphasized. In addition, an instrument of ecological taxes was established in the state of Mato Grosso and Mato Grosso do Sul, corresponding to a compulsory allocation of part of the amounts collected by the State as ICMS (Tax on Operations related to the Movement of Goods and Services of Interstate and

Intermunicipal Transportation and Communication) aimed at financing activities of environmental preservation on behalf of municipalities. These actions will be described in Volume II of this Communication.

1.1.1.5. Cerrado

The Cerrado is the second largest biome in South America. The springs of three major watersheds of South America are located in this area (Amazon/Tocantins, São Francisco and Prata), which results in a high aquifer potential and favors its biodiversity.

The composition of the vegetation is determined by rainfall seasonality, by differences in altitude, low soil fertility and high frequency of natural burnings (CASTRO, 1994; RATTER et al., 2003; RIBEIRO and WALTER, 1998). The result is a complex landscape, composed of a mosaic of vegetation, scattered from grassy fields to forest formations. There are intermediate types of vegetation, such as deciduous forests in more fertile soil and gallery/riparian forest along the rivers. The most grassy and open vegetation are clean and shrubby fields, with the presence of shrubs and more frequent trees in the *stricto sensu* cerrado and cerradão (RIBEIRO and WALTER, 1998).

Among the tropical savannas, the Cerrado is distinguished by its great diversity of plants, with about 12,000 species of angiosperms (MENDONÇA et al., 2008). The typical vegetation found in the Cerrado is small in size, with twisted trees, twisted branches, thick bark and thick leaves. Studies conducted suggest that the Cerrado's native vegetation do not have this characteristic due to a lack of water — because there is a large and dense water network there — but rather because of edaphic factors, such as an imbalance of micronutrients, such as aluminum. The main types of soil are the Oxisoils and Entisol (REATTO et al., 1998), considered generally acid soils, with high concentration of aluminum and low concentration of nutrients.

The climate conditions are key variables in the distribution and spatial structure of the Cerrado (DINIZ-FILHO et al., 2008). The average annual temperature is between 20°C and 26°C, but there is a large variation in temperature due to the differences in altitude (EITEN, 1972). The Cerrado has marked climate seasonality, with average annual rainfall from 800 to 1,800 mm depending on the region, with 90% of the precipitation occurring in the rainy season between October and April. An extensive irrigated hydrographic grid of the Cerrado compensates this seasonal effect.

Brazil's Cerrado is known as the richest savannah in the world in biodiversity, with the presence of several ecosystems and very rich flora and fauna. It houses 11,627 species of already-cataloged native plants, approximately 199 mammals, 837 birds, 1,200 fish, 180 reptiles and 180 amphibians. The Cerrado is also refuge of 13% of the butterflies, 35% of the bees and 23% of the termites in the tropics. However, countless species of plants and animals are endangered. It is estimated that 20% of the native and endemic species no longer occur in protected areas and that at least 137 species of animals that occur in the Cerrado are threatened with extinction. After the Atlantic Forest, the Cerrado is the Brazilian biome that went through most changes with human occupation.

The "cerrados" remained unaltered until the 1950s. Starting in the 1960s, with the country's move inland and the opening of a new highway network, large ecosystems made room for cattle-raising and extensive agriculture. Since the 70s, the occupation of this region has been supported, in particular, in the deployment of new road infrastructure and energy policy and agricultural expansion (PIRES, 2000), motivated by the presence of cheaper land and with topography that is adequate to mechanization, thus allowing profitable agrarian activities. In a short period of time, approximately 50% of the original area of the biome was transformed into a landscape composed of cultivated pastures (most of it) and agricultural commodities (BRASIL, 2009; 2010b). There is a significant loss of native vegetation cover along the riversides (LATRUBESSE, STEVAUX and SINHA, 2005), with significant changes in the hydrological, geomorphological and biochemical systems (NEILL et al., 2006; COE, 2011).

Consequently, there are high rates of deforestation in the region. The topography of the Cerrado, ranging between flat and mildly wavy land, favored mechanized agriculture and irrigation.

In addition to the environmental aspects, the Cerrado has great social importance. Many populations live on its natural resources, including indigenous ethnic groups, *geraizeiros, ribeirinhos, babaçueiras, vazanteiros* and *quilombola* communities, which, together, are part of the Brazilian historical and cultural heritage, and possess traditional knowledge of its biodiversity. More than 220 species have medicinal use and other 416 can be used in the recovery of degraded soils.

Just like the Amazon Biome, the Cerrado also has a series of initiatives for the prevention and the fight against deforestation, which are consolidated in the Action Plan for the Prevention and Control of Deforestation in the Cerrado (PPCerrado); a component of sectoral plans for climate change mitigation, of the National Policy on Climate Change, later detailed in this document. Other sectoral plans such as the Agriculture of Low Carbon Plan (ABC) and the Sectoral Plan for the Reduction of the Emissions from the Steel Industry have a broad complementarity and integration with the PPCerrado, since this biome falls under some of these sectors' economic activities.

1.1.1.6. Caatinga

The Caatinga biome is the main ecosystem in the Northeast region, extending through the domain of semiarid climates and occupying 10 states distributed in a total area of 844,453 km^2, equivalent to 11% of the national territory. It is a unique biome despite being located in a semi-arid climate area, with a great variety of landscapes, relative biological wealth and endemism. Seasonal and periodic droughts create intermittent regimes in rivers and leave vegetation without leaves. Plant foliage sprouts and turns green again during the short rainy periods.

The Caatinga is dominated by vegetation with xerophyte characteristics (dry plant formations that comprise a hot and thorny landscape) with strata comprised of deciduous grasses, bushes and short or medium sized trees (3 to 7 meters tall), with a great number of thorny plants, mixed with other species like cacti and bromeliads.

The predominant climate in the Caatinga is the Tropical semiarid. The average annual temperatures are high, ranging from 23ºC a 27ºC, but can reach up to 40°C in summer, with relative humidity typically lower than 50%. Rain schemes are marked by the limited water flow and spatial and temporal variability (REDDY, 1983). Rains are concentrated in the so-called "rainy season", which last for about 3 to 4 months and in an irregular distribution. In some regions, 20% of the annual rainfall occurs on a single day and 60% in a single month (SAMPAIO, 1995).

Over 80% of the Caatinga has some kind of limitation in terms of pedology, with note to the low fertility and low depth, hampered drainage and excessive concentrations of interchangeable sodium (SILVA, 2000). The condition of the shallow soil (litolic), with high acidity and low capacity for water retention in the dry season, acts as selective edaphic factor for the occurrence of species. This geological formation limits the ability of water infiltration into the soil, providing greater runoff, which in turn makes the storage of groundwater difficult.

The topography of the Caatinga region constitutes an important factor for the understanding of the semiarid climate of its interior (SUASSUNA, 2009). The mountains and plateaus form large geological barriers for the action of the wind and other factors, preventing the rains in higher areas of the eastern and the northern sides of mountains and plateaus. Because of these weather and geomorphological constraints, the average annual rainfall varies from 250 to 600 mm.

The climate seasonality is expressed clearly in the structure and functioning of the Caatinga, which presents different phenological phases (i.e., phases of growth, flowering, anthesis, and fading). The species observed under these conditions meet the physical and socio-environmental characteristics with physiological and morphological adaptations that enable them to resist to seasonal low water supply, such as storage of water in parts of the plant, deciduous or smaller leaves, among others. So far, it is estimated that the vegetation of the Caatinga is composed of about 930 species, including 380 endemic, resulting in 12 different types of Caatinga, that draw special attention due to examples of adaptations to semiarid environments.

Most of the local population survives due to an underdeveloped agriculture, vegetal extraction of low quality and negligible livestock farming. There are cattle and goatherds, with the latter being more important than the former. Unwooled sheep are also raised as an alternative. Climate irregularity is one of the factors that most affects the population. Even when it rains, the shallow and rocky soil is unable to store the rainwater and the high temperatures cause intense evaporation. That is why agriculture is only possible in some areas near the mountains, where there is a greater amount of rain.

This is a region that deserves special attention of public adaptation policies because it combines climate and social vulnerability. Currently, the climate conditions of this biome are marked by climate adversity, and the future projections foresee temperature rise and water stress, resulting from lower levels of precipitation, with consequences for agriculture and the food and nutritional security of the population in the field. The amount of rural population, of low qualification and with high rates of poverty, is impressive in the Caatinga. Future climate change may further intensify the rural exodus, a characteristic of the region. The Caatinga biome is considered one of the major areas of the world prone to desertification (BRASIL, 2004b).

Agricultural practices of deforestation and burning of vegetation cover that occur in this biome, in addition to removing nutrients from the soil, leave it exposed to erosive agents, especially water and wind. The main anthropogenic factors that affect the dynamics of fragmentation of the Caatinga are: large estates, prospection and exploitation of underground water and fossil fuels (oil and natural gas), formation of pastures, irrigation and drainage, steel industries, potteries and other industries. These factors cause, in addition to the loss of biological diversity, deep losses in carbon gains, causing a reduction in soil quality (ARAÚJO, RODAL and BARBOSA, 2005).

The Caatinga biome ecosystems undergo intense changes with the replacement of native plant species with crops and pastures. Approximately 80% of the original ecosystems have now been affected by human action. Another typical environmental problem in the Caatinga is the consumption of native firewood, exploited in an illegal and not sustainable way, for domestic and industrial purposes (centers of production of gypsum, lime, ceramics and pig iron). The Action Plan for the Prevention and Control of Deforestation in the Caatinga was created to combat and anticipate the deforestation in the region, aimed at not only reducing the rate of deforestation, but, at the same time, promoting a new model of sustainable development in this biome. This issue will be explained in detail in Volume II of this Communication.

1.1.1.7. Coastal Ecosystems

In addition to the ecosystems previously described, Brazil's coastal zone extends for over 8,500km in the Atlantic Ocean, from the mouth of the Oiapoque River (04°52'45"N) to the mouth of the Chui River (33°45'10"S) and the limits of the municipalities in the coastal strip, to the west, up to 200 nautical miles, including the areas around the Atol das Rocas, the Fernando de Noronha, São Pedro and São Paulo archipelagos and the Trinidad and Martin Vaz islands, located beyond the aforementioned maritime boundary. Therefore, it is conditioned by the relative interaction among waves, tides and sediment inflows that vary from north to south of the country, being composed of cold waters on the southern and southeastern coasts, and warm waters in the north and northeast (BRASIL, 2010a).

The width of the Brazilian continental shelf varies from 8 to 370 kilometers, with depths between 11 and 4,000 meters. Given its extension, one of the world's greatest, the Brazilian coastal and marine zone encompasses various climatic environments (wet equatorial, tropical, semiarid and subtropical), and diversified geological formation. The watersheds and rivers that feed the Coastal Zone have several dimensions and geographical characteristics, such as the Amazon Watershed, the seasonal rivers in the Northeast, the São Francisco, Doce, Jequitinhonha and Paraíba do Sul Rivers, the Atlantic watersheds, limited by the Serra do Mar mountains, and the Lagoa dos Patos Watershed.

The Coastal Zone is a privileged portion of the Brazilian territory in relation to natural, economic and human resources. However, this is an area where approximately a quarter of the population of Brazil lives, resulting in a population density whose index is five times higher than the average of the national territory. This region also concentrates 13 of 27 Brazilian capitals, some of which are metropolitan regions where millions of people live (BRASIL, 2010a). Such characteristics are indicators of the high degree of anthropogenic pressure that their natural resources are submitted to.

The Brazilian Coastal Zone records expressive territorial overlap with the Amazon and Atlantic Forest biomes, and also, but to a lesser extent, with the Caatinga, Cerrado, and Pampa, which does not characterize it as an ecological unit, but as a complex of contiguous ecosystems forming environments of high ecological complexity and of utmost importance for sustaining life at sea.

Climate changes that occur on the continent as well as in the Atlantic Ocean (extratropical cyclones in the South, the Intertropical Convergence Zone, tropical storms and extratropical cyclones in the Northern Hemisphere) will potentially have important consequences in the coastal region. The effects of climate change on the Coastal Zone are much broader than those caused by the thermal-eustatic rise of the sea level. This is because the coastal zone is responsible for a wide range of ecological functions, such as: prevention of floods, saline intrusion and coastal erosion; protection against storms; recycling of nutrients and pollutants; direct or indirect provision of habitats and resources for a variety of species, many of which are relevant to the food security of communities that live on fisheries resources. In general, the coastal and marine ecosystems, such as coral reefs and mangroves, are considered especially vulnerable to climate change due to their weakness and limited ability to adapt, in such a way that the damage caused may be irreversible (see item 1.3.1).

Information on impacts and vulnerabilities of the Brazilian coastal zone to climate change are still scarce in the country. The little information available relates to some local studies and basically deals with the effects of a possible rise in sea levels on such systems. Brazil does not have a historical series of detailed data about the impacts and vulnerabilities of this ecosystem and this is the greatest limitation for enhanced and consistent analysis on the issue. There are not multilevel studies on the vulnerability of Coastal Areas either. The Brazilian Research Network on Global Climate Change (*Rede CLIMA*) and the National Institute of Science and Technology (INCT) are bodies that have worked in the fulfillment of these scientific gaps, as it will be detailed later in Volume II of this Third National Communication.

In terms of developments in the production of knowledge in the formulation of public policies, the First Assessment of the Priority Areas for the Conservation of Biodiversity in the Coastal and Marine Zone was held in 1999, with resources of Probio[3] and executed by a set of governmental and non-governmental institutions. The results of the workshops that gave rise to this first evaluation were gathered in the document "*Avaliação e Ações Prioritárias para a Conservação da Biodiversidade das Zonas Costeira e Marinha*" (Evaluation and Priority Actions for the Conservation of Biodiversity in the Coastal and Marine Zones), published in 2002 by the Ministry of the Environment. Despite some limitations, this document represented, at the time, the most complete technical-scientific synthesis about the situation of coastal and marine ecosystems at the national level, bringing together a set of data, information and analyzes that were scattered before or reflected only regional cutouts. Later, in 2006, an upgrade process of priority areas and the definition of actions were performed for the Coastal and Marine Zone, which can be found in the new publication of the Ministry of the Environment entitled *"Panorama da Conservação dos Ecossistemas Costeiros e Marinhos no Brasil"* (Outlook of Coastal and Marine Ecosystems in Brazil). This update meant the opportunity to undertake a more detailed analysis, in the scale of the various ecosystems that make up the Coastal and Marine Zone, on the current situation of their ecological representativeness, considering the categories of protected areas of the National System of Protected Areas (BRASIL, 2010a).

Resolution No. 3/2006, of the National Council of Biodiversity (Conabio), provides for the effective conservation of at least 10% of the Coastal and Marine Zone through protected areas, and at least 10% of the marine area, by means of full protection areas and/or areas of exclusion of temporary or permanent fishing, integrated with protected areas, aiming at the protection of fish stocks. Regarding the sustainable use of components of marine biodiversity, the resolution provides for the recovery of at least 30% of the major fish stocks through participative management and the control of capture.

The assessment of 2006 underlined the need for the creation of Protected Areas in 145 areas, representing 34.4% of the total area of the Brazilian coastal zone. The Ministry of the Environment is currently performing a new update analysis to the priority areas of the Brazilian Coastal and Marine Zone, which guides their actions for conservation, sustainable use and benefit sharing of the Brazilian biodiversity.

3 *Project for the Conservation and Sustainable Use of the Brazilian Biological Diversity (Probio).*

With respect to fish stocks, the Ministry of Fisheries and Aquaculture of Brazil was created in 2009. It aims at contributing to the sustainable management and development of fishing activity, replacing the old-fashioned standard of the predatory fishing, by means of monitoring and control systems, as for example, the General Fisheries Register (RGP).

Regarding the corals, Brazil has the only hard-coral reef beds of the South Atlantic. Out of the more than 350 species of coral reefs in the world, Brazil's reef formations feature at least 20 of them, and eight are endemic to the country. A program to monitor coral reefs was created in 2002 with the financial support of the Ministry of the Environment. This program is coordinated by the Federal University of Pernambuco (UFPE) and carried out by the Coastal Reefs Institute (*Instituto Recifes Costeiros*). As of 2011, the Chico Mendes Institute for the Conservation of Biodiversity (ICMBio), an agency under the Ministry of the Environment, has initiated efforts for the continuity and internalization of the program in Federally Protected Areas.

In addition to the integration of the conservation of the Brazilian coastal and marine zones to the National System of Protected Areas, as a way to preserve the biodiversity of coastal ecosystems, the following initiatives also stand out in Brazil: Ecological Corridors Project, Sea Collegiate of the Atlantic Forest Biosphere Reserve and the financing of third-party research, or through the national centers of research and conservation of the ICMBio and Ibama, carried out by the Ministry of the Environment.

In 2008, the National Council of the Atlantic Forest Biosphere Reserve (RBMA) created the Sea Collegiate, aiming at formulating guidelines for the implementation of the marine portion incorporated in the RBMA, as well as the creation of one or more reserves of the marine biosphere that allow for the conservation of the coastal and marine landscapes. The Sea Collegiate is composed of participants from networks of marine coastal NGOs, the Network of NGOs of the Atlantic Forest, the business sector, residents, users and the scientific community. Namely, the RBMA covers approximately 5,000 out of 8,000 kilometers of the Brazilian coast, advancing into the sea and encompassing various oceanic islands, such as Fernando de Noronha, Abrolhos, and Trindade.

1.1.2. Fauna

Fauna's role includes the maintenance of a healthy environment with necessary services to the maintenance of human life, such as food, pollination and dispersion of plants, maintenance of the population balance, and pest control. Brazil is one of the richest countries in number of animal species, with about 13% of all the amphibian species described in the world (SILVANO & SEGALLA, 2005); 10% of all mammals (COSTA et al., 2005); 17.8% of all butterflies (BROWN & FREITAS, 1999) and 21% of all the continental water fish on the planet (AGOSTINHO et al., 2005). Of the 624 *taxa*[4] of existing primates in the world, 133 species and subspecies live in the Brazilian territory, representing 21% of all taxa found on the planet (CHIARELLO et al., 2008). Moreover, Brazil is ranked fourth in relation to the total number of reptiles, after Australia, Mexico and India (MARTINS and MOLINA, 2008).

According to the compilation available on the number of Brazilian fauna species – the "Red Book of the Brazilian Endangered Fauna Species" (MACHADO et al., 2008), within the universe of species known by science, Brazil has 652

4 The Latin word "taxon", plural taxa, is a taxonomic unit, essentially related to a cliassification system. Taxa may be at any level of a classification system, thus, an order is a taxon; a gender, as well as a species, is a táxon, or any other living being classification unit.

species of mammals, 800 amphibians, 1,800 birds, 641 reptiles, 2,300 freshwater fish, 1,298 saltwater fish and more than 100,000 species of land invertebrates, of which insects represent the largest group. However, knowledge about the diversity of Brazilian fauna is still incomplete. It is estimated that less than 10% of the existing total is actually known.

In December 2014, the Ministry of the Environment presented new National Lists of Endangered Species[5]. The Lists of Endangered Species of the Brazilian Flora, produced by the Botanical Garden of Rio de Janeiro, and the List of Endangered Species of the Brazilian Fauna, prepared by the ICMBio, were published. The President of ICMBio, Roberto Vizentin, highlighted the partnerships for this study: 1,383 specialists from the scientific community of over 200 institutions were involved in list-making process, which will provide society with better fauna protection conditions.

Among the data presented, there are the 170 fauna species that left the endangered animals list, such as the humpback whale (*Megaptera novaeangliae*) and the hyacinth macaw (*Anodorhynchus hyacinthinus*), which had their populations recovered. According to research, some factors contributed to this situation: rediscovered extinct species, expansion of knowledge about the species and population growth or habitat protection.

Carried out by ICMBio's General Coordination of Management for Conservation, the mapping of the Brazilian fauna is the result of a continuous process, which started in 2009. Based on the methodology adopted by the International Union for Conservation of Nature (IUCN), there were 73 assessment workshops, followed by the editing of the collected information and the validation step of the methods applied. The new List of Endangered Species of the Brazilian Fauna stands out for its coverage: 12,256 species (including fish and aquatic invertebrates) have been analyzed in the past five years.

The previously used methodology defined as object of study only those species already considered at potential risk of extinction. Now the species studied make up a rich database with information on geographical distribution, ecology and habitat, population data and presence in protected areas (PAs).

1.1.3. Water Resources

In Brazil, there are abundant water resources available and heterogeneously distributed throughout the territory. Endowed with a vast and dense hydrological network, many of its rivers are noted for their length, width and/or depth. Brazilian territory has eight large watersheds: the Amazon River, the Tocantins River, and the South Atlantic – north and northeast sections, the São Francisco River, and the South Atlantic – east section, the Paraná River, the Uruguay River and the South Atlantic – southeast section (Figure 1.4). As a result of the nature of the continental relief, there is a predominance of plateau rivers, which are characterized by sudden drops in altitude, deep narrow valleys, among other characteristics that give them high potential for electric power generation. However, these same characteristics make navigation difficult. Among the great national rivers, only the Amazon and the Paraguay are predominantly lowland rivers and are extensively used for navigation. The main plateau rivers are the São Francisco and Paraná.

5 *Available at: http://www.icmbio.gov.br/portal/comunicacao/noticias/4-destaques/6658-mma-e-icmbio-divulga-novas-listas-de-especies-ameacadas-de-extincao.html*

FIGURE 1.4
Brazil's watersheds

Source: Aneel[6]

The annual average flow rate of the Brazilian rivers is 179,000 m^3/s, which corresponds to approximately 12% of the available world surface water (PBMC, 2013). Brazil also has 3,607 m^3 of maximum volume stored in artificial reservoirs per inhabitant. This value is higher than the volume stored in several continents individually (ANA, 2013).

Water resources are very important for the country, since most of its energy mix is based on hydroelectric plants (for more details see item 1.3 of Volume II of this Communication). The Brazilian hydroelectric potential is estimated at approximately 245 GW, of which 38.8% are located in the Amazon Watershed. For comparison purposes, the Parana Watershed responds for 25.6%, the Tocantins for 10.8% and the São Francisco for 9.2% of the hydroelectric potential of the country (ELETROBRAS, 2013).

In 2013, the watersheds of Paraná, Uruguay, São Francisco, South Atlantic – east section and South Atlantic – southeast section were responsible for supplying hydroelectric power to the country's areas with the greatest demographic and industrial concentration. Among those, the Paraná watershed stands out, not only because of its potential, but also as having the highest percentage in operation or under construction.

In terms of use of the potential, the most saturated watersheds are the Paraná, the Uruguay, the Tocantins and the São Francisco, with usage indexes (ratio between potential used and existing potential) of 69.0%, 55.0%, 50.0% and 47.0%, respectively. The lowest usage rates are seen in the Amazon and the South Atlantic – north and northeast sections.

6 *Available at: http://www.aneel.gov.br/area.cfm?id_area=104>*

The low utilization rates for the Amazon River watershed are due to the predominantly lowland relief, its huge biological diversity and its distance from the main power consumption centers. In the central-south area of the country, the more rapid economic development and the predominant relief (plateaus) made it possible to utilize more of its hydraulic potential. However, with the country's population moving inland and the depletion of the most potential in the South and Southeast regions, it has become necessary to develop hydroelectric power in more remote and economically less developed regions.

In the Northeast region of Brazil, the uneven distribution of rainfall, along with the possibility of a long period of time between rainy seasons, accounts for the intermittent character of many rivers. In view of this climatic peculiarity, ponds are used for water storage and distribution, both for household consumption and for developing irrigated agriculture. In the semiarid Northeast, year-round high temperatures, low temperature ranges (between 2ºC and 3ºC), strong insolation and high rates of associated evapotranspiration affect a scenario in which the rates of evapotranspiration typically exceed the total rainfall, setting negative rates in the water balance. For this reason, this is a region of the country that requires special attention. In the case of ponds, the National Water Agency (ANA) together with the states and agencies responsible for their operation carry out the monitoring of the situation of the reservoirs in the Northeast, a monthly volume monitoring (ANA, 2013).

1.2. CLIMATE OF BRAZIL

Brazil is a country with equatorial, tropical and subtropical climates. This diversity results not only from the country's geographic location, but also due to variations in its terrain, leading to different characteristics for the atmospheric macrosystems. In northern Brazil, especially the region encompassing the Amazon rainforest, equatorial climate is predominant, and characterized by frequent rains and intense heat. The tropical regions have high temperatures, but less regular rainfall. Southern Brazil, in turn, has predominance of subtropical climate, with the possibility of achieving below-zero temperatures during winter.

The Amazon forest contributes greatly to the maintenance of climate conditions in South America, interfering with precipitation of the region and also contributing to the planet's energy balance.

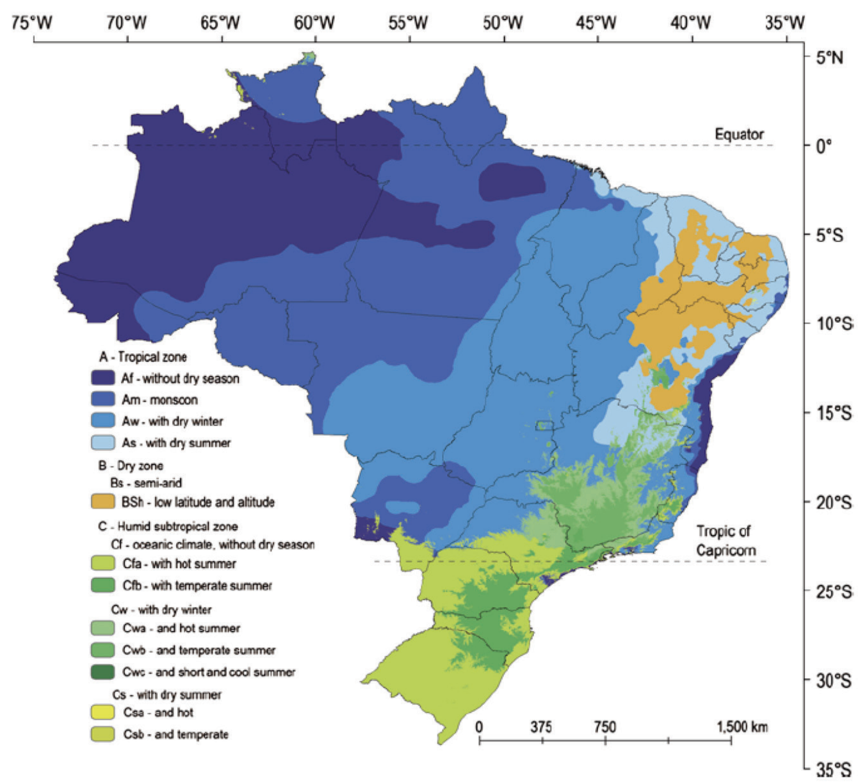
One of the large-scale factors responsible for the climate variability in South America is the occurrence of the *El Niño* Southern Oscillation phenomenon (ENSO), warming of Pacific Ocean waters. In addition to *El Niño*, the meridional gradient of anomalies – variations in relation to the average – in the sea surface temperature (SST) over the tropical Atlantic jointly modulate a large part of the interannual climate variance over South America. The combination of atmospheric circulations induced by spatial distributions of SST on the Equatorial Pacific and Tropical Atlantic oceans affect the positioning of the Inter Tropical Convergence Zone (ITCZ) on the Atlantic, influencing the distribution of rainfall over the Atlantic Watershed and northern South America. This variability exerts profound influence on the climate variability over the eastern Amazon, as well as the far south of Brazil.

There is also the influence of the South Atlantic Convergence Zone (SACZ) that is formed in summer and is described as a persistent band of precipitation and cloudiness oriented towards northwest-southeast Brazil, extending from the southern Amazon to the South-Central Atlantic for a few thousand kilometers.

A recent study (ALVARES et al., 2014) presents a revised version of climate classification in Brazil, using the Koppen system (Figure 1.5). The high resolution of the climate map by Koppen, developed in this study, improved and highlighted different climate categories found along the Brazilian territory, as per the previously published maps. The map extracted from this study also represents the first approach in the literature to develop a map of the climate by Koppen, in hectare-scale for Brazil (851,487,700 ha). In this fine scale, the three types of climate for Brazil (A, 81.4%; B, 4.9% and C, 13.7%) were described with the following subtypes; Af, Am, Aw, As, Bsh, Cfa, Cfb, Cwa, Cwb, Cwc, Csa, Csb. These areas and climate types, identified in this climate high-resolution map, provide both a deeper view of the climate at the local and regional levels of the country, as well as the identification of climate types never reported before.

FIGURE 1.5

Brazil's climate classification, according to Koppen's the criteria (1936)



Source: Alvares et al. (2014)

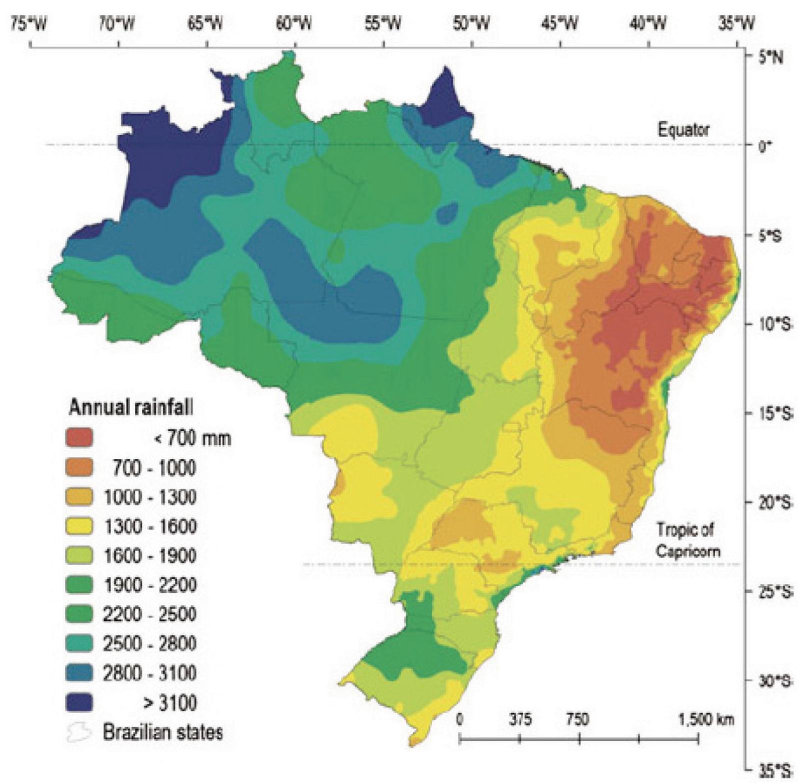
Zone A, representing tropical climate, stretches for about 81.4% of the Brazilian territory. The main reason for this climate to be present in much of the country is because in these areas there are no limiting factors in relation to altitude, precipitation and temperature in order to impose other climate zones. Zone B, representing semiarid climate, is remarkably the typical climate of Northeastern Brazil, occurring primarily in landscapes where annual precipitation falls on average to less than 800 mm/year. The subtropical climate, classified as Zone C, covers 13.7% of the Brazilian territory, occurring mainly in the South Region, on its mountains and plateaus.

1.2.1. Rainfall Climatology and Temperature

Based on rainy seasons, Brazil can be divided into four regions: Amazon, Northeastern Brazil (NEB), Central Brazil and Southern Brazil (Figure 1.6).

FIGURE 1.6

Map of annual distribution of rainfall (mm/year) in Brazil

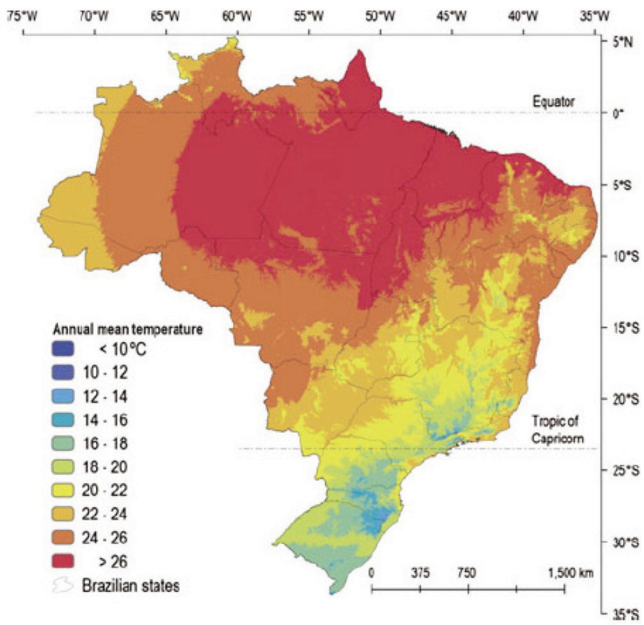


Source: Alvares et al. (2014)

Figure 1.7 shows the map of annual average temperature in Brazil. The highest temperatures are in the Northern Region and in the north of the Northeast, reaching on average over 26ºC, and in the south and west of the Amazon it can vary between 24-26ºC. In the Northeast it varies between 22-24ºC and, in the Central-West and Southeast the averages varies between 20-24ºC, with lowest values in higher regions of the states of Minas Gerais, Rio de Janeiro and São Paulo, reaching up to 14-16ºC. In the South of Brazil, averages range between 12-20ºC, with lower values on the hills (10-12ºC).

FIGURE 1.7

Map of distribution of annual average temperature (ºC) in Brazil



Source: Alvares et al. (2014)

Most of Brazil is under the effect of the monsoon regime, consistent with high monthly totals of rain in spring and summer and low values in the autumn and winter. Generally speaking, precipitation is year-round intense in northwestern Brazil. In Central Brazil, the seasonal variation of rainfall is influenced by the seasonal migration of the high-pressure system of the South Atlantic.

At South of the Equator, winter is the dry season in the tropical zone (0-25°S), with the exception of the coastal regions along the Atlantic, particularly on the coast of the Northeast. In most of southern Brazil, where there is availability of water vapor throughout the year, dynamic conditions in the atmosphere are conducive for maximum rainfall in autumn, winter and spring in different regions. The South is a transition region between the regimes of summer monsoon and winter at medium latitudes, having its precipitation well distributed throughout the year (GRIMM, 2009).

The seasonal cycle of rain in Brazil is affected by inter annual variations, which can produce changes in the cycle of rainfall, such as, for example, the occurrence of drought during the rainy season, or even an abundant rainy season. An important source of inter annual variability are the *El Nino* and *La Niña*.

In the North region of the country, there is an equatorial rainy climate, practically without a dry season. In the Northeast region, the rainy season is restricted to a few months, characterizing a semiarid climate. The Southeast and Central-west are influenced both by tropical systems and medium latitudes, with a well-defined dry season in winter and a rainy season in summer with convective rainfall. Due to its latitudinal location, the South region of Brazil suffers more influence of medium latitudes systems, where the front systems are the main cause of rainfall during the year.

Regarding temperatures, in Brazil, high temperatures are registered in the North and Northeast regions, with little variability during the year, typical of the tropical climate. In medium latitudes, temperature variation over the course of the year is more evident, with predominance of low temperatures during winter, when there is a greater penetration of masses of cold air at high latitudes.

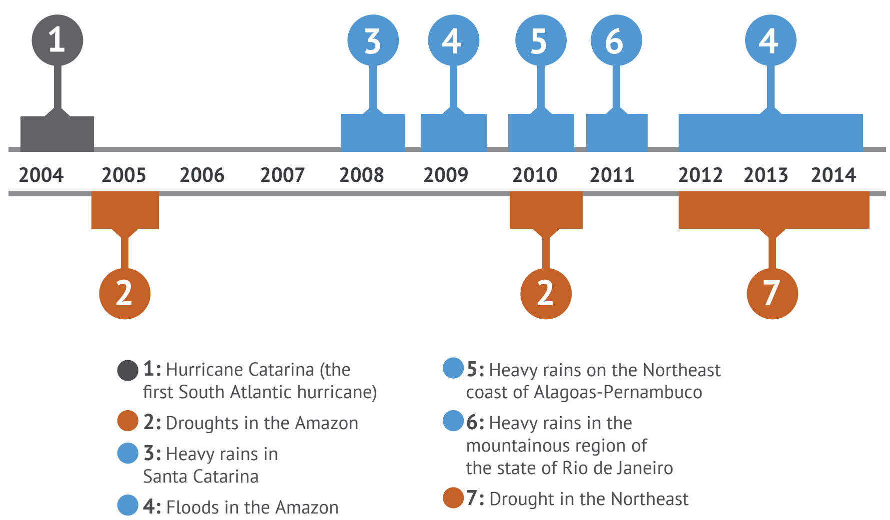
1.2.2. Climate Extremes

Climate extremes (excess and deficiency of rain, heavy rains, and dry periods) may give rise to impacts (droughts, floods, mudslides, landslides). Furthermore, weather and climate extremes have changed their frequency, intensity, spatial distribution, duration and the synchronism between some of these events, resulting in never-seen-before extreme conditions (IPCC, 2012). Changes in extremes can be linked to changes in the average, variance and/or form of their occurrence probability distribution.

The drought or flood in the Amazon can be different from that of the Northeast. In recent droughts in 2005 and 2010, and the flood of 2009, 2012-14 in the Amazon region, droughts and floods have been defined not by the volume of rain recorded in the summer, but by the levels of the rivers in the Amazon during the following autumn-winter. In the case of the Northeast, the drought is rather defined by the volume of rainfalls, and if it is too low, it may compromise the volume stored in reservoirs or dams or in the form of soil moisture. These impacts have been large in Brazil, including economic and social losses and, sometimes, the loss of human lives. Next, some of the most important climate extremes observed over the last 10 years in Brazil are presented. It is important to mention that among the already-observed impacts, there are recent records of an increase in the intensity and frequency of extreme events (floods and droughts), Figure 1.8 shows a summary of the events that will be detailed hereunder.

FIGURE 1.8

Climate extremes observed in the past 10 years in Brazil



First Occurrence of a South Atlantic hurricane, the Catarina (2004)

"Hurricane Catarina" is one of the several informal names for a tropical cyclone of the South Atlantic that reached the South region of Brazil at the end of March 2004.

The disturbance was at a region with excellent weather conditions, with low shear wind and sea surface temperature above the average. The storm winds reached maximum sustained up to 180 km/h, defined as category 2 on the scale of hurricane by Saffir-Simpson rating of hurricanes, becoming the first tropical cyclone to be officially registered in the South Atlantic.

Catarina destroyed about 1,500 homes and damaged another 40,000. The economic losses were significant, especially in the agriculture of banana, where 85% of the production were lost, and rice, where 40% of the plantations were also lost. Moreover, the destructive impact of the cyclone caused the death of three people while 75 were injured. The economic damage caused by Catarina amounted to 350 million dollars.

Heavy rains in the mountainous region of the state of Rio de Janeiro (2011)

In January 2011, heavy rains caused floods and landslides in the mountainous region of the state of Rio de Janeiro, located in the Southeast of Brazil, devastating mountainous cities. According to official Brazilian sources, floods and landslides caused the death of 916 people and left another 35,000 homeless. This was one of the worst natural disasters in the history of Brazil. While the average rainfall (1961-1990) for the month of January in this region is 230mm, the accumulated precipitation during the month of January 2011 was approximately 460mm. Heavy rain in that period caused floods and hillside slidings, and many households located in hazardous areas in deforested slopes were buried. Plantations were ruined. Highways, roads, hospitals and sewage systems collapsed and were all destroyed. The isolation of these cities and the risk of epidemics left the population and local governments in a permanent state of alert (MARENGO et al., 2012).

Episodes of Drought in the Amazon (2005, 2010)

In 2005, a large part of the Western Amazon experienced one of the worst droughts in over a century. The severe drought affected the human population along the main stream of the Amazon River and its West and Southeast tributaries, the Solimões and the Madeira Rivers, respectively. The levels of the rivers fell to historical low levels and the navigation along these rivers had to be suspended, which led several countries of the Amazon Region (Brazil, Bolivia, Peru and Colombia) to officially declare state of "public calamity"[7] in September 2005. The drought left thousands without food, caused problems for the inland waterway transport, agriculture, generation of hydroelectric power, and also affected directly and indirectly the populations living along the rivers in the region. Because tropical forests dried out, severe forest fires broke out in the region, affecting hundreds of thousands of hectares of forest. These fires produced extensive smoke that affected human health, and airports, schools and businesses had to be closed.

7 In Brazil, a state of public calamity is an abnormal situation, caused by disasters, causing damage and losses that lead to considerable impairment of the response capacity by the public authority of the struck agent (Source: Decree Nº 7,257, 4 of August 2010).

After the drought of 2005, drought struck the Amazon region again in 2010. Conditions drier than normal were observed in the area covering the northwest, central and southwest Amazon during the Southern Hemisphere summer and in the rest of the Amazon until the end of the year. Less rain and higher temperatures left water levels in the *Rio Negro* (Black River) at historic lows for the first time in 107 years. Drier conditions also favored the occurrence of forest fires in southern Amazon: September occurrences were approximately 200% higher compared to 2004.

The 2005 and the 2010 droughts were similar in terms of weather severity, however, the hydrological impacts of the drought of 2010 were more extensive on the water levels. Transport, fishing activities and the water supply were affected due to the abnormal low levels of the river.

Heavy rains in Santa Catarina (2008)

Southern Brazil, in the Itajaí Valley, witnessed prolonged heavy rains resulting in extensive flooding and multiple landslides in November 2008. About 1.5 million people across the state of Santa Catarina (one fourth of the total population) were directly affected by this extreme event, 69,000 people were displaced, 120 lives were lost and the state officially declared a state of emergency[8]. Landslides and floods caused by the storms blocked almost all roads in the region and water and electricity were cut-off for thousands of homes. Landslides that swept through homes and businesses caused the majority of deaths. The storms broke part of the gas pipeline coming from Bolivia to the south of Brazil and forced the suspension of fuel supply for part of the state of Santa Catarina and the entire state of Rio Grande do Sul. Non-official estimates of losses due to this extreme rain event, with resulting floods and landslides, are at US$ 350 million, as well as due to the fact that the Port of Itajaí was inoperable for a few days.

Episodes of flooding in the Amazon (2009, 2012-14)

During 10-year period that ended in 2014, severe flooding was detected in Western and Central Amazon in 2009, 2011 and 2012-13 and 2014. Previous observational studies (MARENGO, 2004; RONCHAIL et al., 2002; MARENGO et al., 2008a,b, 2011, 2013; TOMASELLA et al., 2011; ESPINOZA et al., 2011, 2012, 2013, 2014) identified excess rains that produced earlier floods in the Amazon in 1953/54 and 2008/09 and were related to a hot and tropical environment of the South Atlantic.

During what was called at the time “flood of the century” in 2009, the levels of Rio Negro, at the port of Manaus, in July 2009, reached a high record of 29.77 meters according to the CPRM.

In 2012-2013, the Amazon experienced again one of the worst episodes of flooding in recent history. Many cities and urban areas remained under a State of Emergency, with the Solimões River and the Rio Negro, the two main tributaries of the Amazon River, overflowing.

The recent floods in 2014 in Southwestern Amazon revealed a rainfall of approximately 100% above the normal, and the discharge to the Madeira River (main tributary of the southern Amazon) was 74% greater than the normal (58,000 m^3/s) in Porto Velho and 380% (25,000 m^3/s) in January 2014. The levels of Rio Negro in Manaus were 29.47 mm in June 2014, corresponding to the fifth largest record during the 113-year monitoring of the Rio Negro.

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8 *In Brazil, an emergency situation is an abnormal situation, caused by disasters, causing damage and losses that lead to the partial impairment of the response capacity by the public authority of the struck agent (Source: Decree Nº 7,257, of 4 August 2010).*

Drought in the Northeast (2012-2014)

Since 2012, Brazil's Northeast is suffering its worst drought in 50 years, with more than 1,400 municipalities affected. In 2012, the region declared a State of Emergency in the most municipalities in the area due its worst drought in 30 years, affecting more than 4 million people.

The drought destroyed large areas of agricultural land, caused drinking water shortage in hundreds of cities and towns throughout the region, and raised conflict among farmers for food and water for cattle. This situation lasted from 2013 to 2014, but the most intense droughts were detected in 2012.

1.3. SPECIAL CIRCUMSTANCES

This section's objective is to examine special circumstances that result in specific needs and concerns arising from the adverse effects of climate change and the impact of the implementation of response measures pursuant to Article 4, paragraph 8 of the United Nations Framework Convention on Climate Change.

The First National Assessment Report of Working Group 1 of the Brazilian Panel on Climate Change served as an important source of research, from which the following excerpts were extracted.

It is worth noting, however, that a decision was made to include, in the description of Brazilian biomes (item 1.1.1), the susceptibilities and vulnerabilities of each one in face of climate change, restricting and detailing the approach to regions with fragile ecosystems.

1.3.1. Regions with Fragile Ecosystems

The concept of environmental fragility or fragile areas regards susceptibility to any environmental damage, either in fragile ecosystems or areas, or significant portions or fragments with unique characteristics and resources. Fragile ecosystems include deserts, semiarid lands, mountains, wetlands, small islands and certain coastal areas. Most of these ecosystems are regional, and transcend national borders.

In the case of Brazil, it is possible to identify eight major categories of fragile areas, including those already recognized by law: hilltops, slopes and cliffs; springs of water courses; margins of waterways, floodplains and flood beds; lakes, ponds and lagoons; aquifer recharge areas; mangroves; sandbanks; and areas susceptible to desertification (GOMES e PEREIRA, 2011).

Brazilian territory consists of very old geological structures and it is very eroded. The country has modest altitudes, with 93% of Brazil's territory at altitudes below 900 meters. Thus, Brazil does not have high mountain ranges and the country's highest peaks are in national parks[9].

Special attention has been given in the country to conservation of Serra do Mar, a mountainous system that extends from the state of Espírito Santo to the south of the state of Santa Catarina. Serra do Mar is home to the

9 On August 22, 2002, the Montanhas de Tumucumaque National Park was created by Presidential Decree, in northwestern Amapá, on the border with French Guyana. It has 3.8 million hectares of continuous and virtually untouched Amazon forest.

main remnants of the Atlantic Forest, which used to cover the entire eastern coast of Brazil, from the state of Rio Grande do Norte to the state of Rio Grande do Sul.

The springs of water courses are characterized by being areas with high natural vulnerability, mainly because they are, almost always, associated with rugged terrain and/or presence of shallow land. These characteristics expose springs to a fragile condition against natural phenomena (caused due to weather or relief, or pedological and geological phenomena) or anthropogenic actions.

The margins of water courses, floodplains and flood beds have great diversity in terms of species and are the result of a natural phenomenon involving two periods: floods and ebbs. Usually these areas are covered by riparian vegetation, when preserved; exception refers to wetlands that naturally present a grassy undergrowth type; however in areas with intensive agricultural practices, the vegetation, even the one intended for riparian cover, is degraded, with a reduced and fragmented vegetation cover, leading to the extinction of many animals, imbalance in populations, etc. (AGOSTINHO et al., 1997).

Lakes, ponds and lagoons are extremely fragile, both in relation to contamination as volume commitment of its water bodies and may even completely disappear.

Sedimentary aquifers, for example the Guarani Aquifer, are recharged by two mechanisms: a) direct infiltration of rainwater in recharge areas; b) vertical infiltration along discontinuities in containment areas, which is a slower process (ROCHA, 1996; GOMES, 2008). The areas of direct recharge are regions where the aquifer is most vulnerable. Hence, the misuse of land in those areas compromises, in the medium and long terms, the quality of groundwater. Therefore, the need for special handling for these areas is evident, so that the entire system, which includes the areas of recharge and the aquifer itself (the confined part) can be managed sustainably. The sustainable management depends on the identification and control of pollution sources in recharge areas (ROCHA, 1996).

Mangroves are a typical of coastal wetlands in tropical or subtropical climates and are considered one of the most productive natural environments in Brazil, due to the large populations of shellfish, fish and mollusks that it shelters. Mangroves are real nurseries, areas of protection, feeding and reproduction, and contribute to the survival of bird and mammal species. Brazil has the world's largest mangrove belt with about 20,000 square kilometers, extending from the east (Cape Orange – state of Amapá) to the south of the country (Laguna – state of Santa Catarina).

Sandbanks refer to a set of ecosystems of distinct vegetal-floral and physiognomy nature, located predominantly in sandy soils, of marine, river, lagoon and wind origins, or combinations of these, of quaternary age, often with poorly developed soils (CONSELHO NACIONAL DO MEIO AMBIENTE, 2002). These plant communities form an edaphic and pioneering complex, which depends more on the soil than on climate, and are found in beaches, sand ridges, dunes and associated depressions, as well as in plains and terraces.

It should be pointed out that because of these significant natural vulnerabilities there is a national effort to include these fragile areas in the Brazilian legislation. It is noteworthy that since May 2012 a new Forest Law has been in force in Brazil, Law No. 12,651, mostly known as "New Forest Code", which establishes permanent preservation areas (PPAs) in order to protect biodiversity and water resources. More details will be discussed in Volume II of this Communication.

Given their natural vulnerability, combined to very sensitive social indicators, the susceptible areas prone to desertification correspond to the semiarid and dry sub-humid regions, located mainly in the Northeast region and in the north of the states of Minas Gerais and Espírito Santo. The predominant vegetation in these areas is typical of ecosystems in the Caatinga biome, corresponding to a large part of the semiarid Northeastern Brazil.

The total area of degraded planted pasture and degraded lands (eroded, deserted and salinized) is over 2.3 million hectares, or 3.5% of the degraded lands in the country. In these areas, the woody vegetation cover serves mainly for the production of firewood and charcoal for energy, stakes, poles, construction timber etc. Firewood extraction is an economic activity of high capillarity and when it is not performed in a sustainable manner, it threatens the continuity of the production of environmental goods and ecosystems services of the caatinga, which are already quite disadvantaged by climate adversities (PAUPITZ, 2013).

Brazil's semi-arid region is characterized by high evapotranspiration, periods of drought, shallow soil, high salinity, low fertility and reduced capacity for water retention, which limits their production potential. Furthermore, the desertification process is intensified by poverty, and vice-versa. The most alarming social indicators in the country are seen in Brazil's semi-arid region. The areas prone to desertification cover 1,340,172.60 km^2, which is equivalent to 16% of Brazil's territory, concentrating nearly 34.8 million inhabitants (17% of the Brazilian population) distributed in 1,488 municipalities (PAUPITZ, 2013). These numbers make this area the most populous dry region in the world. The municipalities of the ASD fall entirely in the area of operation of Superintendence of the Development of the Northeast (SUDENE).

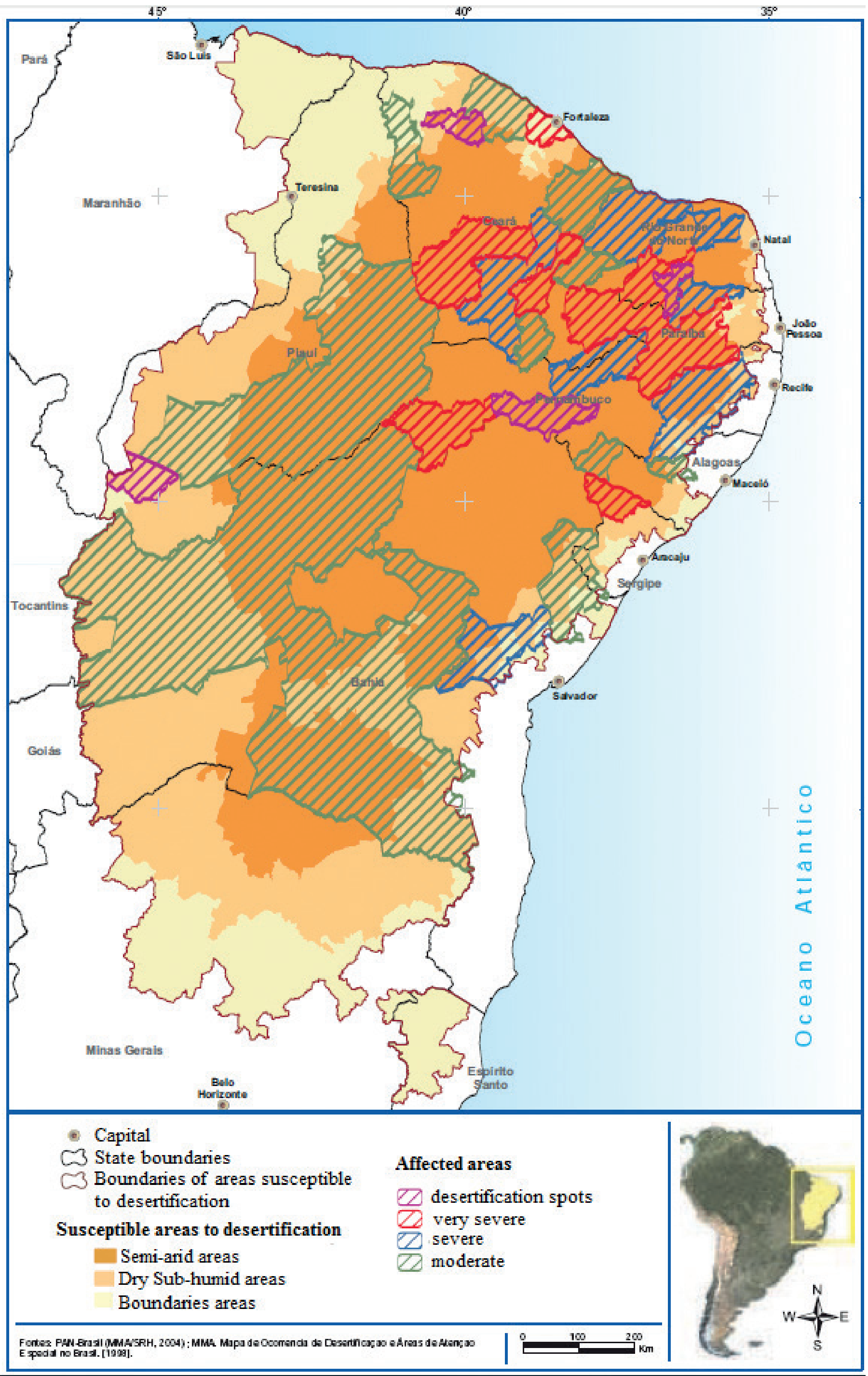
The semiarid Northeastern Brazil, with 1 million km^2, 20 million inhabitants, low and variables rainfall, high risk for agricultural activity and very low technological level, gathers the worst social and economic indicators of the country. The consequence has been slow, but continuous environmental degradation. The prevention and the fight against this degradation is the object of the United Nations Convention to Combat Desertification, of which Brazil is signatory. In this region the desertification is caused by a complex interaction of physical, biological, political, social, cultural and economic factors, often closed in vicious cycles that often progress in stages: 1) Deforestation; 2) soil degradation; 3) reduction of production and agricultural income; and 4) deterioration of social conditions. The erosion is the most serious cause of degradation of the semi-rid Northeastern Brazil, due to its irreversibility, the great extent of shallow soils, intense downpours and agriculture in areas of high slope and without any preventive measure (SAMPAIO, ARAÚJO and SAMPAIO, 2009).

Therefore, in Brazil, the process of desertification is a result of improper use of Caatinga forest resources, and sometimes also the Cerrado Biome. Agricultural practices without proper soil management, indiscriminate use of irrigation systems, with the consequent salinization and overgrazing in extensive farming, compromising the regeneration of species, associated with the actions of deforestation, causing erosion and depletion of soil.

Data from the Ministry of the Environment (BRASIL, 2004b) indicate that an area of 181,000 km^2 in the semiarid region has been seriously affected by the process of desertification, with the generation of diffuse impacts, covering different levels of degradation of soils, vegetation and water resources. The most critical areas, with intense degradation of resources and generating considerable damage, called desertified cores, were initially identified in four locations: Gilbues in the state of Piauí, Iraçuba in Ceará, Seridó, in the state of Rio Grande do Norte and Cabrobó in Pernambuco, totaling 21.7 thousand km^2 with a population of more than 444,000 inhabitants (Figure 1.9).

FIGURE 1.9

Affected areas and desertification spots in the Northeast region of Brazil



Source: BRASIL (2007)

Some measures can be taken to prevent desertification in areas of risk and to recover affected areas. Brazil, as provided for by the United Nations Convention to Combat Desertification, drew up the National Program to Combat Desertification and Mitigate the Effects of Drought (*PAN-Brasil*). The program is a means of planning that aims at setting the guidelines and the main actions for combating and preventing the desertification phenomenon in the Brazilian regions with semiarid and sub-humid-dry climate. The PAN is guided by the development of programs and actions outlined around four thematic axes, for the government's great objectives of strategic guidance in combating desertification. They are: reduction of poverty and inequality; sustainable increase of the region's productive capacity; conservation, preservation and sustainable management of natural resources; democratic management and institutional strengthening. The latter aims at strengthening capacity-building and creating new institutional structures to deal with the management of initiatives to fight desertification. The State Action Programs to Fight Desertification (PAE) – guiding documents for the planning and development of integrated actions and for the implementation of public and private investment in the states – were created to regionalize the *PAN-Brasil* program and give greater capillarity to its actions. They were created for the following states: Alagoas, Bahia, Ceará, Minas Gerais, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, Sergipe and Maranhão.

Brazil also has the Early Warning System for Drought and Desertification (SAP). The system is the result of a partnership between the Earth System Science Center (CCST), the National Institute for Space Research (INPE) and the Ministry of the Environment, with the collaboration of the National Center for Monitoring and Alerting of Natural Disasters (Cemaden).

For this end, a database containing geographic information on physical-environmental and socioeconomic status is being developed, allowing the interaction of desertification indicators. Aiming at crossing information, Geology, Geomorphology, Pedology data from various sources (CPRM, RadamBrasil, Embrapa/Recife) had to be adjusted to the same scale of 1:500,000 and resolution (90m). The data of the Land Use and Cover sector were made on top of satellites images, Landsat/TM and ETM7, year 2010, with a resolution of 30m. The interpretation scale was 1:150,000. However, after completion of the mapping of land use and cover classes, the data was re-sampled for resolution of 90m and 1:500,000 scale. The geographic database has also been fed with socioeconomic and demographic information, at the municipal level, such as: livestock density, outbreaks of hot spots, protected areas (full protection and sustainable use), Human Development Index (HDI) and rural population density. These indicators were selected taking into account their availability for the entire study area and the ability to capture and monitor the desertification process.

The methodology used for the development of the system is based on the methodology developed by MEDALUS Project, which, due to the geo-environmental complexity of the Northeast Region of Brazil, had to be adapted to meet local conditions. This methodology was validated at a regional scale and locations in countries like Italy, Spain, Portugal and Greece, among others (BASSO et al., 2000; BRANDT, GEESON and IMESON, 2003; SALVATI et al., 2011). The system includes four main variables: climate, soil, vegetation and land management (KOSMAS, KIRKBY and GEESON, 1999; KOSMAS et al., 2006; LAVADO et al., 2009).

Preliminary results indicate that, of all the indicators used by the SAP, in the initial phase of the project inadequate land management was one of the main factors for its degradation in the region.

In addition to the SAP, another important initiative by the Brazilian Government is the investment of R$ 20 million in projects towards sustainable development and the conservation of biodiversity of the Caatinga, fighting desertification, and recovery of degraded areas. Resources used come from the Climate Fund, the Brazilian Biodiversity Fund (Funbio), the Socio-environmental Fund of *Caixa Economica Federal* (the Federal Savings and Loans Bank), the National Project of Integrated Public-Private Actions for Biodiversity (Probio) (phase II) and the United Nations Development Program (UNDP)[10].

10 Portfolios available at http://www.mma.gov.br/biomas/caatinga

1.4. PRIORITIES FOR NATIONAL AND REGIONAL DEVELOPMENT

1.4.1. Social Development

The following subsections present the main recent advances in Brazil in terms of improvements in the opportunities of access to the education system, health care, basic sanitation, and in the fight against hunger, poverty and income inequality. Brazil has shown great performance, with international recognition, in combating poverty and extreme poverty. The important factors for these results were improvements in working conditions and household income and the impact of social programs, especially the Family Allowance Program (*Bolsa Família)*. These results combined have contributed to the reduction of income inequality, which, consequently, have contributed to the reduction of poverty.

These improvements have resulted in significant progress in Brazil with respect to the human development index. They are also reflected in the change in the Brazilian demographic profile, with lower fertility and birth rates, and the aging of the population.

The analysis below is based on indicators on the living conditions of households, extracted from the National Household Sample Survey (PNAD), as well as data and information compiled from the Fifth National Report of the Millennium Monitoring Development Goals, by the Institute of Applied Economic Research (IPEA, 2014).

1.4.1.1. National Social Policies System

Since the end of the 1980s, new social concepts became part of the Brazilian public agenda and began to guide the development of social policies in the country, especially the following:

- Reinforcement of selectivity and focus – priority in the agenda, resources and social actions, programs for the poor sectors, focusing expenses and actions on basic needs for the most vulnerable groups based on age and spatial location;
- Combination of universal and selective programs – differently from universalism versus selectivity, an understanding seems to have grown in Brazil that public basic education and healthcare networks are crucial and strategic both because of their services and because they can hold mass programs. This way, focused programs would complement universal programs, with mutual support;
- Minimum income programs – monetary transfers to guarantee minimum individual or family income levels became part of a list of anti-poverty programs, especially through formulas that establish a link between minimum income targets and targets for improving school and health performances for younger children;
- Public-private partnership – greater acceptance of non-governmental organization participation in offering social services, based on the understanding that, alone, the Government is unable to respond to the huge challenge posed by poverty, which makes it necessary, therefore, to expand on initiatives by the various organized segments of society to provide social services;

>> Expansion of production programs – in designing new programs, there is also growing concern for those that may contribute towards reinforcing the capacity and productivity of poor segments in generating income, such as training programs, support for micro and small enterprises and job creation;

>> Expansion of access to food programs – the purpose is to increase the supply of high nutritious foods and to improve the living conditions of families living in situations of food insecurity. When designing these programs, food and nutritional security are considered to be the guarantee of access to food on a daily basis, in sufficient quantities and with the necessary quality;

>> Job and income generation programs – these are actions to generate jobs and income in a sustainable manner for needy, vulnerable families, who benefit from social programs.

In this context, and with the intent of eliminating extreme poverty, in 2004 the Federal Government created the Family Allowance Program (*Programa Bolsa Família*), with a view to guaranteeing the right to food, health, education and achieving citizenship to the population most vulnerable to hunger. In this program, the government transfers funds directly to the families and they assume the commitment to keep their children in school and to monitor the health of children, adolescents and pregnant women.

The *Cadastro Único* (or Single Registry) is the main instrument for the management of the *Bolsa Família* Program and a series of other social initiatives. The Federal Government identifies and qualifies the low-income families through this computerized database. The Government also knows the socio-economic reality of these families, because the *Cadastro Único* consolidates information for the entire family nucleus, the characteristics of the household, the forms of access to essential public services, and also, information on each members of the family. From there, public authorities can formulate and implement specific policies that contribute to the reduction of social vulnerabilities that low-income families are exposed to. The *Cadastro Único* is coordinated by the Ministry of Social Development and Fight Against Hunger (MDS), and must be used for selecting beneficiaries of Federal Government social programs, such as the *Bolsa Família*.

In recent years, the country has also began to implement a set of affirmative-action programs, aimed at, for example, promoting greater access conditions for the black population to the higher education system. The fight against racial educational inequality is a way to combat the Brazilian poverty because the blacks are over-represented in this condition and their difficulty in finding better jobs is associated with their low level of education. The Secretariat of Policies for the Promotion of Racial Equality (SEPPIR) was created in Brazil at the federal level, the Statute of Racial Equality was approved.

Currently, the main social policies in place are those geared towards combating poverty and hunger; universalization and educational qualification; job and income generation for the poorest; expansion and improvement of health services; combating socioeconomic inequalities and those inequalities resulting from race and gender. In summary, they are policies focused on improving the quality of life of Brazilians, especially those in a situation of social vulnerability (IPEA, 2014).

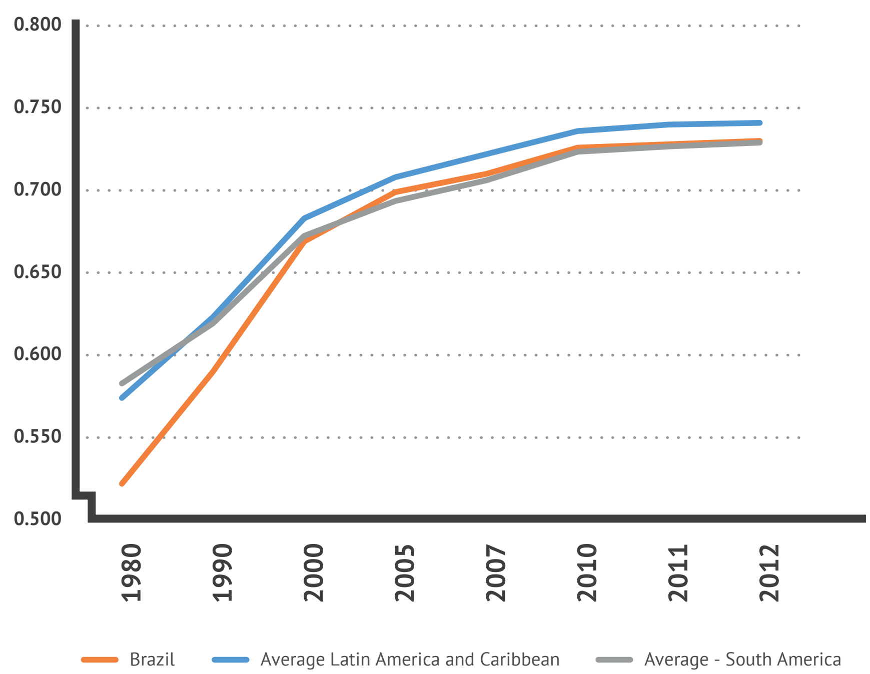
The *Brasil sem Miséria* Plan, based on three strands of activity (Access to Services, Guarantee of Income, Productive Inclusion), structures and adds a number of social policies and programs currently underway in Brazil. Its objective is to raise the population's income and well being. Subsequently, the *Brasil sem Miséria* Plan launched the *Ação Brasil Carinhoso*, aimed at the most vulnerable parts of the Brazilian population, children aged zero to six years old, in the so-called early childhood. The strategy of the *Ação Brasil Carinhoso* was designed to pull out of extreme poverty, by means of income transfer, all households beneficiary of the *Bolsa Família* Program that had children aged up to 6 years.

1.4.1.2. Human Development in Brazil

The Human Development Index (HDI) is a summary measure of human development in a country, used to measure the progress achieved, on average, in terms of three basic dimensions: average life expectancy; access to knowledge, based on adult literacy rates and the combined gross enrollment rate; and purchasing power parity – PPP of GDP per capita, in U.S. dollars. Figure 1.10 shows the evolution of the HDI of Brazil in relation to the Latin American and Caribbean countries in Latin America and the Caribbean and in South America between 1980 and 2012. It is worth pointing out that the Brazilian HDI approached considerably from that of Latin America and the Caribbean during the 1990s, and maintains, since 2010, nearly the same average level of South America, below the average of the former. Also worthy of note that Latin America and the Caribbean hold an average HDI superior only to that of South Asia and the sub-Saharan Africa.

FIGURE 1.10

Evolution of the Human Development Index – Brazil, South America and Latin America and the Caribbean – 1980 a 2012



Source: From PNUD (2013)

According to the 2013 Human Development Report, prepared by the United Nations Development Program, Brazil fell by 10 positions compared to its position in the Report published in 2009, reaching the most recent position of 85th, in the global ranking, being currently considered a country with high human development. Despite the worsening of the relative position of Brazil in the classification, the report mentions that Brazil is on the list of 15 countries whose deficit achieved larger reductions in terms of HDI (PNUD, 2013).

In this context, the Institute of Applied Economic Research (IPEA) of Brazil addressed, in Statement No. 159, published in October 2013 (IPEA, 2013a), the detachment observed between the Gross Domestic Product (GDP) calculated in the National Accounts and the income reported by the population in household surveys, already pointed out in December 2012 by Neri (2012). The expansion of the discrepancy between these two magnitudes in 2012 was surprising: while the Brazilian GDP grew by 0.9% in real terms, the total income of the families, measured by micro data of more than 360,000 people interviewed across the country in the last National Household Sample Survey (PNAD), grew by 8.9% more than inflation. Based on this information, new data from the PNAD was compared with the historical series from 1992, in order to analyze two decades of evolution of poverty and inequality according to the household income *per capita*, which serves as the basis for social literature and the important public policies, which goes a long way toward meeting the following parts of the Human Development Report 2013:

> **"As advocated in Human Development Reports in 1993 and 1996, the relationship between growth and human development is not automatic. It must be forged through policies in favor of the poor that, as a whole, contribute to the investment in health and education [...].**
>
> **[...]**
>
> **The level of households, the increase in income, contributes to a greater satisfaction of basic needs and to increase the level and quality of life. However, higher income does not necessarily translate into a corresponding improvement of human well-being." (PNUD, 2013).**

Thus, the study conducted by IPEA examined the evolution of the main indicators of income, possession of durable goods and access to essential public services as well as the evolution of poverty and inequality to answer how income, poverty and inequality of income of households evolved in the last two decades (Table 1.1).

TABLE 1.1

Annual variation rate of the indicators of income and consumption in selected time periods (%)

INDICATOR	1990/2012	1992/2002	2002/2012	2011/2012
	%			
GDP per capita	1.94	1.29	2.59	0.06
Family consumption per capita	2.44	1.73	3.15	2.23
Average income per capita	3.09	2.53	3.65	7.98
Mean per capita income	3.85	2.1	5.64	7.6
Minimum wage	2.49	-0.22	5.26	7.89
Pop. with basic set of goods (p.p)*	1.78	1.72	1.84	2.16
Pop. with basic set of services (p.p)**	0.93	1.06	0.81	0.98

Note: PNAD data excluding rural areas of the northern region (except Tocantins). Change rate of minimum salary calculated from October of the first year to October of last year.

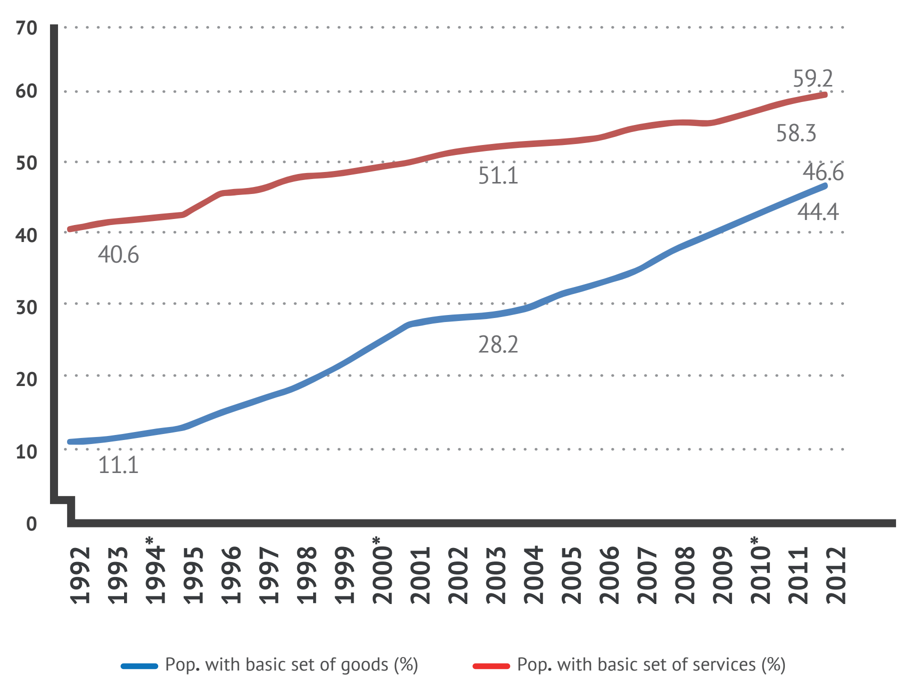
Source: IPEA from PNADs of 1992, 2002, 2011 and 2012. System of National Accounts.

Table 1.1 shows the variation rate of income in selected time periods. In the comparison of decades, it was observed the period from 2002 to 2012 was particularly beneficial to the families: the *per capita* household income increased by 3.6% per year against 2.5% in the previous decade, and similar results were noticed in the *per capita* GDP and *per capita* consumption of households. The minimum wage, whose purchasing power fell by 0.22% per year between 1992 and 2002, rose by 5.26% per year in addition to inflation in the following decade, thus contributing to the increase in family income and to the fall in inequality observed in this period.

The progress shown by PNAD is not restricted only to household income; in 2012, an expansion in the number of people with access to essential public services and a combination of durable consumer goods (Figure 1.11) were also observed. In the period from 1992 to 2012, the population that had access to essential public services and basic durable goods increased by 0.9 percentage points per year, respectively. Both for the whole period and for each decade, separately, the conclusion of the data from the PNAD is that the private conditions of the life of the families – represented by both household income *per capita* and the possession of durable goods – progressed further than the provision of essential public services by the State.

FIGURE 1.11

Possession of durable goods and access to essential public services, 1992-2012



Notes: Basic set of goods = telephone (fixed or mobile), color TV, stove with two burners or more, refrigerator, radio and washing machine. Basic set of services = electricity + waste collection (direct or indirect) + sewage (general system or septic tank connected to the network) + water (general network). Excluding rural areas of the northern region (except Tocantins). Values 1994, 2000 and 2010 obtained by linear interpolation.

Source: IPEA (2013a)

1.4.1.3. Evolution of poverty and income inequality in Brazil

In the beginning of the 1990s, Brazil had one of the highest degrees of inequality in the world, where the average income of the richest 10% was almost thirtyfold greater than the average income of the poorest 40% (BRASIL, 2004a). However, according to the study by IPEA (2013a), previously mentioned, while the poorest 10% of the Brazilian population experienced a 14% increase in household *per capita* income, the income increase obtained by the richest 10% was 8.3% between 2011 and 2012.

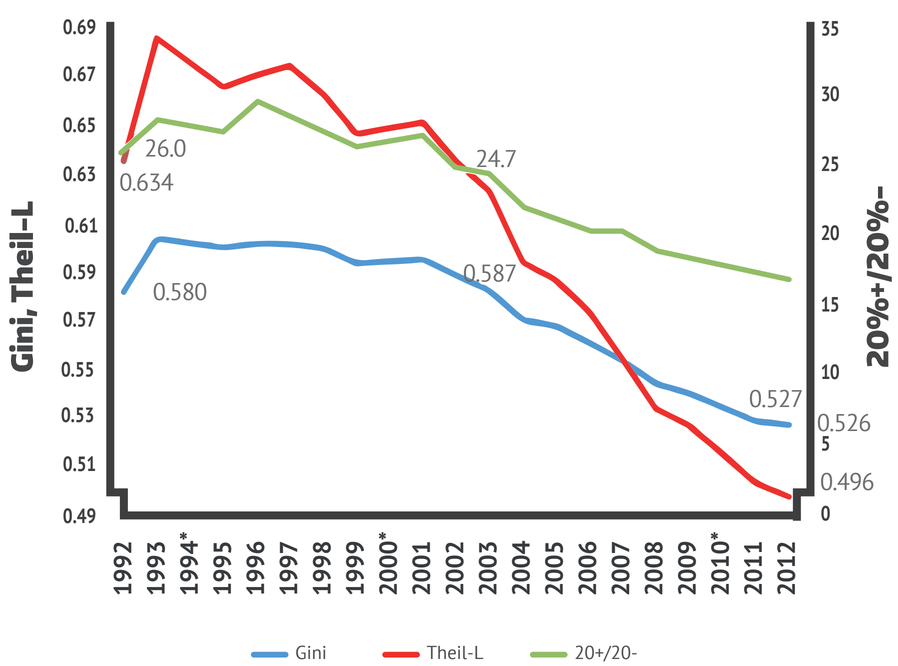
An analysis of the last two decades shows the poorest have been greatly benefited over the past 10 years: while the average income of the poorest 40% increased by 6.4% per year, the annual increase to the richest 5% was 2.4%. This evolution was quite different from that which occurred in the previous decade: in the 1992-2002 period, income growth of the richest 5% surpassed that of the poorest 40% (2.87% per year as against 2.55% respectively).

For a more complete perception on the evolution of income inequality, however, it is necessary to use synthetic indicators – the most usual are the Gini index and the L Theil measure. Both are indexes that vary between zero and one, where 0 (zero) is the case of a perfectly egalitarian society and 1 (one) is the case in which only one individual receives all of society's income. In other words, the higher the index, the greater the income inequality.

Figure 1.12 below shows the evolution of inequality in the 1992-2012 period. Besides the Gini and Theil-L indexes (scale on left axis of the graph), the 20+/20- ratio (scale on right axis) is also shown, representing how much the richest 20% grabs out of the income share in relation to the poorest 20%. The higher this ratio; the greater the inequality would be.

FIGURE 1.12

Inequality indicators, 1992-2012



Note: Excluding rural areas of the northern region (except Tocantins). Values of 1994, 2000 and 2010 obtained by linear interpolation.

Source: IPEA, from micro data of the PNADs 1992-2012

The data show that, since 2002, the *per capita* household income inequality has been decreasing, despite one of the indicators – the Gini index – has remained practically stable in the comparison between 2011 and 2012.

Table 1.2 compares these indicators and the 10+/40- ratio at specific points of the last two decades. It is evident, through the annual variations, the strength of the egalitarian process manifested in the 2002-2012 period, after a decade of erratic movement as regards the evolution of inequality. While indicators such as the Gini index and the 10+/ 40- ratio showed a consistent reduction in the last ten years, in the period before showed a small increase.

TABLE 1.2

Indicators of inequality for selected years

INDICATOR	VALUE			ANNUAL VARIATION (%)		
	1992	2002	2012	1992/2002	2002/2012	2011/2012
Gini	0.58	0.587	0.526	0.12	-1.09	-0.3
Theil-L	0.634	0.634	0.496	0	-2.42	-1.1
Ratio 20+/20-	26	24.7	16.8	-0.51	-3.78	-3.4
Ratio 10+/40-	5.3	5.5	3.8	0.37	-3.63	-1.4

Note: Excluding rural areas of the northern region (except Tocantins)

Source: IPEA (2013a)

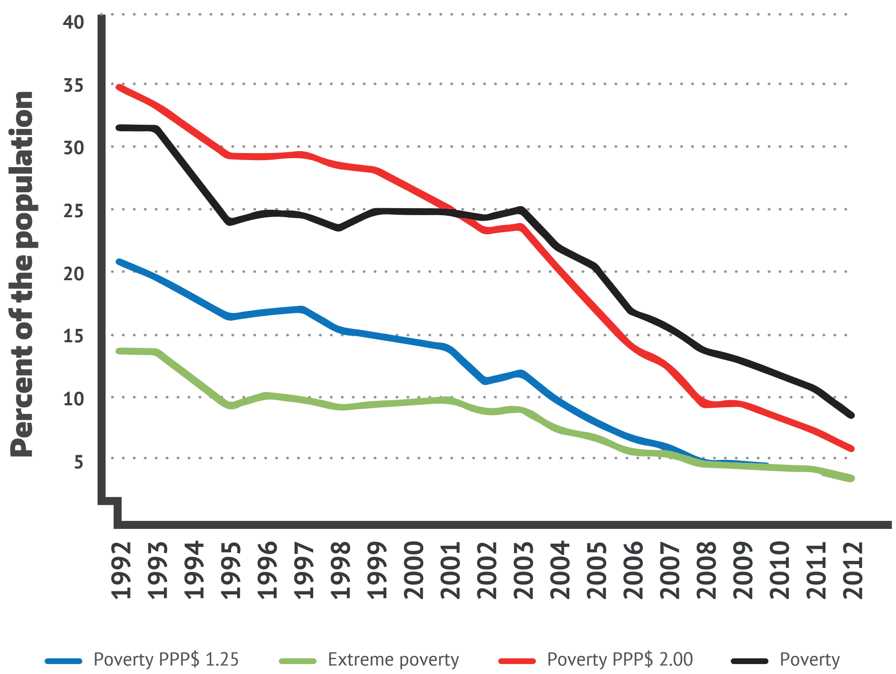
With respect to poverty, Figure 1.13 shows its evolution in Brazil between the years of 1992 and 2012, measured by the proportion of the poor. Four distinct poverty lines were considered: two of them relating to the targets of the Millennium Development Goals (US$ 1.25 and US$ 2.00 per day, converted by purchasing power parity – PPP) and the other two relating to the eligibility criteria for access to federal income transfer programs (R$ 70.00 and R$ 140.00 monthly, adopted in July 2011, corrected by the National Consumer Price Index – INPC).

In 2012, Brazil had approximately 6 million people living in extreme poverty, or about 3.5% of the population, according to the two extreme poverty criteria. Depending on the criterion adopted with respect to the poverty line, conclusion is that Brazil had 10 or 15 million people living in poverty, or between 5.8% and 8.5% of its population, respectively.

More important than the difference in figures is the trajectory of poverty in the last decade: since 2004, poverty has been steadily decreasing, as a result of both an increase in household income *per capita* and the fall in inequality observed in this period.

FIGURE 1.13

Evolution of poverty according to the proportion of poor people, 1992-2012



Note: Excluding rural areas of the northern region (except Tocantins). Values of 1994, 2000 and 2010 obtained by linear interpolation.

Source: IPEA (2013a)

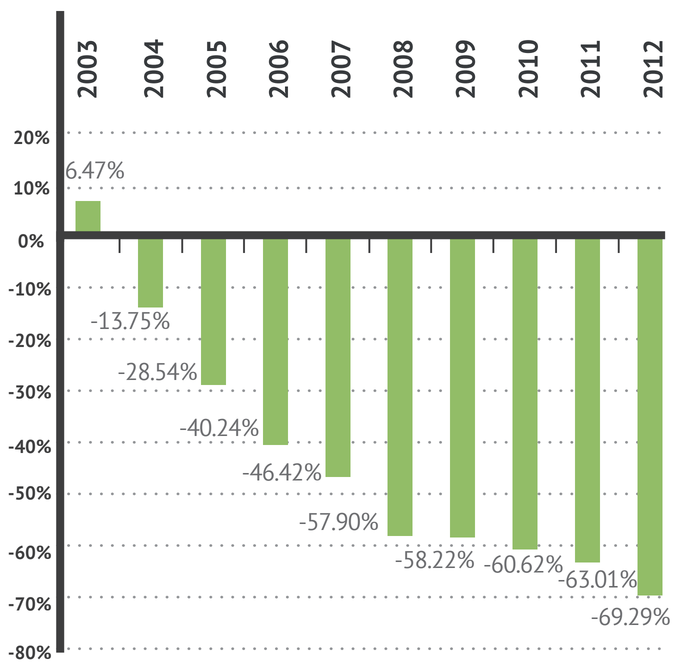
In the comparison between decades, the period of greatest poverty reduction occurred between 2002 and 2012: under the international poverty line of US$ 1.25 PPP/day, the reduction in the number of people in extreme poverty was 10.4% for the year, against 4.2% in the previous decade. In relation to poverty, the reduction was 12.1% per year in the 2002-2012 period compared to a reduction of 2.1% in the previous period.

In observing the international poverty and extreme poverty lines of the Targets of Millennium Development Goals (MDGs), of the United Nations, both have been falling significantly since 2002, and Brazil easily achieved the goal in advance, in 2008. By its own will, Brazil fulfilled the commitment of a quarter of a century in just 6 years, accumulating, by 2012, a decade after, a reduction of 69.29% in the extreme poverty line of US$ 1.25 PPP/day, and 74.8% if considered the line of US$ 2.00 PPP/day (Figures 1.14 e 1.15)[11].

11 For the first MDG, extremely poor people living on less than US$ PPP 1.25 per day, or US$ PPP 38.00 per month, are considered. The so-called factors of Purchasing Power Parities (PPP) are a conversion rate, calculated by the World Bank, of how much Brazilian Reais are required to purchase the same products that one US dollar would buy in the United States. In 2012, the international extreme poverty line corresponded to R$ 2.36 per day, or R$ 71.75 per month in Brazil. The amount of R$ 70.00 corresponds to what most closely approximates the extreme poverty line, acting as a guideline for the Brasil sem Miséria Plan, for example, created in June 2011, and which became part of the Bolsa Família Program. As of June 2014, by means of Decree No. 8,232 of April 30, 2014, this amount was updated to R$ 77.00.

FIGURE 1.14

Accumulated poverty variation since 2002 – US$ 1.25 PPP/day

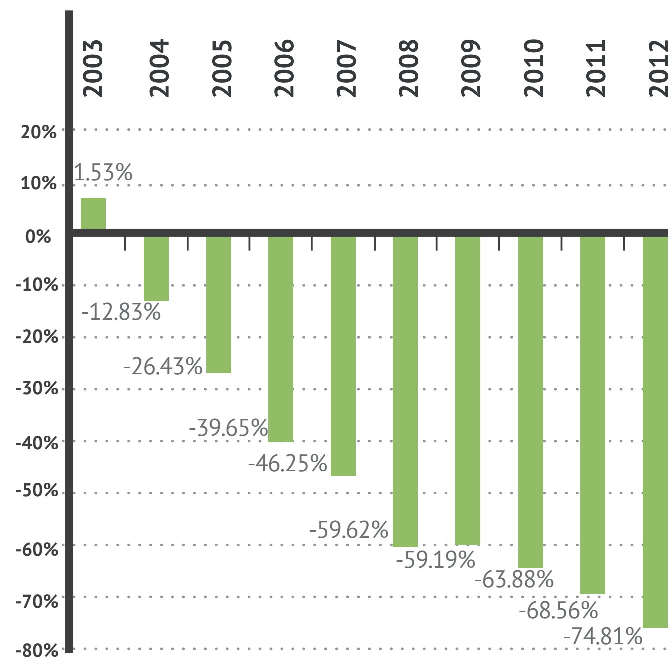


Note: Excluding rural areas of the northern region (except Tocantins)

Source: IPEA, from micro data of PNADs 1992, 2002, 2011 and 2012.

FIGURE 1.15

Accumulated variation of poverty since 2002 – US$ 2.00 PPP/day



Notes: Excluding rural areas in the North region (except Tocantins). Values of 1994, 2000 and 2010 obtained by linear interpolation

Source: IPEA (2013a)

Summing up, it should be emphasized that based on the data of 2012, Brazil was one of the countries that contributed the most to the global achievement of the first target of the Millennium Development Goals (MDG): to cut hunger and poverty to the extent that it succeeded in reducing extreme poverty to less than one-seventh of the 1990 level. Furthermore, originally, the target agreed upon by the international community was to cut extreme poverty and hunger to half of 1990's level by 2015, but Brazil decided to establish more ambitious targets than the global ones: to reduce extreme poverty to one fourth of 1990's level and to eradicate hunger by 2015. Taking into account the indicators chosen by the UN to monitor the first MDG target, Brazil's international and domestic targets were achieved in 2012.

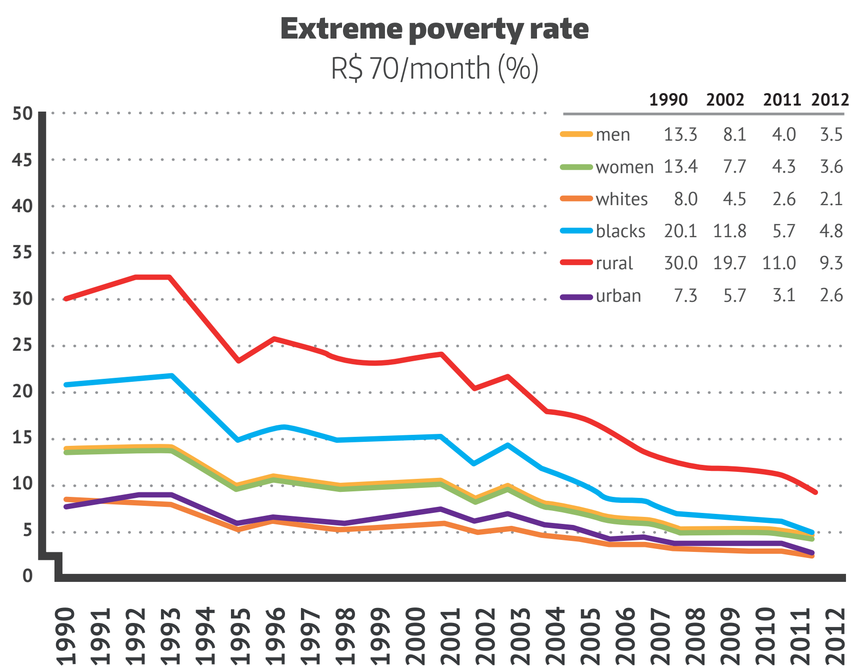
As already highlighted, the reduction of income inequality was an important contribution to the fall of the extreme poverty rate in Brazil. Seen in another way, there was a significant income transfer between the richest 20% of the Brazilian population to the intermediate layer in the distribution. In other words, the intermediate layer received the most of the 8% share of the national income lost by the richest 20% from 1990 to 2012 (IPEA, 2014).

A look at the behavioral evolution of the rate drop of extreme poverty in Brazil, disaggregated by social groups, reveals it has been (virtually) eradicated among the elderly. A broad set of social policies aimed at this group, such as, for example, the expansion of the Continued Provision Benefit (*Benefício de Prestação Continuada* – BPC) or the Rural Welfare, is responsible for the results achieved. In the case of children aged 0 to 6 years old, therefore, in the range of early childhood, the rate of extreme poverty dropped from 21.3% in 1990 to 6.0% in 2012. With respect to racial inequality, there was a reduction in the period. In 1990, the likelihood of blacks being extremely poor was approximately three times higher than that of white people. In 2012, the probability of extreme poverty among blacks was still twice the white population. This is explained by the fact that in spite of the improvement, there is still a lot to move forward in the fight against racial inequality in Brazil, whose determinants reside mainly in educational inequality.

Also worthy of note is the fact that, unlike in other countries, in Brazil there is no inequality in the rates of extreme poverty among men and women (Figure 1.16). This does not mean, however, that asymmetric relations of gender do not influence the extreme poverty experienced by women.

FIGURE 1.16

Evolution of the Brazilian extreme poverty rate as per socio-spatial breakdown



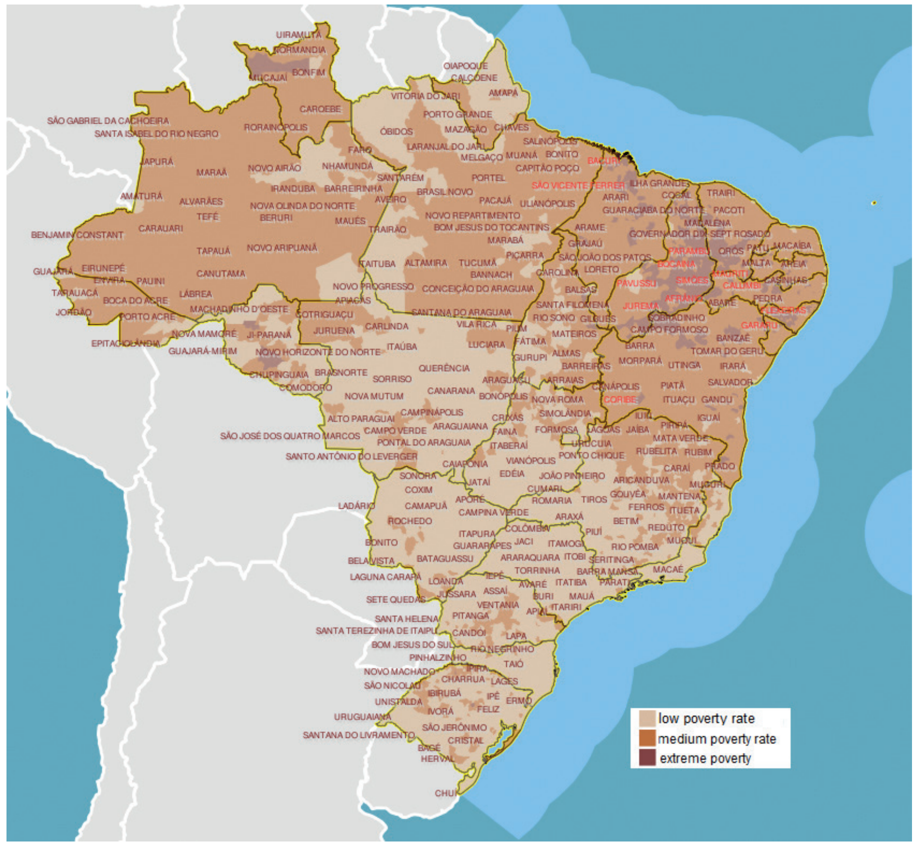
Source: IPEA (2014)

In rural areas, the decline in the rate of extreme poverty was more pronounced in the period, *vis-a-vis* the urban area: 20.7 percentage points against 4.7. However, as the rural poverty is much more present than in the urban environment, in 2012, the rate in rural areas (9.3%) were still higher than the urban environment rate (2.6%), as shown in Figure 1.16.

Still in spatial terms, the Northeast region of Brazil is the area with the highest incidence of extreme poverty: 7.3% of the local population. But in the period under study (1990-2012), the rate left the initial level of 28.5%. The Northeast is a region that will need special attention from public policies to adapt to global climate change because it brings together social vulnerability to climate vulnerability. It is an area that currently has adverse climate conditions and that may worsen, especially in its semiarid part, as informed by the Brazilian and international climate forecast models. Climate change brings implications for agriculture in the region and consequently to the food supply and food security and nutrition of families present in this territory (see Figure 1.17). The darker areas of intense poverty correspond to municipalities located in the Northeast semiarid region.

FIGURE 1.17

Distribution of the incidence of poverty in the Brazilian territory



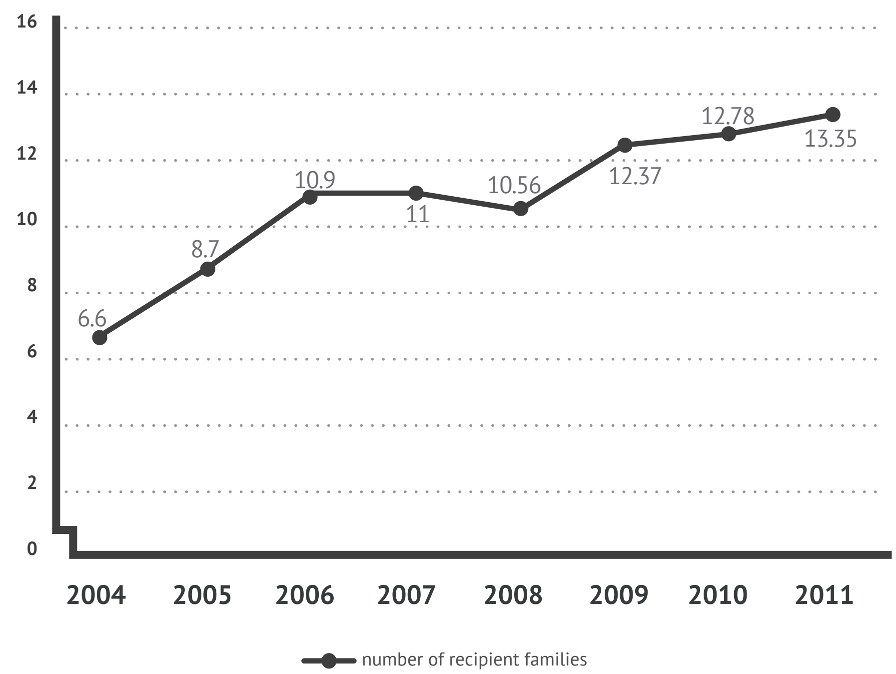
Source: IPEA (2014) with data from the Ministry of Social Development and Fight against Hunger[12]

The resistance to the reduction of the Brazilian income inequality in the 1990s and its subsequent period of sharp fall rose, in the past, investigations with respect to the determinants of this reduction. At the time, a study by a renowned international specialist in inequality and poverty, in partnership with his colleagues (BARROS et al., 2006), demonstrated the government income transfers accounted for one-third of the drop in the income inequality observed in the 2001-2004 period, which proves the importance of this government initiative, strengthened in 2004 with the creation and gradual expansion of *Bolsa Família* Program (Figure 1.18) coverage. It is important to note that government transfers did not only impact the income of families positively. Improvements in the labor market, recovery of the minimum wage, better access conditions to jobs and worker productivity also contributed to a higher income from work.

12 Available at: http://mapas.ipea.gov.br

FIGURE 1.18

Number of Brazilian families benefiting by the Bolsa Família Program (in millions)



Source: IPEA (2013b)

Since the 1990s, the inequality of labor income has been declining, but in the period under study (2001-2004) a clear acceleration of this decline is observed. Had this labor income inequality fall not occurred in recent years, the decline in income inequality would be 50% lower. The increase in worker productivity is an important factor that explains the improvements observed in income inequality for the period.

An analysis of the evolution of productivity of Brazilian workers in the 1995-2012 period reveals that despite years of negative changes, the trajectory is for growth, with an accentuation from 2007, when the increase in productivity was at an average rate of 1.8% per year.

Another positive information about the labor market in this period is that the occupation rate for the working-age group grew for the 20-64 years-old age group. In the age groups of 15-19 years-old and 65 years-old or more, the occupation rate has fallen due to increased coverage of the social protection system for the elderly and the increase of the level of education of young people, which now stay longer in school, delaying their inclusion in the labor market.

Also, the level of formalization varied from 1992 to 2005 at around 46% of the occupied population. From that moment on, it began to rise, achieving almost 58% in 2012. In general, workers with precarious or non-existent employment relationships are the ones that remain in extreme poverty, so the improvement in the degree of formalization in the country impacted positively to the reduction of poverty in Brazil.

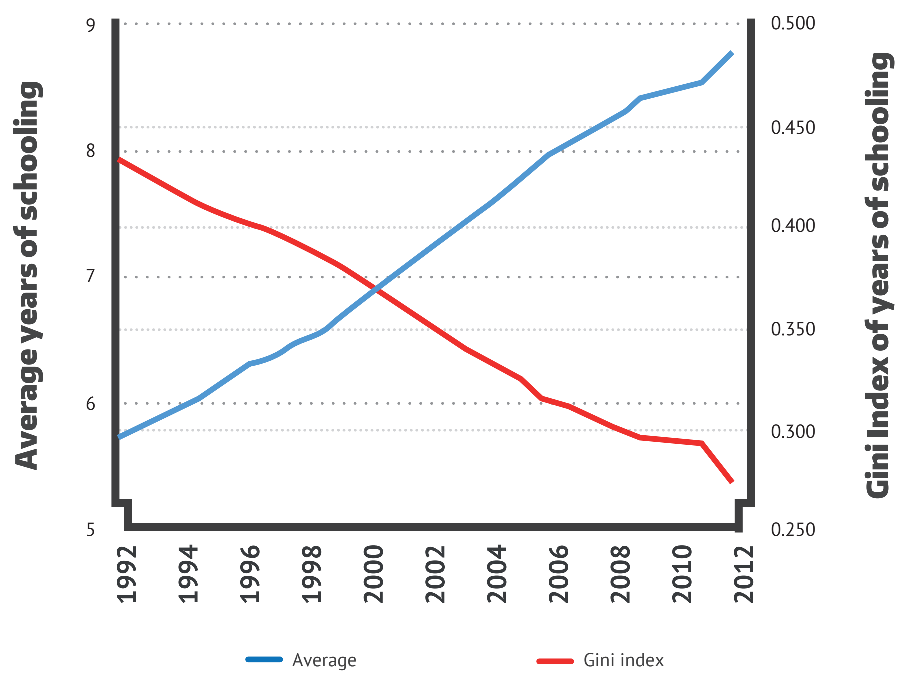
However, the occupation rate of working-age women is not good; it is much lower than that observed for men: 50.3% against 74.1% in 2012. It is observed that the more children per woman, the lower the occupation rate will be. Women who are mothers of one or more children have an occupation rate of 43.1%. Women with two or more children have an occupation rate of 30.0%. Initiatives such as the already-mentioned *Brasil*

Carinhoso, that among a broad range of actions, created incentives for the municipalities to increase the amount of vacancies in daycare centers and pre-schools, are relevant to increase the chances of mothers to occupy posts in the labor market.

The educational advancements were one of the main social changes in Brazil in the past two decades. Unlike in the past, the expansion of the access to education in the country promoted both the increase in the average years in school and the reduction of educational inequality, which, in turn, had positive effects on the reduction of income inequality in Brazil. Figure 1.19 below corroborates this assertion. In 1992, the Brazilian workforce combined low schooling (average of 5.7 years in school) with great inequality (Gini coefficient of 0.435). Two decades later, the average rose to 8.8 years (54% growth) and the Gini fell (37%), achieving the level of 0.274 (IPEA, 2013a).

FIGURE 1.19

Average and Gini index of years of schooling of the remunerated occupied population – Brazil, 1992/2012



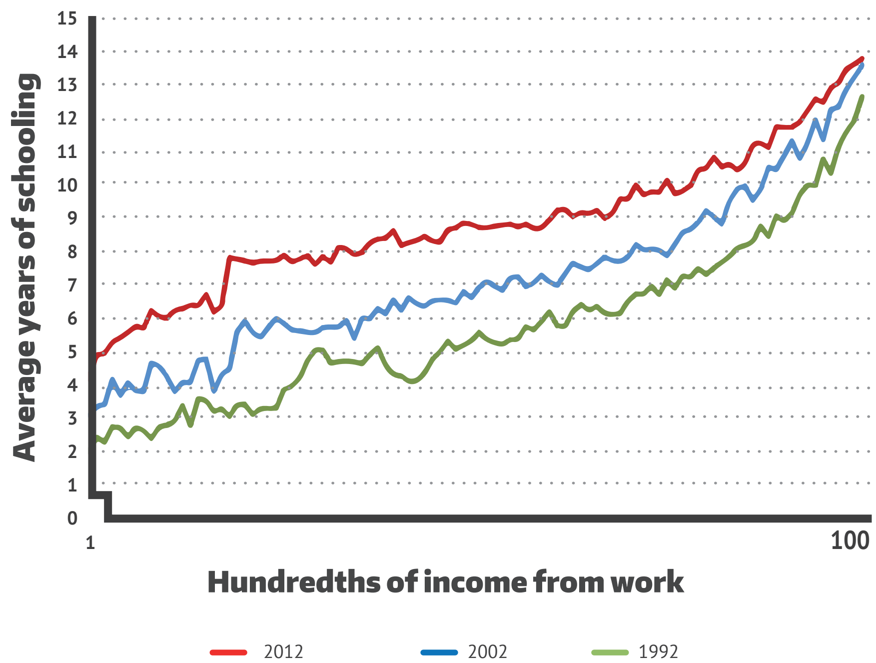
Note: The figure above includes data from rural areas of the Northern Region of Brazil (except Tocantis). Years of schooling vary between zero, for those who have never attended school, and 15, for those who completed the higher level. In Brazil, by definition, those who finished Elementary School have nine years of schooling and those who finished High School eleven years of schooling.

Source: IPEA (2013a)

An analysis of the evolution of the average schooling of Brazilian workers, as per the hundredths of work income distribution, further reveals the positive quality of educational advances experienced in the country (Figure 1.20). Since 1992, educational improvement throughout income distribution, in particular among the poorest of the poor, is perceived. In 1992, only the richest 15% had an average of more than eight years of schooling. In 2012, only the poorest one third in the distribution was below this level of education.

FIGURE 1.20

Average years of schooling by hundredths of work income - Brazil, 1992, 2002, 2012



Note: Including data from rural areas of the Northern Region of Brazil (except Tocantis).

Source: IPEA (2013a)

1.4.1.4. Profile of health care in Brazil

The objective of this section is to briefly introduce Brazil's health profile, focusing on epidemiological characteristics, the demand and supply of health services and expenses.

Infant mortality and mother's health

Ahead of many countries, Brazil has already achieved the goal of reducing childhood mortality[13], as agreed with the Millennium Development Goals. The rate fell from 53.7 deaths per thousand live births, in 1990, to 17.7 in 2011. However, child mortality is still high. For this reason, a lot of emphasis has been given in Brazil to the policies, programs and actions that contribute to the reduction of child mortality, such as, for example, the creation, in 1981, of the National Program of Incentive to Breastfeeding and the joining, in 1992, to the Baby-Friendly Hospital Initiative[14], created by the United Nations Children's Fund (UNICEF) and the World Health Organization (WHO). From 1990 to 2011, there was also a reduction in regional inequality. The rate decreased in all regions of Brazil,

13 Mortality rate among children aged under 5 years old. This rate expresses the frequency of deaths in this age group for every thousand live births, i.e., estimates the risk of death during the first five years of life.

14 The Baby-Friendly Hospital Initiative was conceived in 1990 by the WHO and UNICEF to promote, protect and support breastfeeding. The aim is to mobilize the staff of healthcare institutions to change behaviors and routines responsible for high rates of early weaning. Brazil currently has a network of 321 Baby-Friendly Hospitals, 212 human milk banks and 128 collection points.

with a more rapid pace in the Northeast (reduction by 76%, to an average of 6.6% per year). In 1990, the mortality rate in the Northeast region was 2.5 times greater than that of the South, a difference that was reduced to 1.6 times in 2011 (IPEA, 2014).

The child mortality rate in the country dropped from 47.1 deaths per thousand live births to 15.3 between 1990 and 2011. From 1990 to 2011, the differences between child mortality rates in the Northeast and South regions began to gradually decrease. The index of the Northeast region, which was higher than 70 deaths of children aged under 1 year old per thousand live births, decreased on average by 6.6% per year, reaching less than 20 deaths per thousand live births in 2011 (IPEA, 2014).

Improvements in the health and social conditions, in addition to demographic changes, are responsible for the better performance of the indicators of child mortality. However, the implementation of a system of universal health care, the Unified Health System (SUS), after the Federal Constitution of 1988, and the extension of the coverage of basic health care, mainly through the Family Health strategy, was also relevant.

The Family Health Program (PSF) is designed to provide continuous assistance in basic specialties to a population attended by means of family health teams. This multiprofessional team, comprised of a doctor, a nurse and community health agents, is responsible for basic actions of promotion, prevention, early diagnosis, treatment and rehabilitation, typical of primary care. While in 1995 115 municipalities adopted the Family Health strategy, in December 2013 it was already present in more than 95% of the Brazilian cities.

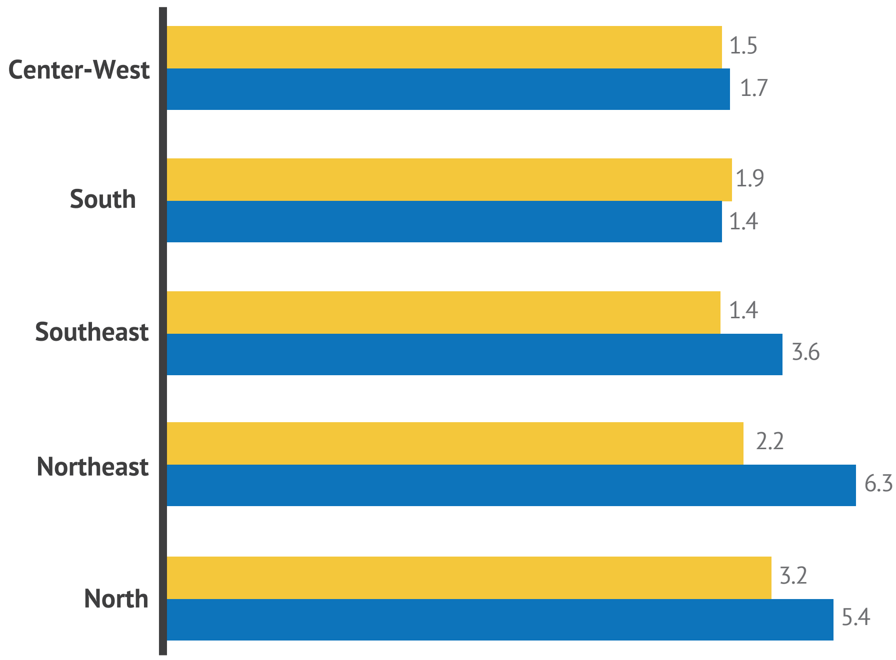
Prenatal care is an important factor for the reduction of child mortality and also mother mortality. From 1990 to 2011, mother mortality rate fell by 55%, from 141 deaths per one hundred thousand live births to 64. Moreover, in 2011, 99% of childbirths were in hospitals or other health institutions, and around 90% of pregnant women have four or more prenatal appointments.

Child malnutrition

Brazil achieved significant results in reducing the prevalence of child malnutrition in children aged below 5 years old, which is an indicator of child health condition, but also hunger proxy. Between 1989 and 2006, the prevalence of child malnutrition, measured as weight below that expected for age, was reduced to a quarter of its initial value: 7.1% to 1.8%, but this average masks some regional and social inequalities (Figure 1.21). In 2006, while among the richest 20% this rate was 1.2%, between the poorest 20% it was 3.7%. A rate lower than 2.3% means that acute malnutrition can be considered statistically eradicated among children (IPEA, 2014).

FIGURE 1.21

Rate of child malnutrition in Brazil (in %) – weight below that expected for age



Source: IPEA (2014)

The main factors that explain the improvements observed in Brazil regarding the indicators of child malnutrition are: increase of maternal educational level, greater provision of basic health services, expanded access to safe drinking water and sanitary sewage, and household growing purchasing power.

Demand and supply of health care services[15]

The demand for health services is associated with the level of development and the actual supply of these services by health networks. Health care use rates grow according to income levels. Furthermore, it has been ascertained that the higher the family income *per capita*, the higher the percentage of people who pay for the health services used, which is close to 60% in classes with family income *per capita* greater than two monthly minimum salaries.

In the past twenty years, the Unified Health System (SUS) progressed in expanding coverage, reducing inequalities in the access to health services and in the process of decentralization of the Federal Government responsibilities for the other states. The Federal Constitution of 1988 provided for the participation of the private sector in the health care system. This participation is materialized in the provision to the SUS, for the direct provision of services to the population and in assistance mediated by health insurance segment. Thus, part of the Brazilian population has access to actions and to health services both with public and private funding.

15 Portions of this section have been extracted almost entirely from the already quoted publication, "Social Policies: monitoring and analysis", No. 21, published by the Institute of Applied Economic Research, in 2013.

On October 24, 2011, the Ministry of Health released the new National Primary Care Policy (PNAB) with the purpose of reviewing some guidelines and standards of the previous edition. The main changes were: the recognition of other forms of organization of basic health care in addition to the Family Health strategy; the incorporation of policies oriented to specific population groups; inclusion of strategies to promote physical activity; changes in the financing system.

With these new measures, the PNAB recognized the multiplicity of forms of organization of Primary Care, channeling the teams of doctors' offices, creating health teams for riverside families (ESFR) and the river family health teams (ESFF), which use fluvial units to assist the remote communities of the Amazon and the Pantanal in the state of Mato Grosso do Sul. It also made investments for the creation of posts of the Health Academy (*Academia da Saúde)*, associated with the Health Academy Program (*Programa Academia da Saúde*), recognizing that physical inactivity increases the risk of developing several chronic diseases and the risk of premature death. It is worth pointing out that health promotion policies geared to encouraging physical activity are also incorporated into the Health at Schools Program (PSE), which is an intersectoral policy of the ministries of Health and Education, created in 2007.

The Stork Network *(Rede Cegonha)* was created in 2011 with the objective of reducing maternal and neonatal mortality. The resources intended for the development of this network are employed in strengthening the conventional hospital network, especially related to high-risk obstetrics, the creation of new structures of assistance, such as the Natural Delivery Centers[16], and the training of health professionals (IPEA, 2014).

Recently in Brazil, the service to the drug user has began to be recognized as a public health problem. Thus, the Psychosocial Care Network (*Rede de Atenção Psicossocial)* started seeking a better integration of health care services not only for the patients with mental disorders, but also to users of drugs and alcohol. In this case, the Psychosocial Care Network includes basic healthcare services that are provided in the Basic Units and also services of mobile teams of doctor's practice, in addition to Home Care Services (SRT).

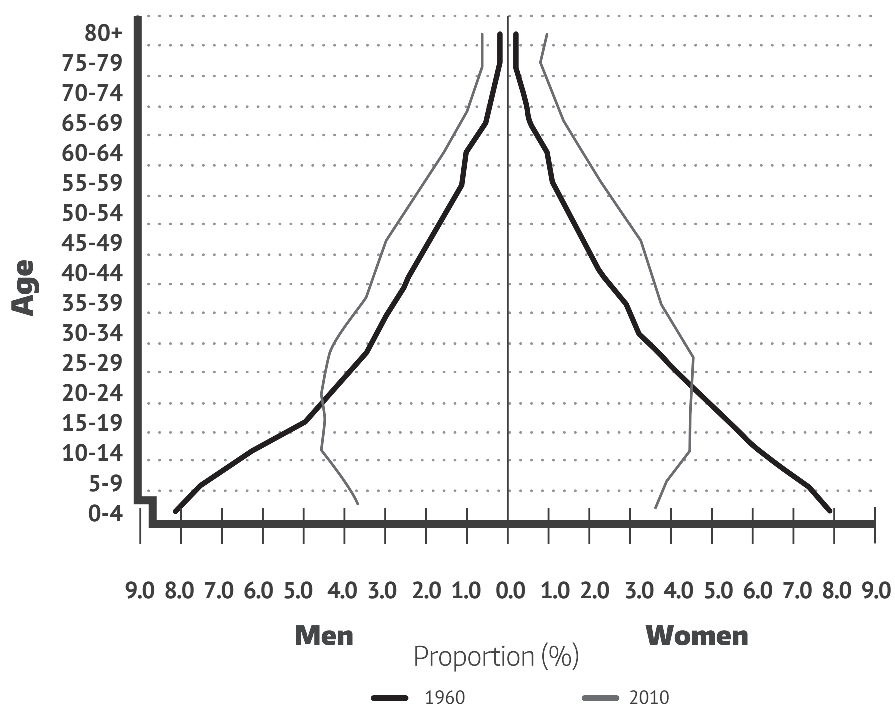
The rapid aging of the population (Figure 1.22), led to the need to intensify health surveillance, as a consequence of the change in morbidity and mortality patterns in Brazil. There was an increase in the occurrence of chronic non-communicable diseases, such as stroke, myocardial infarction, cancer, diabetes and respiratory diseases. In 2010, the chronic non-communicable diseases accounted for 68% of deaths in the country. As an example and comparison with the speed of the changes observed, resulting from the new Brazilian demographic profile, between 1998-2008, there was a relative increase of almost 50% in the prevalence of diabetes in Brazil.

Among adults (20-59 years old), external causes have been the main causes of death. However, when adding the figures for deaths by cancer (neoplasms) and diseases of the circulatory system, this set explains the greater part of adult deaths, reflecting the early mortality from chronic diseases in Brazil. In the elderly population, the non-communicable chronic diseases predominate as the cause of death, with an emphasis on diseases of the circulatory system.

16 In Brazil, a factor that makes the reduction of maternal mortality difficult is the high number of cesarean births. In 2011, 54% of deliveries in health institutions in Brazil were c-sections. The World Health Organization recommends that the percentage of cesarean sections should not exceed the range between 5% and 15% of the total number of births.

FIGURE 1.22

Relative composition of the total resident population by gender and age groups – Brazil (1960-2010)[17]



Source: Demographic Censuses 1960 to 2010- IBGE (IPEA, 2013b)

In order to meet the new demands for health services in Brazil, due to the change in morbidity and mortality profiles of the Brazilian population, the Brazilian health system increased the number of institutions, despite the decline seen recently in the number of beds. This movement was made to prioritize the guideline of decentralization, regionalization and to local government of the National Health Policy.

1.4.1.5. Access to sanitation services

The improvement of sanitation conditions in Brazil is an important factor that explains the improvements observed in some health indicators described above. This section is a brief summary of the progress observed in the recent period based on the statistics published by the 2010 and 2000 Demographic Censuses of IBGE.

In the period between the two censuses, the infrastructure of basic sanitation showed improvements in the water supply by general network, the flow by general network and septic tank, and waste collection from households. The less developed regions of the country showed significant growth in the period, although the advances achieved in the provision of basic sanitation services have not been sufficient to reduce regional disparities in access to appropriate conditions, especially if compared inhabitants of homes located in rural areas to the ones in urban areas.

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17 The combined effect of the fall in birth and fecundity rates, which in 2013 were at 13.82 (per 1,000 inhabitants) and 1.64 children, explains the change in the Brazilian demographic profile. In addition to the increase in life expectancy at birth to 74.23 years.

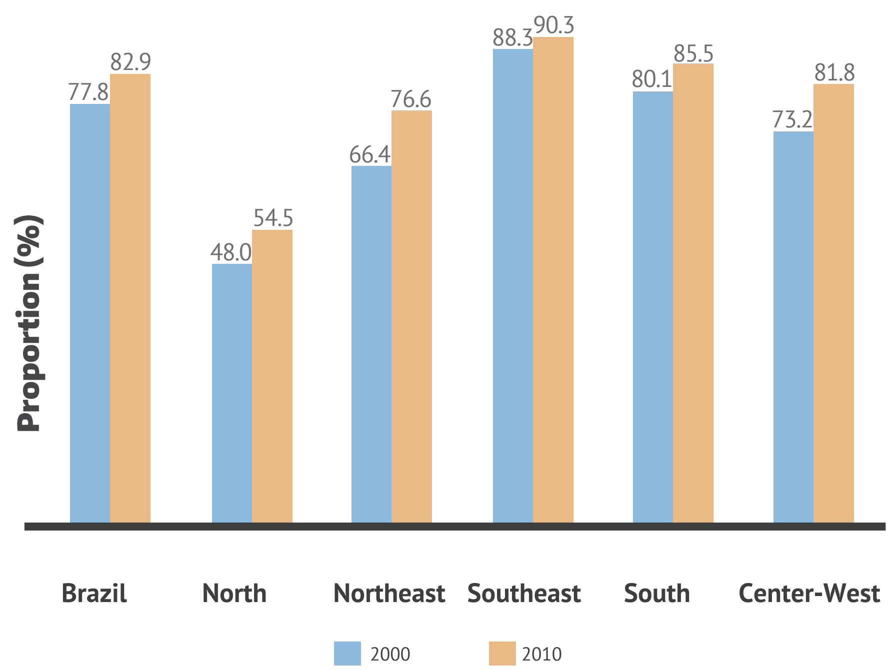
Water supply

The provision of water supply by the general network is associated with better quality of life for residents in permanent private households due to representing a higher degree of comfort and, in essence, a supply of better quality water.

The growth of the water service supply by the public network occurred in all major regions of the country, although unevenly (Figure 1.23). In 2010, the Southeast and South regions continued to be the ones that had the greatest percentage of households connected to the water supply system (90.3% and 85.5%, respectively), in contrast with the North and Northeast regions that, in spite of the progress, continued with the lowest rates (54.5% and 76.6%, respectively).

FIGURE 1.23

Proportion of permanent private households with general network of water supply per major region of Brazil



Source: Demographic Census 2000/2010 (IBGE, 2011)

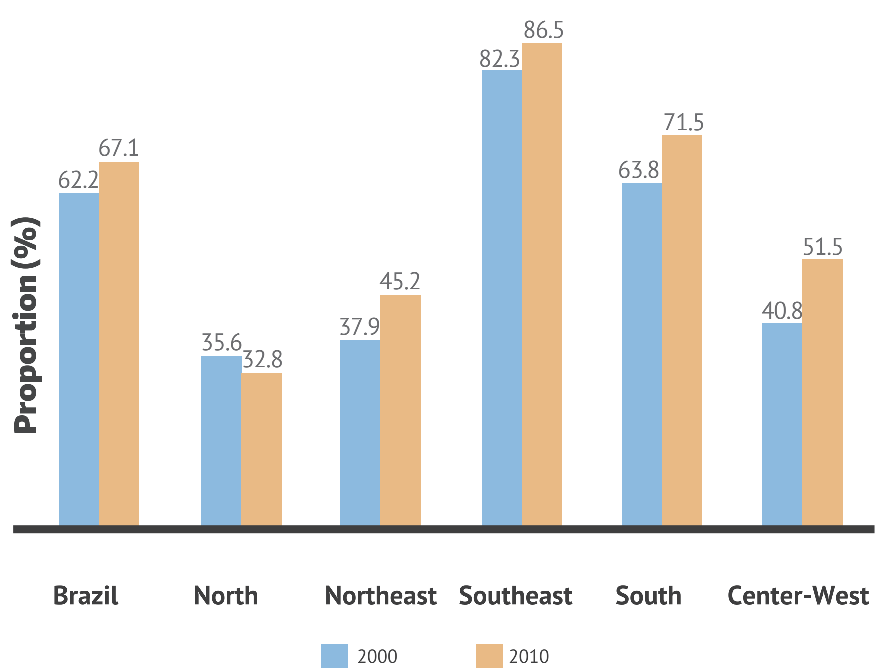
In 2000, the coverage of urban areas that had over 90% of households connected to the supply network was restricted to Southern and Southeastern regions. In 2010, it was also extended to the Northeast (90.5%) and Central-west (90.0%). The expansion of the water supply network took place significantly toward the rural areas. In the South region, the proportion of rural households with supply by public network rose from 18.2%, in 2000, to 30.4%, in 2010. In the Northeast region, in the same period, the growth in the proportion of rural households with supply by general network was even higher (18.7% and 34.9%, respectively). The North region, with the lowest proportion of households connected to the water supply network in 2010 (54.5%), showed a proportional growth in respect of year 2000 that was more accelerated in the rural area than in the urban zone: in the rural area there was an increase by 7.9 percent, while in the urban area increase was 3.7 percent.

Sanitary sewage

Of all the sanitation conditions, the sewage system is the one that still has a long way to go on the road of achieving satisfactory indexes that may ensure improvements in the living and health conditions of the Brazilian population, as well as preserve the quality of the environment. In the course of the ten years in-between Demographic Censuses, the proportion of households connected to the general sewage or septic tank network increased in four out of the five major regions of the country. The North region appears as an exception, in which the increase of 2.0 percent in the rural area was not enough to offset the 6.1 percent drop occurred in urban areas. The Southeast region continued with the best sanitary sewage conditions, going from 82.3% coverage in 2000 to 86.5% in 2010, with the greatest concentration in urban homes in both periods. The South region followed suit, going from 63.8% to 71.5% of households with proper sanitary sewage. The Central-west region showed the greatest growth in households with general network or septic tank in the period: above 10 percent. In spite of the improvement in sanitary sewerage conditions, the Central-west region still had a little over half of its homes with adequate sanitation (51.5%) and the North and Northeast regions showed even lower levels (32.8% and 45.2%, respectively). In these regions, rudimentary cesspits were the solution of sanitary sewage for both urban and rural homes (Figure 1.24).

FIGURE 1.24

Proportion of permanent private households with general sewage and septic tank network per major regions in Brazil



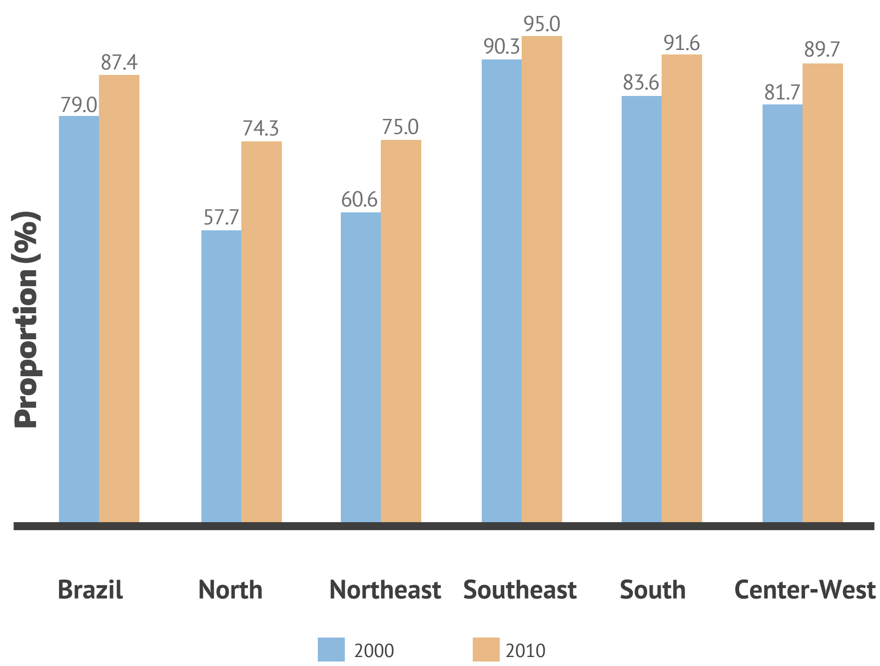
Source: Demographic Census 2000/2010 (IBGE, 2011)

Garbage Collection

Just like the other sanitation services, garbage collection increased in the period between the Demographic Censuses in all regions, reaching 2010 with broad coverage: the most comprehensive was in the Southeast region (95%), followed by the South region (91.6%) and Central-west (89.7%). The North and Northeast regions, which had lower coverage, were the ones that showed the highest growth in the period, an increase by 16.6 percent and 14.4 percent, respectively (Figure 1.25). In urban areas of all major regions, the garbage collection service from households was above 90%, ranging from 93.6% in the North region to 99.3% in the South region. In the rural areas of the country, collection was expanded in comparison to 2000, going from 13.3% to 26.9% in 2010.

FIGURE 1.25

Proportion of permanent private households with garbage collection in the major regions of Brazil



Source: Demographic Census 2000/2010 (IBGE, 2011)

Electric energy

For the first time, IBGE includes the Demographic Census research on electricity supply for the population as a whole, thus confirming the scope of this service to households in the country, showed both in the sample of the 2000 Census, as well as in household surveys of the decade.

In 2010, of all the services provided to households, electric energy was the one that presented the greatest coverage (97.8%), mainly in the urban areas (99.1%), but also with a strong presence in the rural area (89.7%). With the exception of the rural areas of the North Region, where only 61.5% of the households had electricity supplied by distribution companies, the other major regions of the country, both urban and rural, had over 90% coverage, ranging from 90.5% in the rural areas of the Central-west to 99.5% in the urban areas of the South region.

The Brazilian Program for the Universalization of Access and Use of Electric Energy (Light for All – *Luz para Todos*), established by Decree No. 4,873/2003, was a powerful boost for the expansion of electric energy in rural areas. Created with the challenge of ending energy exclusion in Brazil, it set as goal to take free-of-charge access to electricity to more than 15.3 million people in rural areas by November 2014.

1.4.2. Economy

The 1990s showed a low growth of the economy, including fall in the Gross Domestic Product (GDP) per capita in its initial period. The first years of this decade were marked by high inflation, with double-digit average monthly rates, which was not reverted until July 1994 with the adoption of the Real Plan, which created a new currency, the *real*, and instituted a new monetary and exchange regime. The Federal Government simultaneously conducted a successful de-indexation process of the economy with a view to eliminating the inflationary memory of the economic players.

However, this new phase of Brazil's economic history was not problem free. A series of external shocks placed the sustainability of the Real Plan at risk, forcing the government to make use of monetary and exchange policies to slow down domestic consumption and to raise the exchange rate (NEUTZLING, 2007).

In 1999, Brazil enters the floating exchange age, beginning to officially adopt the inflation goal system, which consists of an institutional arrangement where the commitment to price stability is the monetary policy's main objective. The country thus abandoned strict control over evolution of the exchange rate, a policy known as "exchange anchor" (*âncora cambial*) that was pursued during the first phase of the Real Plan.

GDP growth data for the past decade in Brazil are highly volatile, despite the growing dynamism of the economy. From 2003, there has been a trend in GDP growth that greatly exceeds population growth. This trend is confirmed when we examine more recent data published by the Central Bank, which reported that, for the 2000-2013 period, while the average *per capita* GDP had an average annual growth of 1.97%, the national population grew at an average annual rate of 1.14% (Table 1.3). Item 1.4 of the following section analyses some of the social effects such dissociation.

TABLE 1.3

Evolution of Brazilian GDP and per capita GDP

	CURRENT PRICES IN R$	IN MILLION R$ OF THE PREVIOUS YEAR	REAL PERCENTAGE CHANGE	CURRENT PRICES IN MILLION US$*	POPULATION PER THOUSAND	PER CAPITA			
						CURRENT PRICES IN R$	IN MILLION R$ OF THE PREVIOUS YEAR	REAL PERCENTAGE CHANGE	CURRENT PRICES IN MILLION US$*
2000	1,179,482,001,000	3,193,236	4.3	644,984	173,448	6,800	18,410	...	3,719
2001	1,302,135,998,000	3,235,167	1.3	553,771	175,885	7,403	18,394	-0.09	3,148
2002	1,477,822,004,000	3,321,161	2.7	504,359	178,276	8,290	18,629	1.28	2,829
2003	1,699,947,998,000	3,359,242	1.1	553,603	180,619	9,412	18,598	-0.17	3,065
2004	1,941,497,999,000	3,551,131	5.7	663,783	182,911	10,614	19,414	4.39	3,629
2005	2,147,238,999,000	3,663,335	3.2	882,439	185,151	11,597	19,786	1.91	4,766
2006	2,369,484,000,000	3,808,295	4.0	1,088,767	187,335	12,648	20,329	2.74	5,812
2007	2,661,344,001,000	4,040,274	6.1	1,366,544	189,463	14,047	21,325	4.90	7,213
2008	3,032,203,004,000	4,249,221	5.2	1,650,897	191,532	15,831	22,185	4.04	8,619
2009	3,239,403,999,000	4,235,210	-0.3	1,625,636	193,544	16,737	21,882	-1.37	8,399
2010	3,770,084,872,000	4,554,277	7.5	2,143,921	195,498	19,285	23,296	6.46	10,966
2011	4,143,013,338,000	4,678,737	2.7	2,475,066	197,397	20,988	23,702	1.74	12,539
2012	4,392,093,997,000	4,726,976	1.0	2,247,285	199,242	22,044	23,725	0.10	11,279
2013	4,844,815,076,000	4,844,815	2.5	2,243,074	201,033	24,100	24,100	1.58	11,158

** Estimate of the Central Bank*

Source: Central Bank, with data of IBGE

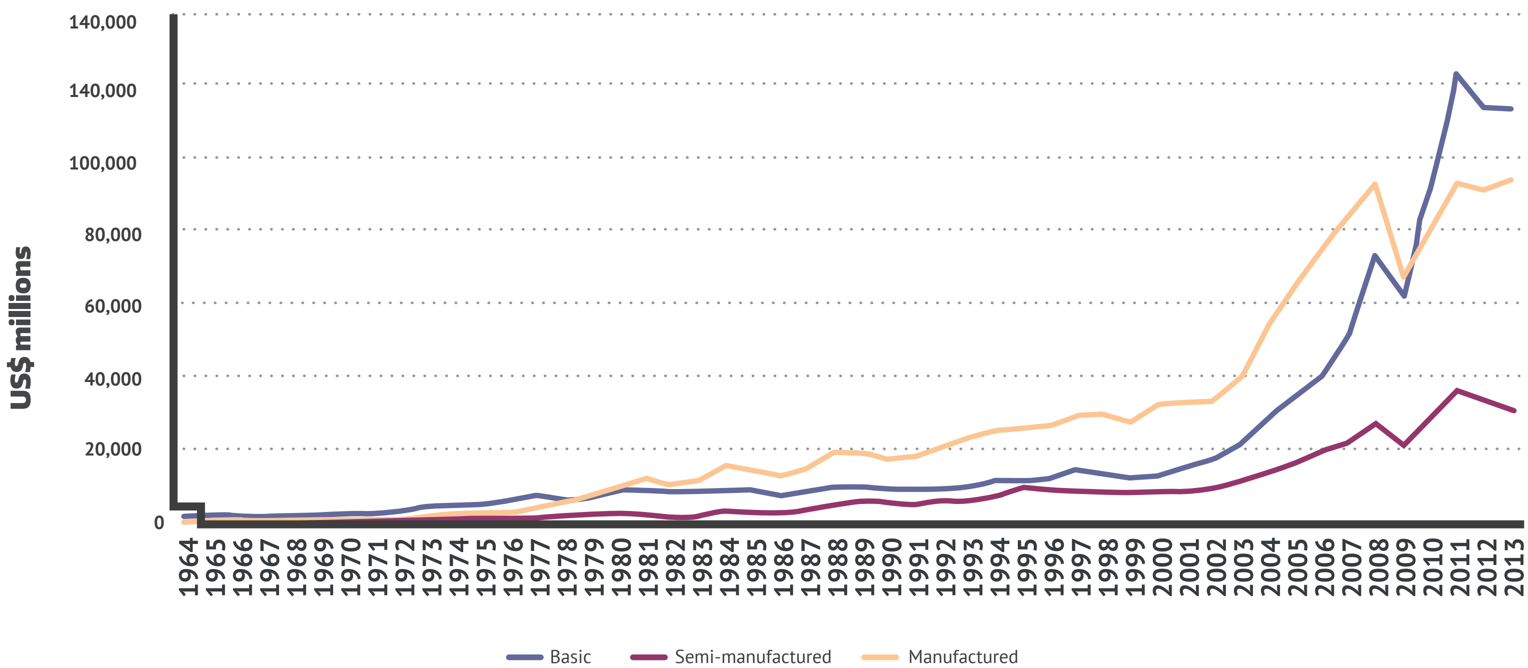
Nevertheless, an analysis of the recent period reveals that after presenting a 7.5% Gross Domestic Product (GDP) growth between 2009 and 2010, the Brazilian economy began a slowdown phase as of the first quarter of 2011. This slowdown initiated a great debate between economists and the general public about the causes of this process. An explanation by the demand side attaches to it the monetary and tax contraction adopted by the government in the first half of 2011, with a view to keeping inflation under control, after a period of strong economic growth, and with it create conditions for the reduction of the basic rate of interest by means of a change in the economic policy, where a greater fiscal rigor would allow the monetary authority to control inflation with lower levels of interest rates. Another possible explanation for the slowdown of the Brazilian economy attributes this phenomenon to factors of structural nature. More specifically, it is argued that, although there are reasons for the cyclical nature to the deceleration of the economic growth (IBGE, 2013).

In 2008, shortly before the breaking of the global financial crisis, Brazil's foreign trade continued to grow, ranking it 22nd among the main global exporters and 24th among the main importers (DANTAS et al., 2009).

Data from the Ministry of Development, Industry and Foreign Trade (MDIC) indicate the growth of Brazilian exports over time, with emphasis on the greater share of basic products, such as agricultural commodities (Figure 1.26). In 2013, the country obtained over 62% of its foreign currency international exports from the "raw materials and intermediate products" category (Figure 1.27).

FIGURE 1.26

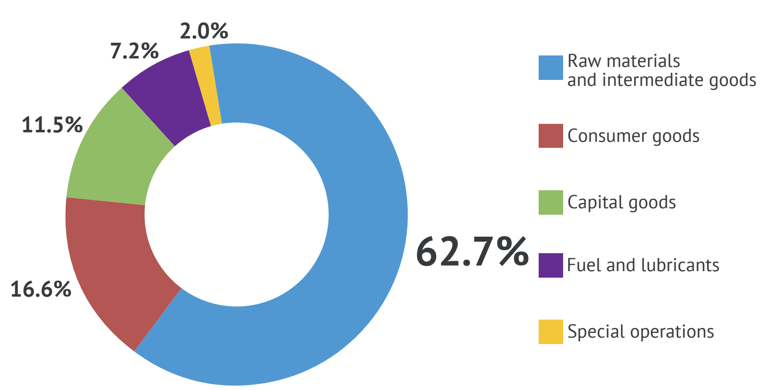
Evolution of Brazilian exports by aggregate factor



Source: MDIC[18]

FIGURE 1.27

Distribution of Brazilian exports by category in 2013



Source: MDIC[19]

18 *AliceWeb – Foreign Trade Information Analysis. Ministry of Development, Industry and Foreign Trade (MDIC). Available at: http://aliceweb.desenvolvimento.gov.br*

19 *AliceWeb – Foreign Trade Information Analysis. Ministry of Development, Industry and Foreign Trade (MDIC). Available at: http://aliceweb.desenvolvimento.gov.br*

Despite a relative decrease of the agriculture share in total Brazilian GDP (Table 1.4), mainly to the credit of the services sector, agricultural production is still of extreme importance to the Brazilian economy and trade balance, accounting for a good share of the 62% exports of "raw materials and intermediate goods" category mentioned above. In addition, it has presented a superior performance against the other economic sectors. Between 2006 and 2013, agricultural productivity grew by 5% per year. By way of comparison, in the last decade, industry productivity declined by 1% per year, and the service sector grew by 1% per year. The remarkable increase in agricultural productivity can be observed when comparing the growth of cultivated area with production growth: since 2003, the cultivated area increased by 13%, while production in the same period grew by 31%. This is illustrated, for instance, in the culture of corn, which more than doubled its agricultural productivity in 20 years. In 1991, the national average productivity was 1.8 tones per hectare and in 2011 it reached 4.2 tones per hectare (IBGE, 2013).

TABLE 1.4

Participation of the economic sectors in the Brazilian Gross National Product

	AGRIBUSINESS	INDUSTRY	SERVICES	TOTAL
	%			
1990	8.10	38.69	53.22	100
1991	7.79	36.16	56.05	100
1992	7.72	38.70	53.58	100
1993	7.56	41.61	50.83	100
1994	9.85	40.00	50.15	100
1995	5.77	27.53	66.70	100
1996	5.51	25.98	68.50	100
1997	5.40	26.13	68.47	100
1998	5.52	25.66	68.82	100
1999	5.47	25.95	68.58	100
2000	5.60	27.73	66.67	100
2001	5.97	26.92	67.10	100
2002	6.62	27.05	66.33	100
2003	7.39	27.85	64.77	100
2004	6.91	30.11	62.97	100
2005	5.71	29.27	65.02	100
2006	5.48	28.75	65.76	100
2007	5.56	27.81	66.63	100
2008	5.91	27.90	66.18	100
2009	5.63	26.83	67.54	100
2010	5.30	28.07	66.63	100
2011	5.46	27.53	67.01	100
2012	5.32	26.02	68.66	100
2013	5.71	24.98	69.32	100

Source: Data from IPEA[20]

Brazil continues to be the world's largest producer of orange juice, coffee and sugar. It also ranks first in the world in terms of the exportation of orange juice, sugar, soy, coffee, and corn. It should be noted that crops of soy and maize cultivations alone concentrate 90% of the total planted area in the country.

20 Available at: www.ipeadata.gov.br

In the agriculture and livestock sector, animal production growth stands out, and it should be noted that since 2008, Brazil has been the world's largest beef exporter. According to the Ministry of Agriculture, Livestock and Supply (MAPA), the statistics also predict growth for the coming years. Beef exports will grow by 2.15% per year, while poultry will grow by 3.64%.

In 2012, Brazil's main herd was that of cattle, with 211.2 million head; followed by the swineherd, with 38.7 million head. The total number of hens, roosters, broilers, and chicks reached 1 billion. The country also had 16.7 million sheep and 8.6 million goats (IBGE, 2012). The Central-west region of the country alone concentrates 34.3% all the Brazilian bovine cattle.

A series of factors ensured the achievements of the agriculture sector in Brazil over recent years: abundant natural resources (soil, water and sunlight); product diversity; and a relatively favorable exchange rate until 2006; increasing demand from Asian countries; and growth in agricultural productivity. The Brazilian Agricultural Research Corporation (Embrapa) has been contributing significantly to the increase in agricultural productivity in the country, by means of research, development, innovation and technology transfer. It is a team of 2,444 researchers, 84% with doctoral or post-doctoral studies at universities in Brazil and abroad, and 47 Decentralized Units, besides 16 offices from North to South. It is a national and international reference in agricultural research.

In summary, the macroeconomic data from Brazil and its trade balance characterize it as an urban-industrial country anchored in world capitalism by exporting agricultural commodities.

1.5. SUMMARY OF NATIONAL CIRCUMSTANCES

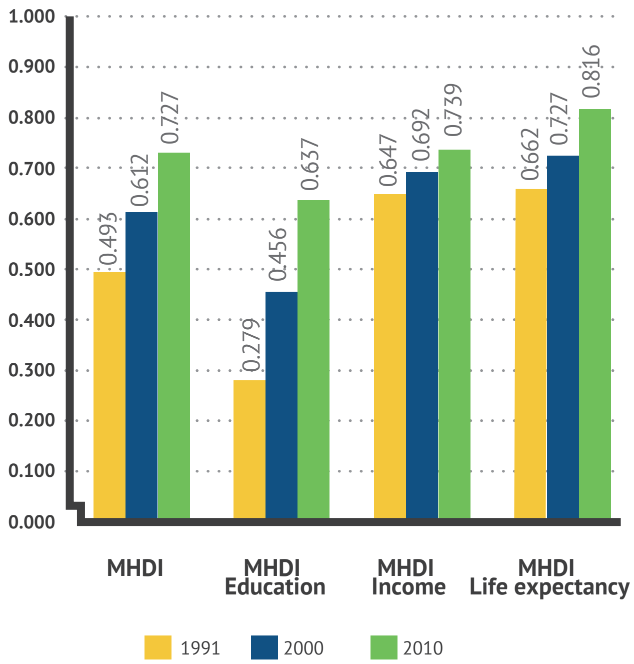
Brazil is a country of great territorial extension and high social and spatial inequality. However, the government has worked to increase the opportunities for access to education and health services through decentralization measures and regionalization of the network assistance, in addition to focusing social programs on the poorest population, which occurs in parallel to the challenge of universalizing programs. This led to a number of improvements in the recent period, some of which received international acknowlegment, such as the sharp drop in poverty and extreme poverty rates, which was strongly influenced by the reduction in family income inequality. In addition to other measures that placed Brazil in the condition of compliance with a great amount of the Millennium Development Goals even before the agreed period (Table 1.5).

Through the *Bolsa Família* Program and *Brasil sem Miséria* Plan, the Federal Government framed a set of actions for the promotion of food and nutrition security in the short term, however, without neglecting the supply of other actions that have a high potential to eliminate, in the medium term, conditions that lead to the reproduction of the poverty vicious cycle for generations.

For the country as a whole, the last two decades have been marked by improvements in the quality of life of the Brazilian population, as summarized and shown by two synthetic indexes about the level of social welfare and human development (Figures 1.28 e 1.29).

FIGURE 1.28

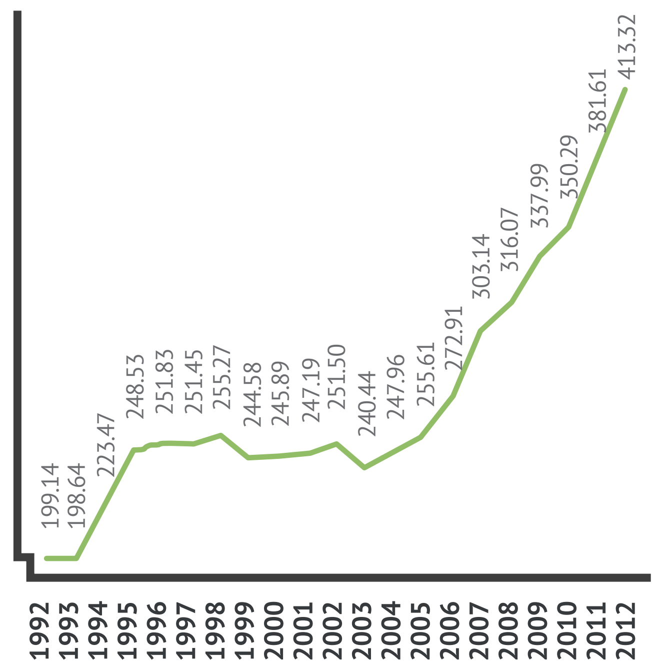
Evolution of the Human Development Index of Brazil and its Sub-indexes



Note: MDHI – Municipal Human Development Index
Source: PNUD (2013)

FIGURE 1.29

Evolution of the social well being index prepared by IPEA to Brazil [21]



Note: Excluding rural areas of the northern region (except Tocantins). Values of 1994, 2000 and 2010 obtained by linear interpolation.

Source: IPEA (2013a)

The Brazilian population vulnerability to climate risk is a situation that depends not only on the expected climate change, but also on the adaptation conditions of families, which are closely related to their social vulnerability conditions. Furthermore, a proper management of natural resources and ecosystems is a way to increase local resiliency.

*21 Built from a simple function of social welfare proposed by Amartya Sen (1992). This function multiplies the average income by the measure of fairness, given by 1 minus the Gini index, that is, Average * (1 - Gini). Therefore, inequality acts as a reducing factor of well-being in relation to the level of average income.*

TABLE 1.5

Summary of National Circumstances

INDICATORS	1990	1995	2001	2005	2012
Gross Domestic Product (million R$ in 2013)	2,486,827	2,892,519	3,235,167	3,663,335	4,726,976
Agriculture's share of GDP (in % of the GDP)	8.1	5.77	5.97	5.71	5.32
Industry's share of GDP (in % of the GDP)	38.7	27.5	26.9	29.3	26
Services' share of GDP (in % of the GDP)	53.2	66.7	67.1	65	68.7
Percentage of the population living with less than US$ PPP 1.25/day	25.5	16.4	14	8	3.5
Percentage of occupied population living with less than US$ PPP 1.25/day	ND	11.2	8.5	4.8	1.3
Gini Index	0.612	0.599	0.594	0.566	0.526
Net schooling rate in the elementary education – population aged 7 to 14 years old (%)	81.2	86.5	94.4	95.8	97.7
Net schooling rate in high school – population aged 15 to 17 years old (%)	16.9	23.7	39.2	48.9	57.9
Net schooling rate in higher education – population aged 18 to 24 years old (%)	5.3	6	9.2	11.7	16.1
Schooling rate – population aged 0 to 6 years old (%)	ND	29.6	37	42.7	51.4
Literacy rate of the population aged 15 to 24 years old (%)	90.3	92.8	95.7	97.1	98.7
Child mortality	53.7	40.2	28.7	23.7	17.7*
Infant mortality	47.1	35.1	24.9	20.4	15.3*
Proportion of the population with access to drinking water	70.1	74.4	79.6	81.8	85.5
Proportion of the population with access to sanitary sewage	53	56.9	64.2	67.8	77
Percentage of urban population living in inadequate housing	ND	52.4	47.6	43.4	36.6

Source: For social indicators: V National Monitoring Report on the Millennium Development Goals. For economic indicators: Ipeadata Database[22] and Time Series Management System of the Central Bank of Brazil[23]

22 Available at: http://www.ipeadata.gov.br
23 Available at: http://www3.bcb.gov.br/sgspub/localizarseries/localizarSeries.do? method=prepararTelaLocalizarSeries

CHAPTER II

OTHER INFORMATION CONSIDERED RELEVANT TO THE ACHIEVEMENT OF THE OBJECTIVE OF THE CONVENTION

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2.1. EDUCATION, TRAINING AND PUBLIC AWARENESS

In compliance with Article 4, paragraph 1, item (i) of the Convention, "All Parties, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, shall promote and cooperate in education, training and public awareness related to climate change and encourage the widest participation in this process, including that of non-governmental organizations".

Since having hosted the Earth Summit in 1992 and the United Nations Conference on Sustainable Development (Rio+20) in 2012, Brazilian citizens have been more exposed to issues related to climate change. However, in general, the majority of the population still does not have more specific information about climate change or the Convention, although the media has increasingly been addressing the subject. Nevertheless, the global climate change is recognized as being a technical and complex issue, difficult to be understood by lay persons and therefore requires efforts to translate the scientific knowledge into a more accessible language, which is important for the social mobilization around the theme.

Despite these difficulties, education, public awareness and training on issues related to climate change have been expanding. The Brazilian civil society has also been called to join participatory preparation processes of plans, programs and instruments of the National Policy on Climate Change, in line with the democratic principles of the country and for social mobilization to deal with climate change in Brazil.

The Brazilian Internet site on climate change of the Ministry of Science, Technology and Innovation has contributed towards an increase in public awareness on the matter, as it provides information about the entire negotiation process under the Convention, the main references about climate science and the preparation of the National Communication. Also, publications in Portuguese (such as the official version of the Convention and Kyoto Protocol), articles from newspapers, magazines and journals, radio and TV shows, as well as the organization of seminars and debates, have helped in generating awareness of an issue that was relatively unknown in the country.

The Brazilian Climate Change Forum (FBMC) (item 2.1.2) aims at promoting awareness and engagement of the society regarding the issue of global climate change. The publication of the Reports of its three Working Groups by the Brazilian Panel on Climate Change (PBMC), also contributes to briefly circulate information in a less technical language about the state-of-the-art of the scientific basis of climate change in Brazil and necessary efforts to be undertaken for adaptation and mitigation[24].

The work done by non-governmental organizations operating in Brazil which, through their activities, mobilize the Brazilian society for taking actions toward the transition to a low-carbon economy are added to the government efforts to propagate information and public awareness on the issue of climate change.

Some organizations promote campaigns, support and manage projects and programs, but the interesting cases are the creation of observatories, such as the Climate Observatory, the Observatory of Public Policies on Climate Change of the Climate Forum Group, the Low Carbon Agriculture Observatory and the REDD Observatory[25].

2.1.1. Awareness in Brazil about Climate Change Related Issues

To build an official Brazilian site on climate change, a project initiated in September 1995, when the Internet was still incipient in Brazil, was a pioneer and innovative idea that has collaborated significantly with the development of the National Communications of Brazil and contributed towards enhancing public awareness on the subject in the country. CGMC/MCT's website[26] thus constitutes an important tool for implementing Brazil's commitments undertaken under the Convention.

The website reflects the entire National Communication preparation process, while gathering and providing all information generated by the various institutions and specialists involved in preparing greenhouse gas inventories and other documents.

Furthermore, the country runs its quality control and assurance program of results generated through the elaboration of National Communications through its website, especially through public consultations on each document produced to feed into the National Communications, ensuring transparency and allowing the participation of specialists not directly involved in the process but who want to make comments or recommendations.

Thus, Brazil's global climate change website has strengthened the coordination unit's capacity and helped decentralize preparation of the National Communications, permitting complete involvement of all relevant institutions regardless of its location.

2.1.1.1. The National Emissions Registry System (SIRENE)

For the purposes of providing perenniality and accessibility to the results of the National Anthropogenic Emissions Inventory by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol, the Ministry of Science, Technology and Innovation (MCTI) developed the National Emissions Registry System (SIRENE).

24 Just like the structure of the Working Groups of the Intergovernmental Panel on Climate Change (IPCC), the PBMC is organized in: Working Group 1 – assesses the scientific bases of the climate system and its changes; Working Group 2 – assesses the vulnerabilities of natural and socioeconomic systems, the positive and negative consequences of global climate change and options for adaptation; Working Group 3 – assesses the options for mitigation in relation to global climate change.

25 Available at: www.oc.org.br; www.forumempresarialpeloclima.org.br/observatorio-de-politicas-publicas-de-mudancas-climaticas; observatorioabc.com.br; observatoriodoredd.org.br, respectivelly.

26 Available at: http://www.mcti.gov.br/clima

SIRENE aims at providing support to decision-making on policies, plans, programs and projects in the area of climate change, particularly the adoption of mitigation measures.

The results of emissions of all greenhouse gases not controlled by the Montreal Protocol (CO_2, CH_4, N_2O, CF_4, C_2F_6, HFC-23, HFC125, HFC134a, HFC143a, HFC152a, SF_6, CO, NO_x and NMVOC) are presented for the following sectors: Waste Treatment, Agriculture, Land Use, Land-Use Change and Forestry, Energy and Industrial Processes. In this sense, SIRENE allows access to the time series of emissions related to recent findings published in the National Inventory as part of the Third National Communication of Brazil to the United Nations Framework Convention on Climate Change or Biennial Update Report, whose graphics and tables can be exported.

2.1.2. Brazilian Climate Change Forum

The Brazilian Climate Change Forum (FBMC)[27], chaired by the President of the Republic, was created in 2000, with the objective of including the organized civil society in discussions related to global climate change, as well as educating and mobilizing society to debate and make a stand on problems resulting from global climate change and regarding the Clean Development Mechanism (CDM). The FBMC should also assist the government in incorporating global climate change issues in the various levels of public policies.

The Forum has the participation of the Ministers as well as civil society personalities and representatives, appointed by the President of the Republic due to their renowned expertise or relevant knowledge on climate change.

The FBMC has contributed in a significant manner towards developing the National Climate Change Plan and the National Climate Change Policy, Sectoral Plans of Mitigation and Adaptation to Climate Change and National Adaptation Policy (PNA), coordinating public hearings and sectoral meetings with representatives of the organized civil society, businesses, universities and subnational governments. These meetings result in significant contributions to the participatory process of drawing up plans and policies, being instruments to raise social awareness and to mobilize society around the issue of global climate change in Brazil.

One of the Forum's attributions is to encourage the creation of state climate change fora at state level, and hold public hearings in diverse regions of the country. State fora are an important means of raising society's awareness and mobilization at the state level to discuss global climate change. At present, 17 Brazilian states have their own state climate change forum: Bahia, Ceará, Espírito Santo, Mato Grosso, Minas Gerais, Pará, Paraná, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, São Paulo, Maranhão, Amazonas, Rondônia and Tocantins.

Some cities in Brazil have also been committed to take mitigation and adaptation actions at the local level and, with this purpose, created governance instances for the initiatives. For example, in the city of São Paulo, a Municipal Committee on Climate and Economics Changes was created. In Belo Horizonte, in the state of Minas Gerais, the Municipal Committee on Climate Change and Ecoefficiency was created. In Recife (PE) the Committee on Sustainability and Climate Change was created. In Rio de Janeiro (RJ), the Municipal Secretariat of Environment created the Climate Change and Sustainable Development Management.

27 See : http://www.forumclima.org.br.

It is worth noting that recently, in September 2014, the mayor of the city of Rio de Janeiro announced at the Climate Summit, in New York, the Compact of Mayors[28] – the world's largest initiative involving cities in the fight against climate change. The Compact gathers the main cities networks dealing with sustainable policies, bringing together almost half a billion people in 228 cities. In addition to the C40[29], chaired by the mayor and integrating the 69 largest cities in the world, the Compact of Mayors also includes members of the ICLEI and UCLG, respectively Local Governments for Sustainability and the Union of Cities and Local Governments, with the support of the United Nations Organization on urban issues (UN Habitat).

In the Compact, the signatory cities publicly commit to significantly reduce greenhouse gas emissions; to make goals and strategic plans public; and to annually report their progress through a standardized measurement system.

2.1.3. Education Programs on the Conservation of Electric Energy and Rational Use of Oil and Natural Gas By-Products

In Brazil, educational programs on conservation and rational use of energy basically refer to two aspects of national programs (which will be discussed in more detail in Volume II of this Communication), which are: Procel at Schools, of the National Electric Energy Conservation Program (Procel) and the Conpet at School, of the Program for the National Rationalization of the Use of Petroleum and Natural Gas By-Products (Conpet).

Procel at Schools is a project developed by the National Program for Electric Energy Conservation (Procel), directed at children and adolescents through educational institutions. It promotes the construction of knowledge in energy efficiency, disseminating information and providing educational resources to formal education systems in the country, so as to enable the Brazilian citizen with means to develop skills, attitudes and values necessary for the efficient use of energy. The actions developed by the project are based on strategies that are coordinated with secretariats of education, technical schools and universities, involving the various educational levels and teaching methods.

The Guidelines for Procel at School project actions, signed in 1993 as a Technical Cooperation Agreement between the Ministry of Mines and Energy (MME) and the Ministry of Education (MEC), decided to:

>> train elementary and high school teachers to work with their students on aspects of electricity waste, including the National Service for Industrial Apprenticeship (SENAI) and the National Service for Commercial Apprenticeship (SENAC);

>> develop pedagogical and didactic materials on energy to be distributed free-of-charge to teachers and students;

>> establish a means to involve students from high school level technical schools and higher learning institutions, in the sense of using technological resources to combat energy waste and to create a change in habit regarding its use.

28 Available at : www.un.org/climatechange/summit/wp-contend/uploads/sites/2/2014/9/CITIES-Mayors-compact.pdf

29 The C40 Cities Climate Leadership Group is a network formed by mega cities of the world committed to climate change. The idea is that these cities, by acting locally, may confront climate change globally. In practice, the C40 group promotes the access of the municipal governments to the technical team that makes available knowledge and practices in various areas against climate change, to be implemented by the management of the cities. The network has the participation of the cities of Curitiba, Rio de Janeiro and São Paulo.

Through a partnership with the MME and MEC, Procel at Schools strives to enable the action of basic education teachers (nursery, elementary and high schools) as multipliers/attitude advisers to combat electric energy waste with their students.

Procel in Basic Education is an interdisciplinary project by Eletrobras/Procel and the country's electric energy utilities. It acts in the education area, within the crosscutting theme of the environment, involving teachers from all subjects given at the schools. In order to successfully impart the information, the communication channel is Environmental Education.

Operationalization of Procel for Basic Education is up to the electric energy utilities, which receive specific training for the work, and then establish an institutional relationship with the education area for implementing the project. Schools should contact their supreme body to participate in the project through the local electric energy utility.

In 2013, R$ 478.6 thousand was invested in Procel in Schools, benefiting 70,000 students of public schools, 2,000 teachers and 600 schools. Since 1995, this sub-program has already benefited 25 million students in Basic Education[30]. Under the Procel at Schools is also the "Procel in Higher Education Institutions", which aims at disseminating "Conservation and the Efficient Use of Energy" among undergraduate Engineering programs in various Brazilian higher education institutions.

The Conpet at Schools Program was created in 1992 through a partnership between the MME and the MEC. Just like the Procel, its primary objective is to integrate and motivate teachers to act as awareness-raising agents and trend-setters for habits and attitudes, not only for their students, but also for their own school and community regarding issues relating to energy, society and the conservation of natural resources and the environment. It is understood that this is the most effective and permanent way of raising the awareness of the Brazilian society over the mid-term regarding the concern for the efficient use of oil and natural gas products. The project involves educators/students from 6th to 9th grades of public and private elementary schools as well technical courses.

In addition to the assessments, educational actions on the rational use and handling of diesel oil are promoted to drivers and businessmen of the sector. The Conpet in Transport assists companies and drivers who participate in the program voluntarily in order to reduce the operating costs with fuel and to meet the resolutions of the environmental agencies.

The educational actions of Conpet in Transport are carried out through partnerships with state and local governments and entities in the transport sector. With the latter, the program also carries out initiatives and studies for the evaluation of technologies for the efficient transport of passengers including new vehicles, engines, fuels and exclusive lanes.

30 Data extracted from www.procelinfo.com.br

2.1.4. Participation of the civil society in preparing the intended nationally determined contribution to the new agreement under the United Nations Framework Convention on Climate Change

In the context of negotiations under the United Nations Framework Convention on Climate Change (UNFCCC) which led to the Paris Agreement the 19th Conference of the Parties to the UNFCCC (COP-19, held in Warsaw, Poland), Parties were invited to initiate or intensify domestic preparations of their "intended nationally determined contributions" (iNDC) to the new agreement and notify them before COP-21.

The iNDC represent the intended contribution of each country to the global effort to combat climate change and will play a central role in the implementation of the new agreement under the Convention.

The Brazilian Government considered it essential that the contributions to the new agreement had the support of various sectors and segments of the civil society, in order to broaden the legitimacy and the degree of ambition in the negotiations. In this sense, with the objective of supporting the preparation of Brazil's iNDC, the Ministry of Foreign Affairs (MRE in Portuguese acronym) coordinated a consultation with the Brazilian civil society in order to increase the transparency of the national preparation process and provide an opportunity to all sectors and interested segments to participate and express their opinions.

The consultation with the Brazilian society was carried out in two phases. The first was through online contributions to issues suggested for debate in the form of a guiding questionnaire. The objective of the questionnaire was to focus on key aspects for the future development of the iNDC. For the second phase, the contributions received in the first phase were consolidated into a Preliminary Report prepared and released online. In this second phase, the preliminary findings of the report were submitted to a new round of consultations, by comments submitted electronically and during meetings for further consideration of the Preliminary Report. The final report was published on the Ministry of Foreign Affairs webpage[31]. The publishing of this document represented a significant step forward towards the Federal Government's decision-making process on Brazil's contribution in the negotiations of the new agreement under the Convention.

2.2. CAPACITY BUILDING

This chapter describes initiatives of excellence, undertaken through institutes and Brazilian research groups that are contributing to the advancement of the scientific basis on climate change in the country. These are advances to fill scientific gaps and in methodological improvements, thus enabling the production of climate modeling results and the impacts and vulnerabilities to climate risk and mitigation options, with less uncertainty and greater robustness. Therefore, they represent the national and regional capacity building for the promotion of adaptation and mitigation actions.

The initiatives listed below share some characteristics: the relation with the government, aiming at contributing to the effectiveness of the policy on climate change in Brazil; the networking work, sometimes at the international level; and the multi-sectoral and interdisciplinary perspective approach that the scientific knowledge on climate change requires.

31 To access the final report of the consultation of the civil society refer to: http://diplomaciapublica.itamaraty.gov.br/consulta-clima/133-negociacoes-na-unfccc-relatorio-final-da-consulta-a-sociedade-civil-brasileira

2.2.1. Inter-American Institute for Global Change Research (IAI)

The Inter-American Institute for Global Change Research (IAI)[32] is an intergovernmental organization created in 1992 and composed of 19 American countries [33]. IAI is guided by principles of scientific excellence, international cooperation and ample exchange of scientific data, aimed at improving the understanding of global climate change and its socioeconomic impacts.

Recognizing the need to better understand the natural and social processes that govern the environmental change on a large scale, the IAI encourages the exchange between scientists and public managers. With that, the IAI aims at increasing the scientific capacity in the region and, at the same time, provide useful information to decision makers. The surveys are usually carried out by means of comparative studies and with the participation of researchers from several countries in each project. The IAI has several research programs and Brazil has exercised a strong representation of projects.

In summary, the mission of the IAI is to develop the capacity to understand the integrated impacts of past, present and future global change under the regional and continental environments of the Americas and promote collaborative and well informed activities at all levels.

IAI work is developed through four basic actions:

>> contribute towards advancing the continent's scientific knowledge, whether through research, education or transfer of technology, complying with a scientific agenda with well-defined priorities;

>> support the international Conventions and Protocols contributing towards elucidating scientific issues and their political implications related to these instruments, supporting national interests;

>> support broad international cooperation, contributing towards international programs on global changes, promoting information policies that ensure free access to data; and

>> support the interests of IAI member countries and provide scientific information that serves the interests of federal, state and local governments, private and public sectors in general.

2.2.2. Intergovernmental Panel on Climate Change (IPCC)

The IPCC was created in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP) to evaluate scientific, technical and socioeconomic information available in the field of global climate change.

IPCC is composed of three groups and a task force. Work Group I evaluates the scientific aspects of climate systems and climate change; Work Group II assesses the scientific, technical, environmental, socioeconomic aspects of vulnerability to climate change, as well as the negative and positive impacts on ecological systems, socioeconomic sectors and human health, and options to adapt to changes; Work Group III evaluates the scientific, technical, environmental, socioeconomic aspects of climate change mitigation, by means of limitation or prevention of greenhouse gas emissions and the increase of activities towards removing them from the atmosphere; the Task

32 Available at: wwwsp.iai.int

33 Argentina, Brazil, Canada, Chile, Costa Rica, the United States, Paraguay, Peru, Uruguay, Bolivia, Colombia, Cuba, Ecuador, Guatemala, Jamaica, Mexico, Panama, Dominican Republic, Venezuela.

Force for Inventories works with developing and refining methodologies for the calculation and presentation of national greenhouse gas emission inventories.

In the IPCC's First Assessment Report of 1990, only six Brazilian scientists participated as collaborators, four in Group I and two in Group II. In 1995, in IPCC's Second Assessment Report, five Brazilians participated as authors (three in Group I and two in Group II), and six as collaborators (one in Group I, two in Group II and three in Group III) and six as reviewers (one in Group I, two in Group II and three in Group III). In the Third Assessment Report, released in 2001, 12 Brazilian scientists contributed as authors (three in Group I, three in Group II and six in Group III), one as a collaborator (Group II) and ten as reviewers (two in Group I, three in Group II and five in Group III). In 2007, in the Fourth Assessment Report, fourteen Brazilian scientists participated as authors (three in Group I, five in Group II and six in Group III) and twenty-one as reviewers (three in Group I, thirteen in Group II and five in Group III). In the Fifth Assessment Report, released in 2014, Brazil counted with the participation of 28 authors (being six in Group I, 19 in Group II and 3 in Group III).

The participation of Brazilian scientists is of utmost importance, mainly due to the fact of having a more specific understanding of processes (for example, those related to the Amazon) and important technologies (for example, use of ethanol fuel in vehicles) for developing countries.

The progressive increase in the participation of Brazilian scientists is the result of an increase in national training programs involving climate related subjects, and consequently, an increase in the number of Brazilian scientists who develop research related to the theme and offer input for a better understanding of the subjects in question.

2.2.3. Brazilian Panel on Climate Change (PBMC)

The Brazilian Panel on Climate Change (PBMC)[34], created by MCTI and MMA, is a national scientific body aiming at providing decision makers and society technical-scientific information about global climate change.

The PBMC's role is to assess, in a comprehensive, objective and transparent manner, the information produced by the scientific community regarding the environmental, social, economic and scientific aspects of climate change to permit a better understanding of the science of climate, the risks of climate change observed and projected for the future, as well as the impacts, vulnerability and associated actions for adaptation and mitigation.

As a result of the work of the Panel, "National Assessment Reports", "Technical Reports", "Summaries for Decision Makers" on global climate change, as well as "Special Reports" on specific themes are periodically drawn up and published. These documents provide important elements for the implementation and monitoring of policies in Brazil, as the National Plan on Climate Change and the Sectoral Mitigation and Adaptation Plans to Climate Change and the National Adaptation Plan, the latter currently under development.

In January 2015[35], the PBMC published three volumes of the First National Assessment Report on Climate Change, referring to scientific information available in Brazil, according to the following structure: compiled by its three working groups (WG): WG1 – Base Science of Climate Change; WG2 – Impacts, Vulnerability and Adaptation; WG3 – Mitigation of Climate Change.

34 Established by Interministerial Directive MCT/MMA No. 356, of 25 September 2009.
35 Available at: http://www.pbmc.coppe.ufrj.br/pt/noticias/82-destaque/440-painel-brasileiro-de-mudancas-climaticas-divulga-o-primeiro-relatorio-de-avaliacao-nacional-completo

The Panel's structure and functioning are based on the same rules that apply to IPCC. The Panel is comprised of a Plenary, Board of Directors, Scientific Committee, Executive Secretary, Working Groups and Technical Support Units. The four Working Groups gathered a total of 100 researchers tied to national research institutions, and specialists in global climate change.

The PBMC offers an opportunity to organize and expand Brazilian scientific and research production on global climate change. It is the first experience developed in the country that seeks to unify and systematize existing knowledge on climate change in Brazil, focusing on regionalization, in a single publication and knowledge platform.

In addition, from an international cooperation and training perspective, the PBMC will share methods, results and knowledge with developing countries, thus helping strengthen their national capabilities to respond to climate change.

2.2.4. Brazilian Research Network on Global Climate Change (Rede CLIMA)

The *Rede CLIMA* was created by the MCT in 2007[36] and is supervised by a Board of Directors comprised of another four Ministries (Environment; External Relations; Agriculture, Livestock and Food Supply; and Health), as well as representatives from the Brazilian Academy of Sciences (ABC); Brazilian Society for the Progress of Science (SBPC); Brazilian Climate Change Forum; National Council of State Secretaries for Science, Technology and Innovation; National Council of State Research Support Foundations; and the business sector.

Rede CLIMA is national in scope, involving dozens of research groups in universities and institutes. Its scientific focus covers all relevant issues of climate change, notably:

- >> The scientific basis of climate change: detection and attribution of causes; understanding of natural variability versus anthropogenic climate change; hydrological cycle and global biogeochemical cycles and aerosol; modeling capability of the climate system.
- >> Studies of impacts, adaptation and vulnerability for systems and relevant sectors: agriculture, forestry, water resources, biodiversity and ecosystems, coastal zones, cities, economy, renewable energy and health.
- >> Development of knowledge and technologies for the mitigation of climate change.

The design and development of *Rede CLIMA* is characterized by the active and coordinated participation of various education and research institutions in Brazil. These are distributed in different regions of the country, which provides outreach to the Network, as well as enhances the transfer of the information generated.

Rede CLIMA is structured into 15 sub-thematic networks: Agriculture, Biodiversity and Ecosystems, Cities, Scientific Dissemination, Natural Disasters, Regional Development, Economy, Renewable Energy, Climate Modeling, Oceans, Water Resources, Health, Environmental Services of the Ecosystems, Land Uses and Coastal Areas.

A Board of Directors, assisted by a Technical Committee, exercises the coordination. The Board of Directors is responsible for, among other things, setting the research agenda of the Network; promoting the management of *Rede CLIMA*, making all decisions necessary for its operation, subject to the powers of the participating institutions; and articulating the integration of the Network to the programs and public policies in the area of global climate change.

The *Rede CLIMA*'s Scientific Committee is comprised of representatives of thematic sub-networks and by scientists external to the Network. The Committee assists the Board of Directors on research themes and the evaluation of scientific results, as well as in elaborating public announcements for research.

36 Directive No. 728 of 20 November 2007.

The *Rede CLIMA*'s objectives are:

- >> to generate and disseminate knowledge and technologies so Brazil can respond to the challenges represented by the causes and effects of global climate change;
- >> to produce needed data and information to support Brazilian diplomacy in negotiations concerning the international global climate change regime;
- >> to conduct global and regional climate change studies in Brazil, emphasizing the country's vulnerability to global climate change;
- >> to study alternatives for adapting Brazil's social, economic and natural systems to global climate change;
- >> to research the effects of changes in land use and in social, economic and natural systems on Brazil's emissions of gases that contribute to global climate change;
- >> to contribute to the formulation and monitoring of public policy on global climate change within the Brazilian territory;
- >> to contribute to the design and implementation of a natural disaster alert and monitoring system for the country;
- >> to conduct studies on greenhouse gas emissions in order to support the achievement of national emission inventories according to Decree No. 7,390/2010.

One of *Rede CLIMA*'s first collaborative products is the regular elaboration of analyses on the status of global climate change knowledge in Brazil, along the lines of the IPCC reports, but with more specific sector analyses for formulating national and international public policies.

In this Third National Communication, *Rede CLIMA*, with the support of the MCTI, played a strategic role in the coordination of unpublished thematic studies[37], which estimated the negative impacts of global climate change and analyzed the risk and vulnerability of the ecosystems and human populations.

Another important task of *Rede CLIMA*, through the Climate Modeling sub-network, is to lead the development of the Brazilian Model of the Global Climate System (MBSCG) to generate future climate scenarios with regional characteristics appropriate to the interests of the country. This effort, which is strategically important for the country to have autonomy and training in modeling the global climate system, has the support of several national and international institutions.

The National Institute for Space Research (INPE) provides full support to the researchers of *Rede CLIMA*, the FAPESP Program on Global Climate Change Research and the National Institute of Science and Technology for Climate Change (INCT) and encourages them to use the new Supercomputing environment of INPE, opened in December 2010.

2.2.5. National Institute of Science and Technology (INCT) for Climate Change

The National Institute of Science and Technology (INCT) for Climate Change[38] is a network of interdisciplinary researches on climate change based on the cooperation of 65 national research groups of all regions and 17 international research groups in Argentina, Chile, Uruguay, United States, Germany, the Netherlands, United Kingdom,

37 See Volume II, Item 2, of this Communication.

38 The National Institutes of Science and Technology Program projects the creation of dozens of National Institutes of Science and Technology (INCTs) spread about the country that will function in a multicentric form under the coordination of an institution-headquarters that already has competence in a specific area of research. The program is conducted by the Ministry of Science, Technology and Innovation (MCTI), through the National Council on Scientific and Technological Development (CNPq), in partnership with FAPESP and with other state Research Support Foundations. The INCT for Climate Change is under the coordination of the INPE.

India, Japan and South Africa, involving in its entirety more than 400 researchers, students and technicians, and is the largest network already developed in Brazil for environmental research.

The INCT for Climate Change is based at the National Institute for Space Research (INPE), in the city of São Jose dos Campos, state of São Paulo, and works closely to other climate change research networks. It is directly associated with the Brazilian Research Network on Global Climate Change (Rede CLIMA) and covers all scientific and technological aspects of interest to the *Rede CLIMA*.

The INCT for Climate Change also enables the linkage, integration and scientific cohesion for the *Rede CLIMA*. On the other hand, existing financial mechanisms for this Network provide additional funding for the implementation of this INCT, which is also associated with the various research programs on climate change, in particular with the FAPESP Climate Change Program[39].

Other partners of the INCT for Climate Change are: the Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA)[40], the Thematic Network of Environmental Modeling Research of the Amazon (GEOMA) and the Brazilian Panel on Climate Change (PBMC).

The main purpose of the INCT for Climate Change is to produce relevant high-quality level information in order to: (i) detect environmental changes in Brazil and South America, especially related to global climate change, and attribute causes to the observed changes (global warming, changes in land use, urbanization, etc.); (ii) develop a Global Climate System model to generate scenarios for global and regional environmental changes, particularly scenarios in high spatial resolution of global climate change and land uses; (iii) study the impacts of global climate change and identify Brazil's main vulnerabilities in strategic sectors: ecosystems and biodiversity, agriculture, water resources, human health, cities, coastal zones, renewable energies and economy; and (iv) develop studies and technologies to mitigate greenhouse gas emissions.

In partnership with *Rede CLIMA*, the INCT for Climate Change contributes as a research and development pillar of the National Plan on Climate Change, which is periodically reviewed, as science advances.

The INCT for Climate Change is organized into 26 research sub-projects listed below by themes:

- Detection, Attribution and Natural Climate Variability;
- Amazon;
- Land-Use Changes;
- Global Biogeochemical Cycles;
- Oceans;
- Greenhouse Gases;
- Biosphere-Atmosphere Interactions;
- Future Climate Scenarios and Reduction of Uncertainties;
- Climate Change Scenarios for the 21st Century;
- Agriculture;
- Water Resources;
- Renewable Energy;
- Biodiversity: Composition, structure and function of ecosystems in the Cerrado and Atlantic Forest Biomes – responses to climate change;
- Human Health;

39 To learn more about this program see http://www.fapesp.br/programas/mudancas-climaticas/
40 See item 2.2.10 about the LBA.

- Coastal Areas;
- Urbanization and Mega Cities;
- Climate Change Economy;
- Science, Technology and Public Policies Studies;
- Emissions of Lakes and Reservoirs;
- Combustion Processes;
- Reduction of Emissions from Deforestation and Degradation (REDD);
- Brazilian Model of the Terrestrial System (BESM);
- Global Atmospheric Model of the CPTEC;
- Multi-Scale Modeling: Challenges for the Future;
- Observational Technologies for Climate Change;
- Information System for the Reduction of Natural Disasters Risks.

2.2.6. National Institute for Space Research (INPE) and climate change

The National Institute for Space Research (INPE) has been providing, since 1995, by means of its Center for Weather Forecasting and Climate Studies (CPTEC), short and medium term weather forecasts, as well as climate forecast, in addition to mastering highly complex technical numerical modeling, of the atmosphere and the oceans, to predict future conditions. Since 2008, INPE, through its Earth System Science Center (CCST), provides studies, climate change projections, and, whenever possible, propose adaption solutions that will enable the development with equity and the reduction of the impacts over the environment of the Earth.

INPE's staff is highly trained, and they use a supercomputer with maximum speed of 258 Teraflops, equivalent to 258 trillion calculations per second, which placed Brazil among the countries that are able to generate future climate scenarios to support the Fifth Report of the Intergovernmental Panel on Climate Change (IPCC).

Their staff is highly trained in the best post-graduation institutions of the country and abroad, and its officials are constantly trained and updated in order to generate new scientific knowledge and develop technology for applications in various meteorology areas.

The joining of knowledge and technology levels up the reliability achieved in numerical weather and climate prediction to other forecast centers in more developed countries.

Tupã is a *Cray XE6* supercomputer purchased with funds from the Ministry of Science, Technology and Innovation and the Research Foundation of the State of São Paulo. Installed at INPE, in the town of Cachoeira Paulista, in the interior of the state of São Paulo, it serves the CPTEC and the Earth System Science Center, in addition to research groups, institutions and universities members of the Brazilian Research Network on Global Climate Change (*Rede CLIMA*), the FAPESP Global Climate Change Program and the National Institute of Science and Technology for Climate Change.

With Tupã INPE can generate more reliable weather forecasts, in advance and with better quality, thus increasing the level of detail to 5 km in South America and 20 km for the entire globe. It is possible to predict even extreme events with good reliability, such as heavy rains, droughts, frosts, and heat waves, among others. The environmental and air quality forecasts are also benefited, generating higher resolution forecasts of 15 km, with up to six days in advance.

In a country with a huge territorial extension as Brazil, with great climate diversity, the good quality of weather forecasts is crucial for the planning and good performance of numerous social and economic activities areas, especially agriculture. INPE, by using numerical models, has been contributing to the prediction of drought or floods, thus favoring decision-making in the areas of civil defense, energy generation and water resources management. There is also important contribution in the fields of transport, supply, tourism and leisure. The computing system and the collections of data provide a significant growth of the meteorological research in the country, with the result of improving the knowledge on atmospheric phenomena of interest.

One of the INPE's main objectives is to construct high-resolution global climate change scenarios that will be used to develop studies aimed at increasing the awareness and training of policy formulators and government authorities in relation to the impacts of global climate change on the different vulnerabilities and on possible adaptation measures. Important applications will be used in hydroelectricity (due to its importance in generating electric energy in Brazil), agriculture, human health and natural disasters, among other areas, which will be provided with needed information to support the decision-making process.

In collaboration with the teams of the Hadley Center, Tyndall Center and the University of East Anglia in the United Kingdom, observational studies and the development of climate modeling capacity have been developed in Brazil, directed to global climate change. INPE is leading the development of the Brazilian Model of the Global Climate System (MBSCG), directed toward the generation of future climate scenarios in the world, thus allowing Brazil to be the only country in Latin America to generate global future climate scenarios that are compatible with the models used by the Intergovernmental Panel on Climate Change (IPCC).

INPE uses dynamic downscaling with the Eta model, developed by INPE itself, for climate change studies. This model connects to the global model desired and allow for the implementation of climate simulations for the country and Latin America and the Caribbean, with greater spatial details. The ETA model for the study of climate change was developed by INPE.

The activity involves strong national and international scientific collaboration in generating knowledge and capacity for implementing global climate change scenarios on a more detailed and precise scale than ever before.

INPE-Emission Model (EM): evolution of the methodology for the calculation of the emissions due to land use and land-use change and forestry (LULUCF)

The development of a framework for modeling the land-use change emissions INPE- Emission Model (EM) is a national effort to a future improvement of the methodology for estimating the emissions for land use and cover change and forestry (LULUCF). INPE-EM is a product of the Earth System Science Center (CCST) of the National Institute for Space Research (INPE), with support of *Rede CLIMA*, in partnership with several institutions.

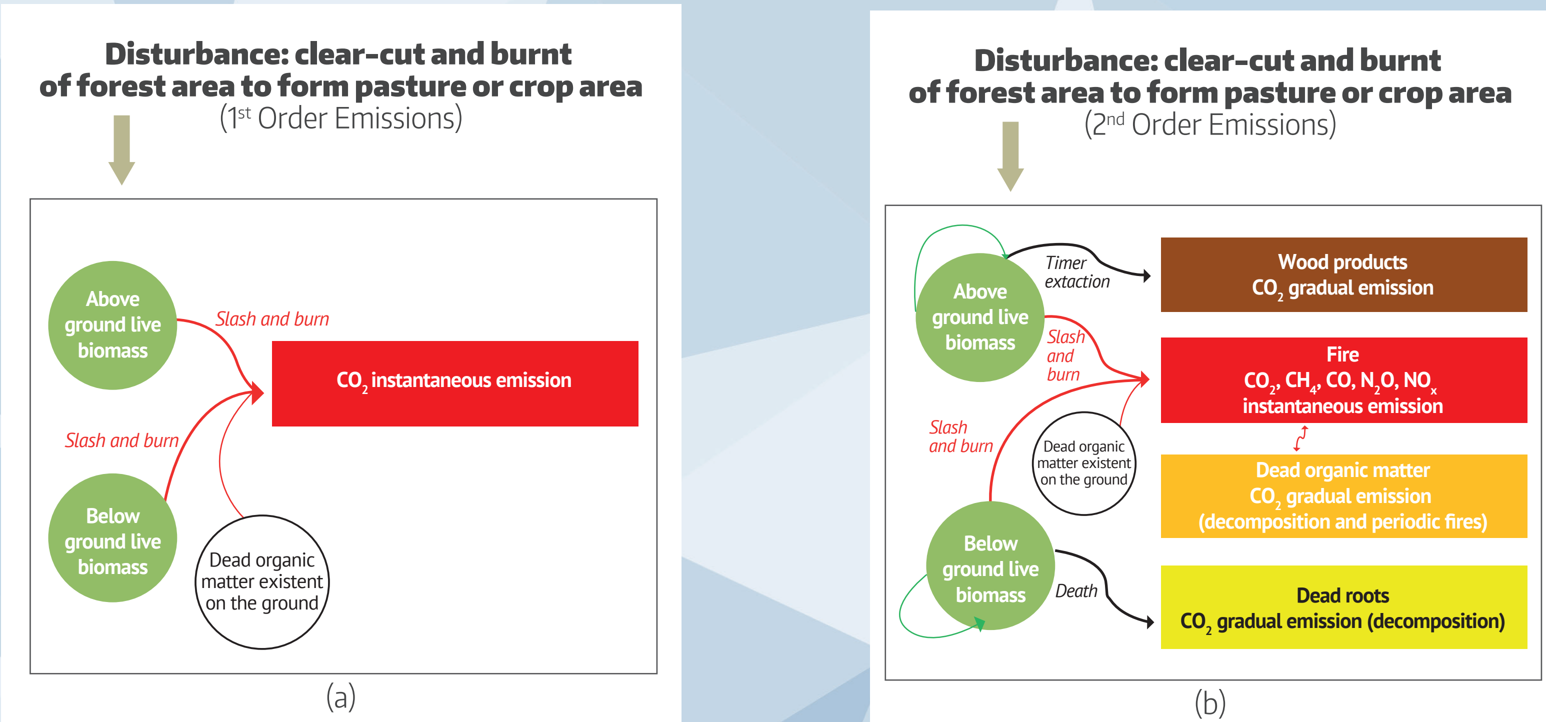
The model is able to generate 1st order estimates (assuming 100% of the emissions occur at the time of land-use transition), and 2nd order estimates (to consider the gradual process of liberation and carbon sequestration, representing flows between biomass compartments)[41]. All parameters that represent the process of emission/removal may be spatially explicit to consider the heterogeneity within a region. The framework is easily configurable, extensible and open source, allowing the development of new modules or modification to the existing ones whenever necessary.

Both alternatives to estimate the net carbon emissions have been introduced to make it more suitable to generally represent the different slash-and-burning practices in different biomes, with a higher flexibility for representing the practices related to aboveground and belowground living biomasses (for instance, partial cut harvesting and root removal). Carbon pools related to dead organic matter (dead wood and litter) were explicitly incorporated, being added to the dead organic matter generated by the slash and burning process[42]. Finally, in addition to estimates of CO_2 emissions, emissions of CH_4, N_2O, CO and NO_x are also calculated. The Figure I (a and b) show schematically how the estimates of the 1st and 2nd Order emissions for the cutting/burning processes of natural vegetation are done in the new version of the framework.

41 *1st order estimates are compatible with Tiers 1 and 2 of IPCC's GPG-LULUCF (Good Practice Guidance for Land Use, Land-Use Change and Forestry). 2nd order estimates are compatible with Tier 3.*
42 *Carbon compartment in soils is not considered in this version of the model.*

FIGURE I

Schematic representation of emission estimates of clear-cut and burnt forests: a) 1st order estimates, considering all the instantaneous emissions; b) 2nd order estimates, considering the flows between carbon pools and instantaneous and gradual emissions



Estimates of 2nd order aim at representing more realistically the carbon release rate into the atmosphere over time – taking into account that part of the biomass is converted into wood products, part is burned, and part is left on the ground, suffering gradual decomposition (above or below ground). In the case of CO_2, emissions of 2nd Order consider the sum of components related to instantaneous release by burning (the living biomass and dead organic matter) to the gradual decomposition of elements of dead organic matter, wood products and elemental carbon. Emissions of CH_4, N_2O, CO and NO_x are proportional to the percentage of biomass burned.

Applications for other Brazilian biomes are being developed, in particular, the Cerrado and Caatinga. Components are also being developed for selective logging and fire in the natural vegetation as well as the subsequent dynamic after these disturbances (as the secondary vegetation growth).

In a nutshell, after the refinements that are currently underway, the INPE-EM framework has a potential as being a tool to be used to refine and to facilitate the emission estimates for this sector, not only in Brazil, but also for other countries, because its parameterization and open code can allow constant improvement and the inclusion of new components – as long as deforestation monitoring systems are operational and can supply reliable data.

2.2.7. Amazon Monitoring Program by Remote Sensing

When changes occur in land use, i.e., a forest is cut and burned, being replaced with pasture, agriculture or other form of land use, there is release of a large amount of carbon in the form of CO_2 to the atmosphere, thus contributing to global warming. At the same time, standing forest acts as a carbon sink, sequestrating the greenhouse gases released from the atmosphere. This way, the monitoring of deforestation and burns maintains a close relation with the global climate change.

Brazil has accumulated national capacity in monitoring deforestation and fires through the National Institute for Space Research (INPE). The recent downward trend of deforestation in the Brazilian Amazon, one of the largest recorded on the planet, is in large part a result of the monitoring systems produced by INPE, which guided the formulation of public policies for the region, as well as the command and control actions to prevent and combat deforestation in priority municipalities[43].

The INPE Remote Sensing Amazon Monitoring Program counts with four operational and complementary systems: Prodes, Deter, Degrad and *Queimadas*.

The Project for the Estimation of the Gross Deforestation of the Brazilian Amazon (Prodes) is the largest monitoring project of the world's forests using satellite remote sensing techniques. Since 1988, INPE has been producing annual estimates of deforestation rates by clear-cutting of the Legal Amazon, when the forest cover is fully removed. The Prodes, supported by the Ministry of the Environment and Brazilian Institute of Environment and Renewable Natural Resources (Ibama) and financed by the Ministry of Science, Technology and Innovation, identifies clear-cutting areas with minimum areas of 6.25 hectares. As of 2003, INPE started to adopt the process of interpretation assisted by computer for the calculation of the deforestation rate in the Amazon, called Prodes Digital to distinguish it from the previous process. The main advantage of this procedure is in the accuracy of the georeferencing of the deforestation polygons in order to produce a multi temporal geographic database. The disclosure of such data highlights the continued commitment of the Federal Government to treat this information with transparency[44].

The calculation methodology of the deforestation rate in the Amazon is based on some assumptions:

- >> The images used are from the LANDSAT satellite and form a grid that covers the entire Amazon Region, composed of a set of orbits and points. Each image is identified uniquely by an orbit-point ordered pair;
- >> Part of the images cannot be analyzed due to problems of cloud cover or conflict between the time required to process all images and the date scheduled for the disclosure of the rate. In this case, the images are selected so as to cover the maximum possible of deforested areas in the previous year;
- >> As of 2005, in cases of high cloud coverage, images from other satellites (or dates) can now be used to compose the scene;
- >> The areas not observed due to cloud cover should be taken into account in the procedure to calculate the increase estimated for each image;
- >> Deforestation occurs only in the dry season. Thus, for each orbit-point, the dry season was established based on climatological parameters. In order to provide an annualized rate of deforestation in the picture, the increments of deforestation detected in each image must be projected for a reference date.

43 Article 2 of Decree No. 6,321/2007, provides that the Ministry of the Environment will issue, each year, a directive with a list of prioritized municipalities located in the Amazon Biome, whose identification of areas will be carried out from the historical dynamics of deforestation checked by INPE, on the basis of the following criteria: total area deforested; total area of deforested forest over the last three years; an increase in the rate of deforestation in at least three of the last five years. These municipalities become the focus of the policy to prevent and combat deforestation in the Amazon.

44 Prodes data are found at http://www.obt.inpe.br/prodes/index.php

The image interpretation methodology consists of the following steps: selection of images with less cloud cover and with date of collection as close as possible to the reference date (August, 1st) for the calculation of the deforestation rate; georeferencing of the images; processing of the radiometric image data into scene component images (vegetation, soil, and shadow) by the application of spectral mixture algorithm to concentrate the information on deforestation in one to two images; segmentation in homogeneous fields of the images of land and shadow components; non-supervised classification, and by fields, of land and shade images; mapping of the non-supervised classes in informative classes (yearly deforestation, forest etc.); edition of the classes mapping result and preparation of thematic maps mosaics of each State.

The information provided by INPE allow the Brazilian Institute of Environment and Renewable Natural Resources (Ibama) and the state environment bodies to perform a survey of the causes, dynamics and consequences of the deforestation process in the Amazon, assisting in its strategy to combat and prevent deforestation.

The integrated monitoring strategy performed by Ibama is based on the following points:

- >> Extensive use of airborne sensing for the identification of selective logging;
- >> Adoption of satellite communication systems, installed on the Ibama's surveillance vehicles, for the consultation of registers, thus allowing the verification of the documentation and the existence of irregularities; and
- >> Identification, dissemination and application of technologies for the sustainable use of the forest, aiming at replacing agricultural and forestry practices that are not compatible with the environment.

As a result, the monitoring of the areas of interest is possible via the issuance of infraction notices, transport permits for forest products and inspection reports, in addition to allowing the monitoring of the inspectors work, once each vehicle is monitored.

The Prodes data alone are not sufficient for prevention and monitoring actions due to the time it takes for them to be produced and because they included only the clear-cutting areas. For this reason, as of 2004, INPE implemented the Real Time Deforestation Detection System (Deter) for the continuous monitoring of deforestation and forest degradation[45], which has been of support to the Action Plan for the Prevention and Control of Deforestation in the Amazon Region (PPCDAm)[46].

Deter provides the location and approximate size of new occurrences of changes in vegetation to support deforestation enforcement and control actions. This system uses images of the MODIS sensor (aboard the TERRA satellite), NASA and WFI (aboard the Brazilian satellite CBERS-2B of INPE). These sensors cover the Amazon with high temporal frequency (two and five days, respectively), but with a moderate spatial resolution of 250 meters. With this spatial resolution, the images of these sensors can only detect deforestations whose areas are greater than 25 hectares. Thus, the Deter measures are more inaccurate than those of Prodes, but made more frequently.

In order to assist in surveillance and control of the illegal use of the forest, the Deter uses a more comprehensive deforestation concept than Prodes. The Prodes only identifies and counts the areas that show clear cutting, which is the final stage of the deforestation process. In Deter, any change of forest cover in the analysis period is singled out as an area of warning and subject to monitoring, without differentiating the deforestation process stage. Thus, the Deter seeks to identify the intermediate stages of the deforestation process. Every 15 days, when the observation

45 See: http://www.obt.inpe.br/deter/
46 For details on the PPCDAm, see Volume II of this National Communication.

conditions are favorable, the Deter produces a digital map with all deforestation occurrences observed in the previous fortnight. In this manner, it allows organizations in charge of monitoring to plan their field actions and operations to combat illegal deforestation.

As of May 2008 INPE started to qualify the monthly deforestation alerts issued by Deter. The qualification is made through the analysis of the polygons sample of Deter with better resolution images (LANDSAT and/or CBERS).

The alerts overlap the images of better spatial resolution and are then classified as Clear Cutting or Mild, Moderate or High Forest Degradation. The unconfirmed alerts such as deforestation are also accounted for. The Deter alert system presents a good average confirmation of deforestation events.

In 2008, INPE developed the Degrad system[47], in accordance with the indications of the forest degradation growth of the Amazon obtained from the Deter data. It is a new system designed to map areas in the process of deforestation in LANDSAT and CBERS images, where the forest cover has not been fully removed yet. This system's objective is to produce detailed maps of forest areas with a tendency to be converted to clear cutting. These areas are not computed by Prodes. As well as Prodes, the minimum area mapped by Degrad is 6.25 hectares.

Additionally, INPE maintains, since 1985, an operating fire-monitoring satellite system all over Brazil and great part of South America. For this, it developed methodologies and programs to identify hot spots in low-resolution satellite images, such as the NOAA, GOES, TERRA, AQUA and METEOSTAT series.

Since 1988, initially with the Program for the Prevention and Control of Fires and Forest Burnings on the Arc of Deforestation (*Proarco*), the government has been promoting actions to eradicate the illegal use of fire and burnings. The *Proarco* Program was ended in 2006, and its activities were transferred to the National System of Prevention and Combating to Forest Fires (*PREVFOGO*), created in 1989, within the framework of the Ibama. The *PREVFOGO* is in charge of, among others things, developing programs to sort, monitor, prevent and combat forest fires, and also developing and disseminating management techniques to control fire.

2.2.8. PIRATA Program

The Prediction and Research Moored Array in the Atlantic (*PIRATA* Program) involves Brazilian, French and Americans scientists, and is implemented by means of international cooperation involving the National Institute for Space Research (INPE), of Brazil; the Météó France and Institute for Development Research (IRD – *Institut de Recherche pour le Developpement*), of France; and National Oceanic and Atmospheric Administration of the USA (NOAA), of the USA. It is considered one of the five largest oceanographic programs of the world. The objective of the PIRATA Program is studying the ocean-atmosphere interactions in the tropical Atlantic and their impacts on the regional climate variability in seasonal scales, either interannual or longer periods. The Pirate Program data also allow the formulation of seasonal climate forecasting models in the region and in underlying continental areas.

In Brazil, the PIRATA Program is ruled by the National Committee of the PIRATA Project, which counts with five institutions: the National Institute for Space Research (INPE), which chairs it; the Navy's Directorate of Hydrography and Navigation (DHN); the Oceanographic Institute of the University of São Paulo (IOUSP); the

47 *See: http://www.obt.inpe.br/degrad/*

Cearense Foundation of Meteorology (FUNCEME); and the National Institute of Meteorology (INMET). The Laboratory of Meteorology of Pernambuco (LAMEPE) and the Federal University of Pernambuco (UFPE) also contribute to the PIRATA Brazil Program.

The project consists of the implementation, in the tropical Atlantic Ocean, of a pilot system that will allow the collection of atmospheric and oceanic data, which counted with the launch and the maintenance of 12 "Atlas" buoys (Autonomous Temperature Line Acquisition System), between 1997 and 2000, anchored on the high seas, in the middle of the Atlantic Ocean and close to the Equator, to a 5,000 meters depth. Currently, there is a total of sixteen systems anchored, being ten from the original arrangement (1997-1998) along the Equator (35W, 23W, 10W, 0W) and at longitudes 38W (4N, 8N, 12N and 15N) and 10W (6S, 10S), three in two southwest extensions, launched in 2005, and two released in the northeast extension, in 2006, the same year a buoy was launched in the southeast extension of Ocean.

The buoys, together with tide graphs and weather stations equipped with Data Collection Platforms in the archipelagos of São Pedro and São Paulo and in Fernando de Noronha, measure the temperature and salinity from the sea's surface layer to a depth of 500 m and it obtains data on weather conditions and sea level in the region. The data obtained are transmitted via satellite through the ARGOS[48] and INPE/SCD[49] services and available in "almost-real" time in the internet. In addition to these, a subset of buoys of the PIRATA arrangement continuously measures the concentrations of O_2 and CO_2 dissolved in seawater.

During the PIRATA program's pilot phase, from 1997 to 2000, the logistics, maintenance and engineering problems that could arise from implementing the observation system were evaluated. During the consolidation phase, from 2001 to 2007, the longevity of maintenance procedures was tested and the logistics aspects of material exchanges between the USA, Brazil and France were improved. As of 2008, the network entered into its "permanent" phase, that is, it became a reference international monitoring network of the Tropical Atlantic, recognized by the World Climate Research Program (WCRP) panels/Atlantic Panel and the Oceans Observations Climate Panel (OOCP). Also, information raised by PIRATA is a great contribution towards the international research effort carried out by the WCRP, especially for activities that followed the Tropical Ocean Global Atmosphere (TOGA) (CLIVAR-GOALS), which monitored the Pacific Ocean, under the same guidelines from 1985 and 1994.

Brazil's interest in the PIRATA Program results from the fact that, from a meteorological and oceanographic perspective, permanent monitoring of this region is necessary, including the inter-hemisphere heat transfer aspects that occur in the sub-surface of the ocean in that region. The collected data is also indispensable for improving climate forecasts, as well as short-term weather forecasts. Temperature anomalies end up determining extreme rain events in the northeast of the country, which are only predictable if there is permanent monitoring of this variable.

With over 350,000 data files distributed by the PMEL/NOAA website alone and for free through the Internet and 139 articles published in journals between 1998 and 2012, the PIRATA Project is a remarkable demonstration of scientific success and an example of international cooperation aimed at global oceanic monitoring for climate variability studies and global climate change.

48 Argos is a system of artificial satellite that collects, processes and disseminates environmental information from fixed and mobile platforms throughout the world.

49 SDC is a data collection Brazilian satellite.

In addition to the PIRATA Program, Brazil also develops other oceanographic initiatives of excellence: observation network through fixed buoys and drifting in the South and Tropical Atlantic (PNBOIA); permanent network of average sea level monitoring (GLOSS/Brasil); monitoring network of waves in shallow water (*Rede Ondas*); monitoring project of the thermal structure characterization, from High Density XBT lines between Rio de Janeiro and Ilha da Trindade (MOVAR). Together these initiatives integrate and contribute to the Overall System of Oceans Observation (GOOS) and for the advance of science in terms of knowledge on the global climate change and its impacts over the coastal areas.

2.2.9. Monitoring System of the Brazilian Coast (SiMCosta)

In November 2011, in Salvador, during the II Workshop on Climate Change in Coastal Zones, the representatives of the Coastal Zone Sub-network of the *Rede CLIMA* decided for the imperative necessity of continuously monitoring the physical, chemical and biological properties of coastal waters, and also providing easy access to the scientific community and public managers. Consequently, the implementation of a country-wide Monitoring System of the Brazilian Coast (SiMCosta) was concluded to be a necessity.

It is an anchored system, with surface buoys, used to support the oceanographic equipment attached to its connection cable as well as to fix meteorological meters and the data transmission system via radio, telephone and satellite.

The SiMCosta Project is based on resources from MCTI, CNPq and the Climate Fund with an objective of implementing and maintaining a monitoring network in a continuous flow of oceanographic and meteorological variables along the Brazilian coast. In the medium run, it is expected that the entire coastal region along the Brazilian territory is going to be attended.

Data extracted from the monitoring network may allow:

- to establish a warning system in cases of occurrence of extreme events;
- to forecast the processes related to climate effects, such as *El Niño/La Niña* events;
- to identify long-term trends;
- to map vulnerabilities of the coastal zone;
- to forecast impacts on the physical, biotic and social-economic surroundings of the coastal zone;
- to generate future scenarios;
- to assess mitigation alternatives;
- to provide modeling information, assess the variables and status of the coastal ecosystems;
- to expand the national capacity of development and managements of oceanographic observation system.

2.2.10. Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA)

The Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) was an international research project of the United States, European Union and Brazilian research institutes and universities. In 2007 it became a program of the Ministry of Science, Technology and Innovation (MCTI). The Amazon National Research Institute (INPA), responds for the scientific coordination, which includes coordinating the work of 288 partner institutions.

The LBA's research program is guided by the need to understand the operation of complex natural ecosystems of the Amazon Watershed with focus on the tropical rain forest biome, the largest one in the planet, and the impacts of the transformations related to changes in land use, which occur as part of land development and occupation. It thus seeks to understand how changes in land use and climate can affect the watershed's biological, chemical and physical processes as well as the region's sustainable development and its interaction with the global climate.

The LBA Program is currently in Phase 2. LBA'S Scientific Plan for Phase 2 was drawn up through a series of meetings involving the MCTI, Brazilian research institutes and universities. The initial program (LBA Phase 1) was restructured after a careful analysis of the results of Phase 1 and based on a future research vision in the Amazon, made by members of LBA's International Scientific Committee. Thus, three integrating axes were defined: (i) the changing Amazon environment; (ii) the sustainability of the environmental services and the terrestrial and aquatic production systems; (iii) variability of the climate and hydrological changes – feedback, adaptation and mitigation.

These three focal points are structured in interdisciplinary areas, organized into three thematic axles: (i) multi-scale physical-chemical interactions in the biosphere-atmosphere interface in the Amazon; (ii) social dimensions of the environmental changes and the dynamics of land use and cover in the Amazon; (iii) physical-chemical-biological processes in the aquatic and terrestrial systems and their interactions.

This interdisciplinary structure is geared to answer two basic questions that guide the LBA research program: (i) How does the Amazon currently work as a regional entity; (ii) How do the land use and climate changes affect the biological, chemical and physical functioning of the Amazon, including its sustainability and its influence on the global climate?

During the first ten years of existence (1998-2007), the LBA counted with NASA and other institutions in the United States and Europe as partners. Together, they accounted for approximately half of the $100 million invested in this period. Today, transformed into a government program, the LBA counts with Brazilian resources budgeted in the Multiannual Plan that ensures the maintenance of its basic infrastructure. Other sources of funds are sought to ensure the continuous expansion of the researches and studies.

Currently, the LBA has 45 ongoing research projects funded by different institutions. The construction of a 320m-high observation tower (ATTO) will be important for several of these projects. The tower will serve as a long-term platform for climate, physics and atmospheric chemistry investigations, including anthropogenic impacts. The results are intended for use in models of cycle/carbon balance.

Another important initiative of the LBA that provides the basis for its own activities is its line of action in training and education, present from the very beginning. The LBA Program was innovative in establishing research lines on topics that were not part of the research agenda of the majority of the Amazonian institutions and also to use cutting-edge technology that did not exist in the region. Many research lines of the LBA were not developed at institutions of the Amazon and Cerrado. For this reason, the LBA, since its conception, still in the planning phase, had to invest in the training of human resources and staff to begin and continue its research activities. The training and education component of the LBA were then created in 1995, with the specific task of developing human resources for the program, with an emphasis in the Amazon and the adjacent region of the Cerrado, and providing direct feedback to the host countries in terms of strengthening their scientific communities.

In ten years, the LBA managed to surpass the goal it had set out to train and qualify 100 doctors, surpassing 140 doctors.

2.2.11. Brazilian Antarctic Program (Proantar)

Antarctica has a key role in the global natural systems. It is the main thermal regulator of the planet, and controls the atmospheric and oceanic circulations, influencing the climate and the conditions of life on Earth. It also owns the largest reserves of ice (90%) and fresh water (70%) of the world.

Over the last few decades, important scientific observations, among which, the ones relating to the reduction of the protective ozone layer of the atmosphere, the atmospheric pollution and the partial disintegration of the ice on the periphery of the continent, showed the sensitivity of the southern polar region to global climate change.

The scientific research of the southern region is of paramount importance for the understanding of the functioning of the Earth system. Clarifying the complex interactions between the Antarctic and global natural processes is, therefore, essential for the preservation of human life.

Brazil's condition as an Atlantic country, located relatively close to the Antarctic region, being the seventh nearest country, as well as the influences of the natural phenomena that occur there on the national territory fully justify the historic interest of Brazil on the southern continent. These circumstances, in addition to strategic, geopolitical and economic reasons, were also determining factors for the country to join the Antarctica Treaty, in 1975, and initiate the Brazilian Antarctic Program (Proantar), in 1982.

The Proantar is a program that will be implemented by the Interministerial Commission for Marine Resources (CIRM)[50].

Since the beginning of PROANTAR up to 2002, funding was based on spontaneous demand projects, in several disciplines of the Sciences of the Atmosphere, Earth and Life. In 2002, at the MMA's initiative, in a partnership with CNPq, new research have been started through two large networks dedicated to: (1) the impact of global environmental changes in the Antartic and their consequences to Brazil; (2) an assessmentof the environmental impacts of the Brazilian activities in that region.

Under this context, Brazil participated in several initiatives organized by the International Council for Science (ICSU) program and World Meteorological Organization (WMO). The main Brazilian projects were focused on: (a) the interaction among the regions of the Antartic continental shelf and the slope (continental shelf-breaking region); (b) the effects of oceanic circulation in the Antarctic climate and connections with South America; (c) high-atmospheric chemistry and physics and connections with South America; (d) mass balance in the glaciers of the Antarctic Peninsula and impacts on the local ecosystems; (e) study of evolution adaptations of Antarctic fishes; (f) impact of local environmental changes in Antarctic stations.

50 More information at: http://www.mar.mil.br/secirm/portugues/proantar.html

In 2012, the Cryosphere Expedition, designed and carried out by the national scientific community, marked a new stage in the Proantar by implementing a new scientific laboratory. This module, called Cryosphere 1, has transmitted, since then, meteorological and atmospheric chemistry data directly to Brazil. This information is essential to improve weather forecasts in Brazil and for studies on the impact of climate change.

2.2.12. Mitigation Scenarios Monitoring

A full assessment of the reduction and costs of potential of greenhouse gas emissions (GHG) are crucial to the efforts to design and guide the climate policies to reconcile mitigation efforts with the economic development and the local social-environmental quality.

Brazil has advanced in the creation of a national capacity to monitor future scenarios of GHG emission and mitigation options. There are currently two ongoing research projects: Mitigation Options of Greenhouse Gas in Key Sectors of Brazil, conducted by the Ministry of Science, Technology and Innovation (MCTI) and the Economic and Social Implications Project (*IES Brasil*), coordinated by the Brazilian Forum of Global Climate Change, with the institutional support of different ministries, including the MCTI.

Mitigation Options of Greenhouse Gas in Key Sectors of Brazil

This project is sponsored by the MCTI in partnership with the United Nations Environment Program (UNEP), with the financial support of the Global Environment Fund (GEF).

The project will establish specific base scenarios per sector, based on the most recent data available (reference scenario) for the 2012-2035 and 2035-2050 periods; and estimate the technical and market potentials, plus the abatement cost for the reduction of GHG emissions. This will be done for each one of the selected sectors: industry; energy production and processing; transport; residential and services; agriculture; land use and forests change; waste management, as well as for specific intersectoral alternatives.

This effort will lead to the establishment of a database on the mitigation of GHG emissions for each of the sectors mentioned above, which will collaborate for the driving of the climate policies and for the training with regard to the mitigation actions of the Brazilian government. The analysis of the results will be made on the basis of three scenarios: reference scenario (baseline), low carbon scenario, and low carbon scenario with innovation.

The scope of the project will also assess the real mitigation potential, considering the Brazilian economy as a whole – while avoiding the double counting of mitigation measures – and analyzing the potential impacts of the adoption of low carbon policies by the Brazilian economy.

In addition to the research, an important component of the project is training. It seeks to increase the capacity and technical skills of governmental and non-governmental actors to identify mitigation options; quantify its respective potentials and costs for the various sectors of the Brazilian economy; and assess the possible impacts of different climate policies on the Brazilian economy. The objective is to strengthen local capacities and prepare for the implementation of policies for the mitigation of climate change. Capacity-building will take three dimensions into account: (i) the institutional capacity to promote the development of policies, procedures, regulations and the systems of goals and incentives comprising the actions for the mitigation of GHG emissions; (ii) the organizational capacity to foster the planning and management capacity of individuals, through the creation of internal goals, mechanisms and resources; and, finally, (iii) the human resources capacity for the training of the government personnel in the definition of objectives, development and management of climate policies programs, mobilization of resources and implementation of the climate policy.

Therefore, the Mitigation Options project has a strategic importance in the estimation of the mitigation potential costs for industrial competitiveness (direct impacts) and the Brazilian economy (indirect impacts) and, at the same time, evaluates the possibility of gains, through innovation, for the reduction of GHG emissions in Brazil.

Economic and Social Implications (IES-Brasil Project)

The *IES-Brasil* Project, coordinated by the Brazilian Climate Change Forum (FBMC), gathers a set of efforts from different sectors of the Brazilian society. Its purpose, based on the impact the GHG emission exerts on the social and economic growth, is to identify distinct development trajectories that may align socioeconomic and environmental objectives. For that, it prepares economic scenarios for the 2020-2030 and 2031-2050 period deemed pertinent by the mobilized sectors. This way it identifies mitigation policies that reveal best answers in relation to their economic and social impacts.

The concept of the *IES-Brasil* Project comes from an international collaboration led by the Mitigation Action Plans and Scenarios (MAPS) initiative. Several countries in the southern hemisphere have decided to bring forward participatory processes, from the MAPS initiative, to model and understand the effects of GHG mitigation policies, trying to align economic and social development. The first case of this kind occurred in South Africa, and similar projects are underway in Chile, Colombia and Peru. The *IES-Brasil* project benefits from the collaboration between the research teams and facilitation of different countries involved in the initiative.

A differential of *IES-Brasil* is that it intends to generate different GHG emissions scenarios in the medium and long term for Brazil through a participatory process involving, from the very beginning, the government, the private sector, the academia and civil society. The project will also provide elements for the business mitigation strategies and civil society organizations active in this field, so that government and society will be able to access their results with the certainty that a high level of contribution of stakeholders was considered and that the best practices and professional research were involved.

For the implementation of the research, the FBMC established a multi-disciplinary expert committee (Scenarios Elaboration Committee – CEC), which will discuss and select the assumptions and input data needed to feed the modeling tool. This committee will decide together, or through the creation of Working Groups, the values of various input variables for the simulation of scenarios. Its members will be those with experience in the sectors in which they operate.

The Research and Modeling Committee (CPM) will deal with the information, and will also run the models and report the results. The FBMC will facilitate all meetings and interactions between the CEC and CPM.

The *IES-Brasil* project counts with the institutional support of various ministries: Ministry of Science, Technology and Innovation; Ministry of Environment; Ministry of Mines and Energy; Ministry of Finance; Ministry of Foreign Affairs; Ministry of Development, Industry and Foreign Trade; Ministry of Planning, Budget and Management and the Executive Office of the Presidency of the Republic ("*Casa Civil da Presidência da República*").

2.3. TECHNOLOGY TRANSFER

The problem of global climate change is notably scientific and technological at the short and medium terms. It is scientific because it deals with defining climate change, its causes, intensity, vulnerabilities, impacts and reduction of uncertainties. It is technological because the measures to combat global warming include actions that aim at the promotion and the cooperation for the development, application and diffusion, including transfer of technologies, practices and processes that prevent the problem and its adverse effects.

As described in Item 3 herein, MCTI, by means of its General Coordination of Global Climate Change (CGMC), is the Brazilian National Designated Entity for the Technology Mechanism of the United Nations Framework Convention on Climate Change.

The Technology Mechanism was established by the 2010 Cancún agreements, and is characterized by a more dynamic approach, focusing on training, on an assessment of the needs of technological innovation, on the promotion of public-private partnerships, fostering research and development activities, and on mobilizing technological centers and national, regional and international networks.

The MCTI recognizes that the range of final objective of the Climate Convention will require technological innovation, as well as a rapid and extensive transfer and implementation of technologies, including know-how for the mitigation of greenhouse gas emissions and to adapt to the impacts of climate change. Consequently, the Ministry started a work agenda focused on the development of research and technical studies that make up the Brazilian project "Technology Needs Assessment for Climate Change" (TNA), which aims at initiating the internalization of the Technological Mechanism in Brazil.

Project TNA aims at supporting Brazil in assessing needs and technological priorities for the establishment of a low-carbon economy, resilient to the adverse effects of climate change, and developing a national Technology Action Plan (TAP), which will establish the activities to be carried out to allow internalization and dissemination of primary technologies in the country.

As it will be seen in the next sections, it is remarkable to note that, even before the General Coordination of Global Climate Change became the National Designated Entity by the Technological Mechanism of the Convention, Brazil had been trying to identify its Technological Needs in relation to Energy and which areas related to vulnerability, impacts and adaptation should receive greater inflow and attention through the Science, Technology and Innovation Policy.

The theme of international cooperation and technology transfer is also an area of activity of the Brazilian government. In compliance with article 4, paragraph 1(c) of the Convention, and taking into account its common but differentiated responsibilities and development priorities, objectives and specific national and regional circumstances, Brazil contributes towards promoting and cooperating "in the development, application and diffusion, including transfer, of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol in all relevant sectors (...)." It is also necessary to stress the Convention's provisions on the transfer of technology, found in its Article 4, paragraphs 3, 5, 7, 8, and 9.

It must be recognized that a fast and effective reduction in greenhouse gas emissions and the need to adapt to the adverse effects of climate change require access to, diffusion and transfer of sustainable technologies.

Brazil understands the expression "transfer of technology" in a more comprehensive manner, encompassing the different stages of the technological cycle, including research and development (R&D), demonstration, increase in scale (deployment), diffusion and the transfer of technology per se, in relation to mitigation as well as adaptation.

Brazil believes the development and transfer of technology related to global climate change should support mitigation and adaptation actions in order to achieve the Convention's ultimate objective. In seeking this objective, identification of technological needs must be determined based on national circumstances and priorities.

2.3.1. Technological Requirements in Relation to Energy

This section highlights the country's technological needs in relation to energy in a manner that combines meeting growing demands with the use of sources that emit fewer greenhouse gases. However, this section does not merely identify the technologies the country needs to receive, but also the great potential for endogenous technologies that can be disseminated and/or transferred to other countries, especially developing ones, through South-South or triangular (North-South-South) cooperation. Sugarcane ethanol is one of these examples, as are technological advances achieved in the agriculture sector.

Brazil's great challenge over the coming decades is to find solutions that meet the growing demand for energy and at the same time satisfy the criteria of economicity, supply security, public health, guarantee of universal access and environmental sustainability. In order to satisfy these criteria, significant efforts in research, development and innovation (RD&I) must be initiated immediately and in coming years to meet expected energy demands in 2030-2050.

In this context, the Center for Strategic Studies and Management (CGEE) has conducted studies aimed at identifying the current status of diverse technologies related to energy generation, and to explore the interest and opportunities for transfer/cooperation between Brazil and abroad in relation thereto. These studies aim at offering inputs for international negotiations related to energy technologies with potential to mitigate greenhouse gas emissions.

As regards technologies for the generation of electricity from natural gas and coal, Brazil has the need for the most modern technologies based on these fuels, including from other developing countries, like South Africa. Brazil has knowledge in the area of pulverized coal, since plants of this type currently exist in the country; however, there are no research initiatives in ultra-supercritical coal systems. In the case of large gas turbines, it is a technology already in use on a commercial scale in the country through multinational companies. There is a budding interest in small gas turbines in Brazil and there are already research groups working in this area, making room for international collaboration in applied R&D.

In the case of technologies for generating electricity from nuclear energy, Brazil has knowledge in the fuel production area, including the uranium enrichment step.

There is an interest to seek better technologies in the photovoltaic solar energy field and to promote cooperation agreements with internationally recognized centers of excellence with the objective of training human resources, enabling exchange of information (such as experiences, standardizations, measurements and support) and promoting project execution. Brazil has a large industrial park that extracts and processes quartz, transforming it into metallurgical grade silicon, but it does not yet have companies that transform metallurgical grade silicon into solar grade.

Wind energy is one of the fastest growing sources and its technological advances are rapidly reaching the market. The country needs to keep up with these advances. There is need to adapt software, technologies and materials to make them more appropriate for Brazilian conditions. There is room for R&D and applied research and for the nationalization of components. There are industries in the country with technology transfer agreements. Brazil also has an industrial structure potentially capable of meeting the demand for new aerogenerators and their components. The main countries that have these technologies are Germany, Denmark and the United States. China and India already have expressive programs for manufacturing and installing aerogenerators.

Brazil is interested in greater use of biomass gasification, a technology currently under development at the international level. The 2030 Energy Plan already considers systems that use gasification and combined cycles in the sugar and alcohol sector. There are already some groups working on this theme at Brazilian universities and more recently efforts at developing prototypes have been observed in the industrial sector. This is an area that can benefit from greater international cooperation with research centers in the USA and Europe. The academic knowledge the country has could be transferred to countries in the South and North.

Medium and large hydroelectric power technology is already mature in Brazil and around the world. But the SHPs have potential for technological development in the world. The country has expertise mainly in hydraulic turbine optimization projects and civil engineering. Currently, private companies are carrying out most of these activities. In terms of transfer of technology, this is an area where Brazil could export knowledge, products and services to both Southern and Northern countries.

The country already produces hydrogen, but its use on a greater scale for energy purposes requires additional cost reduction efforts. There are possibilities for joint developments between Brazil and several developed and some developing countries as already explored under the "International Partnership for a Hydrogen Economy". Brazil already has knowledge in some hydrogen production areas and technologies[51] (water electrolysis, reformation of ethanol and natural gas) and cell to Proton Exchange Membrane (PEM) fuel types[52] for stationary and reduced size applications, and there are even some small companies working in this field. It is worth noting that Brazil also has pilot projects in advanced stages of bus powered by hydrogen.

In relation to natural gas, although liquefied natural gas (LNG) technology is already being used on a commercial scale in the world, Brazil still does not have sufficient knowledge in the area and at present efforts are mostly employed in purchasing natural gas liquefication and regasification technology. Petrobras' Leopoldo Américo Miguez Research and Development Center (CENPES) is trying to acquire knowledge and studies on the state-of-the-art for LNG technologies, but there is still no industrial training in this area. There is also limited knowledge with regard to gas to liquids (GTL) and even coal to liquids (CTL) technology in the country, and it is more developed at the CENPES, although some universities and other research centers also have knowledge, but there is no industrial training in Brazil yet.

The technology to produce ethanol from sugarcane glucose is considerably advanced in the country and it is a technology that Brazil can certainly transfer to other countries, whether developed or developing, including the know-how for integrating it to the oil byproducts system, as will be detailed in the next subsection on International

51 See Item on Hydrogen in Volume II of this National Comunication.

52 The Proton Exchange Membrane (PEM) fuel cell uses a proton conducting polymer membrane. An electrode is attached to each side, which serves as the conductor that provides or removes electric current from a system where reactions occur.

Cooperation. Second-generation ethanol – the lignocellulosic ethanol[53] is being produced in the country. Brazil has several researchers and centers where most of the knowledge is concentrated, including some sugar and alcohol industries. The Center for Bioethanol Science and Technology (CTBE) was recently created. In this area, it is possible to say that Brazil has the possibility to transfer knowledge to developing countries and to benefit from collaborative research with both developed and developing countries.

In relation to low temperature solar thermal energy, Brazil masters flat collector technology. It would be important to develop other applications, such as refrigeration, air conditioning, selective surfaces, vacuum tubes and automated manufacturing processes. Although training exists at universities, coordinated efforts and greater interaction with companies are yet to be observed. It is also necessary to promote the modernization of domestic industry. Brazil will benefit from greater cooperation with other countries, like China and Israel, for example.

Brazil is currently the world's largest producer of farmed charcoal and it stands out in mastering the technology, although it needs to incorporate advances, mainly to increase efficiency in the carbonization process. Therefore, the country would have the opportunity to transfer technology to other countries that depend heavily on charcoal, especially in Latin America, Africa and Asia. There are national and international companies in the country dedicated to producing charcoal for the steel industry.

The country has research groups active in the whole production chain of biodiesel and there are opportunities for the transfer of national technology abroad, as well as greater exchange and cooperation with other major world producers, such as Germany. Brazil also has an industrial sector capable of producing biodiesel with national capital companies.

In relation to CO_2 capture and storage technologies, although still in initial R&D stages, the country is interested in the area. In 2006, Petrobras created a Thematic Network for Sequestering Carbon and Climate Change and set up the Carbon Storage Research Center (CEPAC). All of the technologies involved in Carbon Capture and Storage (CCS) (capture, transport, storage and monitoring) deserve attention and require cooperation with other countries. The country also expects to develop carbon capture and storage from renewable sources (Renewable CO_2 Capture and Storage – RCCS) with the objective of sequestering and storing CO_2 from the sugar fermentation process, especially in ethanol production, underground.

Smart grid related technologies are being developed around the world. Aspects such as interconnection for distributed generation, storage systems, real time load management systems and automation, among others, are important areas for developing these technologies. Brazil already has some knowledge, with good training at universities, at CENPES and at the Electric Energy Research Center (CEPEL). Expansion of this knowledge will be fundamental for encouraging greater deployment of sources such as photovoltaic solar, wind and hydrogen, and therefore, transfer of technology and knowledge from developed countries is desired.

There has recently been great interest in lithium batteries for automotive purposes, which could help disseminate electric vehicles. This technology is in its demonstration phase and is strongly mastered by multinational companies related to the automotive industry. Brazil has both the capacity and companies that manufacture several types of battery and which could, if duly trained, also master this new technology.

53 It is the ethanol produced from every type of plant biomass, including organic waste. Bagasse and straw are excellent alternatives for Brazil in the production of lignocellulosic ethanol. These technologies include the thermochemical (FisherTropsh) and biochemical (acid hydrolysis, enzymatic hydrolysis) routes for biofuel production.

As for social technologies, for many years Brazil has invested in some technologies that were capable of transforming the energy market with important social impact. An example of this is the introduction of LPG to replace wood, as well as sugarcane ethanol. There were concerns related to transforming the existing market, creating suppliers, distributors and points-of-sale for the new stoves, and to subsequently consolidate the market. There are nearly two billion people in the world who still use wood for cooking. This is an opportunity to take this know-how to those regions, as well as other cleaner fuels for this final purpose, such as ethanol, which could also be produced in small distilleries (another technology mastered by the country).

Brazil has invested nearly R$ 100 million in energy efficiency programs for the low-income population. These programs have been conducted by the electricity concessionaires and have contributed towards stimulating the domestic market for suppliers of more efficient equipment such as lamps, refrigerators and solar heaters for household use. These programs are being developed for the urban and peri-urban populations in situations of great logistical difficulty. Thus, there is know-how for implementing programs of this sort on a large scale, which could be transferred to other developing countries[54].

It is worth emphasizing that there is still a need to develop more research geared towards the transportation sector, especially in relation to hydrogen-driven bus technology and flex fuel technologies, particularly those aimed at heavy vehicles.

2.3.2. International Cooperation

Brazil gives special importance to international cooperation, understanding that the exchange of experiences and of knowledge among developing countries creates the feeling of solidarity and responsibility among peoples, benefiting all parts involved in the cooperation. Technical cooperation projects prove to be efficient promoters of social development and represent the efforts by many professionals, demonstrating that with drive and political will it is possible to carry out activities with important socioeconomic value toward the mitigation and adaptation to global climate change.

This subsection focuses on the main joint initiatives and partnerships of Brazil with other countries in the area of: renewable energy sources, climate modeling and studies of impacts, vulnerability and adaptation to global climate change, agricultural technologies for adaptation and promotion of food and nutritional security, management of water resources and the promotion of water security in the context of global climate change.

54 *See Volume II of this National Communication.*

2.3.2.1. Promotion of the production of renewable energy sources

Biofuels[55]

The nature of the theme leads to the leadership of the Ministry of Foreign Affairs (MRE) in international negotiations. Therefore, this Ministry created the Division of New and Renewable Energy Resources, responsible for proposing guidelines for foreign policy and coordinating the participation of the Brazilian government in bilateral and regional negotiations and in international organizations on the subject. This way, the MRE has participated in multilateral forums, such as, for example, the *Global Bioenergy Partnership*, which aims at creating a set of indicators of environmental, social and economic sustainability for biofuels. The objective is that the agreed indicators may serve as basis for the public policies of bioenergy in countries that still do not have legal framework or wishing to reform the already existing one. In the structure of the MRE it is also important to mention the Brazilian Cooperation Agency (ABC), which coordinates the Brazilian international technical cooperation programs and projects through its General Coordination of Cooperation in Agriculture, Energy, Biofuels and the Environment.

Under the coordination of the MRE, other ministries participate in the negotiations and cooperation activities. In the case of the Ministry of Mines and Energy, the Department of Renewable Fuels stands out, and is responsible in Brazil for the supervision of the use of resources for the promotion of renewable fuels and for the monitoring, fomenting and supporting of activities of research and technological development in the industry. By the Ministry of Agriculture, the General Coordination of Agroenergy and the Brazilian Agricultural Research Corporation (Embrapa), through its International Affairs Office and the Embrapa Agroenergy[56], stand out.

Embrapa is a technology diffuser for the production and commercialization of sugar cane and ethanol through its international area, and it coordinates the work of two of its other areas. Embrapa *Tabuleiros Costeiros* is responsible for projects directed to the system of production of sugar cane and ethanol – soil fertility, irrigation, agroecological zoning, and biological control, among others. There, African technicians and agronomists get training courses in production of sugar cane and ethanol promoted and financed by the Brazilian government. Embrapa Agroenergy responds for the technology transfer of bioenergy, from sugar cane and other raw materials, as well as projects of common interest to the partner countries. The Chief of Staff Office, as well as the Ministries of Science, Technology and Innovation (General Coordination of Sectoral Technologies) and Development, Industry and Foreign Trade (Secretariat of Innovation) are also participants of these activities.

The National Bank for Economic and Social Development (BNDES) plays an important role in the implementation of international agreements resulting from these processes of negotiation. The BNDES finances the internationalization of Brazilian companies through the Line of Foreign Direct Investment, created in June 2005. The sector of agrofuels is considered a priority in the policy of internationalization. Africa is a preferred continent for these investments, but

55 *The study by Sergio Schlesinger (2012),* "Cooperação e Investimentos Internacionais do Brasil: a internacionalização do etanol e do biodiesel" *is an important source of research of this subsection and some passages quoted here are taken from the full publication.*

56 *In 2011, the National Congress passed a Provisional Measure by the Executive Government, transformed into law, granting Embrapa the autonomy to operate outside the country. The new law aims at facilitating the international cooperation and the transfer of tropical technology to other countries, especially in Africa and Latin America. Embrapa has offices in Ghana (Embrapa Africa), Panama (Embrapa Americas) and Venezuela.*

under the guidance of its Research Department and Operations, the BNDES has been promoting the implementation of studies and research on the viability of the production of agrofuels in other countries.

It is through this institutional structure created for the promotion of the production of biofuels in partner countries that Brazil formalized a series of agreements and memoranda of understanding for cooperation, and also established the *Pro-Renova*, the Structured Program of Support to other Developing Countries in the Area of Renewable Energies.

In 2006, Brazil and the United States, in partnership with the Inter-American Development Bank (IDB), together created the Inter-American Commission of Ethanol, with the objective of spreading the use of this fuel, also defining policies for the creation of a world market of the product. The Memorandum of Understanding on Biofuels, signed in 2007, was an outcome of this commission and, despite mentioning the biodiesel; it focuses principally on the issues relating to ethanol.

At the bilateral level, the focus is on research and technological development for new generation biofuels, sustainability of ethanol and production standards. At the global scope, the Memorandum provides for the expansion of the market through the establishment of uniform standards and rules. In order to achieve this objective, a joint action was defined within the framework of the International Biofuels Forum, a Brazilian initiative launched in March 2007 at the United Nations Organization. The Forum brings together, besides Brazil, South Africa, China, the United States, India and the European Commission, and has as its main objective transforming ethanol and biodiesel into commodities.

By means of the same memorandum, Brazil and the United States declared their intention to work together to bring the benefits of biofuels to third countries, selected by means of feasibility studies and technical assistance aimed at stimulating the private sector to invest in biofuels. In Brazil, studies were performed on the viability of productive biofuels in seven Latin American countries and also technical and economic feasibility studies for the production of ethanol in the following countries: El Salvador, Haiti, Dominican Republic, Saint Kitts and Nevis and Senegal.

In 2007, Brazil signed a Memorandum of Understanding in the Area of Biofuels with the West African Economic and Monetary Union (UEMOA), a regional organization that involves eight countries in West Africa (Benin, Burkina Faso, Ivory Coast, Guinea-Bissau, Mali, Niger, Senegal and Togo). The Memorandum aims at the preparation of feasibility studies for the production and use of biofuels in the countries that are part of the economic bloc in West Africa. In February 2011, the MRE and the BNDES signed a technical cooperation agreement for the purpose of facilitating studies, in order to identify areas suitable for the cultivation of the main raw materials used in the production of agrofuels. The studies cover various aspects, such as regulatory framework, legislation related to labor, land and tax areas and intellectual property. They should also result in the indication of Brazilian suppliers in the areas of services and equipment technology.

In addition to that, in April 2008, Brazil signed a Memorandum of Understanding with the Netherlands on Cooperation in the area of Bioenergy, including biofuels, where the creation of an international market for biofuels is emphasized. One of the repercussions of this memorandum is the involvement of the Union of Sugar Cane Industry (Unica), in the search for the expansion of the cooperation between both countries to develop new products extracted from sugar cane. Another one is a similar memorandum concerning the engagement between the Ministry of Science, Technology and Innovation in Brazil and the Ministry of Agriculture and Foreign Trade in the Netherlands in initiatives for scientific and technological cooperation and innovation.

In 2009 a joint initiative of Brazil and the European Union for trilateral cooperation with African countries in renewable energy was formalized. This initiative is mentioned explicitly in the Joint Declaration of the III Brazil-EU Summit, in Stockholm, in October 2009. There are two main lines of action resulting from this cooperation: preparation of feasibility studies for the production of biofuels and implementation of projects based on the conclusions of studies. Kenya and Mozambique were the first countries participating, and the Getulio Vargas Foundation (FGV) was hired to perform the studies in Mozambique in 2011.

There is also a series of other memorandum of understanding on the subject in recent years. According to the "*Balanço de Política Externa 2003/2010*" (Foreign Policy Balance 2003/2010), published by the MRE, more than 40 memoranda of understanding for cooperation on biofuels have been signed in recent years. In addition, with Mercosur, there is significant progress with regard to the harmonization of standards and technical standards in progress within the framework of the Ad Hoc Group on Biofuels. And, within the framework of the India-Brazil-South Africa Dialogue Forum, a Memorandum of Understanding between these three members was established, resulting in the Trilateral Task Force on Biofuels.

The Structured Program of Support to other Developing Countries in the Area of Renewable Energies (Pro-Renova), launched in 2009, aims at creating enduring bases for the wide range of actions in Brazil with developing countries in the area of renewable energies, especially in Africa.

The developments in the international interest on the theme contributed to strengthen, on concrete foundations, the South-South cooperation and also promote the sustainable development of Brazil's partner-countries. In addition, specifically as regards the bioenergy, the understandings are fundamental for the establishment of new centers of production and consumption, a precondition for the "commoditization" of the product and the consequent development of an international market, ensuring the inclusion of bioenergy in the global energy mix.

The process of drafting the Pro-Renova involved several areas of the government and observed the following assumptions: collective treatment (because the increasing demand for talks and actions related to this theme makes the MRE and the other Brazilian governmental institutions involved with the theme struggle to meet the demands of the international partners); selection based on geographic, linguistic and political criteria; association with the private sector; structuring pilot projects; and possible involvement of international organizations.

According to a study prepared by the International Renewable Energy Agency (IRENA, 2014) about the adoption panel of advanced renewable energy technologies in developing countries, Brazil's experience with bioethanol offers great opportunity of shared learning through South-South and triangular cooperation for the development of technologies of this energy resource in Africa, particularly regarding to policy combinations that promote both the supply (successful strategies of production), and demand (transport infrastructure development and instruments). This collaboration recovers and strengthens the historical presence of the Brazilian cooperation in Africa, traditionally in the areas of agricultural innovation, food and nutritional security, education and health.

The study identified Brazil as a key partner for the technology transfer of Bioethanol for African countries, not only due to the successful Brazilian experience in the production of Bioethanol, but also because of the climate and soil similarities, the knowledge generated in the country for the development of its agricultural sector, the historical and cultural affinities that allow Brazil to better understand ways to develop new industry in the African context, and the economic challenges common to developing countries when local industries are being developed.

Currently, 37 countries in Africa are producers of sugarcane and there is a good opportunity to begin the production of ethanol from molasses as a first step, and assess the possibility of expansion at the level of each country, including scale, target markets and the necessary social, economic and environmental guarantees.

The current approach and strategy of the South-South Cooperation adopted by Brazil is, according to the study, an interesting opportunity for African countries. It can help increase the institutional capacity of promotion of a Bioethanol industry and encourage a more closely technical cooperation to increase the opportunities for broader solutions, providing a vision from the "south" to the "south".

However, it is important to emphasize that the paths and strategies to develop a bioethanol industry and commerce in African countries should be differentiated according to the specific characteristics of the country: whether the country is an importer of sugar and petroleum by-products, or whether it is an exporter of sugar or an oil importer country.

As many African countries are small in economic terms, in order for them to have their own technical and scientific infrastructure for bioethanol programs, in some cases, a regional approach may be desirable. The regional collaboration for technology of adoption and development of bioethanol can help integrate the region and subsequently facilitate a regional market.

New alternative sources of energy and energy efficiency

It is important to highlight that it is not only in biofuels that Brazil has been securing international cooperation initiatives in the field of renewable energy. By means of approaching the so-called BRICS, acronym that represents the following countries: Brazil, Russia, India, China and South Africa, partnerships have been entered into for the cooperation and encouragement of the promotion of solar and wind power, for example, with the exchange of information and technologies on the production of such sources. In 2013, the BNDES signed an agreement that narrows relations between the Brazilian bank and the development institutions of BRICS aimed at the collaboration between the countries on initiatives for the promotion of a low-carbon economy[57].

The Agreement of Multilateral Cooperation and Co-Financing for the Sustainable Development of BRICS seeks to establish the foundations for the coordination and exchange of information between institutions for the development of the five countries in order to improve its mechanisms for sustainable development and encourage partnerships in this area. Agreements may be signed to finance projects related to sustainability and the low-carbon economy in accordance with the interest and the rules of each institution. Examples are: infrastructure projects aligned to the principles of sustainable development or mitigation of and adaptation to climate change, as well as investments in renewable energy and energy efficiency or that may promote sustainable uses of biodiversity, ecosystems and regeneration of natural resources, as well as actions for the development, dissemination and transfer of environmentally sustainable technologies.

57 The agreements were signed during the 5th Summit of the BRICS, which took place in the city of Durban, South Africa, in 2013. In addition to the BNDES, the signatory institutions were the Bank of Development and Foreign Economic Affairs of Russia (Vnesheconombank), the Exim-Bank of India, the China Bank Development (CBD) and the Development Bank of Southern Africa (DBSA).

Brazil also signed a technical-academic cooperation with China in the area of renewable energy. The China-Brazil Center on Climate Change and Innovative Technologies for Energy is the result of a partnership between the Institute Alberto Luiz Coimbra – Graduate School and Research in Engineering (COPPE) at the Federal University of Rio de Janeiro and the Tsinghua University, the main engineering educational Chinese institution. The two countries expect to obtain benefits of this partnership, especially in renewable energy. China will contribute to the transfer of technology to Brazil related to towers of wind turbines, in the wind power area, solar panels, with emphasis on the photovoltaic and use of palm tree to manufacture biodiesel by means of a technology that the Chinese developed with Denmark. Brazil, in turn, can share knowledge and technologies of an area in which it is recognized as a reference, and on which China is concerned, which is the work that COPPE develops on energy generation from waves and tides.

Through the Brazil-Germany Cooperation for Sustainable Development, these two countries established a partnership with focus on climate protection and the preservation of biodiversity. More specifically, this Cooperation focuses on Fostering Renewable Energy and Energy Efficiency and the Protection and Sustainable Management of the Tropical Forests of the Amazon.

The cooperation for the promotion of renewable energies and energy efficiency includes the creation and improvement of productive general conditions, as well as the expansion of funding opportunities for renewable energy and projects related to energy efficiency. As part of the commitments of the Brazil-Germany Energy Agreement, the Brazil-Germany Cooperation for the Sustainable Development contributes to the reduction of the energy demand associated with the economic growth; guarantee of the energy supply security without increasing greenhouse gas emissions resulting from its generation; creation of new jobs through investments in sustainable technologies for energy efficiency and energy generation.

Some concrete cooperation initiatives have already been undertaken. For example, the German Agency for Sustainable Development (GIZ), supported the first project of social housing in Brazil in which hot water is obtained through thermal-solar systems.

Since 2010, the German bank KfW and GIZ have been accompanying and encouraging the installation of solar energy systems on the roof of a 2014 FIFA World Cup stadium, with a total capacity of 2.5 MW.

The state energy company, Eletrosul, develops a pilot project for the installation of the largest photovoltaic plant on the roof of a building in Brazil and, with a maximum power of 1 megawatt-peak (MWp), which will increase by 40% the total installed capacity of photovoltaic energy coupled to the electrical grid in the country. In this pilot project, GIZ and the German development bank KfW support the Brazilian Energy Company Eletrosul on a large scale. Delegated by the German Ministry of Environment, Nature Conservation and Nuclear Safety, the KfW helps the project with 3 million Euros. GIZ contributes with consulting services in the amount of approximately 0.44 million Euros.

Supported by the German Cooperation for Sustainable Development, the National Bank for Economic and Social Development (BNDES) promotes the wind energy industry through loans with subsidized interest rates. For the financing of wind farms, the German development bank KfW contributed with a loan with subsidized interest rates of 135 million dollars. Together with the own resources of the BNDES and private investors, the investments reached a total amount of 426 million Euros. Thus, a total of four wind farms will be financed, with a total installed capacity of 120 megawatts. Three of the wind farms ("*Vale dos Ventos*", "*Beberibe*" and "*Pedra do Sal*") are close to the coast in the northeast of Brazil; the fourth one ("*Gargaú*") is in the State of Rio de Janeiro.

2.3.2.2. Climate modeling and research networks in impacts, vulnerabilities and risks to global climate changes

As detailed[58] Brazil has shared knowledge, methodologies and technologies in the field of climate modeling and studies of impacts, vulnerabilities, and risks of global climate change. These actions occur through *Rede CLIMA* and the National Institute of Science and Technology for Climate Change, headquartered at the National Institute for Space Research (INPE). The diffusion of these actions is given by means of collaborative studies in research and training networks for modeling regional future climate change scenarios that INPE provides for other countries, for example, by means of courses offered to countries of Latin America and the Caribbean on the Eta Regional Model for Weather Forecasting, Climate Projections and Scenarios of Climate Change.

The National Institute of Science and Technology for Climate Change (INCT) received financing of R$ 7.2 million over three years from the National Council for Scientific and Technological Development (CNPq) and the Research Foundation of the State of São Paulo (FAPESP) and with this inflow is deploying and developing a comprehensive network of interdisciplinary research on climate change. It is grounded on the cooperation of 76 national research groups in all regions of the country and 16 international research groups in Argentina, Chile, the United States, Europe, Japan and India, involving a total of over 400 researchers, students and technicians, and is the largest environmental research network ever implemented in Brazil. The INCT mirrors the structure of the Intergovernmental Panel on Climate Change and is organized in three main scientific areas: (i) scientific basis of the global environmental changes; (ii) studies of impacts, adaptation and vulnerability; and (iii) mitigation. In addition, it has a strong component of technological innovation in three areas: models of the climate system, geo-sensing and system on the prevention of natural disasters.

2.3.2.3. Brazilian Cooperation Agency

The Brazilian Cooperation Agency (ABC), part of the structure of the Ministry of Foreign Affairs, is responsible for the negotiation, coordination, implementation and monitoring of Brazilian technical cooperation programs and projects carried out on the basis of agreements signed by Brazil with other countries and international organizations. In order to handle its mission, ABC is guided by the Ministry's external policy and the national development priorities, defined in the Government sectoral plans and programs. A query in the projects portfolio promoted by Brazil reveals[59] that the country has contributed with a series of cooperations, mainly South-South cooperations, which strengthen adaptation and mitigation actions in partner countries, including initiatives to: Promote Alternative Crops for the Production of Biofuels (Regions of Ucayaly and San Martin in Peru); Strengthen the Forest Public Management for the monitoring of deforestation in Bolivia; Management and Monitoring of Forest Ecosystems to contribute to the fight against erosion and desertification in Algeria; Support Program for the Strengthening of the Process of Economic Integration and Sustainable Development of Mercosur; Support for the Strengthening of Technical and Vocational Education in Mexico in the area of Renewable Energy, Integrated and Sustainable Development of the Touil Watershed (Algeria), among others.

58 See item 2.2 herein on "Capacity Building".
59 Refer to http://www.abc.gov.br/Projetos/pesquisa

It is worth noting that the Brazilian Agricultural Research Corporation (Embrapa), has promoted several partnerships with the African countries to mainly transfer agricultural technologies and the production of biofuels. In the case of agricultural technologies, these are generally directed towards improving the agricultural production of several important crops for local food and nutritional security, with better management of the natural resources, increased agricultural productivity and product diversification that, in an indirect way, contribute to increase the resilience of local agricultural systems due to the global climate change impacts. The African agricultural and livestock sector is considered as one of those, which may be more severely affected negatively by global climate changes worldwide.

CHAPTER III

RELEVANT INSTITUTIONAL ARRANGEMENTS FOR THE IMPLEMENTATION OF THE CONVENTION IN BRAZIL

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3.1. INSTITUTIONAL FRAMEWORK FOR THE IMPLEMENTATION OF THE CONVENTION IN BRAZIL

Brazil has always played a leadership role in the arena of global environmental issues, following the example of the United Nations Conference on Environment and Development, also known as Rio-92, held in Rio de Janeiro in 1992. In 2009, the Brazilian proposal to host the Rio+20 Conference was adopted by the UN General Assembly, at its 64th session and, once again, the city of Rio de Janeiro held the most important environmental conference to date, in which the political commitment of nations to the sustainable development was discussed. Twenty years after the completion of the Rio-92, it was time to assess the progress made by countries since the first conference, identify gaps in the implementation of the decisions adopted by the main summits on the subject, and promote the discussion of new and emerging topics, as the Green Economy or the Institutional Structure for Sustainable Development.

Brazil was the first country to sign the United Nations Framework Convention on Climate Change (UNFCCC) at Rio-92. Later, 194 other Parties (including the European Union) joined the Convention, which is an indication of its virtually universal nature. The Convention entered into force on March 21, 1994, ninety days after the deposit of the fiftieth instrument of ratification by the countries' parliaments. In Brazil, the National Congress ratified the UNFCCC on February 28, 1994, and it entered into force ninety days later, on May 29 of that same year.

The Kyoto Protocol, created in 1997, is a complementary treaty to the United Nations Framework Convention on Climate Change. It defined emissions reduction targets for developed countries (Annex I) and established measures so that the necessary growth of countries listed as Non-Annex I was limited by the introduction of appropriate measures, counting on financial resources and access to technology from industrialized countries. Brazil ractified the Protocol on August 23, 2002. The Protocol was approved domestically by means of Legislative Decree No. 144 of 2002.

Since then, Brazil created a set of regulatory frameworks and management tools which include: the National Policy on Climate Change (PNMC – Law No. 12,187/2009) and its set of sectoral plans which will be detailed in Volume II of this Third National Communication. The PNMC established the voluntary commitment to cut between 36.1% and 38.9% of projected emissions by 2020. Independent reports by the academia and civil society, such as the Union of Concerned Scientists (UCS), show that Brazil is the country with the world's biggest reductions in deforestation and emissions in recent times (UCS, 2014).

When it comes to financing for actions for mitigation and adaptation, Brazil created the Climate Fund and the Amazon Fund. The Climate Fund has the purpose of ensuring resources to support projects or studies and for the financing of projects that have as their objective the mitigation of climate change. The Amazon Fund aims at raising donations for non-recoverable investments in actions of prevention, monitoring and combating deforestation and to promote the conservation and sustainable use of forests, especially the Amazon biome. The Amazon Fund has already got resources of R$ 1.7 billion[60].

In order to meet the broad and diversified set of initiatives for the Brazilian mitigation and adaptation, the government created a governance structure in which climate change is a cross-cutting and bonding agent of a work agenda that involves collective and coordinated production of various ministries and government agencies, including the actions that are being undertaken by levels of subnational governance of the states, as shown below.

It is through this structure and with its own human resources that Brazil has been internalizing the production of knowledge in the scientific field of climate monitoring and evaluation of the vulnerabilities and risks to climate change, and public policies, to promote an action of coping with efficient and integrated actions from the negative effects of global warming.

3.1.1. The General Coordination of Global Climate Change

In response to the mandate granted by Interministerial Commission for Sustainable Development (CIDES) (extinct by a decree dated 3 February 2004, which created the Commission of Policies for Sustainable Development and the National Agenda 21, under the Council of Government), the MCTI created, within its own structure, the General Coordination of Global Climate Change (CGMC) in August 1994.

During its first years of operations, the main task of the CGMC was to coordinate the preparation of Brazil's Initial National Communication to the United Nations Framework Convention on Climate Change, according to those commitments assumed under the Convention. The elaboration of the National Communication is a multidisciplinary effort, which involved in its first edition around 150 institutions and 700 specialists from every region of the country. The Communication poses a great challenge, taking into account the need to build national capacity in the area, since in many cases it represents pioneer and complex work.

Due to its scope and specificity, and considering that emissions of the main greenhouse gases (CO_2, CH_4, N_2O, HFCs, CF_4, C_2F_6, SF_6) from the energy, industrial, forestry, agricultural and livestock and waste treatment sectors are addressed, the preparation of Brazil's Inventory of Anthropogenic Greenhouse Gas Emissions by Sources and Removals by Sinks of Greenhouse Gases Not Controlled by the Montreal Protocol involves a number of ministries (Ministry of the Environment; Ministry of Agriculture, Livestock and Food Supply; Ministry of Mines and Energy; Ministry of Development, Industry and Foreign Trade; Ministry of Foreign Affairs, etc.), federal institutions (Petrobras, Eletrobrás, Embrapa, INPE, among others) and state institutions (Cetesb, Cemig, among others), trade associations (ABAL, ABEGÁS, ABIQUIM, Bracelpa, Unica, Copersucar, White Martins, among others), non-governmental organizations (Funcate, Fundação José Bonifácio, among others), universities and research centers (COPPE/UFRJ, USP, UFRS, UnB, among others).

60 The Climate Fund and the Amazon Fund, as well as their governance structures, will be approached in Volume II of this paper.

Brazil concluded and published its initial inventory in 2004. National greenhouse gas emissions covering the 1990-1994 period were inventoried, and they were summarized based on 15 reference studies. In the Second National Communication, submitted in 2010 to the UNFCCC, the values for the other years in the 1990 to 2005 period were also included. The information presented in the initial inventory was updated for the years 1990 to 1994. In this Third Communication the same process of updating previous information and new information about the Brazilian emissions until the year 2010 is followed.

The International Energy Agency (IEA) compared the inventories from the main developing countries. The IEA evaluation of Brazil's inventory was extremely positive, thus underscoring that the inventory's main qualities are transparency, development of time series and use of more elaborate national emission factors. From an institutional perspective, this reflects the fact that Brazil was able to set up a competent structure for elaborating inventories.

The CGMC is part of the Brazilian delegation to negotiations under the UNFCCC and its subsidiary bodies, as well as follows up reviews of assessment reports and the meetings of the Intergovernmental Panel on Climate Change (IPCC).

Since 1995, the CGMC has participated in discussions of technical and scientific issues related to the regulation and implementation of the Protocol, in conjunction with the Ministry of Foreign Affairs.

Additionally, Brazil's commitments under the Convention include promoting and cooperating in scientific, technological, technical, socioeconomic and other research, in systematic observations and in the development of a climate system database with a view to explaining and reducing or eliminating the remaining uncertainties related to the causes, effects, magnitude and changes over time of climate change and the economic and social consequences of various response strategies.

In order to monitor compliance with the voluntary national commitment to reduce emissions by the year 2020 (Article 12 of Law No. 12,187/2009) Article 11 of Decree No. 7,390/2010 established that, from 2012 on, annual estimates of greenhouse gas emissions in Brazil will be published in an appropriate format to facilitate the understanding on the part of interested segments of society. The responsibility for the preparation of these estimates, as well as the improvement of the methodology for calculating the projection of emissions is under the working group coordinated by the Ministry of Science, Technology and Innovation, with broad involvement of the CGMC. Therefore, the periodic publication of annual estimates of greenhouse gas emissions in Brazil began in 2013 (BRASIL, 2013) whose scope was the period from 1990 to 2010. In other words, the annual estimates had further developments based on the results of the II Brazilian Inventory, which covered the period from 1990 to 2005, extending the assessed period up to 2010.

The CGMC also coordinates the construction of a computer system for the preparation and dissemination of information on greenhouse gas emissions, the National Emissions Registry System (SIRENE) (described in item 2.1.1.1), whose centerpiece is a database based on a system of management, with the possibility of access via the internet, which aimed at the management of information related to anthropogenic emissions of GHG in Brazil.

To contribute to discussions of actions for the mitigation of the Brazilian emissions, the CGMC coordinates the project "*Opções de Mitigação das Emissões de Gases de Efeito Estufa em Setores-Chave do Brasil*" (Mitigation Options for Greenhouse Gas Emissions in Key Sectors of Brazil), in partnership with the United Nations Environment Program (UNEP). The objective of this project is to assist decision-making about actions that potentially reduce

GHG emissions in different sectors of the Brazilian economy – industry, energy, transport, residential and services, uses of land and forests, waste management.

It is an innovative project in Brazil, since it will carry out an integrated analysis of different mitigation options, considering the singularity of these options with its consequent economic and social implications. Another innovative aspect is the inclusion of a scenario, which will consider, for the Brazilian context, technological learning curves for the GHG emission reduction.

In summary, the project, which has resources from the Global Environment Facility (GEF), is performed by means of partnerships with research institutions that are part of the *Rede CLIMA*, whose experts will assist in the preparation of scenarios for mitigation. The project will estimate the potential and costs of abatement of greenhouse gas emissions, through an integrated economic and energy analysis for the period between 2012 and 2050 of the different energy-intensive segments of the Brazilian economy. Three scenarios will be considered: reference scenario or baseline, low carbon scenario, and low carbon scenario with innovation.

Another important area of activities of the CGMC is building public awareness of climate change related issues. A homepage on climate change (http://www.mct.gov.br/clima) was created within the Ministry of Science and Technology's website (item 2.1.1) to facilitate the integration of all the experts and institutions involved. This homepage serves as a forum for bringing together experts from different sectors that can accompany and contribute to the work, as well as opening up a space for society in discussing climate change related issues.

Furthermore, the CGCM promotes and supports events on global climate change in the various areas related to the issue, and publishes and disseminates relevant information, especially regarding the Convention, the Protocol and the IPCC. It thus seeks to develop and disclose legal, technical and scientific information, as well as participate in discussion on global warming, its causes and impacts, aimed at building awareness among opinion leaders, policy-makers, business leaders, students and the general public about the problem.

3.1.2. The Interministerial Commission on Global Climate Change

The perspective of the Kyoto Protocol entering into force and of the regulation of the Clean Development Mechanism (CDM) highlighted the importance of establishing an entity within the Brazilian government that could channel this potential towards national development priorities. Furthermore, the concern for greater institutionalization of the climate change issue in the country due to its strategic characteristics, led to the creation[61] of the Interministerial Commission on Global Climate Change (CIMGC), aimed at coordinating government actions in this area.

Given that the Ministry of Science, Technology and Innovation had already been carrying out national activities related to complying with Brazil's initial commitment related to the United Nations Framework Convention on Climate Change, this body was chosen to chair the Commission and to serve as its Executive Secretariat, since the scientific aspects of global climate change will continue, in the foreseeable future, to dominate the political negotiations, and scientific knowledge necessary to subsidize the discussions can be facilitated through the

61 *Presidential Decree of 7 July 1999, altered by Decree of 10 January 2006.*

support instruments of this ministry. The General Coordination of Global Climate Change serves as the Executive Secretariat of the Commission and the General Coordinator of the CGMC serves as its Executive Secretary. The Ministry of the Environment serves as the Vice-Presidency of the Commission.

The Commission is made up of representatives of the Ministries of External Relations (MRE) and of Science, Technology and Innovation (MCTI), which are the political and technical focal points, respectively, on global climate change in Brazil; ministries with specific attributions and responsibilities over important sectors for greenhouse gas emission reduction activities in Brazil, such as Agriculture, Livestock and Food Supply (MAPA); Transportation (MT); Mines and Energy (MME); Environment (MMA); Development, Industry and Foreign Trade (MDIC); and Cities (MCid); as well as ministries with more strategic and long-term vision, such as Planning, Budget and Management (MPOG); Finance (MF); and the Executive Office of the Presidency of the Republic ("*Casa Civil da Presidência da República*"). The decree also empowers the Commission to request the collaboration of other public or private bodies and representative civil society organizations in carrying out its responsibilities.

The responsibilities of the Commission are:

I issue opinions, when requested, about proposals for sectoral policies, legal instruments and regulations that contain any relevant component for mitigating global climate change and to the adaptation of the country to its effects;

II provide support to the positions of the government in negotiations under the auspices of the Convention and subsidiary instruments to which Brazil is a Party;

III define eligibility criteria additional to those considered by the Convention bodies responsible for the CDM, as called for in Article 12 of Kyoto Protocol to the UNFCCC, according to national sustainable development strategies;

IV consider opinions about projects that result in reduction of greenhouse gas emissions and that are considered eligible under the CDM, and approve them, where appropriate; and

V coordinate activities with representative civil society organizations in order to facilitate activities of governmental and private bodies aimed at complying with the obligations assumed by Brazil under the Convention and the subsidiary instruments to which Brazil is a Party.

The Interministerial Commission thus represented an initial effort in the sense of bringing together government actions related to global climate change. Besides, it is important to highlight that the Interministerial Commission is Brazil's Designated National Authority (DNA)[62], a title provided for by the Kyoto Protocol, being in charge of evaluating and approving project activities under the Clean Development Mechanism (CDM) in Brazil.

CDM project activities shall be elaborated in accordance with the rules defined by decision 17/CP.7 (later, ratified by decision 3/CMP.1) that establishes CDM's procedures and modalities, which were incorporated into the Brazilian legal system through resolution No. 01 of the Interministerial Commission on Global Climate Change on September 11, 2003. The CIMGC has developed and issued resolutions with the objective of incorporating approval requirements for CDM project activities in the country that have been internationally established by the decisions of the Conference of Parties serving as the Meeting of the Parties to the Kyoto Protocol and by its Executive Board, as well as establish additional criteria for approving CDM project activities in Brazil. It should be pointed that the CIMGC, considering that it was the CDM's first DNA to be created in the world, has served as a model for creating many other DNAs, which led to cooperation activities in this regard between Brazil and other developing countries.

62 Pursuant to Article 3, section IV, of the Presidential Decree of July 7, 1999, as amended by Decree of January 10, 2006.

All of the eligible CDM project activities are duly reviewed by the CIMGC in relation to the projects' contribution criteria towards the country's sustainable development.

All material related to the CIMGC, as well as about all CDM project activities in Brazil, is available on the Executive Secretariat's home page (http://www.mct.gov.br/clima), which is the CGMC. Information is also periodically published on CDM's status in Brazil and in the world[63].

3.1.3. The Interministerial Committee on Climate Change (CIM)

In 2007, the Federal Government created the Interministerial Committee on Climate Change (CIM)[64], with the task of steering the development, implementation, monitoring and evaluation of the National Plan on Climate Change, proposing priority actions to be implemented in the short term; supporting international coordination needed to undertake joint activities, exchange of experiences, technology transfer and capacity building; identifying actions needed for research and development, and proposing guidelines for the implementation and design of a communication plan.

The Executive Office of the Presidency of the Republic coordinates the CIM and it is composed of seventeen federal bodies. The Brazilian Climate Change Forum (FBMC)[65] is, as a rule, invited to participate in the CIM meetings. The federal bodies are as follows: Ministry of Agriculture, Livestock and Food Supply; Ministry of Science and Technology; Ministry of Defense; Ministry of Education; Ministry of Finance; Ministry of National Integration; Ministry of Health; Ministry of Cities; Ministry of Foreign Affairs; Ministry of Mines and Energy; Ministry of Agrarian Development; Ministry of Development, Industry and Foreign Trade; Ministry of the Environment; Ministry of Planning, Budget and Management; Ministry of Transportation; and the Center of Strategic Affairs of the Presidency of the Republic.

The Executive Group on Climate Change (GEx), under the CIM, which is coordinated by the Ministry of the Environment, was in charge of developing, implementing, monitoring and evaluating the National Plan on Climate Change.

The GEx was given the task of drafting the preliminary proposal of the National Policy on Climate Change, which after extensive public consultation process to Brazilian society, was launched in December 2008. The GEx also participated in the elaboration of eight Sectoral Plans for Mitigation and Adaptation already concluded and their respective public consultation processes. They are: 1) Action Plan for the Prevention and Control of Deforestation in the Amazon Region (PPCDAm); 2) Action Plan for the Prevention and Control of Deforestation in the Cerrado (PPCerrado); 3) Ten-Year Plan for Energy (PDE); 4) Plan for Agriculture of Low Carbon (ABC Plan); 5) Sectoral Plan for Mitigation and Adaptation to Climate Change for the consolidation of a Low Carbon Economy in the Manufacturing Industry (Industry Plan); 6) *Low Carbon* Mining Plan (PMBC); 7) Sectoral Plan of Transport and Urban Mobility for Mitigation and Adaptation to Climate Change (PSTM); 8) Health Sectoral Plan for Mitigation and Adaptation to Climate Change (*PSMC Saúde*)[66].

63 See Volume II of this National Communication, section called "Project Activities in the Scope of Clean Development Mechanism – CDM in Brazil.
64 Presidential Decree No. 6,263, of 21 November 2007.
65 For more information, refer to item 2.1.2 herein.
66 For description of Sector Plans Mitigation and Adaptation to Climate Change, see Volume II herein.

The sectoral plans served as a basis for the revision of the National Plan on Climate Change, also submitted to public consultation from October 01 to November 08, 2013, for receiving suggestions, analyzed by the GEx, which decides on their incorporation into the text, to the publication of the final version of the new National Plan on Climate Change. The systematic review of instruments of the Brazilian public policy focused on the mitigation and adaptation to climate change aims at improving them in the light of advances in terms of scientific and technical knowledge about the themes that guide them.

GEx was also responsible for drawing up a preliminary proposal of the general objectives, principles and guidelines for the National Policy on Climate Change, transformed into Law No. 12,187, of December 29, 2009[67]. The National Plan on Climate Change and the Sectoral Plans for mitigation and adaptation are instruments of the National Policy on Climate Change. In the formulation of these plans, the contributions of the Brazilian Panel on Climate Change (PBMC) have been important. The PBMC is the national scientific body whose objective is to provide the decision-makers and the society with technical-scientific information on global climate change[68].

Looking at the fact that the Units of the Federation have been proactive in the search for solutions to climate change mitigation and adaptation, including the already existing 15 state laws that have officially created policies on climate change in each state (ETHOS INSTITUTE, 2013), in February 2013 the Federal Climate Articulation Group (NAFC) was created within the framework of GEx. The NAFC counts with the participation of state public managers that work with the climate agenda and various organizations of the Federal Government. Its activities are supported by the work agenda of GEx. The objective of the NAFC is to integrate the various sectoral policies that keep relation with the subject of climate change, particularly with respect to their impacts, integrate the state policies on climate change among themselves and in relation to the National Policy on Climate Change, and promote the exchange of experiences between the government bodies. The expected results with the installation of the Group are the identification of priority issues to be addressed and the formulation of an agenda of articulation work. The Ministry of the Environment and the Executive Office of the Presidency of the Republic ("Casa Civil da Presidência da República") carry out the secretariat of the NAFC.

Under the GEx and the NAFC, working groups may be established for discussion of specific issues of the National Policy on Climate Change (Figure 3.1). Currently, Brazil advances in the formulation of its National Plan for Adaptation through two Working Groups on Adaptation, which is expected to be completed by 2015.

67 Same as the previous one, for a description of the National Policy on Climate Change, in the subsection with this title.
68 See item 2.2.3 herein.

FIGURE 3.1

Working groups set up under the GEx

NAME	PURPOSE	COORDINATION	MEMBERS
Interministerial Working Group (IWG)			
IWG on Carbon Market	Assess feasibility and requirements for the implementation of a Brazilian Emissions Reduction Market	Secretariat of Economic Policies/Finance Ministry (SPE-MF)	Representatives of MMA, MDIC, MCTI, MRE, MPOG and the Executive Office of the Presidency of the Republic.
IWG on REDD+	Prepare the Brazilian REDD+ strategy based on the discussion of the following themes: financial architecture, technical aspects, investments in governance together with federal entities and positive incentives to economic agents.	Secretariat of Climate Change and Environmental Quality (MMA)	Representatives of MMA, MCTI, MRE, Secretariat of Strategic Affairs (SAE), Executive Office of the Presidency of the Republic, Brazilian Forest Service (SFB), National Indian Foundation (FUNAI), Ministry of Agrarian Development (MDA), MAPA and MF.
Working Group (WG)			
WG on Monitoring	Prepare the strategy to monitor the reduction of GHG associated with Sectoral Plans on Adaptation and Mitigation to Climate Change	Secretariat of Climate Change and Environmental Quality (MMA)	Representatives of Ministries that are part of the PNMC.
WG on Adaptation	Propose and prepare a set of government measures on adaptation to climate change for the drafting of the National Adaption Plan by 2015	Secretariat of Climate Change and Environmental Quality (MMA) and General Coordination of Global Climate Change (MCTI)	Representatives of members of the GEx, invited agencies working with the agenda of adaptation to climate change in the Federal Government, FBMC*
Federal Climate Articulation Group (NAFC) Working Group (WG)			
WG on Emissions Report	Provide technical recommendations for the creation of a National Reporting System on Emissions and Removals by Sink	Secretariat of Economic Policies/Finance Ministry (SPE-MF) and Government of the state of Rio de Janeiro/Green Economy Secretariat	State government representatives, CTPIn, MAPA, Ibama and organizations of the civil society and academia.
WG Inventory	Proceed with breaking down data and results for national GHG emissions per state, and, to the extent possible, municipalities. Improve the review process of the Brazilian Inventory through the contribution of state representatives as part of a quality control and guarantee process.	General Coordination of Global Climate Change (MCTI) and Government of the State of São Paulo/Secretariat of the Environment	State government representatives and MCTI

continues on the next page

NAME	PURPOSE	COORDINATION	MEMBERS
WG Adaptation	Develop technical recommendations for a federative conciliation about adaptation so that Federal and State Governments can promote resilience in a coordinated and cooperative way.	Secretariat of Climate Change and Environmental Quality (MMA) and Government of the State of Minas Gerais/ Energy and Climate Change Management of the State Environmental Foundation (FEAM)	State government representatives and MMA

**The WG on Adaptation works based on support and engagement of thematic networks composed of experts in charge of elaborating technical documents with a sector-wise approach, and, whenever possible, a territorial approach. Government, research institutions and universities, civil society and economic sectors representatives have been invited to take part of these networks.*

Source: Based on data available on the internet page of the Ministry of the Environment[69]

3.1.4. Secretariat of Climate Change and Environmental Quality

It is important to emphasize that there are several components of the Ministry of the Environment that promote programs and initiatives related to the mitigation of climate change and the increase of local resilience to its negative effects. The Secretariat of Biodiversity and Forests and the Secretariat of Water Resources and the Urban Environment are some examples of such departments. There is, however, a specific department in the ministry, the Secretariat of Climate Change and Environmental Quality, created to deal with climate change, which reflects the concern about the national climate agenda.

The Secretariat of Climate Change and Environmental Quality is responsible, among other things, for coordinating GEx and the Managing Committee of the Climate Fund, and is composed of three departments: Department of Climate Change, Department of Licensing and Environmental Assessment, Department of Environmental Quality in the Industry. There are several tasks which are incumbent upon the Department of Climate Change, of which the most notable ones are: support and assist the various units of the Ministry of Environment and linked entities in matters related to the global climate change; coordinate meetings aimed at preparing the Ministry's position in relation to global climate change; develop studies for the protection of the global climate system and the ozone layer; monitor and technically subsidize the Interministerial Commission on Global Climate Change, among others.

The Secretariat of Climate Change and Environmental Quality is the main component of the Ministry of the Environment that participates in the meetings of the GEx and the working groups set up under this executive group.

69 Available at: <www.mma.gov.br/clima/grupo-executivo-sobre-mudanca-do-clima>

3.2. INSTITUTIONAL ARRANGEMENTS FOR ELABORATING NATIONAL COMMUNICATIONS ON PERMANENT BASES

The Third National Communication of Brazil to the Convention (TNC) is a project activity executed under the national execution modality by the General Coordination of Global Climate Change at the Ministry of Science, Technology and Innovation (MCTI), which will be responsible for the technical implementation of the project as a whole, through the General Coordination of Global Climate Change (CGMC). The CGMC was also responsible for coordinating the activities of the Initial and Second Communications of Brazil to the Convention. The Global Environment Facility (GEF) funds the project, supervision of the activities required to achieve the project's objectives is up to the United Nations Development Programme (UNDP), whose team works directly with MCTI. In addition to these institutions, the Brazilian Cooperation Agency (ABC) has approved the project.

The project has a Director and a National Coordinator. Both are staff members of the CGMC and are responsible for ensuring that the project implementation follows national policy and standards, as well keeping the MCTI updated on project advances and challenges as needed. They will also have responsibility for, among others: (i) managing and executing the project; (ii) coordinating the management of financial resources and procurement; (iii) reporting on the application of resources and results achieved; (iv) preparing management reports for the MCTI, GEF and UNDP; (v) promoting inter-institutional linkages; and (vi) monitoring and evaluation, and disseminating project results. The team is also composed of supervisors and consultants, hired with GEF resources, who directly act together with the Director and Coordinator on the management and coordination of the project technical activities.

Regarding academic and research contribution, the Brazilian Research Network on Global Climate Change[70] (*Rede CLIMA*) contributed significantly for the development of the TNC. For the third inventory of this Communication, the engagement of this network, with the involvement of sub-network researchers, who supported the production data, is of note. Moreover, the *Rede CLIMA*, in partnership with other researchers made an important contribution to the TNC on the impacts and vulnerability of ecosystems and the Brazilian population to global climate change.

This TNC presents the results of the newest studies on climate modeling, conducted by the National Institute for Space Research (INPE), which estimated climate change impacts on the following sectors: health, biodiversity, energy, water resources, agriculture, natural disasters and coastal zones. CGMC supported and coordinated the preparation of these studies, which will support discussions on the Brazilian National Adaptation Plan – currently underway – under the joint coordination of MMA and MCTI. Such studies filled data and information gaps and represent improvements in Brazil's capacity to forecast and monitor the impacts and adaptation needs of the country to minimize the expected negative effects of global climate change.

In addition to the Greenhouse Gases Inventory in Brazil, the National Communication summarizes information on mitigation and adaptation to climate change in the country, training initiatives, training and public awareness on the subject, Clean Development Mechanism (CDM), research and systematic observation of future scenarios of climate change and technology transfer. The CGCM is responsible for compiling and disseminating this information in the document of the National Communication.

70 About Rede CLIMA, refer to subsection Capacity Building, item 2.2 herein.

In terms of the division of tasks for the Third Inventory, in addition to the institutions linked to *Rede CLIMA* for the study of emissions from the Agriculture, Waste Treatment, Energy and Land Use, Land-Use Change and Forestry sectors, contributions were made by associations of key industries such as aluminum (Brazilian Aluminum Association – ABAL) cement (the National Union of Cimento – SNIC), steel (Brazil Steel Institute – IABr), chemical (Brazilian Association of Chemical Industry – ABIQUIM) and coal (Brazilian Coal Association – ABCM).

The Division of Climate, Ozone and Chemical Safety (DClima) of the Ministry of Foreign Affairs is the National Focal Point and has the mission to promote coordination between the Brazilian Government and the Climate Convention (UNFCCC). It is also responsible for officially submitting the Third National Communication.

3.2.1. Financial, Technical and Capacity-Building Difficulties Associated with the Preparation of the National Communication

Project BRA/10/G32 for the preparation of the Third National Communication (TNC) was funded by the *Global Environment Facility* (GEF), which contributed with US$ 5,720,000, and by the Federal Government, which contributed with US$ 6,500,000. The implementing entity is the United Nations Development Programme and the Ministry of Science, Technology and Innovation is the executing entity. Regarding the financial aspects for the preparation of the TNC there was no difficulty imposed by the correct application of the Project's funds or appreciation of Brazil's currency compared to the dollar at the time.

The work of MCTI staff together with the Technical Supervisors of BRA/10/G32 Project for the preparation of the Third National Communication (TNC) demanded effort to overcome challenges posed by the ambitious goals to be reached. In that sense, the technical and administrative difficulties encountered were proportional to the scope of the document, which sought to contextualize the insertion of Brazil in the Climate Convention under new and more detailed aspects without neglecting the known methodological rigor, whose constant progress is inherent to the presentation of the National Inventory of Greenhouse Gases.

A considerable part of the TNC resulted from a secondary data collection of the Government and other institutional research organizations that, directly or indirectly, contribute to the production of public information. For that, the approximation of the TNC to its collaborating sources for the drafting of sections such as the National and Special Circumstances was made, with collaborations – *inter alia* – of the Institute of Applied Economic Research (IPEA), Ministry of Education (MEC), Ministry of Health (MS) and the Brazilian Panel on Climate Change.

Difficulties were raised throughout the cooperation work usually resulting from the additional steps taken in each front. In that sense, the difficult was more evident when facing non-exclusive dedication to the Project activities of its various partners and lacking of technical-scientific staff with advanced knowledge in specific studies areas was needed. On the other hand, it was possible to promote a convenient approach with the scientific community, especially via *Rede CLIMA*, which embraced its responsibility for the scientific rigor in the elaboration of the National Inventory of Greenhouse Gases and in studies of sectoral vulnerabilities to climate change, launching such partnership in Brazil for the elaboration of a National Communication to the Climate Convention.

In addition to the direct gains that were sought for the TNC, the convergence with *Rede CLIMA* was fruitful in generating additional gains in terms of unprecedented scientific knowledge production and input to other government initiatives, such as the preparation of the National Adaptation Plan, which is underway. Involved in this partnership, INPE provided relevant information to the planning of activities that would result in the development of vulnerabilities studies, which included the support of the Project for the acquisition of equipment and insertion of Brazil in the Earth System Grid Federation (ESGF), which will play a key role in sharing studies, data and information in such a promising field.

Finally, it is worth mentioning that the managing team of the Project, possibly due to the difficulties faced, was able to absorb and document priceless information required to maintain a great level of perfection of the National Communications of Brazil published so far which will certainly contribute to a smoother and even more robust implementation of future editions.

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