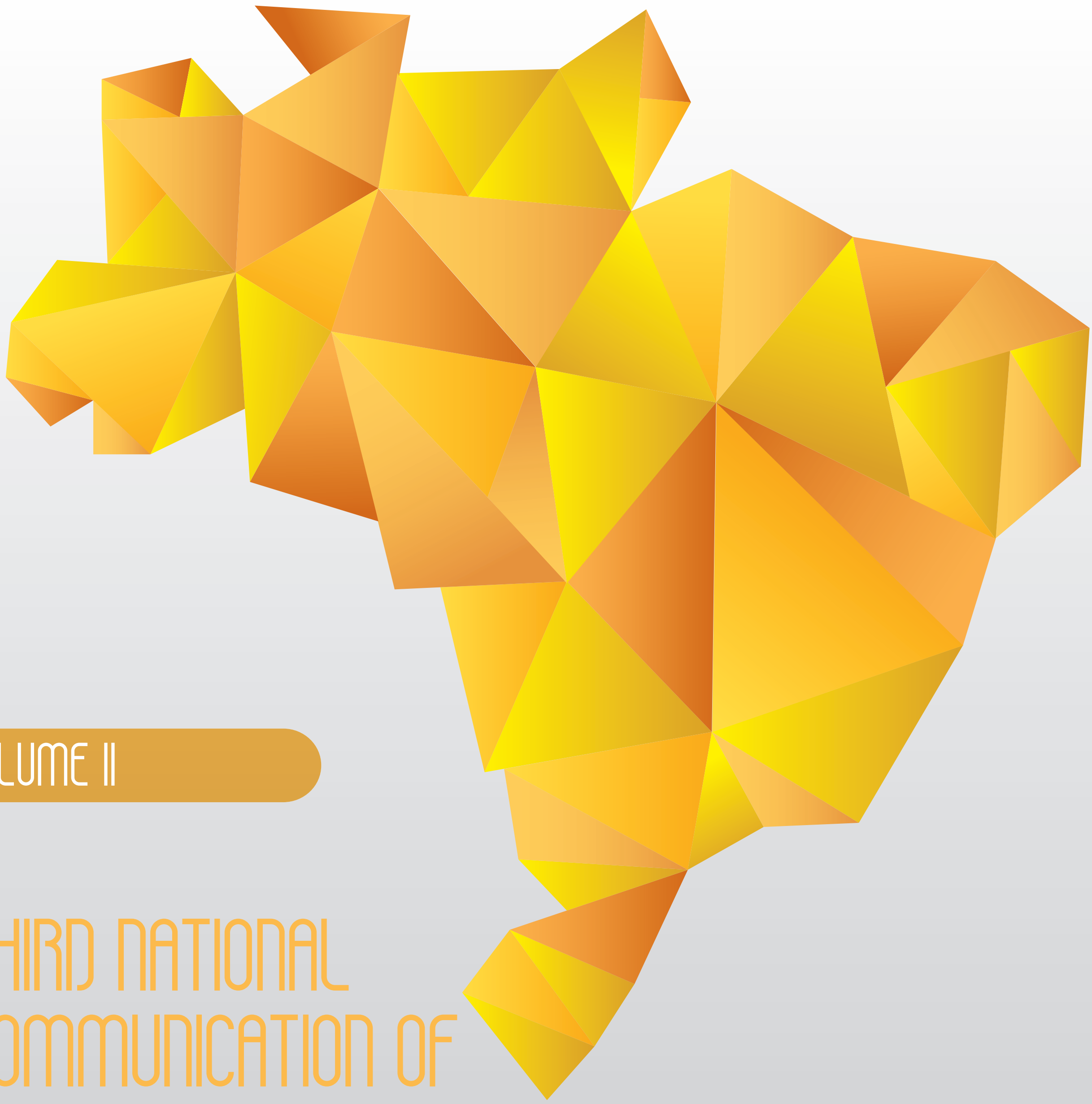
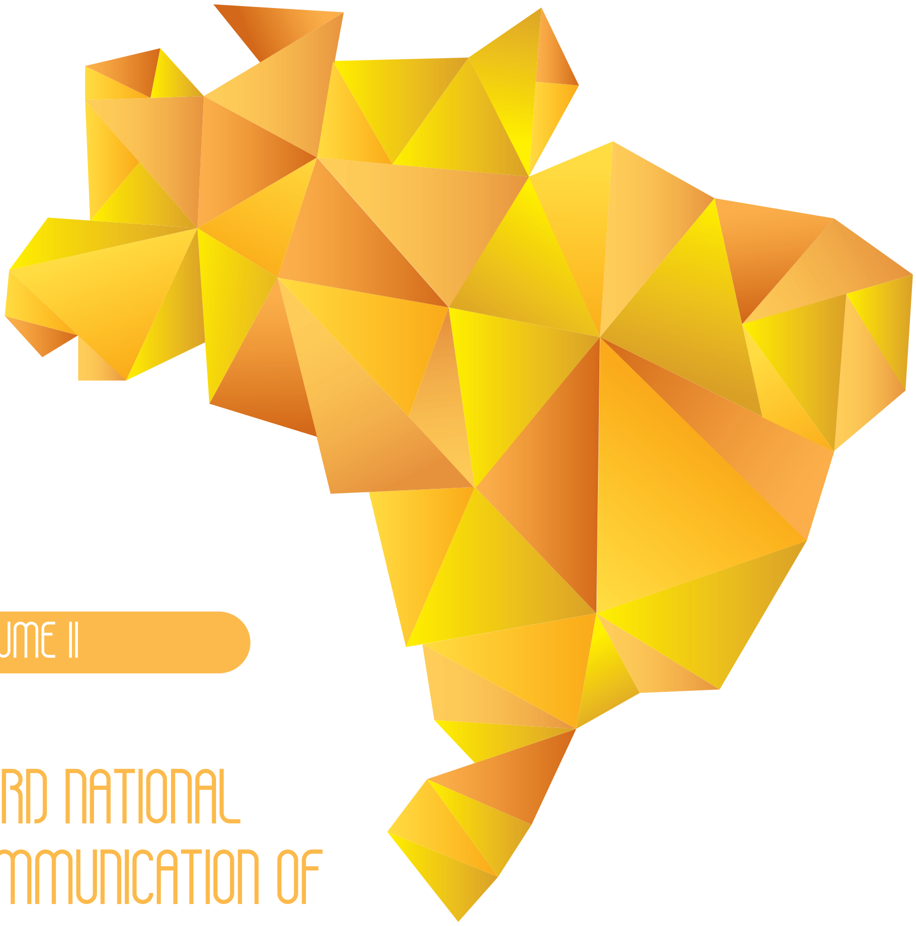


VOLUME II

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



VOLUME II

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
2016

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SYMBOLS, ACRONYMS AND ABBREVIATIONS

°C – Celsius degrees

A1 – high emission scenario of the AR4 Intergovernmental Panel report on Climate Change

A2 – high emission scenario of the AR4 Intergovernmental Panel report on Climate Change

ABC – Low Carbon Agriculture

Abiove – Brazilian Association of Vegetable Oil Industries (*Associação Brasileira das Indústrias de Óleos Vegetais*)

ACI – Adaptive Capacity Index

AFS – Agroforestry system *(SAF – Sistema Agroflorestal)*

AM – state of Amazonas

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

ANEC – National Association of Cereal Exporters *(Associação Nacional dos Exportadores de Cereais)*

ANEEL – Brazilian Electricity Regulatory Agency *(Agência Nacional de Energia Elétrica)*

ANP – National Agency of Petroleum, Natural Gas and Biofuels *(Agência Nacional do Petróleo, Gás Natural e Biocombustíveis)*

APA – Environmental Protected Areas *(Áreas de Proteção Ambiental)*

APIB – Articulation of Indigenous Peoples of Brazil *(Articulação dos Povos Indígenas do Brasil)*

APP – Permanent Preservation Area *(Área de Preservação Permanente)*

AR4 – IPCC Fourth Assessment Report

AR5 – IPCC Fifth Assessment Report

ArcGIS – Geographic Information System Software *(Software de Sistema de Informações Geográficas)*

ARIE – Areas of Relevant Ecological Interest

ARPA – Amazon Region Protected Areas Program (*Programa Áreas Protegidas da Amazônia*)

ATER – Technical Assistance and Rural Extension

AWC – Available Water Capacity *(CAD – capacidade de água disponível)*

B1 – low emission scenario of the AR4 Intergovernmental Panel report on Climate Change

B2 – low emission scenario of the AR4 Intergovernmental Panel report on Climate Change

BAU – Business as Usual

BESM – Brazilian Earth System Model

BIPZON – cumulative water balance program

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

BNEF – Bloomberg New Energy Finance

BNF – Biological nitrogen fixation

BRT – Bus Rapid Transit

BUR – Biennial Update Reports *(Relatório Bienal de Atualização)*

cal/g – calories per gram

CAR – Rural Environmental Registry *(Cadastro Ambiental Rural)*

CBD – Convention on Biological Diversity *(Convenção sobre Diversidade Biológica)*

CC/PR – Executive Office of the Presidency of the Republic *(Casa Civil da Presidência da República)*

CDM – Clean Development Mechanism

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

CENEH – Brazilian Reference Center for Hydrogen Energy *(Centro Nacional de Referência em Energia do Hidrogênio)*

CEPED – University Centre for Disaster Studies and Research *(Centro Universitário de Estudos e Pesquisas sobre Desastres)*

CGEE – Center for Strategic Studies and Management *(Centro de Gestão e Estudos Estratégicos)*

CGEN – Genetic Heritage Management Council *(Conselho de Gestão do Patrimônio Genético)*

CGU – Brazilian Office of the Comptroller General *(Controladoria Geral da União)*

CH_4 – methane

CICE – Commission for the Conservation of Energy *(Comissão Interna de Conservação de Energia)*

CLFi – Crops-Livestock-Forest Integration

cm – centimeters

cm/ano – centimeters per year

cm/hr – centimeters per hour

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

CO_2 – carbon dioxide

CO_2e – Carbon dioxide equivalent

COFA – Guidance Committee for the Amazon Fund *(Comitê Orientador do Fundo Amazônia)*

Cofins – Contribution for Social Security Financing *(Contribuição para o Financiamento da Seguridade Social)*

COIAB – Coordination of the Indigenous Organizations of the Brazilian Amazon *(Coordenação das Organizações Indígenas da Amazônia Brasileira)*

CONACER – Sustainable Cerrado Program Commission *(Comissão Nacional do Programa Cerrado Sustentável)*

Conama – National Environment Council *(Conselho Nacional de Meio Ambiente)*

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)*

Conserve – Industrial Energy Efficiency Program *(Programa de Conservação de Energia no Setor Industrial)*

CONTAG – National Confederation of Agricultural Workers *(Confederação Nacional dos Trabalhadores na Agricultura)*

COP – Conference of the Parties

CPISP – Pro-Indian Commission of São Paulo *(Advocacia Geral da União e Comissão Pró-Índio de São Paulo)*

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

CSD – United Nations Commission on Sustainable Development

CSP – Concentrated Solar Power

CTFA – Technical Committee of the Amazon Fund *(Comitê Técnico do Fundo Amazônia)*

CTPIn – Industry Plan Technical Commission *(Comissão Técnica do Plano Indústria)*

CWD – Consecutive Wet Days

DEGRAD – Mapping of degraded areas in the Amazon

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

DETEX – Forest Exploitation Detection System *(Projeto de Mapeamento de Ocorrências de Exploração Seletiva de Madeira)*

DF – Federal District

DJF – December-January-February

DNAEE – National Department of Water and Electrical Energy *(Departamento Nacional de Águas e Energia Elétrica)*

DOE – United States Department of Energy *(Departamento de Energia dos Estados Unidos)*

DPT – Board of Territorial Protection *(Diretoria de Proteção Territorial)*

ECLAC – Economic Commission for Latin America and the Caribbean *(Cepal – Comissão Econômica para América Latina e Caribe)*

EEZ – Ecological Economic Zoning

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

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

ENREDD+ – National Strategy for REDD+

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

ESA – European Space Agency

EsEc – Ecological Stations

ESGF – Earth System Grid Federation

ESM2M – Earth system model

Eta – Regionalized Climate-Economy Model

ETM – maximum evapotranspiration

ETR – real evapotranspiration

FAO – Food and Agriculture Organization

FBOMS – Brazilian Forum of NGOs and Social Movements for the Environment and the Development *(Fórum Brasileiro de ONG's e Movimentos Sociais para o Meio Ambiente e o Desenvolvimento)*

FEBRAPDP – Brazilian Federation of *No-till* Farmers and Irrigation *(Federação Brasileira de Plantio Direto e Irrigação)*

FGV – Getúlio Vargas Foundation

FINAME – Financing for the Acquisition or Lease of Machinery and Equipment *(Financiamento para Produção e Aquisição de Máquinas e Equipamentos Novos)*

FINEP – Funding Authority for Studies and Projects *(Financiadora de Estudos e Projetos)*

FIP – Forest Investment Program *(Programa de Investimento em Florestas)*

FIPs – Brazilian Equity Investment Funds

FLONA's – National Forests

FNAB – Brazilian Forum of Forest Activities *(Fórum Nacional das Atividades de Base Florestal)*

FNMC – National Fund for Climate Change *(Fundo Nacional sobre Mudança do Clima)*

FREL – Forest Reference Emission Levels

FUNAI – National Indigenous People's Foundation *(Fundação Nacional do Índio)*

GEF – Global Environment Facility

GEx – Executive Group on Climate Change *(Grupo Executivo sobre Mudança do Clima)*

GFDL – Geophysical Fluid Dynamics Laboratory model

GGE – State Management Group

GHG – greenhouse gas

GINI – Gini Index developed by the Italian statistic Corrado Gini to measure poverty

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

GO – state of Goiás

GPTI – Permanent Group for Interministerial Work *(Grupo Permanente de Trabalho Interministerial)*

GTPS – Working Group on Sustainable Livestock *(Grupo de Trabalho da Pecuária Sustentável)*

GVAgro – Getulio Vargas Foundation Agribusiness Center *(Centro de Estudo de Agronegócios da Fundação Getúlio Vargas)*

GVces – Getulio Vargas Foundation Sustainability Center *(Centro de Estudos em Sustentabilidade da Fundação Getúlio Vargas)*

GW – gigawatt

GWh – gigawatt/hour

ha – hectare

HadCM3 – Hadley Centre Coupled Model, version 3

HadGEM2 – Hadley Centre Global Environmental Model

HRU – Hidrological Response Unit

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

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

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

IBRAM – Brazilian Mining Institute *(Instituto Brasileiro de Mineração)*

ICA – International Consultation and Analysis

ICC – Climate Scenarios Index

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)*

IDW – Inverse Distances Weighting

ILO – International Labor Organization

INCRA – National Institute of Colonization and Agrarian Reform *(Instituto Nacional de Colonização e Reforma Agrária)*

Inmetro – National Institute of Metrology, Standardization and Industrial Quality *(Instituto Nacional de Metrologia, Qualidade e Tecnologia)*

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

IPCC – Intergovernmental Panel on Climate Change

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

IPEN – Institute of Energy and Nuclear Research *(Instituto de Pesquisas Energéticas e Nucleares)*

IPHE – International Partnership for the Hydrogen Economy

IPPU – Industrial Process and Product Use

ISNA – Crop Water Requirement Index *(Índice de Satisfação de Necessidade de Água)*

ITCZ – Intertropical convergence zone

IVA – Environmental vulnerability Index *(Índice de Vulnerabilidade Ambiental)*

IVAm – Municipal Environmental vulnerability Index *(Índice de Vulnerabilidade Ambiental municipal)*

IVG – General Vulnerability Index *(Índice de Vulnerabilidade Geral)*

IVM – Municipal Vulnerability Index *(Índice de Vulnerabilidade Municipal)*

IVS – Health Vulnerability Index *(Índice de Vulnerabilidade da Saúde)*

IVse – Socio-economic Vulnerability Index *(Índice de vulnerabilidade socioeconômica)*

IVSo – Social Vulnerability Index *(Índice de Vulnerabilidade Social)*

IVss – Vulnerability Index associated with Access to health services *(Índice de vulnerabilidade associada ao acesso a serviços de saúde)*

JJA – June-July-August

Kc – culture coeficient

KfW *(Kreditanstalt für Wiederaufbau)* – German Development Bank

km – kilometer

km^2 – square kilometer

kWh – quilowatt-hour

LCCS – Land Cover Classification System

LNG – liquefied natural gas

LPG – Liquefied Petroleum Gas

LULUCF – Land Use, Land Use Change and Forestry

m/s – meter per second

m^2 – square meter

m^3– cubic meter

MAM – March-April-May

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

MAX – maximum threshold

MaxEnt – Maximum Entropy Modelling

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

MDA – Ministry of Agrarian Development *(Ministério do Desenvolvimento Agrário)*

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)*

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

MG – state of Minas gerais

MGB-IPH – large-scale *hydrological* model

MHDI – Municipal Human Development Index

MIN – minimum thresholds

MIROC5 – Model for Interdisciplinary Research on Climate version 5

$MJ/m^2.day$ – mega joules per square meter per day

mm – millimeter

mm/day – millimeters per day

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

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

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

MS – state of Mato Grosso do Sul

MT – state of Mato Grosso

MUNIC – Survey of Basic Municipal Information *(Pesquisa de Informações Básicas Municipais do Instituto Brasileiro de Geografia e Estatística)*

MVPM/RJ – Vulnerability Map of the Population of the state of Rio de Janeiro

MW – megawatt

MWh – megawatt hour

N_2O – nitrous oxide

NAMA – Nationally Appropriate Mitigation Actions

NASA – National Aeronautics and Space Administration

NCAR – National Center for Atmospheric Research

NGOs – Non-governmental Organizations

NOAA – National Oceanic and Atmospheric Administration

NSF – National Science Foundation

NTS – No-tillage system *(Sistema de Plantio Direto)*

OECD – Organisation for Economic Co-operation and Development

OEMA – State Environmental Agencies *(Órgãos Estaduais de Meio Ambiente)*

OEPA – State Organization of Agricultural Research *(Organização Estadual de Pesquisa Agropecuária)*

PAHO – Pan-American Health Organization

PAISS – BNDES-FINEP Plan to Support Innovation in the Sugar-based Energy and Sugar-based Chemical Sectors *(Plano Conjunto BNDES-FINEP de apoio à Inovação Tecnológica Industrial no Setor Sucroenergético e Sucroquímico)*

PARNAs – National Parks *(Parques Nacionais)*

PA – Protected Area

PAS – Sustainable Amazon Plan *(Plano Amazônia Sustentável)*

Pasep – Government Employee Fund *(Programa de Formação do Patrimônio do Servidor Público)*

PBACV – Program for the Assessment of Life-Cycle *(Programa Brasileiro de Avaliação do Ciclo de Vida)*

PBE – Brazilian Labelling Program *(Programa Brasileiro de Etiquetagem)*

PBMC – Brazilian Panel on Climate Change *(Painel Brasileiro de Mudanças Climáticas)*

PCS – Sustainable Cerrado Program *(Programa Cerrado Sustentável)*

PDE – The Ten-Year Energy Expansion Plan *(Plano Decenal de Expansão de Energia)*

PDRS – Xingu Sustainable Regional Development Plan *(Plano de Desenvolvimento Regional Sustentável do Xingu)*

PEMFC – Proton Exchange Fuel Cell

PEXTPOB – Percentage of extremely poor people *(Porcentagem de pessoas extremamente pobres)*

PFCs – perfluorocarbons

PGPM-Bio – Minimum Price Guarantee of socio-biodiversity products Policy *(Política de Garantia de Preços Mínimos para Produtos da Sociobiodiversidade)*

PGTA – Territorial and Environmental Management Plans *(Plano de Gestão Territorial e Ambiental)*

PHE – Inland Waterways Strategic Plan *(Plano Hidroviário Estratégico)*

PIS – Social Integration Program *(Programa de Integração Social)*

PMDBBS – Project of Satellite Deforestation Monitoring of the Brazilian Biomes *(Projeto de Monitoramento do Desmatamento nos Biomas Brasileiros por Satélite)*

PMFC – Community Forest Management Program *(Programa de Manejo Florestal Comunitário)*

PNA – National Adaptation Plan *(Plano Nacional de Adaptação)*

PNE – National Energy Plan *(Plano Nacional de Energia)*

PNEf – National Energy Efficiency Plan *(Plano Nacional de Eficiência Energética)*

PNGATI – National Policy on Territorial and Environmental Management of indigenous lands *(Política Nacional de Gestão Territorial e Ambiental das Terras Indígenas)*

PNIA – National Environmental Indicators Panel *(Painel Nacional de Indicadores Ambientais)*

PNLA – National Environmental licensing Portal *(Portal Nacional de Licenciamento Ambiental)*

PNLT – National Plan for Logistics and Transport *(Plano Nacional de Logística de Transportes)*

PNM – National Mining Plan *(Plano Nacional de Mineração)*

PNMC – National Policy on Climate Change *(Política Nacional sobre Mudança do Clima)*

PNPB – National Biodiesel Use and Production Program *(Programa Nacional de Produção e Uso de Biodiesel)*

PNPSB – National Plan for Promoting the Supply Chains of Sociobiodiversity Products *(Plano Nacional de Promoção das Cadeias de Produtos da Sociobiodiversidade)*

PNS – National Health Plan *(Plano Nacional de Saúde)*

Pop – population

PPA – Multi-year Plan *(Plano Plurianual)*

PPAREDE – percentage of people living in houses with inadequate wall *(Porcentagem de pessoas que residem em habitações com paredes impróprias)*

PPCD – State Action Plan for the Prevention and Control of Deforestation *(Planos Estaduais de Prevenção e Controle do Desmatamento)*

PPCDAm – Action Plan for the Prevention and Control of Deforestation in the Legal Amazon *(Plano de Ação para a Prevenção e Controle do Desmatamento na Amazônia Legal)*

PPCerrado – Action Plan for the Prevention and Control of Deforestation and Burnings in Cerrado *(Plano de Ação para a Prevenção e Controle do Desmatamento e das Queimadas no Cerrado)*

PPOB – Percentage of poor people

PRA – Environmental Regularization Program *(Programa de Regularização Ambiental)*

PRADAs – Projects of Restoration of Degraded and Changed Areas *(Projetos de Recomposição de Área Degradada e Alterada)*

Prevfogo – National System for Forest Fire Prevention and Combat

Procel – National Program of Electric Energy Conservation *(Programa Nacional de Conservação de Energia Elétrica)*

Procel EPP – Energy Efficiency in Public Buildings Program *(Programa de Eficiência Energética nos Prédios Públicos)*

Procel GEM – Municipal Power Management *(Gestão Energética Municipal)*

Procel Info – Brazilian Center on Energy Efficiency Information *(Centro Brasileiro de Informação de Eficiência Energética)*

Proconve – Motor Vehicle Air Pollution Control Program *(Programa de Controle da Poluição do Ar por Veículos Automotores)*

PRODES – Amazonian Gross Deforestation Monitoring Project *(Projeto de Estimativa do Desflorestamento Bruto da Amazônia Brasileira)*

PROESCO – Energy Efficiency Projects *(Projetos de Eficiência Energética)*

ProH_2 – Program on Science, Technology and Innovation for Hydrogen Economy *(Programa de Ciência, Tecnologia e Inovação para a Economia do Hidrogênio)*

Proinfa – Alternative Electricity Sources Incentive Program *(Programa de Incentivo às Fontes Alternativas de Energia Elétrica)*

Promot – Program for Controlling Air Pollution from Motorcycles and Similar Vehicles *(Programa de Controle da Poluição do Ar por Motociclos e Veículos Similares)*

Pronaf – National Program for Strengthening Family-based Agriculture *(Programa Nacional de Fortalecimento da Agricultura Familiar)*

Pronamp – Support Program for Medium Rural Producer *(Programa Nacional de Apoio ao Médio Produtor Rural)*

Pronar – National Program for Air Quality Control *(Programa Nacional de Controle da Qualidade do Ar)*

PSA – Payment for Environmental Services *(Pagamento por Serviços Ambientais)*

PSAGUAESG – Percentage of people with no access to water or sanitation

PSENERG – Percentage of people with no Access to electric energy

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

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

PTI – Itaipú Technological Park

PVULPOB – Percentage of people about to become poor

R & D – Research and Development

R,D&I – Research, Development and Innovation

R95P – the amount of rainfall falling above the 95th percentile

RCP – Representative Concentration Pathways

RDS – Sustainable Development Reserve *(Reserva de Desenvolvimento Sustentável)*

Rebio – Biological Reserves *(Reservas Biológicas)*

REDD+ – Reduction of Emission from Degradation and Deforestation, Conservation of forest carbon stocks, Sustainable management of forests, Enhancement of forest carbon stocks *(Redução de Emissões de Degradação e Desmatamento, Conservação dos estoques de carbono florestal, Manejo sustentável de florestas e Aumento dos Estoques de Carbono florestal)*

Rede CLIMA – Brazilian Research Network on Global Climate Change *(Rede Brasileira de Pesquisas sobre Mudanças Climáticas Globais)*

Refau – Fauna Reserve

Reluz – National Program for Efficient Public Lighting *(Programa Nacional de Iluminação Pública Eficiente)*

Resex – Extractives' Reserves *(Reservas Extrativistas)*

ReViS – Wildlife Refuges *(Refúgios da Vida Silvestre)*

RGR – Global Reversion Reserve *(Reserva Global de Reversão)*

RJ – state of Rio de Janeiro

RL – Legal Reserve

RPPN – Private Reserve of Natural Heritage *(Reserva Particular de Patrimônio Natural)*

RS – state of Rio Grande do Sul

RX1day – maximum 1-day precipitation

RX5day – maximum 5-day precipitation

SAE – Secretariat of Strategic Affairs *(Secretaria de Assuntos Estratégicos da Presidência da República)*

SBPC – Brazilian Society for the Progress of Science *(Sociedade Brasileira para o Progresso da Ciência)*

SC – state of Santa Catarina

SCenAgri – Agricultural Scenarios Simulator

SEBRAE – Brazilian Micro and Small Business Support Service *(Serviço Brasileiro de Apoio às Micro e Pequenas Empresas)*

SF_6 – sulfur hexafluoride

SFB – Brazilian Forest Service *(Serviço Florestal Brasileiro)*

SHP – Small Hydropower Plants

SiBBr – Brazilian Biodiversity Information System *(Sistema de Informação sobre a Biodiversidade Brasileira)*

SICAR – Rural Environmental Registry System

Sincarbo – Information System on GHG emissions in industry *(Sistema de Informações sobre Emissões de GEE na Indústria)*

SINIMA – National Information System for the Environment *(Sistema Nacional de Informação sobre Meio Ambiente)*

SIS REDD+ – National REDD+ Information and Safeguards System *(Sistema nacional de Informações de Salvaguardas REDD+)*

SISUC – Collaborative Public System *(Sistema público colaborativo)*

SMCQ – Secretariat of Climate Change and Environmental Quality *(Secretaria de Mudança do Clima e Qualidade Ambiental do MMA)*

SNIF – National System of Forest Information *(Sistema Nacional de Informações Florestais)*

SNUC – National System of Protected Areas *(Sistema Nacional de Unidades de Conservação)*

SOFC – Solid Oxide Fuel Cell

SON – September-October-November

SP – state of São Paulo

SRES – Special Report Emission Scenarios

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

t – ton

tb – average temperature in the present

TDA – Animal Manure Treatment

ts – simulated temperature

TT – Technology transfer

UF – unit of federation (state)

UN – United Nations

UNDP – United Nations Development Program

UNFCCC – United Nations Framework Convention on Climate Change

UNICAMP – University of Campinas *(Universidade de Campinas)*

VLP – Light wheeled vehicle *(Veículo leve sobre pneus)*

VLT – Light Trail Vehicle *(Veículo leve sobre trilhos)*

$Vuln_{Soc}$ – sub-index of socioeconomic vulnerability

W/m^2 – watts per square meter

WG – Working Group

WG REDD+ – Interministerial Working Group on REDD+

WG2 – IPCC's Working Group 2

WHO – World Health Organization

WRI – World Resources Institute

WWF – World Wide Fund for Nature

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CHAPTER I

PROGRAMS CONTAINING MEASURES TO MITIGATE CLIMATE CHANGE

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PROGRAMS CONTAINING MEASURES TO MITIGATE CLIMATE CHANGE

As one of the 195 signatories to the United Nations Framework Convention on Climate Change (UNFCCC), Brazil abides by the provisions contained therein, according to the principle of common but differentiated responsibilities, in view of its development priorities, specific goals and circumstances. Among the Convention's obligations that apply to Brazil, the agreement, in its Article 12, paragraph 1, item (b) provides that the signatory must regularly update the Conference of the Parties with a general description of steps taken or planned to implement the Convention in the country.

According to Decision 17/CP.8, the steps that need to be notified include two main groups: information on programs containing measures to mitigate climate change, including the reduction of anthropogenic emissions and the increase of removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, and also measures to facilitate adequate adaptation to climate change, including information on specific concerns due to its adverse effects.

1.1. POLITICAL STRUCTURING FOR THE NATIONAL INTEGRATION OF CLIMATE CHANGE ISSUES

Before approaching the specific plans and programs related to climate change mitigation, a brief introduction of the main national policies aimed at structuring a medium and long-term planning is necessary, considering sustainable development and GHG emissions reduction.

1.1.1. Brazilian Environmental Legislation

Article 225 of the Federal Constitution establishes that: "Everyone has the right to an ecologically balanced environment, which is an asset of common use and essential to a healthy quality of life, and both the Government and the community shall have the duty to defend and preserve it for the present and future generations". Thus, the environment is characterized as an inherent right for individuals and for society as a whole, with Public Authorities and the community equally held responsible for preserving and ensuring the environmental balance.

Besides the measures and provisions assigned to the Public Authorities, the Federal Constitution imposes a set of rules on those who may direct or indirectly harm the environment. In addition, the Constitution[1] stipulates that the Brazilian Amazon Forest, Atlantic Forest, Serra do Mar, Pantanal Wetlands and the Coastal Zone are national heritage, and their use must be carried out in accordance with the law under conditions that ensure the preservation of the environment.

Despite the fact that the Constitution heeds special attention to preventive activities, it also makes reference to repressive measures. Paragraph 3 of Article 225 stipulates criminal and administrative sanctions to offenders, either individuals or organizations, whose conduct or activities are deemed harmful to the environment, regardless of the obligation to repair the damage caused.

In 2000, the National System of Protected Areas (*Sistema Nacional de Unidades de Conservação,* SNUC)[2] updated the concept of protected area by introducing the social dimension and the use for other purposes. The importance of the definition of a National System of Protected Areas is that it standardizes and consolidates criteria for the creation and management of these areas, thus making it possible to enhance management of the Brazilian environmental heritage. Further information on this issue is shown in Item 1.1.1.1.

It is worth noting that since May 2012, a new forestry act has been in force in Brazil: Law No. 12,651, commonly known as the "New Forest Code", which was created after an extensive discussion with the Brazilian civil society. This new legislation provides that rural properties must maintain a coverage area of native vegetation as Legal Reserve, regardless of the implementation of the rules on Permanent Preservation Areas (PPAs)[3]. For rural properties located in Brazil's Legal Amazon region[4], the following minimum percentages of native vegetation cover in relation to the property area apply: (a) 80% for properties located in forest areas; (b) 35% for properties located cerrado areas; (c) 20% for properties located in an area of general grasslands. For properties located outside the Legal Amazon the minimum percentage is 20%.

The new Forest Code entailed the creation of the Rural Environmental Registry (*Cadastro Ambiental Rural*, CAR), and the Environmental Regularization Plan (*Plano de Regularização Ambiental*, PRA). The CAR is an electronic record[5], mandatory for all rural properties, aimed at integrating environmental information concerning the situation of Permanent Preservation Areas (APP), Legal Reserve areas, forests and the reminiscent native vegetation in Areas of Restricted Use and the consolidated areas of the rural properties and settlements of the country. Created within the framework of the National System of Information on the Environment (SINIMA), the CAR is a database for controlling, monitoring and combating the clearing of forests and other forms of native vegetation of Brazil, as well as for the environmental and economic planning of rural properties. The PRA is a strategic instrument of the New Forest Code because it allows the solution of the various environmental liabilities of rural producers. The registry will also serve as a factor to be considered in terms of access to agricultural incentives, in the hiring of agricultural insurance, for the tax exemption of the main agricultural inputs and equipment, among other economic benefits.

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1 *Article 225 paragraph 4.*

2 *Law No. 9,985, of 18 July 2000.*

3 *The definition of Permanent Preservation Areas is provided for in article 4 of the New Forestry Law. The Legal Reserve (RL) has a role to play in ensuring the sustainable economic use of the natural resources of the rural property and contributing to the conservation of the biodiversity. Its definition is provided for in articles 12 and 13 of the new Forestry Act.*

4 *Area encompassing nine states of Brazil: Acre, Amazonas, Amapá, Maranhão, Mato-Grosso, Rondônia, Pará, Roraima and Tocantins. The state of Maranhão was included in its total extension in May 2008.*

5 *See: http://www.car.gov.br*

It is a recognized fact that the Brazilian environmental legislation is one of the most advanced in the world, incorporating, from a legal perspective, clear guidelines in the pursuit of sustainable development, although there may be institutional and administrative difficulties for its broad implementation. There are, to some extent, difficulties in such a continent-sized country to control factors that drive economic development and are inconsistent with sustainable development.

Nevertheless, the United Nations Conference on Environment and Development – Rio 92 – was a milestone, as it represented a global effort for the establishment of new development guidelines based on environmental protection, social justice and economic efficiency. This conference produced five documents: the Rio Declaration on Environment and Development, the Agenda 21, the Statement of principles to guide the management, conservation and sustainable development of all types of forests, the United Nations Framework Convention on Biological Diversity and the United Nations Framework Convention on Climate Change.

Considering the need to establish specific priorities for development, the signatories of the agreements resulting from the United Nations Conference on Environment and Development made a commitment to develop and implement their respective domestic Agenda 21. The domestic Agenda 21 is intended to develop the parameters of a strategy for sustainable development by setting national priorities and enabling the sustainable use of natural resources. The Brazilian Agenda 21 was completed in 2002. As of 2003, the Brazilian Agenda 21 not only launched the implementation phase, assisted by the United Nations Commission on Sustainable Development (CSD), but it was also granted the status of a program within the 2004-2007 Multiannual Plan[6] (PPA 2004-2007) by the Government.

1.1.1.1. The National System of Protected Areas (SNUC)

In Brazil, the set of federal, state and municipal protected areas comprise the National System of Protected Areas (SNUC), created by Law No. 9,985/2000, regulated by Decree No. 4,340/2002. A protected area can be defined as the "territorial space and its environmental resources, including jurisdictional waters, with important natural characteristics, legally instituted by Public Authorities, with the objectives of conservation and limits defined, under a special administration regime to which appropriate guarantees of protection apply".

Brazil has an extensive set of protected areas, which has widely increased in recent years. The framework for the policy of creating, appreciating and using protected areas is drawn up by the National Environment Council (Conama). The implementing bodies are the Chico Mendes Institute for Biodiversity Conservation (ICMBio)[7], as well as state and municipal entities. The objectives of the protected areas are described in Table 1.1.

6 *The Multiannual Plan (PPA), in Brazil, is provided for in Article 165 of the Federal Constitution, and regulated by Decree No. 2,829, of October 29, 1998, laying down the measures, costs and objectives to be followed by the Federal Government over a period of four years. A four-year law, subject to different time limits and procedures, approves it. It shall be in force from the second year of a presidential mandate until the end of the first year of the next mandate. It also provides for the work of the government, during the period mentioned, in programs of continuing duration already established or to be established in the medium term.*

7 *Law No. 11,516, of August 28, 2007, created the Chico Mendes Institute for the Conservation of Biodiversity (ICMBio), whose duties are related to the proposition, deployment, management, protection, supervision and monitoring of Protected Areas imposed by the Central Government.*

TABLE 1.1
Categories of Protected Areas covered by SNUC

CATEGORY	GROUP	OBJECTIVE
Ecological Station (Esec)	Integral Protection	Preservation of nature and conduction of scientific research.
Biological Reserve (Rebio)	Integral Protection	Full Preservation of the biota and other natural attributes existing in its limits, without direct human interference or environmental changes, except for the measures of recovery of its changed ecosystems and the management actions necessary to recover and preserve the natural balance, the biological diversity and natural ecological processes.
National Park (Parna) State Park or Municipal Natural Park	Integral Protection	Preservation of natural ecosystems of very important ecological and scenic beauty, enabling the achievement of scientific research and the development of environmental education and interpretation activities, leisure in contact with nature and eco-tourism.
Natural Monument (MN)	Integral Protection	Preserve rare natural unique sites, or of great scenic beauty.
Wildlife Refuge (RVS)	Integral Protection	Protect natural environments where the conditions for the existence or reproduction of species or communities of the local flora and resident or migratory fauna are ensured.
Environmental Protection Area (APA)	Sustainable Use	Protect biological diversity. Regulate the process of occupation and ensure the sustainable use of natural resources.
Area of Relevant Ecological Interest (Arie)	Sustainable Use	Maintain the natural ecosystems of regional or local importance and regulate the permissible use of these areas, in order to bring it into line with the objectives of nature conservation.
National Forest (Flona), State Forest or Municipal Forest	Sustainable Use	Multiple sustainable uses of the forest resources and scientific research, with emphasis on methods for the sustainable exploration of native forests.
Extractive Reserve (Resex)	Sustainable Use	Protect the livelihood and the culture of traditional extractive peoples and ensure the sustainable use of the natural resources of the unit.
Sustainable Development Reserve (RDS)	Sustainable Use	Preserve nature and, at the same time, ensure the conditions and means necessary for reproduction and improvement of the livelihood and the quality of life and exploration of the natural resources of traditional populations, as well as enhance, preserve and improve the knowledge and environmental management techniques developed by these populations.
Fauna Reserve (Refau)	Sustainable Use	Keep native animal populations, either terrestrial or aquatic, resident or migratory, suitable for scientific and technical studies on the economic sustainable management of fauna resources.
Private Reserve Natural Heritage (RPPN)	Sustainable Use	Protect the biological diversity.

Source: Law No. 9,985/2000 (SNUC).

Table 1.2 presents a current overview of Federally Protected Areas in the country, divided by biomes, in relation to the total area of Brazil, and the area of each biome. The Amazon biome is the country's largest and best preserved. Adding up Full Protection and the Sustainable Use PAs, the total covers 61.2 million hectares, which accounts for 14.6% of the total area of the biome. The Cerrado has Federally Protected Areas that cover over 5 million hectares, which corresponds to 2.6% of the total area of the biome. The Atlantic Forest, in turn, is in an area experiencing high pressure in terms of the real-estate market and urban growth, because it is located along the entire coast of the country, where some of Brazil's largest cities are located, such as São Paulo and Rio de Janeiro. For these reasons, the creation and maintenance of Protected Areas in areas with Atlantic Forest cover are more important than in any other region of the country. The coastal ecosystems make up the region with the highest percentage of protected areas in the country. Its Federally Protected Areas represent approximately 21% of the biome's total area. With regard to the Southern Fields and the Pantanal, what draws attention is the low representativeness of preserved areas through federal PAs in relation to the total area of biome: 1.8% and 1.0% respectively. In the Caatinga, in turn, the preserved area corresponds to 4.7% of the total biome, with most units having been recently created (2000-2010). In general, there are two historical moments to highlight in the process of setting up federal PAs in Brazil, the 1980-1990 and 2000-2010 periods.

TABLE 1.2

Federally Protected Areas by Biome created by decade

BIOME-ZONE	AREA OF THE BIOME	PERCENTAGE OF THE BIOME OVER THE TOTAL OF BRAZIL	1930-1940	1940-1950	1950-1960	1960-1970	1970-1980	1980-1990	1990-2000	2000-2010	2010-2014	TOTAL PAS CREATED	TOTAL AREA OF PAS IN HECTARES	TOTAL AREA OF PAS AS % OF THE BIOME
Amazon	419,694,300	49.0	0	0	0	1	6	30	17	51	1	106	61,187,985	14.6
Caatinga	84,445,300	9.9	0	1	1	1	1	5	4	10	1	24	3,998,048	4.7
Southern Field	17,649,600	2.1	0	0	0	0	0	1	1	0	0	2	319,783	1.8
Cerrado	203,644,800	23.8	0	0	1	3	1	11	8	16	0	40	5,252,056	2.6
Coastal Zone	5,056,768	0.6	0	0	0	0	1	23	9	23	4	60	1,048,807	20.7
Atlantic Forest	111,018,200	13.0	3	1	1	12	2	16	12	25	7	79	3,024,841	2.7
Pantanal	15,035,500	1.8	0	0	0	0	0	2	0	0	0	2	147,161	1.0
Total	**856,544,468**	**100.0**	**3**	**2**	**3**	**17**	**11**	**88**	**51**	**125**	**13**	**313**	**74,978,681**	**8.8**

Source: ICMBio[8]

1.1.1.1.1. Indigenous Lands

In Brazil, indigenous areas are set aside by the Federal Government for the exclusive use of those indigenous communities that inhabit them. According to the Indigenous People Statute[9], indigenous lands are regarded as reserved areas (indigenous reserve, indigenous park and indigenous agricultural settlement) and lands under the control of indigenous communities. Concomitantly, the National Indian Foundation (FUNAI)[10] stipulated the name "indigenous land" for any territory occupied by the indigenous people. In practical terms, indigenous lands are not only the space occupied by indigenous peoples, but also all the space necessary for the survival of their culture. The study for their demarcation, therefore, takes into account all the territory used by indigenous peoples to survive and maintain their beliefs, pursuant to the Federal Constitution. FUNAI has the role to take the initiative, guide and run the demarcation of land, through the Board of Territorial Protection (DPT).

Besides Funai, the process can also be carried out by INCRA and through a statement by the Justice Minister and its approval by the President of the Republic. The Central Government may also establish, in any part of the national territory, areas intended for the possession and occupation by indigenous peoples, where they can live and have means of subsistence, with the right to the enjoyment and use of natural resources, while ensuring the conditions of their physical and cultural reproduction.

From 1500 until the 1970s, the Brazilian indigenous population decreased sharply and many peoples were extinguished. The disappearance of indigenous peoples became a sad historical contingency. As of 1991, IBGE included indigenous peoples in the Demographic National Census. The number of Brazilians who considered themselves as indigenous grew by 150% in the 90s, representing an appreciation and recognition of this identity that is self-declared in the Census. The growth pace was almost six times greater than that of the population in general. In the last Census of 2010, 272,654 indigenous peoples were identified living on the coast and 545,308 living in the interior of the country. This Census revealed that there are indigenous peoples in all the States of the Federation, including the Federal District. The Northern Region shelters the highest number of indigenous people, 37.4% of the total. FUNAI also registers 69 references of indigenous communities not yet contacted, in addition to groups that are requesting the recognition of their indigenous condition by the federal agency. Regarding the 274 indigenous languages spoken, the Census showed that about 17.5% of the indigenous population does not speak the Portuguese language. The Tikuna people, residing in the State of Amazonas, were the ones with the largest number of Portuguese speakers.

The Brazilian indigenous population, in their vast majority, has been experiencing an accelerated and complex social transformation, running into concrete problems, such as land invasions and territorial and environmental degradations, food insecurity, sexual exploitation, bullying, drug use, labor exploitation, including children, begging, disorganized exodus causing large concentration of indigenous people in the cities. Thus, it is pivotal to look for new answers for their physical and cultural survival, as to ensure the

8 Available at: http://www.icmbio.gov.br/portal/biodiversidade/unidades-de-conservacao/biomas-brasileiros.html, last seen in September, 2014.
9 Law No. 6,001/1973.
10 By Directive No. 1,060/1994.

next generations better conditions and life standards. FUNAI, through a strategy of ethnic-development, has been promoting actions to care for the basic needs of the indigenous population, but with respect to the indigenous people's vision of the world and socio-productive organization. Other ministries, for example, the Ministry of Social Development and Fight against Hunger, develop integrated and joined-up actions with FUNAI.

Indigenous areas are not considered protected areas since their primary management objective is not the protection of biological diversity. However, due to their extension, they are very important in protecting the country's biological wealth and for the economic sustainability of indigenous peoples, which in large part survive off extraction and sustainable agricultural practices. Table 1.3 summarizes the situation of the indigenous areas in Brazil.

TABLE 1.3
Situation of Indigenous Lands in Brazil

MODALITY	NO.	AREA
Interdicted	6	1,084,049.0000
Private property	6	31,070.7025
Indigenous Reserve	30	33,358.7036
Traditionally occupied	544	111,963,634.4401
Total	**586**	**113,112,112.8462**
PHASE	**NO.**	**AREA**
Delimited	38	2,307,660.91
Declared	66	4,535,583.10
Approved	14	531,917.01
Regularized	426	104,588,473.42
Total	**544**	**111,963,634.44**
Under studies	129	0
Interdiction Directive	6	1,084,049.00

Source: FUNAI[11]

In short, it can be emphasized that the existence of protected areas generates benefits for the whole society, through the so-called environmental services, and protects this natural heritage for future generations. Among the environmental services provided by the PAs, the following are worthy of mention: the continuous supply of good quality water; the microclimate improvement in regions with extreme temperatures and excessive pollution; pollination, which ensures high productivity of agricultural crops, genetic bank, land protection and conservation; slope protection, which reduces the severity of natural disasters; the status of agricultural production, mitigation of climate change effects, among others.

11 *Available at: http://www.funai.gov.br/index.php/indios-no-brasil/terras-indigenas*

1.1.2. National Policy on Climate Change (PNMC)

In 2009, the National Policy on Climate Change (*Política Nacional de Mudança de Clima,* PNMC), Law No. 12,187/2009, was put in place aiming at, among other things, harmonizing social and economic development while protecting the climate system; reducing anthropogenic greenhouse gas emissions in relation to their various sources; strengthening anthropogenic removals by sinks of greenhouse gases in the country; and implementing measures to promote adaptation to climate change by the three levels of government, with the participation and collaboration of the economic and social stakeholders, particularly those especially vulnerable to its adverse effects.

The objectives of the National Policy on Climate Change should be in line with sustainable development in order to pursue economic growth, poverty eradication and reduction of social inequalities.

The following are considered instruments of the National Policy on Climate Change: the National Plan on Climate Change, the National Fund for Climate Change[12]; the Action Plans for the prevention and control of deforestation in the biomes; Sectoral Plans on Mitigation and Adaptation to Climate Change; National Communications of Brazil to the United Nations Framework Convention on Climate Change, according to the criteria established by the Convention and by the Conference of the Parties; the resolutions of the Interministerial Commission on Global Climate Change; the fiscal and tax measures to encourage emission reductions and removal of greenhouse gases, including differentiated tax rates, exemptions, compensations and incentives, to be established by specific legislation; the lines of credit and financing of specific public and private financial agents; the development of research programs by funding agencies; the specific allocations for actions on climate change in the federal budget; the financial and economic mechanisms related to climate change mitigation and adaptation to the effects of climate change that exist under the United Nations Framework Convention on Climate Change and the Kyoto Protocol; and the financial and economic mechanisms, at national level, pertaining to mitigation and adaptation to climate change.

Furthermore, instruments of the PNMC also include existing or future measures that encourage the development of processes and technologies that contribute to the reduction of greenhouse gas emissions and removals, as well as to adaptation, among which the establishment of eligibility criteria in tenders and bids, including public-private partnerships, and the authorizations, permits, grants and concessions of public services and natural resources, to proposals that provide greater savings of energy, water and other natural resources; and to the reduction of greenhouse gas emissions and waste.

The institutional instruments for the implementation of the National Policy on Climate Change include[13]:

I the Interministerial Committee on Climate Change;
II the Interministerial Commission on Global Climate Change;
III the Brazilian Climate Change Forum;
IV the Brazilian Research Network on Global Climate Change (hereinafter referred to as *Rede Clima*);
V the Commission for the Coordination of Meteorology, Climatology and Hydrology Activities.

The text of the law provides that, in order to achieve the goals of the PNMC, the country will adopt, as a voluntary commitment at national level, actions to mitigate greenhouse gas emissions with a view to reducing its projected emissions by 36.1%-38.9% by 2020. Accordingly, in January 2010 the Government of Brazil informed the Secretariat of the Convention of the Nationally Appropriate Mitigation Actions (NAMA)

12 See item 1.4.1, on the National Fund for Climate Change (FNMC).
13 Further details are available in Volume I of this Communication, which discusses in detail some of the institutional instruments of the PNMC.

that it intended to undertake, for the information of the Parties to the UNFCCC. It should be emphasized that these are voluntary actions, and that they are being implemented in accordance with the principles and provisions of the Convention, particularly Article 4, paragraph 1; Article 4, paragraph 7; Article 12, paragraph 1(b); Article 12, paragraph 4; and Article 10, paragraph 2(a). Use of the Kyoto Protocol's Clean Development Mechanism (CDM) is not excluded.

The PNMC provides that the projected emissions for 2020, as well as the detailed actions to achieve the reduction goal above would be established by Decree, based on the Second Brazilian Inventory of Anthropogenic Emissions by Sources and Removals by Sinks of Greenhouse Gases not Controlled by the Montreal Protocol.

In 2010, work on the measures to implement the PNMC started, with a view to establishing the sectoral plans to achieve the goal expressed in the PNMC regarding mitigation actions, described in item 1.2.

1.1.3. National Plan on Climate Change

Although Brazil is not in the list of countries in Annex I of the Convention, the country has been playing a critical role and has made one of the most significant contributions by any country in reducing emissions of greenhouse gases.

Hence, in 2007 the development of a plan, initially called "National Action Plan to Combat Climate Change", was included in the agenda of governmental activities, aimed at structuring and coordinating the government's actions concerning the effects of global warming arising from anthropogenic activities.

In 2007, the government created the Interministerial Committee on Climate Change (CIM), coordinated by the Executive Office of the Presidency of the Republic, with a mandate to develop the National Plan on Climate Change and the National Policy on Climate Change.

The Executive Group on Climate Change (GEx), which is coordinated by the Ministry of Environment and reports to the CIM, is responsible for elaborating, implementing, monitoring and evaluating the National Plan on Climate Change. As a result of the GEx's work, a bill for the National Policy on Climate Change (as described in item 1.1.2) and the draft National Plan on Climate Change were submitted to the National Congress.

The overall objective of the National Plan on Climate Change is to identify, plan and coordinate actions and measures that can be undertaken to mitigate greenhouse gas emissions generated in Brazil, as well as those necessary for the adaptation of society to the impacts of climate change. Hence, the Plan created, for the first time in an organized fashion, domestic conditions to cope with the impacts of global climate change on productive activities, ecosystems and the Brazilian population. The plan must be guided by the National Policy on Climate Change on an ongoing basis, and it sets some goals that contribute to the reduction of GHG emissions.

Because of its dynamic nature, the National Plan on Climate Change will go under periodic reviews and assessments of results, as happened during the recent update process. As it was implemented during the Plan's development process in 2008, the Brazilian Climate Change Forum (hereinafter referred to as FBMC, in the Portuguese acronym) coordinated the so-called sectoral dialogues, aimed at discussing and receiving contributions of the civil society in the updating process of the National Plan on Climate Change.

During the review of the National Plan on Climate Change, Sectoral Plans for mitigation and adaptation were incorporated in the contents. These sectoral plans will be detailed in item 1.2 and are implementation instruments of the National Plan.

1.2. ACTION PLANS FOR THE PREVENTION AND CONTROL OF DEFORESTATION IN THE BIOMES AND SECTORAL PLANS OF MITIGATION AND ADAPTATION TO CLIMATE CHANGES

Decree No. 7,390/2010 provides for the development of Sectoral Plans with the inclusion of actions, indicators and specific targets for the reduction of emissions and mechanisms for monitoring compliance to meet the voluntary commitment. The Sectoral Plans not only delineate mitigation strategies but also include actions for adaptation, as provided for by Law No. 12,187/2009, such as initiatives and measures to reduce the vulnerability of the natural and human systems due to the current and expected effects from climate change.

The Sectoral Plans were developed by the relevant sectoral organization, but coordination was up to the Executive Group (GEx). Each body produced the technical content and fostered the participation of stakeholders, including representatives of the FBMC. The procedure can be summarized as follows: in the first phase, preliminary versions of the plans are finalized and approved by the Interministerial Committee on Climate Change (CIM), then enter the process of public consultation followed by a new consideration by the CIM for final decision.

According to Decree No. 7,390/2010, the Sectoral Plans should be submitted to revisions on a regular basis not exceeding two years up to 2020, aiming at adapting them to society's demands and incorporating new actions and targets, in accordance with the specificities of the sector.

It is important to emphasize that the design and implementation of the Sectoral Plans for the Mitigation of and Adaptation to Climate Change are based on the rules established in the United Nations Framework Convention on Climate Change, and do not affect the continuing validity of such rules, including in relation to the flexibilities reserved for countries not included in Annex I for the measurement, reporting and verification of emissions and emissions reduction. The Plans to be detailed herein are:

- Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAm);
- Action Plan for the Prevention and Control of Deforestation and Burnings in Cerrado (PPCerrado);
- Sectoral Plan for the Mitigation and Adaptation to Climate Change for a Low Carbon Emission Agriculture (ABC Plan);
- Sectoral Plan for the Mitigation and Adaptation to Climate Change for the Consolidation of a Low Carbon Emission Economy in the Manufacturing Industry (Industry Plan);
- Sectoral Plan to Reduce Emissions in the Steel Industry;
- Sectoral Plan for the Mitigation and Adaptation to Climate Change in Low-Carbon Emission Mining;
- Sectoral Transport and Urban Mobility Plan for the Mitigation and Adaptation to Climate Change (PSTM);
- Health Sectoral Plan for the Mitigation and Adaptation to Climate Change (PSMC-*Saúde*);
- The Ten-Year Energy Expansion Plan (PDE).

1.2.1. Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAm)

It is estimated that up to 1980 the deforestation in the Amazon stood at around 300 thousand km², equivalent to 6% of its total area. In 1980s and 1990s, about 280 thousand km² were incorporated to the deforested area. In the beginning of the last decade, the pace was intensified, totaling a cumulative area of approximately 670,000 km² in 2004, equivalent to approximately 16% of the forest area of the Legal Amazon, seriously threatening the process of sustainable development for the region.

Historically, the main cause of deforestation in the Amazon has been the expansion of the agricultural frontier. Since 2004, after the launching of the Action Plan for the Prevention and Control of Deforestation in the Amazon Region (PPCDAm), the annual deforestation rate has been drastically reduced, reaching 6,418 km² for the period of 2010-2011, according to data from the PRODES system[14]. In 2012, the rate of deforestation reached the lowest historical figure among the monitoring series performed by INPE, reaching 4,571 km².

The PPCDAm is a tactical operational plan with clearly-defined responsibilities, actions and goals[15]. Although it aims at the end of illegal deforestation, it is a coordinated governmental effort to help with the transition from the current model of predatory growth to one that may consider the importance of the standing forest, the associated natural resources and the promotion of economic and social measures to benefit the 25 million inhabitants of the Amazon. It converges with other public and private initiatives that may have this same purpose in its concept and practice.

Moreover, the PPCDAm joins efforts with the Sustainable Amazon Plan (PAS), which proposes a set of guidelines to drive the sustainable development of the Amazon by valuing the sociocultural and ecological diversity and reducing regional inequalities. Launched in May 2008, the PAS was developed under the coordination of the Executive Office of the Presidency of the Republic and the ministries of the Environment and National Integration. Currently the Secretariat of Strategic Affairs of the Presidency of the Republic coordinates it.

With respect to the National Policy on Climate Change, the PPCDAm is one of the instruments through which the Brazilian Government contributes to the fulfillment of the volunteer national commitment to reduce its greenhouse gas emissions, along with the contribution from other sectoral plans for the mitigation and adaptation to climate change and the Action Plan for the Prevention and Control of Deforestation and Fires in the Cerrado, pursuant to Article 12 of Law No. 12,187/2009. In this sense, it is worth highlighting that the actions of the Sectoral Plan for the Mitigation and Adaptation to Climate Change for a Low Carbon Emission Agriculture (ABC Plan) and the Sectoral Plan to Reduce Emissions in the Steel Industry are complementary with the PPCDAm.

The PPCDAm is structured in three thematic axes that guide the government's activities: (i) Land tenure regularization and land-use planning, (ii) Monitoring and Environmental Control, and (iii) Fostering Sustainable Production activities.

14 The PRODES project, of the General Coordination of Earth Observation from the National Institute for Space Research (INPE), performs the satellite monitoring of deforestation by clear-cutting in the Amazon Region and has produced, since 1988, the annual rates of deforestation in the region, which are used by the Brazilian government for the establishment of public policies. The annual rates are estimated from the increments of deforestation identified in each satellite image that covers the Legal Amazon. More information about PRODES and other deforestation and fire monitoring systems (DETER, DEGRAD, Terraclass) performed by INPE ate available in Volume I of this Communication on "National and Regional Capacity Building" with information about INPE's activities.

15 More information can be found in the Annex herein.

In the first and second phases of the PPCDAm (2004 to 2011), the actions of greater impact for the drop in deforestation rates came from the Monitoring and Control axis, and are strongly associated with the development of the DETER system (Real Time Deforestation Detection System) and integrated surveillance planning. Currently, however, the pattern of deforestation has changed, leaving most deforestation below the detection threshold of DETER. The reduction in the area of polygons and their dispersal (spraying) therefore increase the cost of supervision.

During the implementation period's 1st and 2nd stages, the PPCDAm also included: the implementation of the Macro Economic Zoning and of the Legal Amazon; the geo-referencing of 25,618 rural properties within the scope of the Terra Legal Program[16]; the attendance of 13,852 families in projects for the management of natural resources in settlements of the Agrarian Reform; the granting of approximately 225,000 hectares of forests for Sustainable Forest Management; the creation of the Sustainable Forestry District along highway BR 163; the *Bolsa Verde* (Green Grant) Program[17].

The active participation of state governments has become more evident from the second phase of the PPCDAm on and is essential for the reduction of deforestation rates. The importance of the role of the states is mainly due to their proximity to the local problems and greater ease of coordination with the municipalities, where the policies are in fact enforced.

The first State Plans for the Prevention and Control of Deforestation (PPCDs) began to be developed in 2008 with the technical support of the Ministry of the Environment (MMA), and, currently, all nine states in the Legal Amazon rely on their respective Plans, some already in the review phase. The dialogue with the states has been strengthened since the 2nd phase of the PPCDAm, when the coordinated strategy of the state and federal levels became more robust with the integration of actions of the PPCDAm and the State Plans (Figure 1.1). The Federal Government, in addition, has been supporting the States by means of the Amazon Fund[18] and partnerships and technical support, mainly from the MMA.

Originally released on May 2008, the *Operação Arco Verde* (Green Arc Operation) is an integral part of the PPCDAm and aimed at meeting the demands for greater presence of the Federal Government in priority municipalities (43 at the time). Since the beginning, its objective is to collaborate for a transition from the current model of predatory production to a new model based on the maintenance of the standing forest and the generation of sustainable employment, and income and the improvement of citizenship and life quality. For that, in addition to the actions listed in the PPCDAm, the *Operação Arco Verde* involved other governmental areas (social area, social security, civil defense, public banks etc.).

Due to the success of the Operation, Decree No. 7,008/2009 was signed in November 2009, establishing the *Operação Arco Verde* under the PPCDAm and creating its National Managing Committee. Thus, the Operation continues on a permanent basis and with the purpose of promoting productive sustainable models in municipalities considered as priorities for the control and reduction of deforestation in the Legal Amazon.

Another important instrument is the Rural Environmental Registry (*Cadastro Ambiental Rural*, hereinafter referred to as CAR), which allows monitoring of deforestation within rural properties. Created by Law No. 12,651/2012

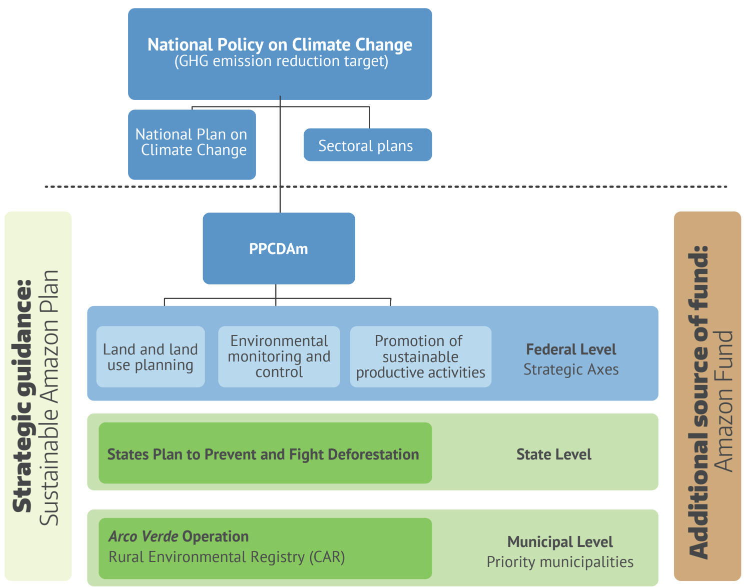
16 This is a program of initiative by the Ministry of Agrarian Development, with the objective of promoting the land regularization of occupations in federal public lands located in the Amazon Region.
17 Refer to item 1.5.4 herein.
18 Refer to item 1.4.3 herein.

(Forest Code) within the framework of the National System of Information on the Environment (SINIMA, in the Portuguese acronym), the CAR is based on strategic data for the control, monitoring and combating deforestation of forests and other forms of native vegetation of Brazil, as well as to the environmental and economic planning of rural properties. The CAR was also established as a criterion to remove priority municipalities with high rates of deforestation from the list of larger deforesters of the Amazon, as per lists given by Decree No. 6,321/2007 and the Directives issued annually by the MMA.

The PPCDAm expands the ongoing CAR initiatives, directly supporting some priority municipalities. Furthermore, it strengthens and enhances the implementation of the Environmental Regulation Program. The Amazon Fund has supported projects that enable the accession of rural landowners to the CAR.

FIGURE 1.1

PPCDAm and public policies



Source: BRAZIL (2013b)

In this context, the PPCDAm began its third implementation phase (2012-2015), seeking primarily to promote actions that are consistent with the new dynamics of deforestation and provide the axis of Foresting Sustainable Productive Activities with scale and emphasis.

Some R$ 1.4 billion were earmarked from the 2012-2015 Multiannual Plan and other sources for the third phase of the PPCDAm, to be invested mainly directed in the promotion of sustainable productive activities. Three main observations and recommendations, which have been incorporated into the planning of the third phase of the PPCDAm, are highlighted, as follows:

1 Review of the Plan's governance structure, strengthening the participation and interaction with other federal entities and civil society.

2 Restructuring of the Sustainable Activities Funding Axis: partially completed. A new territorial approach has been adopted, and the prioritization of strategic actions for important sectors has been designed.

3 Integration to actions of the Land and Territorial Planning Axis. There have been important advances in terms of prioritization of areas and institutional cooperation at the federal level to provide the processes with speed, cross barriers and promote the allocation of federal public lands. The analysis of the actions and resources to be invested in this 3rd phase showed that the scope of the new ambitious plan will depend on the approval of extra resources and greater integration with other levels of government for various actions of land governance and territorial management. The establishment of the Rural Environmental Registry and the Rural Environmental Registry System (SICAR, in the Portuguese acronym), to assist in the process of regularization of environmental properties and rural settlements, are reinforcements in this direction.

An assessment of the results achieved by PPCDAm from 2007 to 2010, held jointly by the Institute for Applied Economic Research (IPEA), the German International Cooperation Agency (GIZ) and the United Nations Economic Commission for Latin America and the Caribbean (ECLAC) indicated that the PPCDAm contributed in a fundamental way to reduce deforestation and established a new integrated framework for combating illegal deforestation in the region. Through the Plan, the problem of deforestation in the Amazon was inserted in the federal government's highest-level political agenda, involving a large number of ministries. The centers established in order to tackle deforestation in the Amazon – land and land-use planning, environmental monitoring and control, and promotion of sustainable production activities – contain the key elements to promote the transition from the current development model into a sustainable model. Furthermore, the Brazilian government developed a National REDD+ Strategy to consolidate efforts in the area and in order to get organized to achieve the emissions reduction targets set out in the PNMC and international voluntary commitments to reduce deforestation in the Amazon and Cerrado biomes by 2020[19].

The Brazilian National Strategy of REDD+ seeks to maximize the impacts of actions of prevention and control of deforestation and forest degradation in progress, with a focus on coordinated actions, considering sustainable development and regional diversity. The National Policy on Climate Change and the Law for the Protection of Native Vegetation (Forest Code), provide the broad guidelines for the actions of REDD+ in Brazil. The Action Plans for the Prevention and Control of Deforestation in the biomes are the main instruments of operationalization and coordination of REDD+ initiatives. As domestic financing mechanisms for REDD+, emphasis is upon the Amazon Fund and the National Fund on Climate Change.

In this context, in 2014, Brazil was the first country to submit its reference level of emissions to the UN Framework Convention on Climate Change in order to receive REDD+ results-based payments for emission reductions[20]. The Brazilian submission is a landmark for the beginning of the implementation of the Warsaw Framework for REDD+ (decisions 9 to 15/CP.19). A document on the safeguards to be observed in this process (in Annex) was submitted on a complementary basis to the Climate Convention in May 2015[21].

19 Additional information on REDD+ in Brazil can be found in the Annex herein, which is a summary of how the Cancun safeguards have been approached and respected by Brazil during the implementation of actions to reduce emissions from deforestation in the Amazon.
20 Available at: http://www.mma.gov.br/redd/images/Publicacoes/submission_frel_brazil.pdf
21 Available at: https://unfccc.int/land_use_and_climate_change/redd_web_platform/items/7282.php

1.2.2. Action Plan for the Prevention and Control of Deforestation and Burnings in the Cerrado (PPCerrado)

The Cerrado Biome occupies nearly 24% of the Brazilian territory, with a total estimated area of 2,036,448 km^2, and encompasses about 1,330 municipalities. According to data of the Project of Satellite Deforestation Monitoring of the Brazilian Biomes (PMDBBS), the Cerrado biome lost 48.5% of its area of native vegetation up to 2010. In the 2002-2008 period the Cerrado presented the largest annual deforestation rate when compared to other biomes (BRASIL, 2011a).

The main causes identified for the deforestation in the Cerrado are: illegal use of native vegetation for the production of charcoal and firewood; impunity for environmental offenses; existence of brown fields, degraded and abandoned areas; low recognition of environmental services value; low percentage of protected areas (BRASIL, 2011a).

Due to the increased rates of deforestation in the Cerrado, in September 2009, the Ministry of the Environment started the development of the Action Plan for the Prevention and Control of Deforestation and Burnings in the Cerrado (PPCerrado), with its own initiatives and those of related institutions: Brazilian Institute of the Environment and Renewable Natural Resources (Ibama), the Chico Mendes Institute for the Conservation of Biodiversity (ICMBio), National Water Agency (ANA) and Brazilian Forest Service (SFB).

The entire Federal Government participated in the first phase of PPCerrado, planned for 2010/2011 and in line with the Multiannual Plan in effect at the time (PPA 2008-2011). In 2013 the process of revising the PPCerrado began, in order to renew the government planning of the 2014-2015 Plan period, pursuant to the new Multiannual Plan (2012-2015).

Decree No. 7,390/2010, which regulates the National Policy on Climate Change, sets the reduction of 40% of annual rates of deforestation in the Cerrado Biome in relation to the average rates of the years ranging from 1999 to 2008, as one of the actions to achieve the PNMC's voluntary national commitment. The PPCerrado is the main public policy instrument that brings together a series of actions, programs and initiatives to achieve this goal.

Therefore, the PPCerrado's general objective is to promote the continuous reduction of the rate of deforestation and forest degradation, as well as the incidence of burnings and forest fires in this biome[22], through the articulation of actions and partnerships between the Federal Government, the States, Municipalities and civil society organizations, the business sector and universities. The PPCerrado's expected results were divided into two horizons, a short-term one, with actions for the years of 2010 and 2011; and a long-term one, with results to be achieved up to 2020, which are listed below:

- Improved quality of forest management plans;
- Increased volume of financial resources available for forest management in the Cerrado;
- Increased number of families served by the Forest Management assistance;
- Increased areas in Cerrado under Forest Management;
- Improvement of degraded areas information management;
- Increased investments for the development of technologies for sustainable production of the Cerrado biome;

22 *Refer to Volume I of this Communication, on "Capacity Building", information on Ibama's National System for Prevention and Combat of Forest Fires (Sistema Nacional de Prevenção e Combate aos Incêndios Florestais – Prevfogo), a strategic instrument for the operationalization of PPCerrado.*

>> Increased sustainable production practices;
>> Increased number of family farmers able to perform diversified and sustainable projects;
>> Increased consumption and promotion of the Cerrado's socio-biodiversity products;
>> Increased financial resources for different productive modalities;
>> Recovery of and increased sustainable use of native species with productive potential;
>> Increased purchase volume of socio-biodiversity products;
>> Increased number of the Cerrado's socio-biodiversity products marketing chains;
>> Increased number of micro watershed with preserved and restored permanent protected areas (PPA);
>> Systematic mapping of deforested areas, in the process of degradation and forest regeneration;
>> Increased speed of deforestation control and supervision activities;
>> Increased efficiency of deforestation control and monitoring;
>> Reduction of illegal deforestation in the surroundings and in the interior of Protected Areas and Indigenous Lands;
>> Reduction of forest fires and burnings;
>> Increased administrative accountability for illegal deforestation;
>> Increased capacity of environmental state organizations (*órgãos estaduais de meio ambiente – OEMA*).

In order to achieve the reduction of deforestation, not only by means of environmental surveillance, the PPCerrado is structured in three thematic axes: 1) Monitoring and Control; 2) Protected Areas and Territorial Planning; and 3) Fostering Sustainable Production activities.

In addition to these, the issue of Environmental Education is perceived as a cross-cutting theme and aims at disseminating sustainable development, especially considering the peculiarities and richness of the Cerrado, through capacity-building, qualification of voluntary environmental agents and the development of a new vision of the value of this Biome to Brazil.

On the horizon of expected results of PPCerrado is the creation of a new economic development model based on, for example, sustainable agricultural practices and forestry, in increasing consumption of farmed coal for the pig-iron industries, in reducing the environmental liabilities of family farming enterprises, so that, together, they may reduce the rates of forest fires, burnings and deforestation in the biome. The other sectoral plans based on the PNMC, such as the Agriculture Plan (ABC Plan) and the Steel Industry Plan (charcoal), have broad complementarity and integration with the PPCerrado, since this biome falls under some economic activities of these sectors.

Among the instruments for implementing the PPCerrado, each relevant institution uses their associated budget within the Multiannual Plan or the provision of other sources as funds and financial resources of international cooperation.

Thus, in the context of PPCerrado, further reductions of deforestation rates will depend on actions to promote sustainable activities that may enhance the biodiversity of Cerrado and, mainly, the monitoring of rural properties through the Rural Environmental Registry (CAR). For the purposes of expediting the implementation of the CAR in the municipalities of the Cerrado Biome, the MMA defined seventy-five priority actions based on information on the PPCerrado and indication of the states, such as information campaigns, task forces for registration and support for the development of Projects of Restoration of Degraded and Changed Areas (*Projetos de Recomposição de Área Degradada e Alterada – PRADAs*).

In addition to the financial instruments, an important instrument to promote actions to encourage the sustainable development of the Cerrado is the identification of the municipalities with the highest rates of deforestation. Based on the deforestation observed between 2009 and 2010 and the percentage of areas with remaining native vegetation in the municipality or in the presence of protected areas (Indigenous Lands, *Quilombola* Territories and Protected Areas), the MMA published Decree No. 97 of March 22, 2012, with a list of 52 priority cities for monitoring and control of illegal deforestation, land-use planning, encouraging environmentally sustainable economic activities and maintenance of native areas and recovery of degraded areas.

One of the main results achieved by PPCerrado was a reduction of 60.5% of the deforestation in 2010 (6,469 km^2) in relation to the average for the 1999-2008 period. In spite of this positive result, the systematic monitoring is a necessary condition for developing effective strategies to reduce deforestation by PPCerrado. In this sense, there has been an ongoing monitoring of Cerrado performed by Ibama and the National Institute for Space Research (INPE), for the years 2011 to 2015.

In the context of public policies for conservation and sustainable use of the Biome, the National Program for the Conservation and Sustainable Use of the Cerrado Biome – Sustainable Cerrado Program (PCS), established by Decree No. 5,577/2005, stands out. Its objective is to promote the conservation, restoration, recovery, and the sustainable management of natural ecosystems, as well as the appreciation and recognition of their traditional populations, seeking to reverse the social-environmental negative impacts of the traditional occupation process.

The same Decree established the Sustainable Cerrado Program Commission (CONACER), with representatives of the Federal Government, states, academia, NGOs, social movements, and the business sector. The main functions of CONACER are to monitor the implementation of the Sustainable Cerrado Program, encourage the establishment of partnerships and suggest adjustments in the Biome policies.

1.2.3. Sectoral Plan of Mitigation and Adaptation to Climate Change for the Consolidation of a Low-Carbon Emission Agriculture Economy (ABC Plan)

Brazil has invested in the sustainability of its agricultural sector. By means of research and technological development, today the country has an important role in food production, through increased production capacity while maintaining its agricultural area: in the past 35 years, the Brazilian agricultural productivity increased from 1.2 t/ha to 3.4 t/ha. In this context, the ABC Plan was established, in 2011, as a government instrument to increase the area under sustainable agricultural practices. The set of technologies promoted by the Plan, shown in Table 1.4, is the result of a long research work, and proven to increase agricultural productivity, integrating the challenges of land and water conservation, improving efficiency in the use of natural resources, thus resulting in production systems that are more resilient against climate oscillations, and add to the efforts of keeping the country's food production capacity, in a global context of food safety. Still, this set of technologies have also proven effective against the challenge of reducing GHG emissions from the agricultural sector, contributing to Brazil's broader efforts to reduce its GHG emissions.

In order to promote the adoption of different technological arrangements, the ABC Plan adopts a set of cross-cutting actions, such as strengthening technical assistance, training and information, strategies for technology transfer (TT). Actions also planned to provide economic incentives and funding to producers for the deployment of activities of the Plan and some cross-cutting actions, such as the encouragement and support of research and technological development, mechanisms of provision of basic inputs (seeds, seedlings, inoculants), the study of the development of new economic incentives to support the actions of increased resilience and adaptation, as well as income generation and improving the quality of life of rural producers, and the management and monitoring of the actions of the ABC Plan.

The specific objectives of the ABC Plan are:

- Contribute to the achievement of the voluntary commitments taken by Brazil on the reduction of GHG emissions, in the context of international climate agreements and provided by domestic legislation;
- Ensure continuous and sustained improvement of management practices in the various sectors of the Brazilian agriculture that might reduce GHG emissions and, in addition, increase the atmospheric retention of CO_2 in the vegetation and in the soil of the Brazilian agriculture sectors;
- Encourage the adoption of Sustainable Production Systems to ensure the reduction of GHG emissions and raise the income of producers, especially with the expansion of the following technologies: Recovery of Degraded Pastures; Crop-Livestock-Forestry Integration (CLFi) and Agroforestry Systems (AFS); No-tillage system (NTS); Biological Fixation of Nitrogen (BFN); and Planted Forests;
- Encourage the use of Animal Manure Treatment for the generation of biogas and organic compound;
- Encourage studies and the application of techniques of plant adaptation, productive systems and rural communities to new scenarios of atmospheric warming, in particular those of greater vulnerability; and
- Promote efforts to reduce the deforestation of forests resulting from the expansion in livestock and other factors.

TABLE 1.4
ABC Plan's Low Carbon Technologies

TECHNIQUE	PROBLEM	MODALITIES	EXAMPLES OF BENEFITS
Recovery of degraded pastures	The increase in meat production in Brazil led to an increased use of the soil-plant-animal system. The pastures are often deployed inappropriately and explored in an extractive way, which accelerates degradation. In the process of degradation, infestation of weeds, pests and soil degradation may occur resulting from inadequate management, which produces the deterioration of natural resources. With the advancement of the degradation process, there is a loss of vegetation cover and reduction in organic matter and soil carbon, emitting CO_2 and other greenhouse gases.	(1) Recovery: restoration of forage production while maintaining the same species or cultivar. (2) Renewal: forage production recovery with the introduction of a new species or cultivar, replacing the degraded one. (3) Pasture reform: conduct corrections or repairs after the establishment of pasture.	Increase in biomass production and the carrying capacity of pastures, reducing the pressure by the opening or conversion of new areas for native pastures; Increased supply and better forage quality; Better animal performance in the production of meat or milk; Soil and water conservation; Increasing soil fertility and nutrient cycling; Support for reducing CO_2 emissions and other greenhouse gases; Increase in the agricultural productivity and income of farmers.
TECHNIQUE	**PROBLEM**	**MODALITIES**	**EXAMPLES OF BENEFITS**
Planted forests	The planting of forests for timber, pulp and paper and charcoal production is presented as a technological alternative that enables the generation of income and increasing carbon sequestration in the atmosphere, contributing to mitigate the effects of climate change. Despite the excellent climate and soil conditions for the planting of economic forests in Brazil, much of the raw material used by the forestry sector is obtained from homogeneous stands, i.e., species of pine and eucalyptus. However, other species have been used in commercial forest plantations, as acacia, rubber trees, paricá, teak, araucaria and the populous.	(1) Implement a long-term source of income for the family of the producer; (2) Increase the supply of wood for industrial purposes (pulp and paper, furniture and wood paneling); energy (charcoal and firewood); construction; among others; (3) Reduce the pressure of deforestation over the wild areas; (4) Promote the CO_2 capture from the atmosphere through photosynthesis, in order to reduce the effects of global warming.	Soil and water conservation; Watershed and water sources protection; Reduction of air pollution; Climate regulation; Maintenance of biodiversity; Increasing soil fertility and nutrient cycling; Lower soil temperature changes; Increased organic matter content and soil carbon; Higher water infiltration and replacement of underground water; Increased biological soil activity.

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TECHNIQUE	CLFI	MODALITIES	EXAMPLES OF BENEFITS
Crop-livestock-forest integration (CLFi)	The crop-livestock-forest integration (CLFi) is a sustainable production strategy that integrates agricultural, livestock and forestry activities carried out in the same area, intercropped and as succession or rotation. As a technological alternative, the CLFi seeks synergistic effects among the components of the agricultural production system. Its major objective is to change the land-use system based on the integration of the components of the production system, in order to achieve higher levels of productivity, product quality, environmental quality and competitiveness.	(1) Agriculture-Livestock Integration (Agri-Pastoral): production system that integrates crop and animal production in rotation, inter-cropping or succession in the same area, and in the same crop year or multiple years. (2) Livestock-Forest Integration (Silvopastoral): production system that integrates livestock and forestry by inter-cropping. (3) Agriculture-Forest Integration (agri-forestry): production system that integrates forest and crops by inter-cropping tree species with agricultural crops (annual or perennial). (4) Crop-livestock-forest integration (agri-silvo-pastoral): production system that integrates crops, animal production and forestry in rotation, inter-cropping or succession in the same area. The crop component may be restricted or not to the initial phase of implementation of the forestry component.	Minimize the occurrence of diseases and weeds; More efficient use of inputs and extension of positive energy balance; Pressure reduction to the opening of new native areas; Improved use of natural resources by the complementarity and synergy between plants and animals; Decrease in the use of pesticides to control insect pests, diseases and weeds; Reduction of soil erosion risks; Improvement of recharge and water quality; Increased annual food production at a lower cost; Increased annual fiber, biofuels and biomass production; Increasing the competitiveness of chains of animal products in domestic and international markets; Possibility of new arrangements of land-use and exploitation of specialties and skills of different stakeholders (tenants and owners); Risk of reduction due to improvements in the conditions of production and diversification of business activities; Fixing and greater social inclusion for the generation of employment and income in rural areas; Increased safe food supply; Improvement of the agricultural production image and of Brazilian products because they reconcile productive activity and environmental conservation.

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TECHNIQUE	NTS	BASIC PRINCIPLES	EXAMPLES OF BENEFITS
No-Tillage (NTS)	The NTS is a set of technological processes recommended by Conservation Agriculture and for the exploration of productive agricultural systems. It is a technological alternative to increase agricultural productivity, resilience, recovery/reconstruction of the soil and to minimize greenhouse gas emissions. The NTS also reduces degradation and the use of fossil fuel, as it decreases the use of machinery. This system also allows the reduction of fertilization due to the improvements obtained in soil quality.	The NTS is based on the following basic principles: (a) reduction or elimination of soil stirring with equipment; (b) soil stirring only at the sowing line; (c) permanent soil cover with plant residues (straw) or live plants for as long as possible; (d) crop diversification, aiming at increasing biodiversity by growing multiple species, in rotation, succession and/or inter-cropping; (e) adding straw to the soil in qu'antities, quality and frequency compatible with the biological demand (consumption and decomposition) of the soil; (f) implementation of reap-sow process; (g) use of farm inputs accurately; (h) control of traffic of agricultural machinery and equipment.	Elimination of erosion and soil and water conservation; Fuel efficiency; Save time and labor; Greater possibility of sowing at the right time; Lower risks in the dry season (due to moisture retention in soil); Best crop response to rainfall after a dry period; Better seed germination and better plants emerging; Best effect of fertilizers and; Minor variation of soil temperature; Improving soil quality; Increasing content of organic matter and soil carbon; Increasing soil fertility and nutrient cycling; Increased stability of the soil physical structure.
TECHNIQUE	**BFN**	**BRAZIL WORLD REFERENCE**	**EXAMPLES OF BENEFITS**
Biological Fixation of Nitrogen (BFN)	The BNF is one of the technologies that arise from the search for adaptation of cultivated species to tropical conditions. It is a sustainable alternative for the replacement of the use of nitrogen, and one that considers the costs and environmental conditions. In a natural process of plant-bacteria interaction, the technique incorporates the available nitrogen in the air into the plant nutrition mechanism.	Specifically for the soybean crop in Brazil, the most successful example worldwide, there are estimated savings of US$ 6 billion annually due to the BNF replacing the mineral nitrogen fertilization.	Savings in mineral nitrogen; Reduction in the cost of production; Reduction in GHG emissions.
TECHNIQUE	**PROBLEM**	**TDA**	**EXAMPLES OF BENEFITS**
Treatment of animal manure (TAM)	Brazil produces about 180 million tons of stabled waste and effluents (pigs, cattle and poultry) per year. Randomly disposed of in nature, these manure and effluents can cause environmental impacts of great magnitude, for example, pollution of the water and air.	The technology used for the treatment of waste and effluent is the adoption of the digestion process of this organic waste (biodigestion), made by mixed colony of microorganisms, in an area without oxygen. The result from the biodigestion is two products: biogas and liquid bio fertilizer.	Mitigation of environmental impacts caused by animal waste without treatment; Reducing emissions of methane gas CH_4 and other GHG gases; Increased supply of biogas; Increased energy supply; Generation of bio-fertilizers (liquid and solid); Reduction in the use of manufactured fertilizers; Reduction of production costs; Provision of a new and growing source of income for the farmer.

The ABC Plan has nationwide coverage, and the formal participation of states and municipalities is encouraged. The Ministry of Agriculture, Livestock and Supply (MAPA) and the Ministry of Agrarian Development (MDA) are responsible for the national coordination of the ABC Plan through the ABC Plan National Executive Committee, linked to the Interministerial Committee on Climate Change, with the purpose of monitoring and regularly following up the implementation of the Plan and proposing measures to overcome any difficulties in this process. The duration of the Plan extends until 2020 and is subject to periodic reviews.

The State Managing Groups (*Grupos Gestores Estaduais*, *GGE*) were created at the state level for the decentralization of the ABC Plan, and are in charge of promoting the coordination of the plan in the states. It is the responsibility of each GGE to elaborate State ABC Plans, and their scenarios and goals according to the identified opportunities and priorities at the subnational level, but always based on the National ABC Plan. The State Plan is an instrument that institutionalizes the formal commitment of the State to contribute to the reduction of GHG emissions from agricultural activities, and must be approved by a legal instrument of the State.

Each of the Managing Group is coordinated by the representative of the respective State Secretariat of Agriculture, with the participation of MAPA, MDA, the State Secretariat for the Environment, the Brazilian Agricultural Research Corporation (Embrapa), State Organizations of Agricultural Research (OEPAs), official banks (*Banco do Brasil*, *Banco da Amazônia* and/or *Banco do Nordeste*) and with the integration of representatives of the civil society (productive sector, workers, universities, research centers, cooperatives, Agriculture Federation, NGOs etc.). MAPA has been conducting workshops in each State in order to support capacity building of Managing Groups and the development of State ABC Plans. The premise for the creation of GGEs is the understanding that the state stakeholders have a better perception of their reality, weaknesses and opportunities, which favors their insertion in the process. Brazil is a heterogeneous country, therefore it is expected that the creation of GGEs may lead the ABC Plan to better fit into local realities.

The strategic importance of the ABC Plan consists in the fact that, as per the Annual Estimates of Greenhouse Gas Emissions in Brazil, published by the MCTI, in 2010, the emissions from the Agricultural Sector represented 35% of the total GHG emissions of Brazil, and it is the sector with the greatest relative participation among those covered by the estimates. As a comparison, in 2005, the emissions from the agricultural sector accounted for 20% of the total emissions and the Land-Use and Forestry Sector alone contributed with 57%. Therefore, the ABC Plan is committed to the expansion of low carbon technologies that have the potential for mitigating GHG emissions, summarized in Table 1.5, below.

TABLE 1.5

National potential and relative commitment in relation to mitigation by GHG emissions reduction in low-emission technologies of the ABC Plan

TECHNOLOGICAL PROCESS	COMMITMENT (INCREASE IN AREA/USE)	MITIGATION POTENTIAL (MILLION $MgCO_2e$)
Degraded Pastures Recovery [1]	15.0 million ha	83 to 104
Crops-Livestock-Forest Integration [2]	4.0 million ha	18 to 22
No-tillage System[3]	8.0 million ha	16 to 20
Biological Fixation of Nitrogen[4]	5.5 million ha	10
Planted forests[5]	3.0 million ha	-
Animal manure treatment[6]	4.4 million m3	6.9
Total	**-**	**133.9 to 162.9**

Notes:

[1] Through proper management and fertilization. Calculation basis was 3.79 Mg CO_2e.ha^{-1}.year^{-1}

[2] Including Agroforestry Systems (AFS). Calculation basis was 3.79 Mg CO_2e.ha^{-1}.year^{-1}

[3] Calculation basis was 1.83 Mg CO_2e.ha^{-1}.year^{-1}

[4] Calculation basis was 1.83 Mg CO_2e.ha^{-1}.year^{-1}

[5] Not including the Brazilian commitment regarding the steel industry; and potential for the GHG emission mitigation was not accounted for.

[6] Calculation basis was 1.56 Mg CO_2e.m^{-3}

Source: BRASIL (2012b)

For the purposes of encouraging and fostering the use of low carbon technologies by Brazilian farmers, besides actions for capacities and other instruments for publishing information and technical action, the ABC Program credit line was established by Resolution No. 3,896 of the Central Bank of Brazil on August 17, 2010. Rural Producers (individuals or legal entities) and their cooperatives, including the intermediation to cooperative members, may request funding for projects aimed at developing projects that will establish production systems based in the technological arrangements proposed by the ABC Plan, including the possibility of funding to recover preservation and legal reserve areas.

The ABC Program offers access to credit with interest rates ranging from 4.5% and 5.0% and up to 15 years for amortization[23]. By December 2014, 32,310 contracts had been approved, with a total disbursement of R$ 10 billion to different system production structuring projects recommended by the ABC Plan countrywide. An evaluation of targeting of resources, nature of the project, considering the suitability classification of use of Brazilian land, considered that the projects are being directed properly, because about 80% of the contracts are made with projects to be developed in areas considered as high-priority.

It is important to highlight that, in addition to the initiative of the Federal Government with the ABC Plan and Program focused on the reduction of GHG emissions of the Brazilian agricultural sector, civil society organizations have also been concerned with the issue of growing GHG emissions from this sector and have promoted initiatives that contribute to a better management of their emissions.

23 4,5% per year for eligible producers that are recipients of the National Program to Support Average-sized Rural Producers (Pronamp); and 5% per year for the other cases. More information available at: http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Institucional/Apoio_Financeiro/Programas_e_Fundos/abc.html

In June 2014, the World Resources Institute, in partnership with Embrapa and UNICAMP, created a Tool for the Calculation of Greenhouse Gas Emissions in Agriculture sector, aiming at helping Brazilian rural producers to remain competitive in the low-carbon economy. The rural producers in Brazil were the first in the world to gain this specific calculation tool, already tested by units of large companies of the sector located in Brazil.

In May 2013 the ABC Observatory was launched, which is an initiative aimed at engaging society in the debate on low carbon agriculture[24]. Coordinated by the Center for Studies on Agribusiness of the Getulio Vargas Foundation (GVAgro) and developed in partnership with the Center for Sustainability Studies of the FGV (GVces), it focuses on monitoring the implementation of the Low Carbon Agriculture Plan at federal and state levels (Legal Amazon states). In practice, the Observatory performs the social control of the ABC Plan aiming at its improvement and effective application, by means of suggestions and proposals submitted to governmental stakeholders.

At the end of 2007 the Working Group on Sustainable Livestock (*Grupo de Trabalho da Pecuária Sustentável* – GTPS) was created. It is composed of representatives of the different segments of the value chain of cattle livestock in Brazil. Representatives of industries and industry organizations, producers and their associations, retailers, suppliers, banks, civil society organizations, research centers and universities also participate. The GTPS's objective is to transparently discuss and formulate principles, standards and common practices to be adopted by the industry, which will contribute to the development of a sustainable, socially just, environmentally sound, and economically viable livestock.

In this context, the GTPS committed to zero deforestation and in May 2012 signed a Memorandum of Understanding with the Federal Government (MAPA, MMA and EMBRAPA) for cooperation for the achievement of the target to recover 15 million hectares of degraded pastures, as provided for in the National Plan on Climate Change and on ABC Plan. At the local level, the GTPS sought to foment partnerships in joint work with MAPA, MMA, Embrapa and the Secretariat of Strategic Affairs of the Presidency of the Republic (hereinafter referred to as SAE), first for the state of Mato Grosso, and then extended to other states. The local effort has a strong focus on sustainable management, thus avoiding future degradation[25].

The frontline of GTPS involves the strengthening and empowerment of stakeholders in the supply chain that are committed with technical assistance and rural extension. The Training Centers are focused on the development of model units for beef cattle, aimed at the recovery of degraded pastures and sustainable production, by means of technology already tested by the Demonstrative Units of Embrapa. The GTPS also supports the Rural Environmental Registry (CAR) and the Territorial Intelligence Nucleus.

Since August 2012, the GTPS promotes the Sustainable Farming in Practice Program, whose objective is to develop and test mechanisms and tools for a more sustainable production in various regions of the country. By the end of 2015, the year of the program completion, a Guide for Sustainable Livestock and a training model for multipliers for Technical Assistance and Rural Extension (ATER, in the Portuguese acronym) will have been compiled, in addition to the production of indicators.

Trade associations and thematic groups such as the Brazilian Federation of *No-till* Farmers and Irrigation (FEBRAPDP) or the Sectoral Chamber of Planted Forests, for example, also seek to engage, whether in the discussion

24 Available at: http://www.observatorioabc.com.br/
25 Available at: http://www.pecuariasustentavel.org.br/

of capacity building and participation in the sector, or in providing information and updated statistics. In many ways, a wide range of stakeholders is involved in the implementation of the ABC Plan, which is seen by the productive sector as an important tool that promotes competitiveness and industry sustainability.

1.2.4. Sectoral Plan to Reduce Emissions in the Steel Industry (Steel Industry Plan)

In 2008, the Ministry of Development, Industry and Foreign Trade (MDIC) commissioned a study to support the development of public policies to foster the use of sustainable planted charcoal to be used in the steel industry, aiming at: (i) promoting the reduction of emissions; (ii) avoiding deforestation of native forest; and (iii) increasing the competitiveness of the Brazilian iron and steel industries in the context of the low-carbon economy.

The study developed a scenario of low emissions for the production of pig iron with renewable charcoal by 2020, considering actions for the replacement of raw material originating from native forest with planted forests and for the improvement of the process of conversion of wood into charcoal, with emphasis on the control of methane emissions in the coking process. This was reflected in the preparation of the Sectoral Plan to Reduce Emissions in the Steel Industry (Steel Industry Plan) as one of the Brazilian NAMAs, submitted to the UNFCCC, for the promotion of sustainable production of charcoal (which is used as a feedstock in the production of pig iron) in order to reduce emissions and increase the sector's competitiveness.

This transition to sustainability involves the development of solutions for the adequate provision of sustainable raw material (planted forests, forest management, wood waste) for the production of coal, as well as the development and dissemination of more efficient coal technologies that may increase the gravimetric efficiency of the conversion of wood into charcoal and guarantee the improvement of the process' environmental quality.

The Steel Industry has as specific target the reduction of greenhouse gas emissions by 8 to 10 million tons of CO_2e, by replacing the use of native forest with planted forest in the production of charcoal used as thermal-reducer in the production of pig iron.

The coordination of the Steel Industry Plan is shared by the MMA and MDIC, each one acting within its attributions and with the instruments available, the former being responsible for the forestry component and the latter for the industrial and technological components of the carbonization process.

The initial diagnosis of the Steel Industry Plan indicated that to ensure raw materials from renewable sources up to 2020 it would be necessary to plant 2 million additional hectares of forests for the production of charcoal. However, the significant reduction in the international demand for pig iron due to the global economic crisis[26], has determined the need for reassessing the main measurements of the Plan. The second phase of the Plan will see additional studies for the review and update of the measurements.

The main instrument of the first phase of the Plan was the institutional articulation fostered by governmental bodies and by sectoral associations, which resulted on the adoption of voluntary measures, increasing the sustainability of the sector. Financing lines were also created for the efficiency of the carbonization kilns.

26 See more in item 1.3.1.3.3 herein

The main result of the Plan's first phase was the adoption of the Charcoal Sustainability Protocol by companies associated with the Brazil Steel Institute (IABr), that brings together the main companies in the steel sector in Brazil. The Sustainability Protocol has the objective to increase awareness throughout the production chain about the importance of charcoal sustainable production so its signatory companies may undertake specific commitments aiming at this objective[27].

Independent producers of pig-iron also established voluntary initiatives in the pursuit of sustainability of production in the scope of the Working Group for the Sustainability of Charcoal Production to Steel Industry Use in Brazil (WG Sustainable Coal), coordinated by the Ethos Institute[28].

The scope of the Second Phase of the plan's implementation is the revision and update of the Plan's quantified objectives, the creation of instances of governance that may bring together relevant stakeholders to the sector, and the establishment of a system for monitoring the Plan's specific actions, as well as greater coordination with the ABC Plan to promote planted forests.

1.2.5. Sectoral Plan for the Mitigation and Adaptation to Climate Change in Low-Carbon Emission Mining (Mining Plan)

The general objective of the Sectoral Plan for the Mitigation and Adaptation to Climate Change in Low-Carbon Emission Mining (Mining Plan) is to promote a sectoral analysis, by means of a preliminary diagnosis, based on the 2030 National Mining Plan (PNM), the inventory of the Brazilian Mining Institute (IBRAM) and direct companies consultations in the industry, with a view of reducing GHG emissions in mining, through initiatives of the companies involved to reduce emissions related mainly to energy efficiency and reduce the use of fuels with high levels of non-renewable carbon content.

The specific objectives of the Mining Plan are:

- >> To contribute to achieving the voluntary national commitments under the National Policy on Climate Change;
- >> To promote knowledge regarding GHG emissions resulting from the process of mining among the companies in the industry;
- >> To promote efforts to transform good practices for the reduction of GHG emissions in a national standard;
- >> To influence and encourage the formulation of policies in support of small mining companies for the adoption of effective adaptation and mitigation actions of GHG emissions;
- >> To integrate the mining sector and public policies of national coverage related to climate change;
- >> To develop mechanisms to encourage greater investment in Research, Development and Innovation and support for Small and Medium-sized Enterprise.

The Plan was defined taking into account three dimensions: value chain, mineral asset, and organizational and operational emission limits.

The main emitting sources in this industry, responsible for about 80% of the projected emissions by 2020, are the extraction and the physical transformation of iron ore and aggregates (sand and crushed stone for construction), and the processing of iron ore into pellets. For these minerals, approximately 70 initiatives for mitigation were

27 More info at: http://www.acobrasil.org.br/site/portugues/sustentabilidade/sustentabilidade-carvao-vegetal.asp
28 Information at: http://www3.ethos.org.br/conteudo/projetos/em-andamento/carvao-sustentavel/

analyzed, and 12 were discussed in the drafting of the plan due to their higher reduction potential and facilitated application in the Brazilian context. These 12 initiatives were grouped in three mitigation programs, as follows:

1. Alteration of the energy source used in the processes – program consisting of initiatives to replace non-renewable high-carbon content fuel with renewable fuels or with less non-renewable carbon content.
2. Optimization of mining assets – program consisting of equipment replacement initiatives or installation of parts that optimize the consumption of fuel or electricity.
3. Use of new technologies in mining – program consisting of initiatives to alter of mine projects and use of new technologies for mining.

Table 1.6 details the types of initiatives in each of the three programs.

TABLE 1.6

Initiatives to reduce GHG emissions from the mining sector according to the reduction program

PROGRAM	PROGRAM'S INITIATIVES
Alteration of the energy source used in the processes	Use of biofuels in internal transport Use of natural gas in pelletizing plants Use of charcoal to replace anthracite
Optimization of mining assets	Fleet replacement and increasing the capacity of mining trucks Optimization of combustion in pelletizing furnaces Use of equipment to optimize consumption of raw materials Installation of VSD drives on fans in pelletizing plants Alternative torque equipment installation in mining trucks Installation of vertical mills to replace tube mills in pelletizing plants
Use of new technologies	Electric aid to trucks Use of conveyor belts and crushing in mines Use of hybrid vehicles

Source: BRASIL (2013a).

Resources from budgetary sources addressed in the Annual Budget Law; credit lines from BNDES (such as the Financing for the Acquisition or Lease of Machinery and Equipment – FINAME) for the purchase of new equipment and vehicles for companies; planned investments by the private sector; and the Climate Fund resources are used in order to reach the objectives of the Mining Plan.

1.2.6. Sectoral Plan for the Mitigation and Adaptation to Climate Change for the Consolidation of a Low Carbon Emission Economy in the Manufacturing Industry (Industry Plan)

Drawn up by the Ministry of Development, Industry and Foreign Trade (MDIC), the main objectives of the Industry Plan for the 2012-2020 period are: the maintenance of efficiency in specific emissions from sectors that are in a good position in international rankings, the creation of infrastructure for monitoring, reporting and verification of GHG emissions from industrial activity, with the institutionalization of emission inventories in all large and medium-sized companies of the sectors covered by the Plan, as well as the implementation of cross-cutting actions on energy efficiency and use of materials to promote emission reductions with gains in competitiveness in the industry as a whole (BRASIL, 2012a). A Technical Commission (CTPIn), was created for its operationalization, comprised by representatives of government, industry, civil society and academia, responsible for detailing the actions of the Plan, monitoring and periodic update[29].

The target established by the Industry Plan was calculated based on a projection of the emissions scenario for 2020 (*Business As Usual* - BAU), establishing a commitment to reduce emissions in the manufacturing industry sector by 5% in relation to the business as usual emissions scenario for 2020.

An updating of this value and the potential establishment of targets for the reduction of emissions, whether by gas, sector or company, will occur during the periodic review of the Industry Plan over the coming years and will be technically justified by the CTPIn. The role of the target is to be a stimulus to improve the efficiency of industrial processes and not a constraint to economic growth.

A few industrial sectors concentrate most of the GHG emissions. As a consequence, the Industry Plan proposes that, in a first phase, the sectors that are responsible for most of the emissions are of a special focus. They are: Aluminum, Lime, Cement, Pig Iron and Steel, Pulp and Paper, Chemical, Glass[30].

The Plan is organized into five lines of action: management of carbon; recycling and co-processing; energy efficiency and co-generation; voluntary actions for mitigation; low-carbon technologies. Table 1.7 summarizes the key initiatives on each activity area.

TABLE 1.7
Action of the Industry Plan per activity area

Activity 1: Carbon management
Create a database of emission factors.
Train technicians to collect emission data of the plants.
Create an Information System on GHG emissions in the industry (Sincarbo).
Commission studies of emission scenarios for each sector.
Establish emission efficiency requirements for the granting of public financing and delivery of different treatment for the companies with low emissions.
Activity 2: Recycling and the use of co-products
Assess regulatory barriers to the processing of industrial waste and propose changes in the regulatory framework.
Establish a differentiated tax treatment for recycled raw material.
Organize residues stocks
Activity 3: Energy efficiency and cogeneration
Create an energy efficiency stamp for capital assets.

continues on the next page

29 The CTPIn was established by the Interministerial Directive No. 207, of the MDIC and MMA, and had its inaugural meeting on 30 November 2012.
30 See Volume III of this Communication.

Establish different credit lines for equipment to enhance carbon efficiency of industrial plants.
Leverage the National Energy Efficiency Plan (PNEf) actions for the industrial sector.
Activity 4: Voluntary initiatives
Conduct sectoral surveys of mitigation opportunities through emission reduction projects (CDM).
Promote public-private partnerships for the accomplishment of CDM projects in the industrial sectors.
Create a Voluntary Emission Reduction Program (green PPB).
Activity 5: Low carbon technologies
Create a Database of low-carbon technologies.
Create a fast track to grant patents in low-carbon technologies.
Facilitate the transfer of low carbon technologies.

Source: Industry Plan (BRASIL, 2012a)

The Industry Plan has nationwide coverage and seeks to harmonize with the state and municipal initiatives on the subject. In addition, it aims at the articulation with other public policies, for example, with: Greater Brazil Plan (*Plano Brasil Maior*)[31], National Solid Waste Policy (*Política Nacional de Resíduos Sólidos* – PNRS), National Energy Efficiency Plan (*Plano Nacional de Eficiência Energética* – PNEf), Brazilian Life Cycle Assessment Program (*Programa Brasileiro de Avaliação do Ciclo de Vida* – PBACV).

1.2.7. Sectoral Transport and Urban Mobility Plan for the Mitigation and Adaptation to Climate Change (PSTM)

Drawn up by the Ministry of Transport and the Ministry of Cities, the Sectoral Transport and Urban Mobility Plan for the Mitigation and Adaptation to Climate Change (PSTM) aims at: (a) broadening knowledge regarding CO_2 emissions from the subsectors of transport and urban mobility, and its mitigation potential in the coming years; (b) contributing, aligned with other government policies, with decision-making on the expansion and transfer of more efficient means of transportation, and infrastructural and logistics solutions that may lead to the reduction of emissions; (c) enhancing the gains from investments in urban mobility, emphasizing the co-environmental benefits of the expansion of the public passenger transport and non-motorized transport; (d) allowing the scaling of the efforts needed for the country to achieve its international voluntary commitment to reduce CO_2 emissions with ongoing actions; (e) strengthening the institutional links to overcome barriers to increase the mitigation capacity of the Transport and Urban Mobility Sector (BRASIL, 2013d).

The achievement of these objectives requires the expansion of database and official information on the subsectors, structuring the existing information in an operational manner and making them accessible, and resolving identified gaps. Moreover, it is necessary to harmonize different methodologies for the calculation of projected emissions, by consolidating methodological solutions for progressively more consistent scenarios and to reduce the necessarily assumed simplifications, as will be explained further along.

Based on the elaboration of emission scenarios and mitigation measures, the PSTM includes the highways for

31 *The Greater Brazil Plan (Plano Brasil Maior in Portuguese) is the Federal Government's industrial, technological and trade policy.*

the carriage of cargoes (road transport by heavy, medium and light trucks), rail and waterway, specifically, inland and coastal waterways (shipping or coastal navigation); and in the case of passenger transport, the individual transport (for light vehicles and motorcycles), public transport on wheels as bus corridors, LWT (light wheeled vehicles), BRT (Bus Rapid Transit), and public transport on rails, like subway, urban train, monorail, LVR (light vehicle on rails) and air-mobile.

The PSTM is national in scope and its time horizon is 2020, however, as defined by Decree No. 7,390/2010 and No. 7,643/2011[32], the plan must be updated at a regular basis not exceeding two years, aiming at adapting it to the demands of society and incorporate, if necessary, new actions and objectives. In the case of cargo transport, the PSTM adopts the theoretical framework for 2020, but, on account of the alignment of its actions with the National Plan for Logistics and Transport (PNLT), it makes emissions and mitigation projections up to 2031, the period of validity of the latter.

Alongside the PSTM, other Federal government initiatives have been done. The Growth Acceleration Program (*Programa de Aceleração do Crescimento – PAC*) regarding Big Cities Mobility was launched in 2011 and aims at upgrading and deploying structured public transportation systems in order to expand the capacity and the promotion of mobility system's inter-modal, physical and toll integration in large urban centers. It provides for the selection of medium and high-capacity systems and, unlike the projects of urban mobility associated with the World Cup, allows, in addition to the adoption of technologies of BRTs, bus corridors, and light wheeled vehicles, the deployment of subway systems.

The investments for the World Cup in 2014 included the implementation works of exclusive corridors for mass public transport, Bus Rapid Transit (BRT), Light Rail, Monorail, construction and re-fitting of roads, stations, terminals, and monitoring systems to control traffic in the World Cup host cities: Belo Horizonte, Brasilia, Cuiaba, Curitiba, Fortaleza, Manaus, Natal, Porto Alegre, Recife, Rio de Janeiro and Sao Paulo.

As future enhancements for the estimation of impacts in terms of mitigation of projects and investments in passenger transport, the PSTM highlights the need for obtaining data and more precise information on projects of urban mobility that are under the responsibility of state and municipal governments to have a more accurate sizing of the infrastructure that will be deployed in the country until 2020.

Another identified demand consists in carrying out a survey of modal shift after the implementation of the projects that will come into operation in the coming years. The implementation of research projects associated with the achievement of the 2014 FIFA World Cup Brazil and the Big Cities Mobility PAC will make it possible to obtain the modal shift in several cities, allowing for the improvement of estimates calculated in the PSTM, from a broader data base, associated with the Brazilian reality. It is also necessary to identify the potential to make individual and public transport by bicycle, due to the deployment of infrastructure and other measures to facilitate the inclusion of bicycles in the policy of urban mobility, mainly in the medium and large cities.

To ensure the effective emission reduction provided for in the projects considered in PSTM it is necessary to create monitoring and control instances of the actions carried out and their potential to reduce emissions. Thus, within the framework of the Ministry of Cities, the Technical Group of Mitigation and Adaptation to Climate Change in Urban Public Transport (TG on Climate/Public Transport), through the implementation of information system, will coordinate the

32 *Decrees of reference of the National Policy on Climate Change.*

monitoring. The monitoring of the Sectoral Plan should interact with the TG on Greenhouse Gas Emissions Monitoring, in the context of the GEx Executive Group, coordinated by the MMA, with the purpose of monitoring the implementation of actions and propose new measures that may be necessary for the reduction of emissions.

1.2.8. Health Sectoral Plan for the Mitigation and Adaptation to Climate Change (PSMC-*Saúde*)

The Health Sectoral Plan for the Mitigation and Adaptation to Climate Change (PSMC–*Saúde*) seeks to establish measures for mitigation and adaptation, with emphasis on actions to strengthen the responsiveness of health services due to the impacts caused by climate change. The PSMC–*Saúde* was developed aiming at harmonizing the objectives, guidelines and instruments of public health policies with the National Policy on Climate Change. As guiding elements, the Resolution of the World Health Organization of 2008 (WHA61.19), the WHO Work Plan on Climate Change and Health of 2009 and the Strategy and Action Plan on Climate Change by the Pan American Health Organization (PAHO), of 2011, were considered.

Building up from these guiding elements and in accordance with the context presented on the possible direct and indirect impacts of climate change on human health, the Ministry of Health has prioritized some health problems and identified four intervention axes – Health Surveillance, Health Care, Education and Health Promotion, and Health Research – seeking to align the Plan with the elaboration of adaptation, awareness and education strategies, partnerships and evidence, and ensure the interdependence and specificity of the action of the Unified Health System (SUS).

These intervention axes provide the guidelines, objectives and targets organized and aligned with the Federal Government and the Ministry of Health's planning instruments. The planning instruments used were the Multiannual Plan (PPA), the National Health Plan (PNS) and the strategic agendas of secretariats and units linked to the Ministry of Health, with an implementation period between 2012 and 2015. They also considered the suggestions collected in Public Consultation, which aimed at ensuring the effective participation of society in the drafting stage of the PSMC-*Saúde*.

The actions of promotion, prevention, education and care proposed on the intervention axes of the PSMC–*Saúde* advocate, as per the principle of fairness in the SUS, a differentiated view towards vulnerable groups, such as the indigenous peoples, from the field and forests, the elderly, women and children, in addition to particular care for people with chronic diseases and those with special needs.

The PSMC–*Saúde* has the challenge to establish a landmark of relevant knowledge about the impacts of climate change on human health and health services, seeking to deploy practices that may promote integration and multidisciplinary approach, qualification of professionals and research and development.

1.2.9. The Ten-Year Energy Expansion Plan (PDE)

The planning of the energy supply expansion is carried out under the guidelines of the Ministry of Mines and Energy, through decennial studies reviewed on an annual basis, the so-called Ten-Year Energy Expansion Plan (PDE). The plan consists of defining a reference scenario for the implementation of new facilities in the infrastructure of energy supply. This supply shall be required to meet the growth requirements of the market, according to the criteria of guaranteed supply elaborated in an environmentally sustainable manner and may minimize the total expected investment costs, including the environmental and operational ones.

The PDE also presents detailed actions aimed at mitigating greenhouse gas emissions in the energy sector, considering as a basis the expansion of hydro-energy supply and the supply of renewable alternative sources, notably wind energy plants, small hydro-power plants and bioelectricity, expansion of biofuel supply and the increase in energy efficiency.

The energy part of the National Plan on Climate Change aims at maintaining a high share of renewable sources in the national energy mix. The actions for the mitigation of greenhouse gas emissions resulting from this plan must comply with the elements of the national energy policy, such as energy security in response to demand, affordability of prices and tariffs and the universalization of access to energy, in addition to the competitiveness between the sources and the use of national technology. Decree No. 7,390/2010, in its Article 3, considers the PDE as the sectoral plan on mitigation and adaptation to climate change for the energy sector.

According to Article 5 of the said Decree, without the impacts of PDE emissions projections from the energy sector would for 2020 be 868 million ton CO_2e. However, with the adoption of actions established in PDE, emissions must be reduced by 234 million ton CO_2e, reaching, therefore, the amount of 634 million ton CO_2e; pursuant to the terms of the Communication of the Brazilian Government, which deals with the NAMAs, and informed to the United Nations Framework Convention on Climate Change in January 2010.

Due to this issue's relevance, item 1.3 below will further discuss energy in the country, dealing with the characterization of renewable and low-carbon energy sources in Brazil, as well as the rational use of energy consumption.

1.3. LOW-CARBON ENERGY AND ENERGY EFFICIENCY PROGRAMS IN THE CLIMATE CHANGE CONTEXT IN BRAZIL

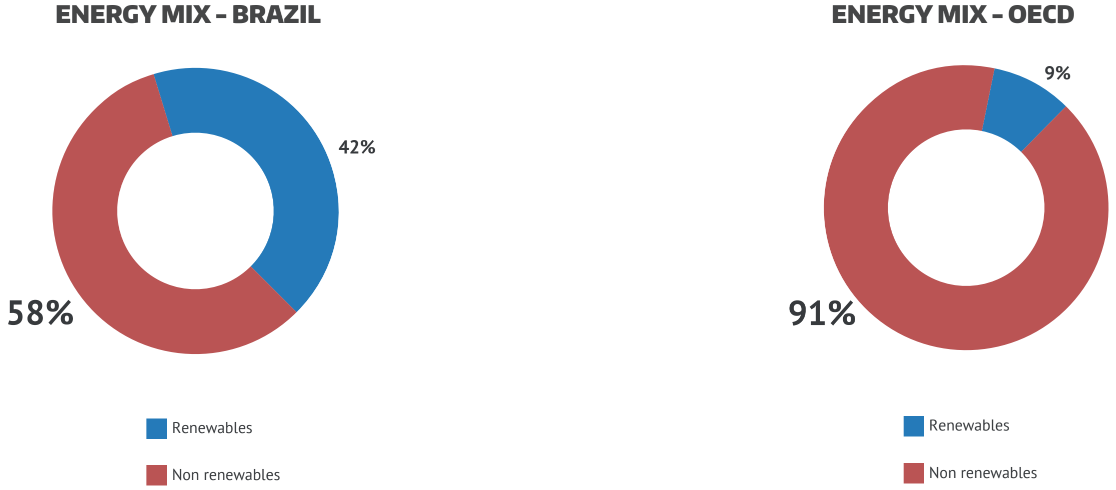
The results obtained in the Third Brazilian Inventory of Anthropogenic Emissions and Removals of Greenhouse Gases show the significant share of the energy sector in greenhouse gas emissions (29% of the total emission). However, it is also possible to identify the Brazilian effort in actions to replace fossil sources, as well as promoting the rational and efficient use of energy.

Brazil's geography and climate contribute greatly to the potential of renewable energy sources. The country has been making use of this condition effectively, bringing tangible benefits not only to society, but also in relation to the global effort to mitigate greenhouse gases. Hydroelectric generation and the strong presence of ethanol in fuels are renowned initiatives, making the Brazilian energy mix an example of low emission of greenhouse gases, when compared to similar economic-size counterparts.

Renewable energies have a significant share in the national energy mix, having as one of its basic principles the diversification of sources. Therefore, several mechanisms are provided and considered in the legislation in order to achieve this commitment. Figure 1.2 compares Brazil's energy supply percentage with OECD (Organization for Economic Cooperation and Development) countries in 2012.

FIGURE 1.2

Domestic Energy Supply: Brazil x OECD



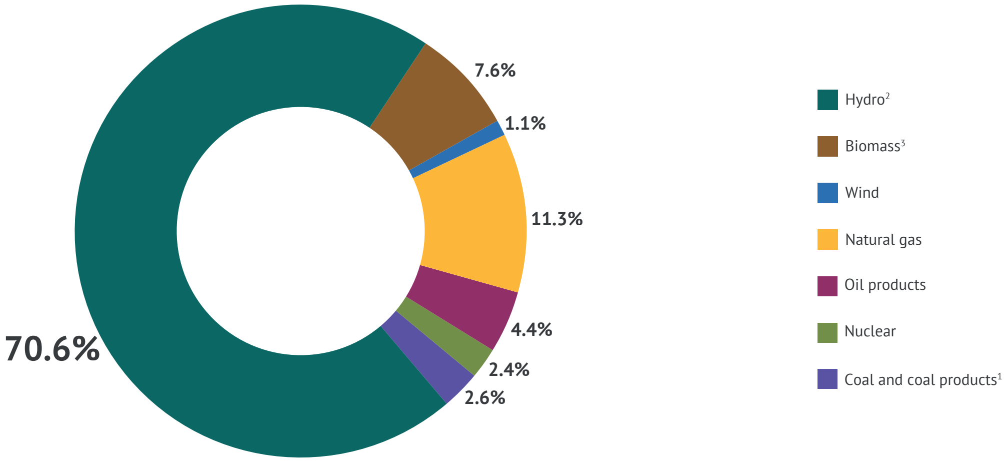
Source: Based on EPE (2014a)

In remote areas of the country, there is still pent-up demand that will increase the demand for solar PV, small wind energy systems and biomass electric generation systems. Furthermore, in the context of global climate change and its impacts (droughts and extreme droughts) on the Brazilian water security, the importance of other renewable sources such as wind energy and solar PV, has become strategic to complement the production of energy in order to meet the demand of economic activities in the country.

Regarding the domestic electricity supply in Brazil, 79.3% is from renewable sources, with emphasis on the role of hydropower as per Figure 1.3.

FIGURE 1.3

Domestic electricity supply by type of source



Notes:

(1) Includes coke oven gas

(2) Includes electricity imports

(3) Includes firewood, sugarcane bagasse, black liquor and other primary sources

Source: EPE (2014a)

Thus, this section will focus primarily on the country's energy issue, detailing an overview of the relationship between the national energy mix and its contribution to the mitigation of climate change. In this context, the initiatives will be presented by energy sources in addition to the emphasis on energy efficiency initiatives.

1.3.1. Hydroelectric power generation

As seen in the National Circumstances chapter (Volume I), Brazil is characterized for being a country of continental dimensions, with eight large watersheds. The average annual flow of Brazilian rivers is 179,000 m^3/s, which corresponds to approximately 12% of the world's available surface water (PBMC, 2013). Brazil also has 3,607 m^3 per inhabitant of maximum volume stored in artificial reservoirs. This value is higher than the volume stored in several continents individually (ANA, 2013).

The use of hydroelectric power in Brazil is a consolidated practice, both on the accumulated experience in building hydroelectric plants and related transmission systems, as well as in the production of equipment for energy generation and distribution.

Starting in the 1970s, the share of hydroelectric power in the country's electricity production saw great growth.

Several factors contributed to this, such as: the rise in fuel prices, with the consequent renewed pressure of imports on the trade balance; reduced units costs for transmission, thus enhancing the value of more remote potentials; exploitation of hydrological diversities; longer service life of hydroelectric power plants; flood buffering; increased cost of thermal power plants, mainly coal-fired ones, due to the relatively low quality of domestic coal; increased environmental restrictions on fossil fuels; worsening of the oil crisis, in 1979, when all importing countries sought to reduce their dependence; and geopolitical factors that favored the decision to implement some projects, such as Itaipu and Tucurui.

In December 2014, Brazil had 1,186 hydroelectric power plants with total installed capacity of 89,193 MW, representing 66.6% of the electricity generation structure of the country (BRASIL, 2015a). Out of the total installed capacity, 4,790 MW (3.6% of the national structure) refers to Small Hydropower Plants (SHP). Brazil has great technical knowledge, production capacity and natural resources. However, unlike wind farms, SHP showed a downward trend of competitiveness in energy auctions since 2009. Because of mature technology, with stable unit costs, SHPs did not remain competitive during the significant reductions in the unit cost of wind power. Moreover, it is not unusual that issues related to environmental licensing processes, construction prices and cost of land hinder the feasibility of SHP projects (EPE, 2014b).

Still, it is also envisaged that hydroelectricity will continue an important role in the expansion of the national generation capacity in upcoming years, having yet to explore 2/3 of its inventoried potential. It is estimated that in 2023 installed hydropower capacity, not considering SHPs, will be 116.9 GW (EPE, 2014b).

Despite the fact that hydropower is a renewable source that does not contribute, like fossil sources, for greenhouse gas emissions in the usage stage, consensus has been directed to diversify the Brazilian electrical mix based on other renewable energy sources given that hydrological cycle, with seasonal droughts and subject to extreme weather, implies additional risk to the predominance of hydroelectric plants.

However, considering this scenario and Brazil's potential for the production of electricity and fuels from renewable sources, the sector's main strategy to mitigate climate change is precisely maintain a high share of these sources in the mix in order to ensure that emissions from energy production and use remain relatively low. The trend presented in the Ten-Year Energy Expansion Plan (EPE, 2014b) reflects the various government measures to keep this feature of the Brazilian energy mix.

1.3.2. Liquid biofuels

Some factors, such as energy security, reduction of greenhouse gas emissions, improved air quality in large cities, and even more jobs through the cultivation of biomass, have led some countries to adopt incentive policies towards the production and use of biofuels. Brazil has a prominent position in this scenario, from the consolidation of production and policies for the use of ethanol and biodiesel.

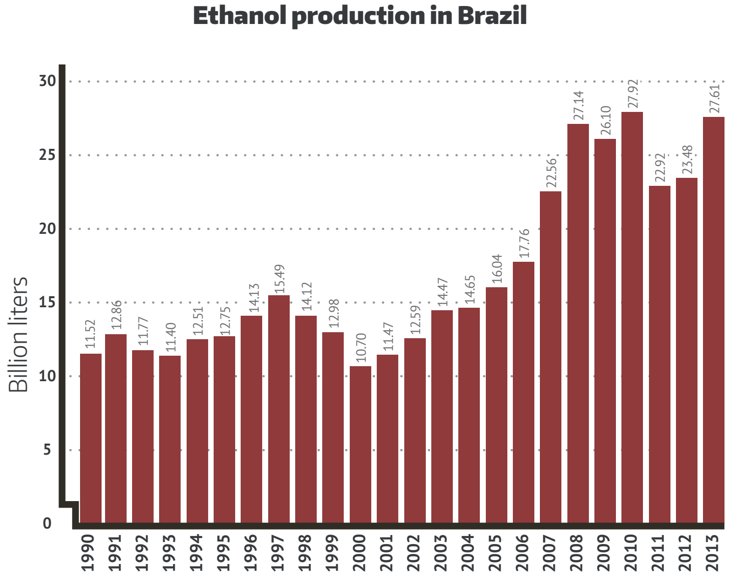
1.3.2.1. Sugarcane Ethanol

Since the launching of the National Alcohol Program (Proálcool), aimed at stimulating the production of ethanol, meeting the needs of domestic and foreign markets of automotive fuels, Brazil achieved a prominent position in the liquid biofuels scenario.

In addition to the mandatory blend of anhydrous ethanol to motor gasoline sold domestically (up 27.5%[33]), the advent of flex fuel vehicles in 2003 allowed the sector to be leveraged again leading to an increase in the domestic consumption of ethanol.

Brazil is currently the world's second largest ethanol producer, behind the United States (REN21, 2014). Figure 1.4 shows a historical series of anhydrous and hydrous ethanol since 1990.

FIGURE 1.4
Domestic anhydrous and hydrous ethanol production (total) per harvest



Source: EPE (2015)

The expansion of bioethanol and sugar production in recent decades has occurred not only with the increase in

33 *Law No. 13,033, of 24 September 2014.*

the cultivated area, but also with significant productivity gains in the agricultural and industrial stages.

Technological advances are observed in this period: sugarcane genetics improvement; improvements in production management through the use of land maps and satellite images; adoption of more efficient and modern processes with the extraction, processing and fermentation of the broth and the stage of distillation; increase in the use of sugarcane bagasse in the boilers; use of biological methods to control pests, which reduces the need for pesticide.

As a direct consequence of the productivity evolution, there was a progressive reduction in costs, which is reflected in the amounts received by the producers. Some researchers (GOLDEMBERG et al., 2004) consider a learning and consolidation process much like to the one presented by other innovative energy technologies, such as wind power. The scale gains are translated into a progressive decrease in prices. Thus, starting from a growth scenario with productivity and efficiency gains, the development of ethanol segment moves towards the formation of consortia and productive units groups *(clusters)*, as a resource for the rationalization of costs, particularly in the components associated with the adoption of new technologies. There is a significant diversification of the composition and origin of the capital invested in agribusiness, and, in a smaller scale, the presence of financial investors, both domestic and foreign, individually or in consortium with operators.

In light of this efficiency concept of the bioenergy chain, the share of sugarcane bagasse as the raw material for generating electricity from cogeneration systems is worthy of note (see more details in 1.3.1.3.3).

An increase in total ethanol production in the country to 37.6 billion liters is expected for 2018, and 47.8 billion liters in 2023 (EPE, 2014b).

Despite the unfavorable scenario for the industry, the gross amount handled throughout the sugarcane chain in the 2013/14 harvests was over US$100 billion. The sugar and ethanol market accounted for almost 2% of the Brazilian Gross Domestic Product for 2013, estimated at US$ 43.36 billion, which promoted a generation of other currencies at US$ 14 billion. The sector generates 1 million direct jobs and has approximately 16 thousand companies linked to the ethanol production.

Job generation in the sugarcane and energy chain has a social relevance as the rural nature of these jobs contributes to the containment of the rural-urban migration, thus preventing unplanned growth of large Brazilian cities and, occasionally, urban poverty.

As for environmental aspects, Brazil was the first country in the world to totally eliminate tetraethyl lead from fuels in 1992. Since 1989, nearly 99% of the oil refined in the country has not used this additive. This achievement was possible due to the use of ethanol as an additive to gasoline.

Moreover, the International Energy Agency estimated that the ethanol derived from sugarcane, like the one produced in Brazil, might reach a reduction of over 90% in greenhouse gases emissions compared to the conventional gasoline and diesel, while the ethanol derived from corn reduces emissions by 35% (MACEDO et al., 2004; MACEDO e SEABRA, 2008).

Unlike Brazilian ethanol, which is produced from sugarcane and using sugarcane bagasse as an energy source in its industrial production process – with negligible net emissions –, the alcohol produced from grains (especially corn, like in the United States) consumes large volumes of energy inputs from fossil fuels for its production. Hence, although there are emissions of greenhouse gases in sugarcane production (due to the use of fertilizers, fuels and inputs) and in its transport from the field to the facilities, the final balance is positive, with a net reduction in the CO_2 rate emissions by 2t CO_2e per m^3 of ethanol consumed (MACEDO and SEABRA, 2008). The sugarcane and energy industry has also been involved in certification initiatives that address environmental, social and economic aspects related to the cultivation and processing of sugarcane. It is usually a voluntary accession process, whose criteria are agreed among the various stakeholders, including producers, industry, consumers and NGOs.

The change in the current configuration of the sugar, conventional ethanol and bioelectricity production processes, to one where, besides the said products, cellulosic ethanol is also produced, poses new challenges for plant management. The project that is considered to be more economical is one that integrates the two productions.

In 2011, the Federal Government, by means of the National Bank for Economic and Social Development (BNDES) and the Funding Authority for Studies and Projects (FINEP), under the PAISS (Support Plan for Innovation in the Sugar-based Energy and Sugar-based Chemical Sectors), tried to stimulate the sugar and ethanol industry with a budget of one billion reais credit for the development, implementation and advancement of technology related to second generation ethanol production, cogeneration efficiency and new bioproducts (EPE, 2014b).

Brazil has been establishing itself at the forefront of biofuels, with the beginning of second-generation production of ethanol. With R$ 507 million financing by BNDES, the first cellulosic ethanol plant is already in commercial operation in the state of Alagoas and the second in state of São Paulo. The units are capable of producing 82 and 42 million liters of second-generation ethanol per year, respectively (BRASIL, 2015b).

1.3.2.2. Biodiesel

After the launching of the National Biodiesel Use and Production Program (PNPB) by the Federal Government in 2004, biodiesel production chain was leveraged in Brazil. The PNPB is an interministerial program responsible for organizing the production chain, defining lines of credit and structuring the technological base, aimed at developing production technologies and the biofuels consumption market.

Biodiesel totally or partially replaces diesel oil in automotive diesel cycle (trucks, tractors, pick-up trucks, automobiles, etc.) or stationary (electricity and heat generators, etc.) motors. It can be used pure or mixed to diesel in various proportions. In 2005, the blend of 2% of biodiesel to diesel oil (B2) became mandatory throughout the national territory[34]. After gradual extension, as of 1 November 2014, the mandatory addition of biodiesel to diesel oil sold was increased to 7%.

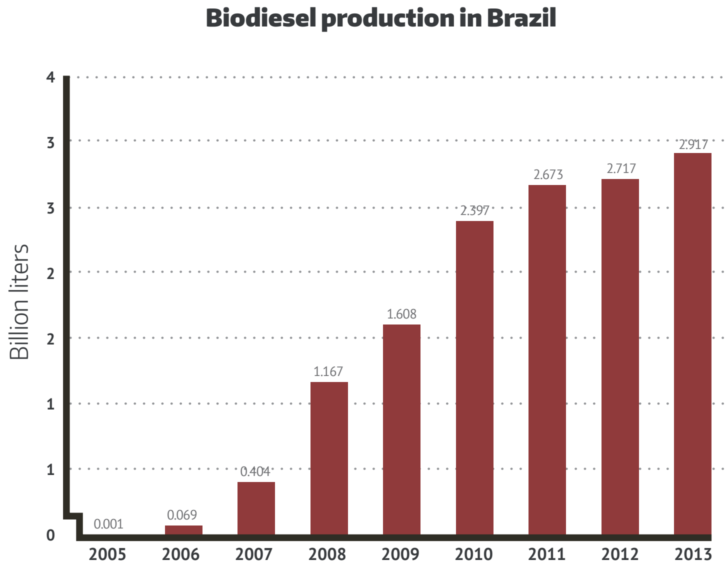
Studies show that the production of national biodiesel, especially for modern diesel vehicles, presents opportunities and advantages, such as reduction of greenhouse gas emissions, considering the fuel use stage; reduced local GHG emissions of carbon monoxide (CO), particulate material (PM), sulfur oxide (SO_x), total hydrocarbons (HC) and most of toxic hydrocarbons, contributing to pollution reduction of cities and improved quality of life and health of the inhabitants; strengthening and diversification of renewable energy sources in the Brazilian energy mix; new business opportunities, particularly in agribusiness, job and income generation.

Brazil is the world's third largest biodiesel producer, behind the United States and Germany (REN21, 2014). The

34 Lei n° 11.097/2005, em seu art. 2º.

evolution of domestic production is shown in Figure 1.5. The Brazilian installed capacity is worthy of note: in 2015, there were 58 biodiesel production facilities in Brazil with production capacity of 21 thousand m^3/day (ANP, 2015).

FIGURE 1.5
Evolution of biodiesel production (B100)



Source: EPE (2015)

Biodiesel must meet the technical specifications as a single product, without the need for defining the origin of the vegetable oil or type of alcohol to be used in the production, but rather as a set of physical-chemical properties for the final product that guarantees its adaptation for use in diesel cycle motors. In Brazil there are several options of oilseed raw materials, with different energy potentials.

The largest relative share of the Center-West region in the national production of biodiesel is due to the fact that this region is the country's largest producer of soybeans, the main feedstock used for the production of Brazilian biodiesel. The biodiesel produced from soybean oil corresponds to a share of 74.5% of the national production, followed by contributions of animal oil (cattle, poultry and swine) with 22.2%, cottonseed oil with 1.6%, and other fatty materials (palm oil, peanuts, forage radish, sunflower, castor, sesame, used oil and others), with 1.7% (ANP, 2015).

Despite this scenario, there are several research projects for use and improvement of other oilseeds like *Jatropha curcas*, macauba palm and dende oil for biofuel production.

The federal government has also promoted initiatives in order to regulate the expansion of oilseed production in Brazil and offer instruments to ensure production on sustainable environmental and social bases. The guidelines involve the preservation of forest and native vegetation and the expansion of the integrated production of family farming in priority territories: degraded areas of the Amazon and territories for the reconversion of areas previously used for sugarcane cultivation.

In 2006, a Soy Moratorium was established, aiming at avoiding the trade of soy coming from recently-deforested areas in the Amazon biome. This initiative was a decision by the Brazilian Association of Vegetable Oil Industries (Abiove) and the National Association of Cereal Exporters (Anec), and is strictly controlled by satellite images and aerial photographs, monitored by the National Institute for Space Research (INPE). The agreement also includes the participation of non-governmental organizations, such as the Greenpeace, Conservation International, The Nature Conservancy and WWF, in addition to the Ministry of the Environment (MMA) and the Bank of Brazil.

Moreover, the Agroecological Zoning of palm oil is an important pillar of the Sustainable Palm Oil Production Program in Brazil, which has only delimited areas suitable for production, in terms of land and climate, in anthropized regions without environmental restrictions.

Between 2005 and 2010, approximately R$ 4 billions were invested in the biodiesel industry and 1.3 million jobs were created. The adoption of 20% of biodiesel to diesel by 2020, may lead to the creation of 532,000 direct jobs and 6 million indirect jobs (UBRABIO e FGV PROJETOS, 2010).

Particular attention must be drawn to the fact that raw material cultivation and the industrial production of biodiesel, i.e., the biodiesel production chain has great potential to generate jobs and income, thus promoting social inclusion and economic development.

The Federal Government launched the "Social Fuel Seal", a set of specific measures aimed at stimulating social inclusion in agriculture within this important production chain[35]. Family farmers who wish to participate in the biodiesel productive chain also have access to credit from the National Program for Strengthening Family-based Agriculture (Pronaf) [36], through banks that operate with this program, as well as access to technical assistance provided by the companies that have the "Social Fuel Seal", with the support of the Ministry of Agrarian Development (MDA) by means of public and private partners. Consequently, the producer has an extra opportunity to generate income without leaving the main activity of planting food.

The share of family farming as a feedstock supplier for the biofuel production has been increasing: it jumped from 16,408 families in 2005 to 103,000 in 2010, which corresponds to 20% of the total produced. In June 2010, out of the 47 functioning plants producing biodiesel, 31 had the Social Fuel Seal, which corresponds to 66% of the total, or approximately 90% of the installed capacity (UBRABIO e FGV PROJETOS, 2010). In the 2011/2012 harvests, the feedstock sale for biofuel production handled over R$ 2 billion for Brazilian family farming, through 103 cooperatives were able at the time to participate in the PNPB. The three states in southern Brazil gather more than half of the Program's participant families (BRASIL, 2013e).

35 Pursuant to Normative Instruction No. 1, of 5 July 2005.

36 The Pronaf ECO Credit Line, meant for environmental sustainability, is responsible for, including but not limited to, granting loans for mini biofuels plants. Individually, the family farmer has access to credits ranging from R$10 thousand to 150 thousand, with a depreciation period of 12 years, grace period varying from 3 to 5 years and interest rates of 1% and 2% per year, for the first and the second cases, respectively.

1.3.3. New renewable energy sources

In 2012, it was estimated that 19% of final consumption of global energy resulted from the use of renewable sources (REN21, 2014). In general, renewable sources include: hydropower, solar energy, wind energy, biomass, geothermal power, tidal energy and hydrogen. The use of renewable sources has been increasing in certain niche markets, such as electricity generation (including rural areas), fuels for transport, heating and cooling.

By the end of 2013, the countries with the largest installed capacity for electricity generation from renewable sources were: China, the United States, Brazil, Canada and Germany (REN21, 2014).

Brazil occupies a prominent position in the world scenario, given that 42% of its energy mix comes from renewable sources. However, this section will discuss the main points related to new renewable sources, which in the Brazilian context are basically: solar energy, wind energy, modern use of biomass and hydrogen.

In Brazil, the use of new forms of renewable energy gained momentum after the United Nations Conference on Environment and Development – Rio92.

The Alternative Electricity Sources Incentive Program (Proinfa)[37] was a milestone in the regulatory framework of the electricity sector as an organized effort to promote alternative sources of energy, designed as a feed-in tariff regime[38].

Proinfa's objective is to increase the share of electricity produced from sources like wind energy, solar energy, SHPs and biomass. Proinfa[39] started a new strategy for the sustainable integration of renewable energy in the Brazilian energy mix and reinforced the Brazilian mix diversification policy in order to encourage the development of renewable energy sources.

In Proinfa's first phase, contracts were signed, ensuring the purchase of all energy to be produced by Eletrobras for a 20-year period. Under Brazil's new power auction model, since 2005 construction and operating concessions are awarded to bidders offering the lowest annual revenue (CGEE, 2012). The end of 2011 had implemented a total of 119 undertakings, with 41 wind energy plants, 59 SHPs and 19 biomass-fired power plants (ELETROBRAS, 2015).

Besides, at the individual level, in 2012 a framework[40] was established in order to facilitate and encourage access to mini and micro-generation that uses clean energy sources, such as hydropower, wind energy, solar energy, biomass, or qualified cogeneration. The resolution also established the Energy Clearing System, in which the surplus energy can go into the local distribution network and generate consumer credits.

The resolution is very positive, but still very few consumers have built plants in their homes or offices in Brazil. The cost of some technologies is high and may take many years to pay off. Also, there are still no specific credit lines that could finance the acquisition of technology, and Brazil opted for a regulatory model in which consumers earn credits for the surplus energy produced, unlike other countries with feed-in tariff regime, where the generator receives money for the energy produced. Advances in these last two aspects can help leverage greater interest from the individual consumer about energy production.

37 Created by Law No. 10,438/2002
38 This system determines a minimum price the dealer will pay for the electric power generated by the producer, when the former connects its plant to the grid. On other occasions, this incentive may also be the total amount received by the producer including subsides and/or reimbursement rates or the premium paid in addition to the price of the energy market.
39 Regulated on 30 March 2004, when implementation began.
40 Resolution No. 482/2012 by the Brazilian Electricity Regulatory Agency (ANEEL).

1.3.3.1. Wind Power

In 2013, the global installed capacity for electricity generation from wind sources was 318 GW. The main countries contributing to this scenario were: China, USA, Germany and Spain (REN21, 2014).

In Brazil, the use of wind power gained momentum from 2004 on, with Proinfa. The program accelerated the learning curve of wind energy in Brazil, which, since 2009, has already competed at power auctions in the regulated environment with other traditional forms of generation. Since the beginning of Proinfa until the A3 Auction held in 2011, the price of Brazilian wind energy fell by 60%, putting Brazil in the lowest price position of wind energy among the countries of Latin America (CGEE, 2012).

Figure 1.3 shows that wind energy generation in 2013 accounted for 1.1% of the domestic energy supply, and power generation rose from 61 GWh in 2004 to 6,576 GWh in 2013 (EPE, 2015). In 2015 the installed capacity of the 274 plants operating in the country was 6,070 MW (ANEEL, 2015).

There still are differences regarding the estimated Brazilian wind energy potential, mainly due to lack of information (surface data) and the different methodologies used. However, several studies indicate very significant values. Estimates in the Wind Energy Potential Atlas point to a wind energy generation potential of 143 thousand MW. The Northeast Region shows the greatest potential, representing 52% of the country. In general, the best areas for wind energy utilization are located at endpoints in the electrical system, far from hydroelectric generation, which shows an important geographic complementarity between wind and hydraulic potential in Brazil (AMARANTE et al., 2001).

Although today Brazil is not set among the largest wind power producers in the world, it stood out among the countries with the highest growth rates of production in the period 2005-2013 and the government's expectations for the future are promising. According to the Ten-Year Energy Expansion Plan, estimates for 2023 point to an installed capacity of 22,439 MW (EPE, 2014b).

In spite of efforts of the Brazilian government to promote incentives and regulate the market for wind power in the country, in order to make it attractive for receiving investments aimed at the development of a supply chain, national research, innovation and technology are the main obstacles to leverage and strengthen the production of wind energy in Brazil. Without innovation and technology there is a risk of remaining with old-fashioned technologies and, especially, without exploring the enormous potential that exists in the country for this renewable source.

In order to encourage wind power generation, providing greater security to the sector and enabling the equal treatment and competitiveness of wind sources in power auctions, in October 2014, the Federal Government enacted Provisional Measure No. 656/2014 which reduces to zero the PIS/Pasep and Cofins taxes[41] for wind power in sales and imports of parts used in the manufacturing of wind turbines. In addition, by means of the Joint Action Plan Innovative Power, an initiative for the coordination of actions to promote innovation and the improvement of the integration of support instruments made available by the Funding Authority for Studies and Projects (FINEP), the National Bank for Economic and Social Development (BNDES), and the Brazilian Electricity Regulatory Agency (ANEEL), resources are being made available for the development of technologies for the exploitation of wind power, including the structuring of projects, their wind turbines and components, such as towers, blades and nacelles[42].

41 *Taxes to finance social security, unemployment insurance and salary bonus.*

42 *For the period between 2013 to 2016 resources in the amount of R$3 billion are being made available by means of the Innovative Energy Plan, directed not only to encourage the wind power sector, as well as for smart grids and transmission in ultra-high voltage (UHV); hybrid vehicles and vehicles energy efficiency; thermal chain and solar power.*

As of June 2014, the Energy Research Company (EPE) went on to publish a quarterly bulletin in order to monitor the fluctuations in wind energy production based on an average value. The indexes are presented for three major regions – Northeast Coast (states of Rio Grande do Norte, Ceará and Piauí), Bahia (also comprising the interior of Pernambuco) and Rio Grande do Sul, which concentrate today over 90% of wind farms installed in Brazil. The bulletin is an important management instrument for the production of wind power in Brazil.

1.3.3.2. Solar Energy

The solar energy presents three main modalities: solar photovoltaic power (use of solar energy for direct conversion into electricity), solar thermal energy or concentrated solar power (CSP) (for final generation), and solar energy for water heating.

Data from the Brazilian Solar Metric Atlas report that Brazil has an average global radiation between 1,642 and 2,300kWh/m^2/year. In practice, this means that, if photovoltaic panels covered 3% of the urbanized area of Brazil, a tenth of the Brazilian demand for electricity could be supplied. For the sake of comparison, in the European countries that exploit this source, such as Germany and Spain, the values vary, respectively, around 900-1,250 and 1,200-1,850 kWh/m^2/year.

The Brazilian Solar Energy Atlas[43] shows that despite the different climatic characteristics observed throughout the country, it is observed that the average annual global irradiation has good uniformity, with relatively high annual averages in the country. The annual values of global solar radiation incident on any region of Brazil (1,500-2,500 kWh/m^2) are above those of most countries in the European Union, such as Germany (900-1,250 kWh/m^2), France (900-1,650kWh/m^2) and Spain (1,200-1,850 kWh/m^2), where projects for use of solar resources, some relying on strong government incentives, are widely disseminated.

Regarding the generation of energy from photovoltaic panels, according to the Ten-Year Energy Expansion Plan 2023, it is expected that Brazil will have an installed capacity of 3,500 MW. There are currently 317 operating projects with installed capacity of 15.2 MW (ANEEL, 2015).

In the first bid for procurement of solar energy, held in October 2014, this source debuted with a great recruitment and an average price considered as very competitive by market. The bid resulted in hiring projects for 20 years at an average price of R$ 215/MWh. Winners of these contracts are responsible for 31 projects, totaling 890MW of dispatched capacity. This is one of the world's lowest solar energy prices; according to the analyst firm Bloomberg New Energy Finance (BNEF). So far, the most competitive contracts for solar energy were signed in the United States, at an estimated price of US$ 50/MWh, however, these projects received significant subsidies.

Brazil has a prominent position in relation to the solar heating market. Globally, the country ranks 5th in operating installed capacity, behind China, the United States, Germany, Turkey and India (REN21, 2014). Within a six-year period, the Brazilian market for solar heating more than doubled, with a total built up area of 9,793,000 m^2 by the end of 2013 (DASOL, 2015).

43 Available at: http://sonda.ccst.inpe.br/publicacoes/livros/brazil_solar_atlas_R1.pdf

This demand is driven by the economic competitiveness of solar thermal energy in the country, local regulations for construction of buildings with installed technology and social housing programs, such as My Home, My Life (*Minha Casa, Minha vida*), which provides that 100% of contracted houses use solar energy to heat water, focusing especially on electric shower, which accounts for a large share of the domestic consumption. In the first stage of the program, some housing units had already adopted this feature and the prospect now is universalization.

Besides these applications, Brazil has two ongoing heliothermal projects[44]. In 2010, the Ministry of Science, Technology and Innovation (MCTI) and the Ministry of Mines and Energy (MME) signed an agreement to support the development of a research facility in the Brazilian semiarid region. The project includes the construction of a 1 MW parabolic trough plant in Petrolina, state of Pernambuco. The German Corporation funds it via International Cooperation (GIZ). In addition to the said project, the construction of a 3 MW commercial plant in the state of Rio Grande do Norte is also on the horizon, implemented by PETROBRAS together with the Gas & Renewable Energy Technology Center (CTGAS-ER), Federal University of Santa Catarina (UFSC) and Federal University of Rio Grande do Norte (UFRN).

1.3.3.3. Biomass

Biomass has been long used as a source of energy (firewood) without, however, relying on sustainable production, and has been long associated with deforestation. Out of the total energy consumed in the world, traditional biomass still represented 9% in 2012 (REN21, 2014). The use of modern biomass began only in the twentieth century, with practices such as use of biofuels and reforestation for timber production.

Biomass can be used in several forms, from direct combustion (with or without physical drying processes, sorting, compressing, cutting/breaking, etc.), thermal-chemical processes (gasification, pyrolysis, liquefaction and transesterification) or biological processes (anaerobic digestion and fermentation).

In 2013, biomass in Brazil accounted for 7.6% of the domestic supply of electricity (EPE, 2014a). According to ANEEL (2015), the generation of electricity from biomass has an installed capacity of 12,527 MW (8.6% of the installed mix), with 508 projects in operation. The cogeneration plants from sugarcane bagasse account for over 80% of installed capacity with respect to biomass.

This item will contextualize some of the main sources of power generation from biomass such as charcoal, electricity generation from agri-industrial and forest biomass and the use of biogas – with the exception of production of liquid biofuels, which has been discussed in item 1.3.1.2.

Charcoal

In Brazil, most of the domestic charcoal production is consumed by the iron and steel industries. Brazil is the only country to still have a significant production of iron and steel using charcoal as the iron ore reducing agent. In the rest of the world, as well as in the greater part of Brazilian steel production, coke derived from coal is used, ever since it was deemed an alternative for the growing industry in the mid 19th Century, with the growing shortages of forest resources in Europe.

44 Available at: http://energiaheliotermica.gov.br/pt-br/fatos/existem-projetos-heliotermicos-no-brasil

Wood and lumber are used for obtaining charcoal through a chemical process known as “pyrolysis”, which consists of the thermal decomposition of biomass in the absence of oxygen.

The production of renewable charcoal presents benefits in several phases of the production chain, from planting and maintaining the forest to improving the efficiency of the carbonization process, which generates a reduction in greenhouse gas emissions, and even the consequent mitigation of emissions in the final uses of the product. Therefore, domination of reforestation technology in the country indicates significant potential for mitigation by using the renewable charcoal, so long as specific stimulation and incentives programs are developed for the country to overcome the current deficit of planted forests for energy use.

The planting of forests can provide the wood needed for producing renewable charcoal, able to supply a large part of industry’s demand. It is thus possible to avoid part of the coke derived from coal and use of native forests for this same purpose. Thus, new and additional planted forests are added to the carbon stocks from native areas, increasing carbon removals as a whole.

Domestic data indicate that over 85% of all charcoal production is intended for the pig iron and steel sector (EPE, 2014a).

However, sector numbers show there are large-scale challenges to be faced, for example, the large share of native forest charcoal in the iron and steel sector. In spite of that, numbers show that consumption of planted forest charcoal had a 61.4% growth between 2009 and 2012, due to several factors, among which are the requirements and constant pressure from major domestic and international pig iron consumers to reduce or even eliminate use of native forest charcoal, combined with ever more severe national environmental requirements through laws and regulations (ABRAF, 2013).

In 2014 an initiative called “Planted, Sustainable and Renewable Charcoal for the Iron and Steen Industry”, headed by the ministries of the Environment (MMA) and of Development, Industry and Foreign Trade (MDIC) for allocating financial resources into charcoal promotion activities in the steel industry, was implemented. The idea is for increased process efficiency, and consequently the reduction of greenhouse gas in the industry.

Power generation from waste

Brazil shows significant potential for power generation from waste. The main waste types used to date and that will be discussed in this item for the generation of power in thermal electric plants are concentrated in the agri-industrial sector, with the use of sugarcane bagasse, elephant grass and rice husks in boilers, and in the forest sector with the use of black liquor and wood residues. Biomass of agribusiness and forest sectors can be used for energy generation from both crops and waste, as well as from waste from the industrial processing of these materials. The discussion on the energetic use of biogas will be presented below.

TABLE 1.8
Installed capacity of biomass undertakings as energy sources

SECTOR	SOURCE	NUMBER OF PLANTS	MW	% OF THE NATIONAL INSTALLED CAPACITY
Agri-industrial	Sugarcane bagasse	388	10,011	6.91
	Rice husk	11	40	0.03
	Elephant grass	3	66	0.05
Forest	Black liquor	17	1,785	1.23
	Wood residues	47	359	0.25

Source: ANEEL (2015)

In the sugar and ethanol agri-industrial sector, all energy consumed in the process is provided by a combined heat-and-power production system (cogeneration system) installed in the plant, using sugarcane bagasse as an energy source. Thus, the plants are self-sufficient and often manage to export more relevant surplus electricity to the grid, due to the increasing use of better performing equipment.

Still, much of the existing power plants use low-pressure boilers. Government initiatives aim at promoting the renewal and modernization of cogeneration facilities, as well as facilitating connections to the SIN. Although some steps have already been taken in this direction, there are still a large number of low-efficiency boilers that could be exchanged for more efficient ones. However, the inclusion of cogeneration from sugarcane bagasse has proven to be a competitive alternative in the electricity market, contributing to the diversification of this sector and the increase of its revenue.

According to the Brazilian Energy Balance, in 2013, 29,871 GWh were produced in autoproducers. However, it is possible to significantly expand the use of sugarcane energy in the national energy mix, not only because of the increased production of sugar and alcohol, which will provide a growing supply of residual biomass from sugarcane, but also through the modernization of sugarcane and ethanol plants.

In addition to bagasse, sugarcane also generates residual biomass composed of straw and pointers. Due to the traditional practice of burning before cutting, much of this waste is almost entirely ruled out. However, the current environmental legislation established deadlines for mechanized harvesting, making it possible to use this residual biomass in energy production. It is believed that within a ten-year horizon, the main producing states will already have mechanized their harvest, producing a significant amount of straw and pointers that can be used for energy generation. As previously mentioned, until September 2013, 88.3% of cane processed in the Center-South had been mechanically harvested (EPE, 2014b).

It is worth mentioning that cogeneration from sugarcane bagasse is a great alternative to mitigate emissions, representing an excellent opportunity for CDM project activities. In November 2014, Brazil had 27 registered projects, which correspond to an estimate of avoided emissions of 3,828,251 tCO_2e.

Besides sugarcane bagasse, rice husk, with smaller share, also appears in this scenario as a potential biomass to be exploited in power plants. Over 70% of rice production is in the southern region, which also has the majority of the installed capacity for electricity generation.

Elephant grass is traditional forage used to feed livestock, or as fodder. Because of its high productivity, this biomass has great potential to be explored in the country. Some research groups, such as Embrapa, have been working so as to try to expand this source's share and promote the diversification of the country's renewable mix, given challenges such as the cycle of domain and the production chain, and the need for dissemination of knowledge. However, it is possible to identify three units with an installed capacity in the states of Bahia, Amapá and Mato Grosso.

Black liquor or bleach is an important byproduct of the pulp and paper industry and is used as fuel in boilers for power generation. According to the National Balance (EPE, 2014a) 17,404,000 tons of black liquor were consumed for energy production that total represented 47.1% of energy consumption sources in the industrial pulp and paper sector.

Wood residues used in Brazil for power generation include several byproducts resulting from the processing of logs in the wood industries. Among other possible uses, this type of energy use provides significant environmental, economic and social benefits, ranging from the diversification of the national grid to the reduction of waste that is not properly disposed of in the country.

Biogas

Landfills and the anaerobic treatment of sewage and residual waters are the two main sources of biogas, from the natural process of final disposal of organic waste in landfills and wastewater treatment. Among the biogas components, there is methane (CH_4), which represents a major source of climate impacts in the waste sector, but also presents several energy applications.

Although its main application is as fuel in a stationary internal combustion engine gas, other possibilities may be identified, such as process heat production for grain drying on farms, for example; sludge drying in Sewage Treatment Plants (STPs); poultry farm heating; gas lighting; slurry treatment; vehicle fuel; among others.

In the case of landfills, regardless of the end use of the biogas, a standard collection, treatment and combustion system must be set up in order to guarantee greater efficiency of the process. In relation to biogas resulting from wastewater treatment and sludge, the anaerobic process that occurs in the sludge digesters of urban sewage treatment stations generates the same biogas from landfills, and its energy use demands the same technological principles and the same equipment for energy use in landfills. Capturing the gas, however, is simpler because it is generated in confined spaces, unlike landfills, which involves a suction operation inside landfills with higher degrees of technical complexity. The disadvantage is the still low percentage of treated sewage in the country.

Regarding electricity generation, there are currently 24 biogas plants connected to the grid, according to ANEEL (2015). They have a total installed capacity of 66.1 MW. The solid waste sector has 10 units with installed capacity of 62.3 MW, followed by the animal manure industry with 12 plants and installed capacity of 2.1 MW and the agri-industrial sector with 2 plants and power of 1.7 MW.

The use of biogas in landfills of the country became a reality with the opportunity of the Clean Development Mechanism (CDM), an instrument provided for in the Kyoto Protocol, to be discussed in further detail in item 1.6. Until November 2014, 50 CDM activities were in place in landfills in Brazil, corresponding to 15.2% of the number of activities of CDM projects, with a total emission reduction of 87,280,381 tCO_2.

There is also a potential that has gradually been studied and explored, and is related to biogas in sludge from agri-industrial processes. This scenario presents a huge potential. In Brazil there are no consolidated statistics on the full potential of biogas. However, considering only two potentially generating segments, such as the food agribusiness sector and the sugar and ethanol sector, there is an estimated potential from 8 to 12 billion m^3 of biogas per year, respectively. However, these two sectors need to develop increased energy efficiency for economic and environmental sustainability, and this includes the mobilization of energy resources available in their production processes (BLEY JR., 2015).

An example of biogas production in small rural properties in the state of Parana, with the use of slurry from the agricultural activity, is the initiative of the Itaipu Binacional Company, which brings together 33 small rural producers. The manure from livestock production (pigs and dairy cattle) is transferred to digesters, for the extraction of methane. The digesters are connected by 22 kilometers of pipeline to a thermal power plant, which supplies energy to the rural properties. The entire surplus can be sold to the state's energy utility company of the State and the residual organic matter of the biodigester is transformed into a high quality bio-fertilizer. Despite the reduced scale of the Brazilian project, its importance stems from the perspective to build capacity and innovation and technology transfer. The technology developed in the state of Paraná is being replicated by means of a pilot project in the Department of San Jose, Uruguay.

The use of biogas cuts across various sectoral plans mentioned in item 1.2. In addition, the Ministry of Cities, through the National Environmental Sanitation Secretariat, has developed actions, along with the German Government, under the German International Cooperation Agency (GIZ), aimed at conducting a technical cooperation project focusing on the energetic use of biogas in Brazil. This initiative, called Brazil-Germany Fostering Energy Use of Biogas Project (Probiogás) is valid for five years and seeks to contribute to the expansion of efficient energy use of biogas and therefore to reduce methane and carbon dioxide emissions into the atmosphere.

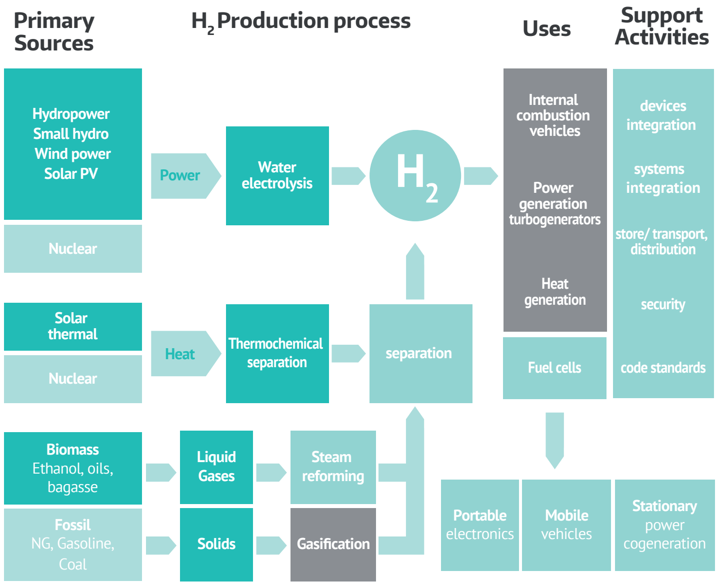
However, it is still necessary to highlight the challenges such as the significant deficit in waste and sewage treatment in Brazil and the great potential still unexplored in the sanitation sector for the development of new options for recovery of waste and effluents beyond the incipient investment to the use of biogas, especially when taking into account the potential of agricultural production.

1.3.4. Hydrogen

Hydrogen is the simplest and more abundant element in the universe, and has the largest amount of energy per unit of mass. Another advantage of hydrogen is the possibility of its production to be made by means of various inputs and processes, characterizing it as an element of integration between various technological routes (Figure 1.6).

FIGURE 1.6

Technological routes for the production and use of hydrogen as an energy vector



Source: Brazilian Reference Center for Hydrogen *Energy (CENEH), taken from the Center for Strategic Studies and Management (CGEE) (2010).*

With regard to the use of hydrogen as energy, it can occur in different systems and technologies. There is currently great interest in vehicle applications and distributed generation of electricity. The technology of fuel cell vehicles has a strong advantage in view of the greater efficiencies of these systems, achieved by the fuel cell and electric engine set and, especially, local emissions practically nil. Regarding the distributed generation of energy, the technologies available are: internal combustion engines, turbines, fuel cells and hybrid turbine/fuel cells systems, all available in a wide range of powers, from kilowatts to megawatts (CGEE, 2010).

However, there is a consensus in the international scientific community that the transition from the current energy infrastructure to one that uses hydrogen in large commercial scale may take decades, requiring the removal of technical, economic and institutional barriers. Production, storage, transport, distribution and hydrogen conversion systems still face technological and economical bottlenecks (CGEE, 2010).

Despite the challenges, several Brazilian groups for Research, Development and Innovation (RD&I) based in universities and technology centers have contributed to the development of hydrogen technologies in Brazil, and the federal government is supporting the improvement of technological routes in pilot and experimental phases through the Program on Science, Technology and Innovation for the Hydrogen Economy -(ProH_2), of the Ministry of Science, Technology and Innovation (MCTI).

This program was structured in the form of R&D (Research & Development) cooperative networks, promoting the coordination of actions and projects of each institution, in order to share the infrastructure already established, promote the training of human resources, ensure the knowledge exchange based on information systems and encourage the participation of companies. The Institute of Energy and Nuclear Research (IPEN)[45] participates actively in the ProH$_2$. At its Center for Fuel Cells and Hydrogen strategic studies are developed in four areas of research: Proton Exchange Fuel Cell (PEMFC); Solid Oxide Fuel Cell (SOFC); Renewable hydrogen; Development of systems associated with fuel cell technology and their peripherals and accessories.

It is also emphasized that, by initiative of the United States, through its Energy Department, was established in November 2003, the International Partnership for the Hydrogen Economy (IPHE), of which Brazil is a member.

The International Partnership for the Hydrogen Economy (IPHE), of which Brazil is a member, should also be underscored. It is an initiative of the United States Energy Department, established in November 2003, towards an international effort with the purpose of organizing and effectively implementing international research and development, activities related to the commercial use and demonstration of hydrogen and fuel cells.

By signing the terms of cooperation, the partners commit to accelerate the development of hydrogen and fuel cells technologies, seeking the improvement of energy security, environmental standards and promotion of the hydrogen economy.

In the State of Parana, in turn, with the support of the Itaipu Binacional, responsible for the generation of hydroelectric power, the first plant for the production of experimental hydrogen of Parana was launched in July 2013; in the city of Foz do Iguacu, the second in the Southern region of the country. The structure comprises an area of 2 thousand square meters, within the Technology Park of Itaipu (PTI).

1.3.5. Natural Gas

In terms of energy supply, it is always best to prioritize renewable sources, but in times of need, in order to ensure the country's energy security and also, because the transition of some sectors to a low-carbon economy might take some time, natural gas is a much better environmental alternative when compared to mineral coal.

Besides being a basic input in the petrochemical industry, natural gas has proven to be increasingly more competitive compared to several other fuels in the industrial and transport sectors and in electric power generation. In the latter case, inclusion of natural gas in the national energy mix plus the need to expand the electric generation network and the search for alternatives in relation to the country's hydraulic potential has aroused interest in analysts and entrepreneurs to expand its use for thermoelectric generation.

Versatility is the main characteristic of the natural gas, adapting to a broad range of applications which include LPG and natural gasoline production; replacement of LNG and manufactured gas in residential, commercial, industrial and other uses; use as a raw material in the petrochemical and fertilizer industry; replacement of diesel in bus fleets and public utility vans; replacement of oil byproducts in industry; and generation of industrial heat. However, one of the main trends for gas penetration is its use as a fuel for thermoelectric generation, a determining factor for reducing the risk of possible restrictions in the supply of electricity during unfavorable hydrological periods. Thus, through thermoelectric generation, natural gas acts as a promoting agent of the decentralization of

45 Located on the campus of the University of the State of Sao Paulo (USP), it is a branch of the State government, linked to the Department of Science, Technology and Development. IPEN is technically, administratively and financially managed by the National Nuclear Energy Commission (CNEN), a federal authority linked to the Ministry of Science, Technology and Innovation (MCTI). See: https://www.ipen.br>

the electric system operation.

In environmental terms, the use of natural gas as an energy input has some advantages when compared to other fossil energy sources, such as coal and oil byproducts. They include: (i) lower CO_2 emissions per unit of energy generated (approximately 20% to 23% lower than the fuel oil and 40% to 50% lower than the solid fuels such as coal); (ii) low presence of contaminants; (iii) cleaner combustion; (iv) greater ease of transport and handling, which contributes to the reduction of truck traffic; (v) does not require storage, eliminating the risks from fuel storage; (vi) greater safety; due to being lighter than the air, the gas dissipates rapidly by the atmosphere in the event of a leak; (vii) contribution to the reduction of the urban pollution when used in automotive vehicles, since it reduces the emission of sulfur dioxide, soot and particulate materials, present in diesel.

The exploration of natural gas in the country began timidly in the 1940s with discoveries of gas associated with oil in Bahia. The great leap in reserves occurred in the 1980s, with the discovery of the Campos Basin. Finally, the beginning of operations for the Bolivia/Brazil pipeline, in 1999, with capacity to transport 30 million m^3 per day, significantly increased the country's natural gas supply in relation to the country's gross domestic supply, which jumped from 3.1% in 1990 to 12.8% in 2013. These percentages rank natural gas as the third most important source of energy supply in Brazil, behind oil and oil byproducts (39.3%) and sugarcane byproducts (16.1%) (EPE, 2014a).

In the 1990s, continuous development of exploration activities made it possible to expand total proven reserves of natural gas, going from 172 billion m^3 in 1990 to 434 billion m^3 in 2013 (EPE, 2015).

In 2013, the country showed an end consumption of natural gas of approximately 21 billion m^3, with the industrial sector accounting for 53% of this total and the energy sector accounting for 30% (EPE, 2014a).

The participation of new producing areas and the need to meet increased demands, both non-thermal and thermal, will result in higher volumes of natural gas produced, imported, transported and marketed. The federal government has been working on a new network of large pipelines that cut Brazil to meet the growing demand for natural gas by 2023. It is estimated that in 2023 natural gas will account for 14.2% of the domestic energy supply (EPE, 2014b).

1.3.6. Rational use of energy and energy efficiency

Promotion of energy efficiency covers the optimization of processing, transport and use of energy resources, since their primary sources up to their use. The maintenance of user comfort, security and productivity conditions is adopted as basic assumption, contributing, in addition, to the improvement of the quality of the energy services and to the mitigation of environmental impacts. More efficient equipment, projects and industrial processes and the use of cogeneration reduce the demand for energy. Therefore, using energy efficiently is less expensive than generating more energy, not to mention the economic and environmental benefits. An efficient energy mix planning must take into account measures of efficiency and waste reduction in energy consumption.

Brazil has had, for at least two decades, internationally recognized energy efficiency programs. This subsection makes a brief retrospect of the regulatory frameworks created over time, aimed at encouraging energy efficiency in the country. The National Program of Electric Energy Conservation (Procel), and the National Program on the Rationalization of the Use of Oil and Natural Gas Products (Conpet) are practical results of the initiatives promoted by the government for the rational use of energy.

1.3.6.1. Background of Government Energy Conservation Programs

Energy conservation measures in Brazil were implemented by the Federal Government as a means to avoid the impacts of foreign crises, notably the rise in oil prices and the increase in interest rates that affected the trade balance. Since then, a series of laws, decrees and resolutions have been enacted towards promoting energy efficiency in Brazil (Table 1.9).

TABLE 1.9

Evolution of the regulatory framework and programmatic incentives for energy efficiency in Brazil

1981	Directive MIC/GM46 created the Conserve Program, aimed at promoting energy conservation in the industry through the development of more energy-efficient products and processes, and encouragement to the substitution of imported energy by domestic alternative sources. It was intended to encourage conservation and substitution of fuel oil consumed in the industry, especially in the steel, pulp and paper and cement industries. The incentive was given in the sense of taking advantage of the excess capacity of hydraulic power generation in order to generate heat in industries.
1982	Decree No. 87,079 approved the guidelines for the Program of Energy Mobilization (PME), which gathered a set of actions aimed at energy conservation and the replacement of oil products. Energy conservation was one of the program priorities.
1984	The Brazilian Institute of Metrology, Standardization and Industrial Quality (Inmetro) implemented the Energy Conservation Program for Appliances aiming at reducing energy consumption in household equipment such as refrigerators, freezers and air conditioners. In 1992, the program was renamed as Brazilian Labeling Program, but all their initial assignments have been maintained, with the addition of some safety requirements and establishment of actions for the definition of minimum energy efficiency levels.
1985	Establishment of the National Program of Energy Conservation (Procel) by inter-ministerial Directive No 1,877 of the Ministries of Mines and Energy and Industry and Foreign Trade.
1990	Creation of the Internal Commission of Energy Conservation (CICE) by Decree No. 99,656, which must be institutionalized in each agency or entity of the direct and indirect Federal Administration, foundations, public enterprises and joint stock companies directly or indirectly controlled by the Federal Government that have an annual electric energy consumption above 600,000 kWh or annual consumption above 15 toe. CICE is responsible for elaborating, implementing and monitoring the Energy Conservation Program goals and the dissemination of their results in the premises of each facility.
1991	Creation of the National Program on the Rationalization of the Use of Oil and Natural Gas Products (Conpet) by Presidential Decree.
1993	Creation of the National Award for Conservation and Rational Use of Energy and the Green Seal for Energy Efficiency in order to identify equipment with optimum levels of efficiency in energy consumption.
2000	Law No. 9,991, which provides for investments in research and development and energy efficiency by the concessionaires, licensees and authorized public utilities in the electricity sector is enacted.
2001	Law No. 10,295, also known as the Energy Efficiency Law, is enacted. It determines that it is up to the Executive Branch to establish maximum levels of specific energy consumption or minimum energy efficiency for machines and energy-consuming appliances that are manufactured or sold in the country, and that one year after the publication of efficiency levels, manufacturers and importers must take the necessary measures in order to meet the targets. The Executive Branch is also responsible for the development of mechanisms to promote energy efficiency in buildings constructed in Brazil. Decree No. 4,059 regulates the Energy Efficiency Law determining the procedures for the establishment of indicators and energy efficiency levels, and also establishes the Energy Efficiency Level and Indicators Management Committee (CGIEE).
2011	In 2011, the strengthening of energy sector planning led to the publication, for the first time, of the National Energy Plan (PNE 2030), and the energy efficiency issue was incorporated into the plan and studies that gave rise to it. Subsequently, the Ten-Year Energy Expansion Plan (PDE) also discussed the issue. Furthermore, a specific plan was also published in 2011, called National Energy Efficiency Plan (PNEf).

Source: National Energy Efficiency Plan (BRASIL, 2011b)

Annual investments in research and development and in energy efficiency, on the part of energy concessionaires, permissionaires and authorized companies, are currently regulated by law[46], which requires public utility electric energy distribution concessionaires and permissionaires to invest at least 0.5% per year in research and development in the energy efficiency programs for end use. From 1 January 2016, for utilities and licensees whose energy sold is less than 1,000 (one thousand) GWh per year, the minimum percentage to be applied in energy efficiency programs in end use, which is currently 0.25%, could be extended to up to 0.50%. Also, utilities and electricity distribution licensees should apply at least 60% of its efficiency programs resources for consumer units that benefit from the Social Fare[47].

Generation concessionaires and companies authorized for independent production, as well as public utility concessionaires for electric energy transmission, are obliged to invest the minimum sum of 1% of net operating revenues in research and development of the electrical sector annually excluding, by exemption, companies that generate energy exclusively from wind, solar and biomass facilities, small hydropower plants and qualified co-generation[48].

Brazil established a target of 10% reduction in energy consumption at the end of the period laid down in the National Energy Plan (PNE 2030), i.e., the year 2030 through the *National Energy Efficiency Plan* (PNEf). The Ministry of Mines and Energy (MME), the Brazilian Electricity Regulatory Agency (ANEEL), the National Petroleum, Natural Gas and Biofuels Agency (ANP) and the Energy Research Company (EPE) are bodies whose responsibilities include actions directly related to the promotion of energy efficiency. For this, the major sources of funding are: the Global Reversion Reserve (RGR); sectoral funds; PROESCO.

1.3.6.1.1. Procel

The objective of the National Program of Electric Energy Conservation (Procel) is to promote the rationing of electric energy production and consumption with a view to eliminating waste and reducing costs and investments in the sector, indirectly contributing to the reduction of the environmental impacts from the avoided greenhouse gas emissions.

Procel establishes energy conservation goals that are considered in electrical sector planning, assessing the needs for expanding the supply of transmission energy. Those that stand out are the reduction in technical losses at concessionaires; the rationing of electric energy use; and the increase in energy efficiency in electric devices. Thus, Procel has achieved significant results.

Since its creation, the energy results obtained allow for the postponement of investments in the electricity sector, the reduction in the emissions of carbon dioxide equivalent (CO_2e), in addition to encouraging the technological development of electric power-consuming equipment, through the promotion of the Procel Eletrobrás Trademark of Energy Savings and through the support of the Brazilian Labeling Program (PBE), of the National Institute of Metrology, Standardization and Industrial Quality (Inmetro).

46 *Initially regulated by Law No. 9,991 of 24 July 2000, whose final edition of this item is given by Law No. 12,212 of 2010.*
47 *The Energy Social Fare is a discount in the light bill for families enrolled in the Single Register with an income of up to half a minimum wage per capita or which have some component of the Social Assistance Continued Provision Benefit. The discount varies with the energy consumption.*
48 *According to the new text of Law No. 9,991/2000 provided by Law No. 10,438, of 26 April 2002.*

Procel uses resources from Eletrobrás and the Global Reversion Reserve (RGR) and has been accounting for total energy savings of 70.1 billion kWh since its creation (Table 1.10). For the purposes of comparison, for that amount of energy to be generated in a year, a hydroelectric plant of 16,812 MW of installed capacity (according to patterns of losses in the Brazilian electric system and capacity factor for hydroelectric energy plants) is required (ELETROBRAS, 2014).

In 2013 alone, energy savings generated by the program corresponded to 7.80% of the total consumption of electricity in Brazil (ELETROBRAS, 2014). Also, only with the results obtained by the program in 2013, it was possible to avoid an emission of 935,000 tCO_2e.

TABLE 1.10

Investments and results obtained by Procel

	1986/ 2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Investments Eletrobras/Procel (R$ million)*	252.0	27.2	37.2	29.2	13.6	5.5	38.0	38.7	31.3	31.0	21.1
Investments RGR (R$ million)	412.0	54.0	44.6	77.8	39.2	25.8	72.8	55.7	78.9	47.5	13.3
Energy Saved (billion kWh/year)	17.2	2.4	2.2	2.9	3.9	4.4	5.5	6.2	6.7	9.1	9.7
Peak Demand Reduction (MW)	4633.0	622.0	585.0	772.0	1357.0	1569.0	2098.0	2425.0	2619.0	3458.0	3769.0
Plant Equivalent	4033.0	569.0	518.0	682.0	942.0	1049.0	1213.0	1478.0	1606.0	2182.0	2337.0

** Refers only to Procel's budget resources effectively carried out each year, not considering Eletrobras/Procel staff salaries.*

Source: Procel

It is important to highlight that Procel comprises a wide range of areas:

>> Procel Education – operates in order to contribute to the construction of a knowledge base in energy efficiency, disseminating information and providing educational resources to the formal system of the country[50];

>> Procel Builds – aimed at dealing with energy efficiency in buildings by means of actions that include research and support to the production of new technologies, materials and building systems, and encouraging the development of efficient appliances used in buildings. The partnership with Inmetro brought up the Brazilian Program of Building Labeling, which defines the procedures required to ensure the Brazilian buildings continuously incorporate sustainability concepts in its construction or renovation industry and also during their use/operation;

>> Water Solar Heating in Residences – incentive to the use of solar heating systems;

>> Procel EPP – the actions of the Energy Efficiency in Public Buildings Program stipulated the immediate reduction by 17.5% of the average consumption in public administration buildings based on consumption in January 2000. Procel EPP develops the following actions: support to the agents involved in the administration of public buildings; promotion of demonstration projects; support to standardization; implementation of infrastructure; support to energy companies in energy efficiency projects in public buildings;

>> Procel GEM (Municipal Power Management) – helps municipalities and other public spheres of government to spend less on electricity. In order to do so, it collaborates with the public authority towards efficient energy use in consuming units under its management, in order to identify opportunities to minimize

49 *Available at: http://www.procelinfo.com.br/main.asp?View={EC4300F8-43FE-4406-8281-08DDF478F35B}*

50 *Refer to the Volume I of this Communcation, item Education, Training, and Public Awareness which details the Procel Education.*

waste, and in monitor energy costs;

- Procel Industry – develops activities to encourage energy efficiency through agreements and protocols with state industry federations, the National Industry Confederation (CNI), universities, Brazilian Support Service to Micro and Small Enterprises (SEBRAE) and trade associations. It focuses mainly on driving systems optimization projects (actioning, electric engines, mechanical transmission, actuated loads and fluid-mechanical installations), bearing in mind they are responsible for around 62% of the electricity consumption in the industrial sector and 25% of the total consumption of electricity in the country;
- Procel Reluz – implements energy efficiency projects in public lighting and traffic light systems, through the replacement of obsolete equipment by more efficient ones. In 2013 alone, the electric power savings and the reduction of demand arising from the projects and actions of Procel Reluz corresponded respectively to 23,654.04 MWh and 5,400 KW;
- Procel Sanear – Energy Efficiency program towards environmental sanitation. Develops capacity building on energy efficiency for professionals of environmental sanitation companies; encourages the development of projects that may promote energy efficiency and awareness against water and energy waste in the context of sanitation and irrigation systems; and supports actions of applied research, development and innovation for the area;
- Procel Info – Brazilian Center on Energy Efficiency Information. Main objectives: to create and maintain dynamic knowledge on energy efficiency, from information produced in Brazil and abroad and disseminate it to those interested in the topic; to facilitate the integration and collaboration among agents working in the area of energy efficiency. A web portal that brings together information on energy efficiency in Brazil and the results obtained by the Procel Program[51] has been launched;
- Procel Selo – established by Presidential Decree No. 8, of December 1993. This program aims at guiding the consumer at the time of purchase, indicating the products that have the best energy efficiency levels within each category, thus providing savings on energy bills. It also stimulates the manufacturing and marketing of more efficient products, contributing to technological development and the preservation of the environment. In 2013, there were 36 categories of products with the Procel Seal, involving 187 manufacturers and 3,748 participant models. The energy results of Procel Eletrobrás Seal in 2013 totaled 9,578 GWh of energy saved and 3,733 MW of withdrawn demand.

1.3.6.1.2. Conpet

Conpet was created to encourage the efficient use of non-renewable natural resources in several sectors, but mainly homes, industry and transportation.

The main objectives of Conpet are: to rationalize the consumption of oil products and natural gas; to reduce the emission of polluting gases into the atmosphere; to promote research and technological development; and to provide technical support for the increase of energy efficiency in its end-use.

Conpet also aims at educating consumers on the importance of the rational use of energy towards sustainable development and better life standards.

The work to clarify the population on the need to rationally use energy resources is carried out through its areas

51 Available at: http://www.procelinfo.com.br of expertise: Energy Efficiency of Equipment, Conpet in Transport, and Conpet in Education.

The Brazilian Labeling Program was developed towards equipment energy efficiency. It is coordinated and regulated by Inmetro and runs in partnership with Conpet. This program provides information on equipment and appliances energy performance, taking into account energy efficiency, noise and other criteria that might influence consumers' purchasing decisions and help them to make informed decisions. It also stimulates competition in the industry, leading to the manufacturing of ever more efficient products.

Conpet in Transport, for the heavy vehicles, aims at promoting greater efficiency in the use of diesel oil in buses and trucks. As a result, besides fuel savings, there will be a reduction in emissions of black smoke and gases associated with the greenhouse effect.

The Conpet at School is directed to elementary school and technical course teachers of public and private education. They receive information about oil, natural gas and energy efficiency by means of educational videos, brochures and debates on the issues. The role of knowledge multipliers is encouraged so they can incorporate the information received on the programmatic content of their classes.

1.3.6.1.3. National Program for the Universalization of Access to and Use of Electric Energy – "Electricity for All" Program

Although the Electricity for All Program (*Luz para todos*) may not have been created directly towards the quest for energy efficiency, it is considered here because it promotes the rational use of energy through the replacement of sources of energy with higher emissions (such as diesel, gasoline, kerosene or coal) for the generation of electricity, which in Brazil is produced mainly from hydroelectric energy, a renewable source.

Established by Decree No. 4,873/2003, the National Program for the Universalization of Access to and Use of Electric Energy – (Electricity for All), is intended to take energy to the portion of the rural population that still does not have access to this public service. The program provides for the free attendance of consumers, including the installation of up to three points of light (one per room), two outlets, conductors, lamps, and other required materials in the homes.

Works for attending the communities included in the Citizenship Territories Program and the Brazil without Misery Plan are a priority, as well as those from rural settlements, indigenous communities, *quilombolas*, communities located in extractive reserves or in areas and undertakings for the generation or transmission of electricity whose responsibility is not the dealer's, in addition to schools, health clinics and community wells.

The initial goal (achieved in May 2009) was taking energy to 10 million people. By February 2015, the program has benefitted 15.4 rural dwellers, and was extended to December 2018.

1.3.6.1.4. Other initiatives

In 2006, the National Bank for Economic and Social Development (BNDES), approved PROESCO; a program aimed at financing energy efficiency projects. The Program aims at supporting the implementation of projects that have proven to contribute with energy savings, outbreaks of action in lighting, engines, process optimization, compressed air, pumping, air-conditioning and ventilation, refrigeration and cooling, production and distribution of steam, heating, automation and control, energy distribution and energy management. The financing line also includes end-users of energy interested in purchasing efficient appliances. Run in the same standards and in line with the projects for environmental sustainability, PROESCO grants a credit line of US$ 100 million to cope with up to 80% of the total value of the projects. The following may be financed by PROESCO: studies and projects, works and installations, machinery and equipment, specialized technical services, information systems, monitoring, control, and surveillance.

With a view to increasing efficiency projects in the public sector and the establishment of a framework that facilitates the carrying out of these projects, the UNDP Project BRA/09/G31 established the "Energy Efficiency Market Transformation in Brazil", run by the Ministry of the Environment in partnership with the United Nations Development Programme (UNDP) and funded by the Global Environment Facility (GEF).

The project will contribute to increasing energy efficiency in commercial and public buildings by 4 million MWh of electricity for 20 years, directly reducing emissions of gases that contribute to global warming by 2 million tons of CO_2 over this period. This will strengthen the local economy by reducing the country's dependence on imported fossil fuels and reducing building operating costs for owners/project maintainers.

In the transport sector, besides the Conpet in Transport and the Brazilian Vehicle Labeling Program, the Motor Vehicle Air Pollution Control Program (PROCONVE)[52], coordinated by Ibama, set the first emission limits for light motor vehicles and contributed towards meeting the air quality standards instituted by Pronar. In 1993, Law no 8,723 endorsed the mandatory reduction in pollutant emission levels from motor vehicles, contributing towards encouraging technological development by fuel, motor and auto part manufacturers, and enabling domestic and imported vehicles to meet the established limits.

Compliance with these requirements is verified by standardized dynamometer testing and with "reference fuels". Furthermore, Proconve also requires the certification of prototypes and statistical monitoring of vehicles in production phases (production testing); Ibama's authorization for use of alternative fuels; removal or repair of vehicles and motors found in noncompliance with production or design; as well as a ban on the sale of non-certified motor vehicle models.

The certification of prototypes is indeed the backbone of Proconve, and it forces auto manufacturers to apply design concepts that ensure low polluting potential in new vehicles and an emission deterioration rate throughout its service life that is as low as possible.

After 28 years since its creation, the result achieved by the program show that the strategy for implementation was correct, and its success is due to the adoption of increasingly more restrictive phases, accrediting it as one of the most successful programs in terms of policies for the environmental sector.

52 *http://www.ibama.gov.br/areas-tematicas-qa/programa-proconve*

The rapid growth of the motorcycle and similar vehicle segment in recent years in the country and their usage profile – notably in the delivery service economic sector in urban regions – made it necessary to establish a specific program to control the category's emissions, the Program for Controlling Air Pollution from Motorcycles and Similar Vehicles (Promot) was created, with the objective of complementing Proconve's controls and contributing towards reducing air pollution by mobile sources in Brazil.

An official publication entitled National Inventory of Atmospheric Emissions by Road Vehicles (BRASIL, 2013c) monitors the results of Proconve, Pronar and Promot. This document presents estimates on the national emissions of air pollutants and greenhouse gases in the segment of transport of cargo and passengers, relating mainly the results of emissions estimates to the control phases of air pollution control programs. It analyzes the impacts of these policies by means of the results obtained in the Third Brazilian Inventory of Anthropogenic Emissions and Removals of Greenhouse Gases[53] using a methodological approach that is similar to the one used by the Ministry of the Environment.

1.4. FINANCING FOR ACTIONS WITHIN THE SCOPE OF CLIMATE CHANGE

1.4.1. National Fund for Climate Change (FNMC)

The National Fund for Climate Change (*Fundo Nacional sobre Mudança do Clima,* FNMC), known as Climate Fund[54], is one of the instruments of the National Policy on Climate Change. It is a trust fund under the Ministry of the Environment (MMA), aimed at ensuring resources to support projects and studies and to finance undertakings that aim at mitigating climate change and adapting to its effects.

FNMC funds are available in two modalities: reimbursable and non-reimbursable (grants). The National Bank for Economic and Social Development (BNDES) manage reimbursable funds. Non-reimbursable funds (grants) are controlled by the MMA. Funding sources are donations appropriated in the Federal Government's Annual Budget Law; donations made by public or private, domestic and international entities; other forms as provided for in the Fund's creation law[55].

A Steering Committee coordinated by the MMA administers the FNMC. Its competence and composition are established in appropriate regulations. The composition of the Steering Committee includes representatives of the Federal Government; the National Bank for Economic and Social Development (BNDES); States and Municipalities; the scientific community, civil society and non-governmental entities; and workers and entrepreneurs from rural and urban areas.

53 See Volume III of this Communication.
54 Established by Law No. 12,114, of December 9, 2009 and regulated by Decree No. 7,343 of 26 October 2010.
55 Available at: http://www.mma.gov.br/apoio-a-projetos/fundo-nacional-sobre-mudanca-do-clima

The non-reimbursable resources supports projects related to the mitigation of climate change or adaptation to climate change and its effects, approved by the FNMC Managing Committee. These resources are used for public calls and bids and requests for the investment of resources in the projects proposals.

The BNDES directs reimbursable funds to concessional loans. In order to manage that, the Climate Fund Program was created within BNDES, which has ten sub-programs: Urban Mobility; Sustainable Cities and Climate Change; Efficient Machinery and Equipment; Renewable Energy; Solid Waste; Charcoal; Combating Desertification; Native Forests; Carbon Management and Services; Innovative Projects.

1.4.2. Financing by National Bank for Economic and Social Development (BNDES)

It is important to emphasize that in addition to the Climate Fund Program, the BNDES, main public bank devoted to financing the development of medium and long-term projects in Brazil, is involved with funding and programs to support sustainable development: BNDES Finem, BNDES Proplástico-Socioambiental, Agroecology Pronaf, Pronaf Eco, and the ABC Program.

The BNDES also has participation in three Equity Investment Funds (FIPs) focused on environmental projects. The FIP Brazil Sustainability is focused on projects for Clean Development Mechanism (CDM) and with the potential to generate Certified Emission Reductions (CERs).

In 2013, the MCTI, the BNDES, the MMA and the Funding Authority for Studies and Projects (FINEP) created, through a public call for the preparation of business plans of the private sector, the Sustainability Innovation Plan. The purpose of the Sustainability Innovation Plan is to encourage investment in the environmental area, with the promotion of innovative solutions to mitigate impacts of productive activities on the environment.

1.4.3. Amazon Fund

The Amazon Fund, created in 2008, aims at contributing to the reduction of greenhouse gas emissions resulting from deforestation and forest degradation. It is an instrument for raising funds from voluntary donations for non-refundable investment in actions of prevention, monitoring and combating deforestation and to promote the conservation and sustainable use of the forest in the Amazon Biome[56]. The Fund may be considered a practical demonstration of the operation of incentive mechanisms for REDD+ (Reducing Emissions from Deforestation and Degradation, i.e., Reduction of Emission of Greenhouse Gases from Deforestation and Degradation).

BNDES is responsible for the management and administration of the Fund, with responsibility for operating, informing and monitoring it. With the funds received, and based on real emissions reductions from deforestation obtained in recent years, the Amazon Fund collaborates for the achievement of the goals established by the National Plan on Climate Change (PNMC), in particular the sustained reduction of deforestation rates.

56 Up to 20% of the resources of the Fund may, in addition, be used to finance the projects of development of systems for monitoring and control of deforestation in other biomes and in tropical forests located in other countries.

The Amazon Fund resources come from donations. Together, the contributions from the Norwegian Government[57], the German Development Bank KfW and Petrobras amount to approximately US$ 902 million, according to the Amazon fund Annual Report 2014.[58]

Still, the projects supported by the Amazon Fund should be in line with the Sustainable Amazon Plan (PAS), the Prevention Plan and Control of Deforestation in the Legal Amazon (PPCDAm), the State Plans to Fight Deforestation, the Managing Committee's guidelines and criteria as well as the BNDES operating policies.

For more information on the Amazon Fund, refer to the Annex herein.

1.4.4. The National Fund for Scientific and Technological Development (FNDCT)

The National Fund for Scientific and Technological Development – FNDCT was created in 1969 by Decree-Law No. 719, as a financial instrument to integrate science and technology with the national development policy. Starting in 1998, the Federal Government took the initiative to create the Sectoral Funds, whose funds were allocated in FNDCT. This enabled a combination of continuous flow of budgetary and financial resources with efficient decision-making mechanisms in support of research and development at all levels, with high quality standards.

The revenues composing the Fund come from various types of taxes and contributions: ordinary funds from the National Treasury; the Contribution for Intervention in the Economic Domain (CIDE); percentage of the royalty value on the production of oil or natural gas; percentage of net operating revenues of electric utilities; percentage of resources arising from assignment of rights of use of road infrastructure for the purposes of operating communication and telecommunication systems contracts; percentage of funds from financial compensation for use of water resources for electricity generation; percentage of revenues aimed at promoting scientific research activity and technological development of the space industry; percentage of gross sales of companies that develop or produce information technology goods and services and automation; percentage of tax collection for the renewal of Merchant Navy that is part of the Merchant Marine Fund (FMM); income from its investments in programs and projects, as well as in investment funds; resources from tax breaks; loans from financial institutions or other entities; contributions and donations from public and private entities; the return of loans granted to FINEP.

This Fund's contribution is relevant to foment studies and research on climate and global climate change, in order to increase scientific knowledge and to support the adoption of efficient measures to deal with events caused by climate change. The most important initiatives in this area include but are not limited to the implementation of the Brazilian Research Network on Global Climate Change (*Rede Clima*), funded with by FNDCT/Sectoral Funds.

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57 The government of Norway was the first and, so far, the largest donor of resourced to the Amazon Fund, having allocated fully everything that was committed in contracts of donation signed with the BNDES (NOK6 4,550,000,000,00), equivalent to R$ 1,653,944,934.43 (US$758,589,348,12). This partner has manifested the intention to donate a total of US$1,000,000,000.00 by 2015, with the condition that deforestation in the Amazon Biome is reduced.

58 Sum of donations received converted to US$ (american dollar) and R$ (brazilian real) on the date of effective receipt of funds by BNDES, as expressed in donation diplomas (approximate conversion 1 US$ = 2,23 R$). Available in <http://www.fundoamazonia.gov.br/FundoAmazonia/export/sites/default/site_pt/Galerias/Arquivos/Relatorio_Anual/RAFA_2014_port.pdf>.

1.5. FINANCIAL AND TAX MEASURES TOWARDS CLIMATE CHANGE MITIGATION

1.5.1. Financial institution's Social-Environmental Responsibility

The National Environmental Policy Law[59] includes mechanisms that, when applied to financial institutions, in a broad sense, increase financing and credit at the level of instruments for environmental control. Financing, especially through government incentives, should incorporate the environmental component when granted, through the conduction of environmental impact studies prior to analysis of projects and granting of credit, as has been occurring within the World Bank.

Financing organizations include traditional banks, but also cooperatives, public entities, mixed economy companies, multiple and investment banks and pension funds, in short, all those institutions that may, in a broad sense, fit in the expression "entities or bodies for financing and government incentives".

Discussions on social-environmental accountability have gained momentum in the past few years in Brazil. The landmark was the Protocol of Intentions for Social-Environmental Accountability ("Green Protocol"), a declaration of intentions with principles for sustainable development signed in 1995 by official banks. This document was updated in 2008 and in the following year a new version included private banks. This process led to the standardization of social-environmental accountability in the National Financial System, by means of Resolution No. 4,327 of the National Monetary Council (CMN), of 25 April 2014. This Resolution defined principles and guidelines on which social-environmental actions by financial institutions and institutions authorized by the Central Bank must rely in terms of businesses and relationships with stakeholders. It also defined social-environmental risk as a component of what these institutions are exposed to, as well as guidelines to manage it.

Green Protocol

In 1995, the Federal Government launched the Green Protocol program aimed at incorporating the environmental variable as an indispensable criterion to sustainable development in the analysis process for granting official credit and fiscal benefits.

The Protocol's two original objectives are: give priority to allocating public resources through credit operations or fiscal benefits in projects that present the best capacity for social-environmental self-sustenance; and avoid using these resources in projects that contribute towards increasing negative impacts on the environment.

The Green Protocol achieved results mainly in what concerns awareness and equipping the involved federal financial institutions; the institutional adjustment of licensing mechanisms; the effort to identify external private resources directed towards the environment; designing projects and programs together with the banks, geared towards sustainable development and for discounting environmental liabilities; and most especially, rationing the use of pesticides.

59 *Articles 3, 12 and 14.*

1.5.2. Ecological ICMS[60]

The idea behind payment for environmental services is to compensate those who, directly or indirectly, preserve the environment. This means rewarding those who help preserve or produce environmental services through the adoption of practices that favor the maintenance of the biomes. The preservation of the environment should generate more economic benefits than its destruction, so that this new market would make sense. The Ecological ICMS (Value-Added Tax on Sales and Services) fits in this context.

The Ecological ICMS is a tax mechanism that makes it possible for municipalities to access parcels larger than the ones they are entitled to, of the financial resources collected by the Member States through the Value-Added Tax on Sales and Services, the ICMS, by reason of certain environmental criteria established in state laws. It is not a new tax; it is the introduction of new criteria for the redistribution of ICMS funds, which reflects the level of economic activity in the cities in conjunction with the preservation of the environment.

Municipalities that preserve their forests and biodiversity are granted a higher score in the compensation criteria and receive financial resources to compensate for areas intended for conservation, and, at the same time, an incentive for the maintenance and creation of new areas for the conservation of biodiversity. Paraná was the first Brazilian state to establish the Ecological ICMS and today 16 of the 27 Brazilian States adopt the mechanism, in accordance with the web portal www.icmsecologico.org.br, created in 2009 with the objective of disseminating information on the Ecological ICMS in Brazilian states.

1.5.3. Payment for Environmental Services

Policies for Payment for Environmental Services (PSA) have been identified around the world as a viable option for achieving this goal, complementing the command and control actions[61]. In Brazil, several states have implemented PSA or similar schemes. There are ongoing discussions on the adoption of a national law on the subject.

Draft Bill No. 792/2007 has been under debate in the Senate since 2007. It defines environmental services and provides for the transfer of resources, either monetary or not, to those who help produce or retain these services, by means of a National Program of Payment for Environmental Services. Brazil faces the challenges of creating metrics and valuation of environmental services before the creation of a national program, in order to facilitate the creation of a market, and the need to expand and disseminate knowledge of the services provided by biodiversity along with the development of projects and environmental public policies in the country. Another common need raised by experts is the incorporation of the conservation of biodiversity as a company strategy, related to a greater governmental transparency and efficiency to transfer and allocate the amount of environmental funds, as already occurs with resources for environmental compensation.

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60 This subsection was written based on information extracted from the Environmental Dictionary online by O Eco Association.

61 In general, the literature on the concept of PSA as a voluntary transaction in which a well-defined environmental service or a land use that may ensure this service is purchased by, at least, a purchaser of, at least, a provider under the condition that the provider may ensure the provision of this service. Almost all existing PSA include environmental services associated with one of the four distinct categories: (i) retention or carbon sequestration; (ii) conservation of biodiversity; (iii) conservation of water services; (iv) conservation of scenic beauty (SVEN WUNDER, 2009).

A study by Brito et al. (2012) identified 28 legislative initiatives on the issue. Eight of them are at the federal level (2 laws, 2 decrees and 4 draft bills) and 20 are within the scope of the state (14 laws and 6 decrees). The states covered by these laws include: Acre, Amazonas, Espírito Santo, Minas Gerais, São Paulo, Rio de Janeiro, Santa Catarina and Paraná. In some cases, mainly at the federal level, laws do not approach PSA directly, but their content includes norms on the issue, like the legislations on water resources and climate change.

1.5.4. The Green Grant Program

At the federal level, the Green Grant Program of Support for Environmental Conservation, launched in September of 2011, grants quarterly benefits of R$300 to the families in extreme poverty that live in priority areas in terms of environmental conservation. The benefit is granted for two years and may be renewed. As the majority of the families living in extreme poverty are in rural areas, the proposal is to combine an increase in income with the conservation of the ecosystems and the sustainable use of natural the resources.

The Green Grant is part of the Brazil Without Misery Program[62] and is intended for families that develop activities for the sustainable use of the natural resources in Extractive Reserves, National Forests, federal Reserves of Sustainable Development and Environmentally Differentiated Settlements of Agrarian Reform. Territories occupied by riverine, extractive, indigenous, rural populations and other traditional communities can also be included in the Program, in addition to other rural areas defined by act of the Executive Branch.

The account balance to the beneficiary families shows that the *Bolsa Verde* Program supported 16,821 families in September 2014. The management of the *Bolsa Verde* Program is at the discretion of a Steering Committee, coordinated by the Ministry of the Environment, with participation of representatives of the Presidency of the Republic (CC/PR) and the Ministries of Social Development and Fight Against Hunger (MDS), Agrarian Development (MDA), Finance (MF) and the Ministry of Planning, Budget and Management (MPOG)

1.6. CLEAN DEVELOPMENT MECHANISM (CDM) PROJECT ACTIVITIES IN BRAZIL

One of the main elements of the Kyoto Protocol is the possibility of using market mechanisms by developed countries to meet their quantified greenhouse gas emission limitation and reduction commitments. Brazil can participate in this market through the Clean Development Mechanism (CDM), taking into account that it is the only mechanism under the Kyoto Protocol that allows for voluntary participation of developing countries. Under the CDM, developing countries can benefit from project activities resulting in Certified Emission Reductions (CERs)[63], to be used by developed countries as an additional way to meet their goals. This mechanism should result in emission reductions in addition to those that would occur in the absence

62 *Information on the Brazil without Misery was presented in Volume I of this National Communication.*
63 *CERs do not use decimals. One CER is equivalent to one ton of CO_2e.*

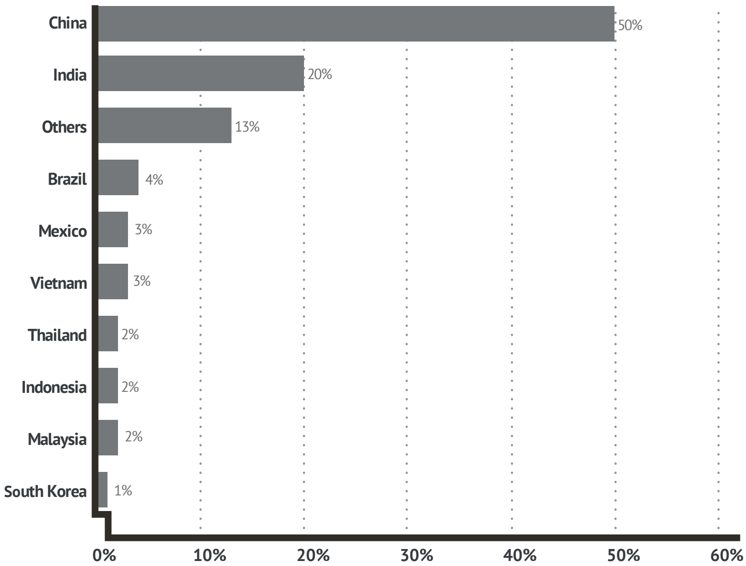
of the project, ensuring real, measurable and long-term benefits to the mitigation of climate change.

Next, an analysis on the *status* of Project Activities under the CDM in Brazil and in the world up to 30 November 2014[64].

Spatial Distribution of the Project Activities

As regards to the status of the CDM in the world, up to 30 November 2014, 7,579 Project Activities were registered. Brazil ranked 3rd in the world in relation to the number of Project Activities, with 330 (4%), after China, with 3,763 (50%), and India, with 1,536 (20%). It should be noted that China and India's energy mixes are heavily dependent on fossil fuels, which encourages more projects of renewable energy generation than in the case of Brazil.

FIGURE 1.7
Brazilian participation in the total of Projects Activities under the CDM in the world

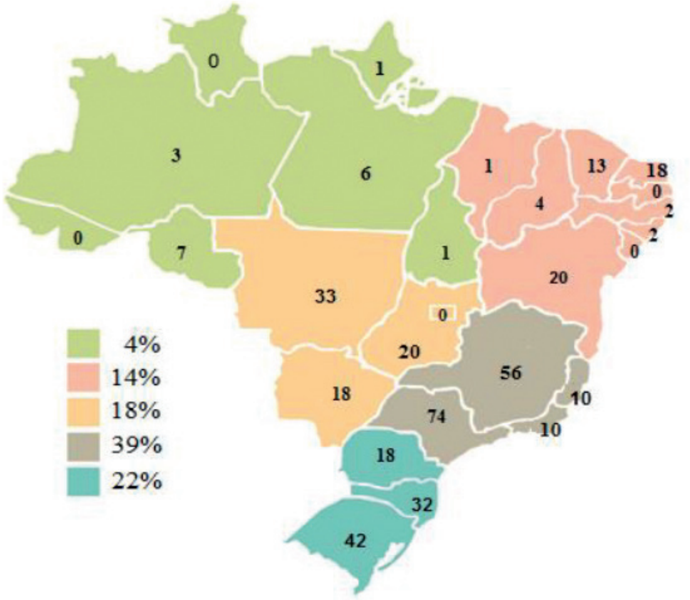


In relation to the distribution of the number of Project Activities of the CDM in Brazil per state, the leader was Sao Paulo (74), followed by Minas Gerais (56) and Rio Grande do Sul (42), highlighting a predominance of projects in the South Central region of the country.

64 *Statistics from: https://cdm.unfccc.int/*

FIGURE 1.8

Distribution of the number of Project Activities of the CDM in Brazil per State[65]



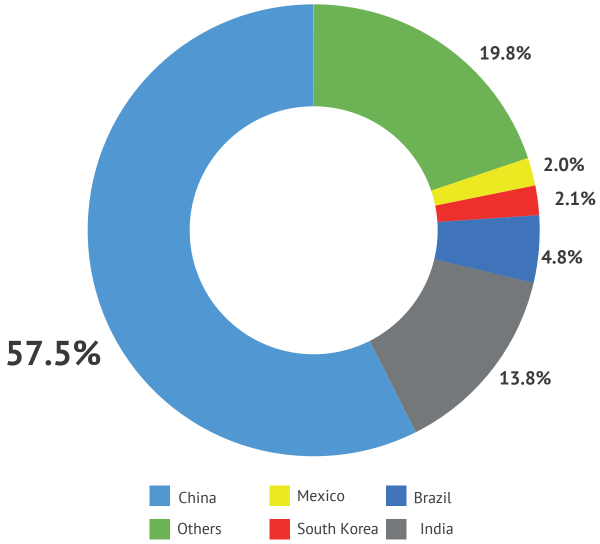
Emission Reductions

In terms of estimating emission reductions associated with the projects in the cycle of the CDM, Brazil ranked third in the international scenario, being responsible for a reduction of 370 million tCO_2e, which corresponded to 4.8% of the world total, for the first crediting period[66]. China ranked first with a reduction estimate around 4.4 billion tCO_2e (57.5%), followed by India with approximately 1 billion tCO_2e (13.8%) of projected reductions.

65 Some activities include more than one State.

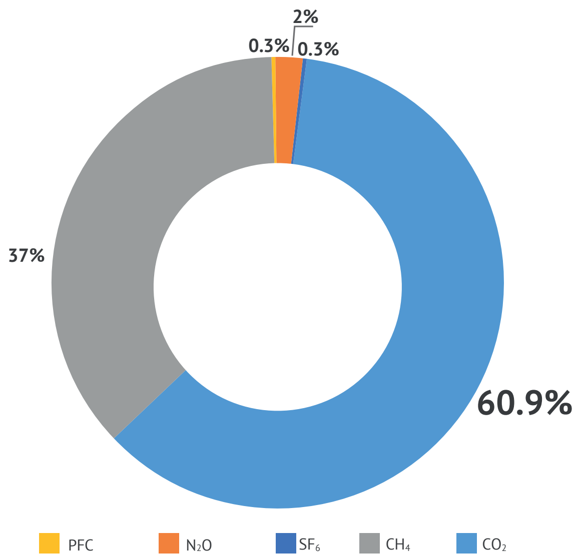
66 The first crediting period can be a maximum of ten years for projects of fixed period or seven years for projects of renewable period (the projects are renewable for a maximum of three periods of seven years, totaling twenty-one years).

FIGURE 1.9
Estimate of emission reductions by countries for the first period of obtaining credits from Project Activities registered up to November 2014



An analysis of the distribution of Project Activities in Brazil per type of greenhouse gas revealed that the ones that reduce carbon dioxide (CO_2) were the most significant ones, with 201 activities, followed by the ones that reduce methane (CH_4) with 122 and nitrous oxide (N_2O) with 5 Project Activities.

FIGURE 1.10
Distribution of Project Activities in Brazil per type of greenhouse gas reduced

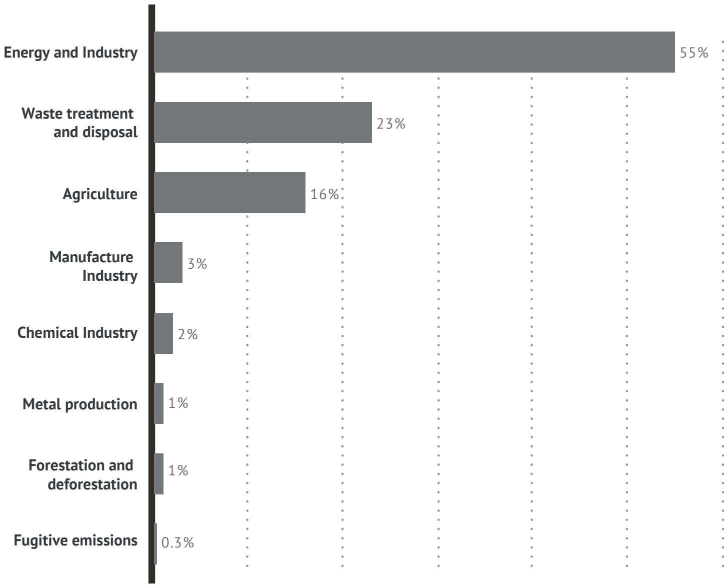


Sectoral Scope

With regard to the sectoral scope, the ones that attracted the interest of participating in projects of CDM in the country were Energy Industries, leading with 197 projects, followed by Waste handling and disposal (82) and Agriculture (59). The other sectors responded for: Manufacturing Industries (9), Chemical Industries (6) Afforestation and Reforestation, and Metal Production with 3 in each and Fugitive Emissions with 1 project.

FIGURE 1.11

Distribution of Project Activities in Brazil per sectoral scope

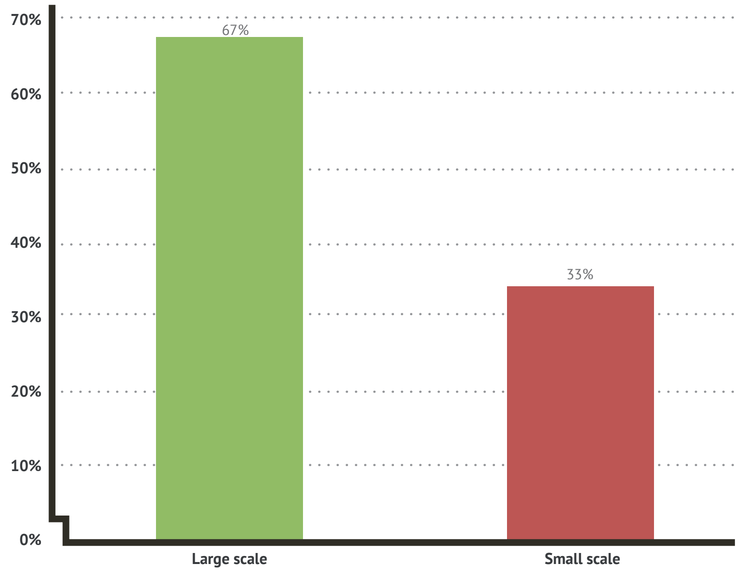


Project scale

The methodologies of Project Activities can be classified in small and large scale. Definitions for Projects Activities of small-scale were established through the Marrakech Agreements. Later, these definitions underwent modifications contained in Decision 1/CMP.2, which defines as small-scale the following Project Activities: Type I) Project Activities of renewable energy with maximum production capacity equivalent to up to 15 megawatts (or a suitable equivalent); Type II) Project Activities to improve energy efficiency, which will reduce the energy consumption of the supply and/or demand, up to the equivalent of 60 gigawatt/hours per year (or a suitable equivalent); and Type III) other Project Activities limited to those that result in emission reductions equal to or lower than 60 tCO_2e per year. The other activities are then classified as large-scale Project Activities. Out of the total of the Brazilian CDM Project Activities registered on the UNFCCC, 220 are classified as large-scale and 110 as small scale.

FIGURE 1.12

Distribution of Project Activities in Brazil per type of project



Project Type

As for the number of Brazilian Projects Activities developed per project type, up to November 2014, the hydroelectric energy[67] ones were heading with 26%, followed by biogas (20%), wind power plants (16%), landfill gas (15%) and biomass energy (12%). The types of project with the highest estimates of emission reduction of CO_2e were the Project Activities of Hydroelectric Energy, Landfill Gas and Decomposition of N_2O, totaling 72.5% of total CO_2e emissions to be reduced in the first crediting period, with an emissions reductions estimate of 269,029,763 tCO_2e.

67 Micro hydropower plants (MHPs), small hydropower plants (SHPs) and large hydropower plants (LHPs).

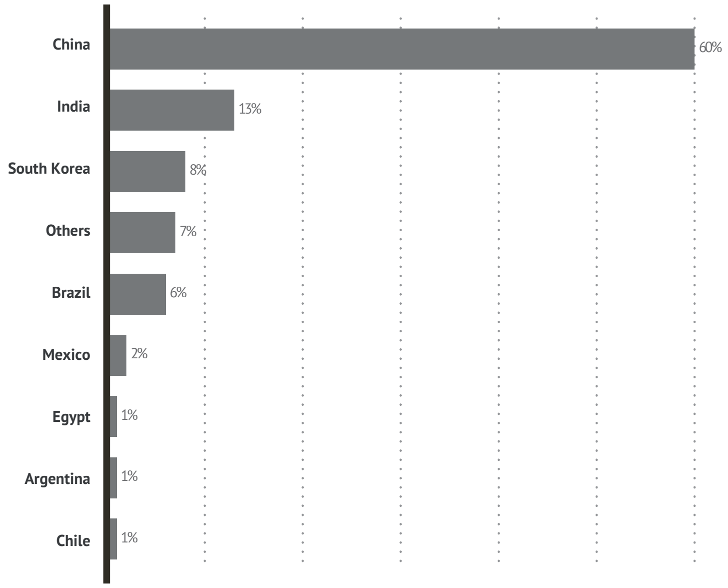
TABLE 1.11
Distribution of the number of Project Activities in Brazil per type of project

TYPE OF PROJECT	NUMBER OF CDM ACTIVITIES	SHARE (%)	TOTAL GHG EMISSIONS REDUCTION ESTIMATES (TCO_2e)	SHARE IN REDUCTIONS (%)
Hydroelectric	87	26.4	137,088,500	37.0
Biogas	63	19.1	24,861,823	6.7
Wind Power	54	16.4	40,968,209	11.0
Landfill Gas	50	15.2	87,280,381	23.5
Biomass Energy	41	12.4	16,091,394	4.3
Substitution of Fossil Fuel	9	2.7	2,664,006	0.7
Avoided Methane	9	2.7	8,627,473	2.3
N_2O decomposition	5	1.5	44,660,882	12.0
Heat Utilization and Recovery	4	1.2	2,986,000	0.8
Reforestation and Forestation	3	0.9	2,408,842	0.6
Use of Materials	1	0.3	119,959	0.0
Photovoltaic Solar Energy	1	0.3	6,594	0.0
Energy Efficiency	1	0.3	382,214	0.1
Substitution of SF_6	1	0.3	1,923,005	0.5
Reduction and Substitution of PFC	1	0.3	802,860	0.2
Total	**330**	**100.0**	**370,872,142**	**100.0**

Quantity of Certified Emission Reductions

In relation to the quantities of Certified Emission Reductions (CERs) issued up to 30 November 2014, Brazil ranked fourth in the world, with over 97 million CERs, after China with over 900 million, India with 199 million and South Korea with 127 million.

FIGURE 1.13
Distribution of CERs issued per country



Regarding the distribution of CERs issued per type of project until 30 November 2014 in Brazil, those related to N_2O decomposition top the rank with over 49% of the total, followed by landfill gas (20%) and hydroelectric power (11%).

CHAPTER II

VULNERABILITIES AND ADAPTATION TO CLIMATE CHANGE

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VULNERABILITIES AND ADAPTATION TO CLIMATE CHANGE

In continuing with the efforts commenced in the Second Communication of Brazil to the Convention, national initiatives are presented herein to provide assessment of necessary adaptation measures to climate change effects, with special attention to analyses of vulnerability in strategic areas for the country, commissioned by this Communication.

In order to establish measures to facilitate proper adaptation to climate change, the actions taken by the Ministry of the Environment's Secretariat of Climate Change and Environmental Quality (SMCQ) are worth mentioning. The Secretariat is in charge of providing information for the preparation and implementation of public policies for adaptation to climate change.

SMCQ's actions are focused specifically on: developing and consolidating methodologies and tools for vulnerability analysis, climate risk management and generation of adaptation measures; producing, managing and disseminating knowledge about vulnerability and climate risk management – identification of impacts and vulnerabilities, projections and scenarios for possible thematic cutouts and land scales for use in public policies; proposing and implementing institutional, economic and legal instruments to promote adaptation, including the National Plan for Adaptation by the Interministerial Committee on Climate Change; primarily promoting the reduction of vulnerability and climate risk in policy and biodiversity plans and ecosystems (conservation), forests (production and protection), coastal zones, water resources, food security; promoting institutional coordination and technical support to federal agencies, states, cities, society and the private sector; establishing international cooperation on adaptation to climate change.

Although in-depth discussions on this theme are recent in the country, since 2013 the main activities and projects carried out have been:

- An analysis of vulnerabilities for public policies – vulnerability mapping studies and methodological variations; construction of climate scenarios and projections; development of vulnerability and resilience indicators; development of local and participatory approaches;
- An analysis of climate change in the socio-environmental and economic systems – cost studies of impacts and adaptation; losses and damages, macroeconomic projections, discussions on land dynamics; synergies and trade-off of sectoral actions, among others;
- Promotion of public policies and their instruments to reduce vulnerability – including identification, discussion, categorization, assessment and prioritization of public policies towards adaptation, focused on local, regional and national levels, depending on the vulnerabilities identified and their consequences; development of tools for analysis of climate risk, Plans and government programs incorporating climate

risk management, and capacity-building for public and private managers at the national and sub-national levels;

- Development of a system for monitoring, assessment, and information dissemination of information on public policies for adaptation;
- Development of the National Adaptation Plan (hereinafter referred to as PNA) to Climate Change and provision of support to sectoral Ministries for the development and implementation of specific strategies.

The PNA is an important tool to implement the National Policy on Climate Change and has been prepared with the participation of several ministerial departments under the co-coordination of the Ministry of the Environment (MMA) and the Ministry of Science, Technology and Innovation (MCTI).

In order to support the elaboration and implementation of public policies for adaptation to climate change, including the PNA preparation process, this section of the Third National Communication (TNC) presents the results of an unprecedented effort in assessing vulnerability in strategic areas for the country, such as biodiversity, agriculture, water resources, renewable energy, natural disasters and human health.

The resources used in the elaboration of this National Communication endorsed the voluntary national initiative for cutting-edge knowledge production that supports future mitigation and adaptation policies to possible adversities imposed by climate change. This effort, which began in the Second National Communication, gave rise to the search for technical and scientific deepening of impacts, risks and vulnerabilities to climate change, reflected in new areas of research and development of climate scenarios using mathematical modeling. The need to develop methods of *downscaling* (reduction of scale and consequent increased resolution) of climate projections and assessments of impacts associated to climate change with better resolution than the global climate model was identified to that end.

Thus, the Project for the elaboration of this TNC proved to be a major push to increase the degree of complexity of the vulnerability analysis. This initiative led to the building of national capacity for basic scientific, and methodological strengthening in favor of the formulation of public development policies in Brazil related to the climate issue.

In this way, the results presented herein are not only an important basis for decision-making processes on adaptation measures to be planned in Brazil, but they are also evidence of the importance of continuing support to the theme, whose role is expected to become a critical element of sectoral planning and policy in such a vast and diverse territory.

2.1. MODELING PROGRAM ON FUTURE CLIMATE CHANGE SCENARIOS IN BRAZIL

Current knowledge about the regional dimensions of global climate change in Brazil is still very fragmented, requiring more studies. However, the preparation of these analyses require long-term climate change models of development with adequate spatial resolution for regional analysis, which provides conditions for the development of possible future scenarios of climate change, with different concentrations of CO_2 in the atmosphere, and analysis of global climate change impacts on Brazil.

Climate change projections for the 21st century derive from various global climate models used by the IPCC, which assesses future impacts based on different GHG emissions scenarios up to 2100. In 2000, the IPCC published a special report called SRES – Special Report Emission Scenarios[68], presenting the four main emissions scenarios with future projections for climate change: A1 and A2 – high emissions of GHG, B1 and B2 – low emissions of GHG. More recently, in its AR5 – Fifth Assessment Report (2014)[69], the IPCC developed climate and socioeconomic scenarios representing trends, the RCPs – Representative Concentration Pathways, considering: RCP 8.5 – high emissions, RCP 6.0 and RCP 4.5 – intermediate emissions, and RCP 2.6 – low emissions. The most severe projected impacts would occur only in a long-term scenario (2100) supposing greenhouse gas emissions will have not been mitigated, especially in case of significant increase in population and global economy growth based on the intensive use of fossil fuels. Thus, the most pessimistic scenarios and related impacts may not occur if the international community adopts effective measures to combat climate change by reducing greenhouse gases emissions. For the purposes of submitting the Third National Communication of Brazil, scenarios RCP 4.5 and RCP 8.5 were selected.

The main conclusions of the Working Group (WG2) Report of the IPCC's AR5 (2014) that have affected and may affect Brazil in the future are:

- A climate projection suggests increases in temperature, and increases or decreases in precipitation for South America by 2100. After the IPCC's Fourth Assessment Report (AR4), climate projections derived from dynamic downscaling models, for differentiated global climate models (RCP 4.5 and RCP 8.5), project a warming varying from +1.7°C to +6.7°C in Brazil. Observed variations in precipitation suggest a reduction of 22% in the Northeast region of Brazil and in the Eastern part of the Amazon, as well as increase of 25% in the Southern and Southeastern Brazil. Projections for 2100 show an increase in dry spells in Northeast Brazil and in the Amazon, and warmer days and nights in most of Southern Brazil. Changes in stream flows and water availability have been observed and projected to continue in the future in South America, and Southern and Southeastern Brazil will be the most vulnerable regions.
- Risk of water supply shortage is expected to increase due to reductions in rainfall and the increase in evapotranspiration in semi-arid regions, affecting water supply for cities and hydroelectric power generation, with impacts particularly on subsistence agriculture.
- The sea-level rise and human activities on the marine and coastal ecosystems pose threats to fish stocks, corals, mangroves, recreation and tourism, in addition to the control of diseases. Sea-level rise varied from 2 to 7 mm per year between 1950 and 2008. In South America, the main drivers of mangroves loss are deforestation and land conversion into agriculture and shrimp farming. The participatory management of Brazilian fisheries, involving all stakeholders, is an example of adaptation that favors a balance among conservation of the marine biodiversity, the improvement of livelihoods and the cultural survival of traditional populations.
- Changes in weather and climate patterns are negatively affecting human health in South America and Brazil, by increasing morbidity, mortality and disabilities, and through the emergence of diseases in previously non-endemic areas. With very high confidence, climate changes might be associated with respiratory and cardiovascular diseases, vectorsand water-borne diseases (malaria, dengue fever, yellow fever, leishmaniasis, cholera and other diarrheal diseases), hantaviruses and rotaviruses, chronic kidney diseases, and psychological trauma. Vulnerabilities vary according to geography, age, gender, race, ethnicity and socioeconomic status, and are rising in large cities. Climate change will exacerbate current and future

68 *http://www.ipcc.ch/ipccreports/sres/emission/emissions_scenarios.pdf*
69 *http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_ALL_FINAL.pdf*

risks to health, given the region's population growth rates and vulnerabilities in existing health, water, sanitation and waste collection systems, nutrition, pollution, and food production in poor regions. In Brazil, as in many countries, a first step toward adaptation to future climate changes is to reduce vulnerability to present climate. Long-term planning and related human and financial resource needs are deemed conflicting with the present social deficit for the welfare of the population.

It is important to emphasize that future climate projections will show uncertainties that are inherent to all usage models, which, on one hand, recommend caution with respect to interpretations of data and information, and on the other hand, impel the search for technical and scientific improvement.

The reduced resolution grid of global models implies a need for downscaling[70] methods that may be used in climate change scenarios that are built from global models, so that they obtain more detailed projections for states, valleys or regions, with higher spatial resolution than that provided by a global climate model. Therefore, downscaling is of great use for climate change impacts studies on management and operation of water resources, natural ecosystems and agricultural activities as well as on health care and on the spread of diseases.

Downscaling activity or regionalization, has been used by the MCTI to support the studies of the Third National Communication and also counted on the support given by the Secretariat of Strategic Affairs of the Presidency, which in turn developed a project called 20º40º[71] using the data provided by this method. The impacts of climate change in various sectors – which must be observed, considering that they are results of scenarios – were assessed through simulations for the Third National Communication.

The National Institute for Space Research (INPE) and the National Center for Monitoring and Alerting of Natural Disasters (CEMADEN), via *Rede CLIMA*, with the support of MCTI, coordinated the preliminary results related to the preparation of regional climate modeling and climate change scenarios as well as researches and studies on vulnerability and adaptation of strategic sectors, which are vulnerable to the impacts associated with climate change in Brazil. The data from these simulations has allowed for the elaboration of new reports with new results on climate change scenarios aiming at supporting studies on vulnerability, which are presented below. Specific adaptation projects with the appropriate scientific background could be developed thereof, thus enabling increased efficiency in the use of public resources in the implementation of actions dedicated to adaptation strategies to climate change.

70 The downscaling technique is used to make the regionalization or "interpolation" of a sub-grid scale with less resolution to a higher resolution one, suitable for medium scale processes, such as those at the level of a watershed. The downscaling technique consists in the projection from large-scale to regional scale information. This "translation" of a global scale to a regional one and from annual time scales to daily ones would also increase the uncertainty degree of climate change projections. For example, although a climate model may be able to replicate with some success the precipitation field observed, it is likely it may have less success in replicating the daily variability, especially with respect to the high level statistics, such as the standard deviation and the extreme values. Thus, while it may seem reasonable to adopt an interpolated temperature scenario from the grid points of a global climate model to a specific location, the interpolated time series may be considered inappropriate for current climates and, therefore, generate uncertainty in the climate change scenarios.

71 Brasil 20°40°: cenários e alternativas de adaptação às mudanças do clima" (Brazil 20°40°: adaptation scenarios and alternatives to climate change), which started in 2013, was a project developed by the Secretariat of Strategic Affairs of the Presidency in an attempt to approach adaptation impacts and alternatives based on climate change and water resources scenarios.

The Brazilian Model of the Earth System (BESM)

The Brazilian Earth System Model (BESM), developed by INPE, in collaboration with universities in Brazil and research centers in South Africa, India, Europe and the United States, aims at establishing a model of the Earth System suitable for long term climate change projections, as well as contributing to the formation of a new generation of researchers capable of understanding the limitations and the capacities of the products derived from weather forecasting mathematical models.

BESM is based on the main structure of the CPTEC ocean-atmosphere coupled model (used for seasonal weather forecast), but includes more realistic representations of phenomena that act in a wider time scale, such as: sea-ice transitions, dynamic vegetation, variability of marine and land CO_2, and other improvements currently in progress such as the effects of aerosols and atmospheric chemistry and the development of atmospheric convection parameterizations that best represent precipitation over Brazil. The advance of BESM enabled INPE to participate in the Fifth IPCC Assessment Report with global climate change scenarios from 2005 to 2100 (NOBRE et al., 2013).

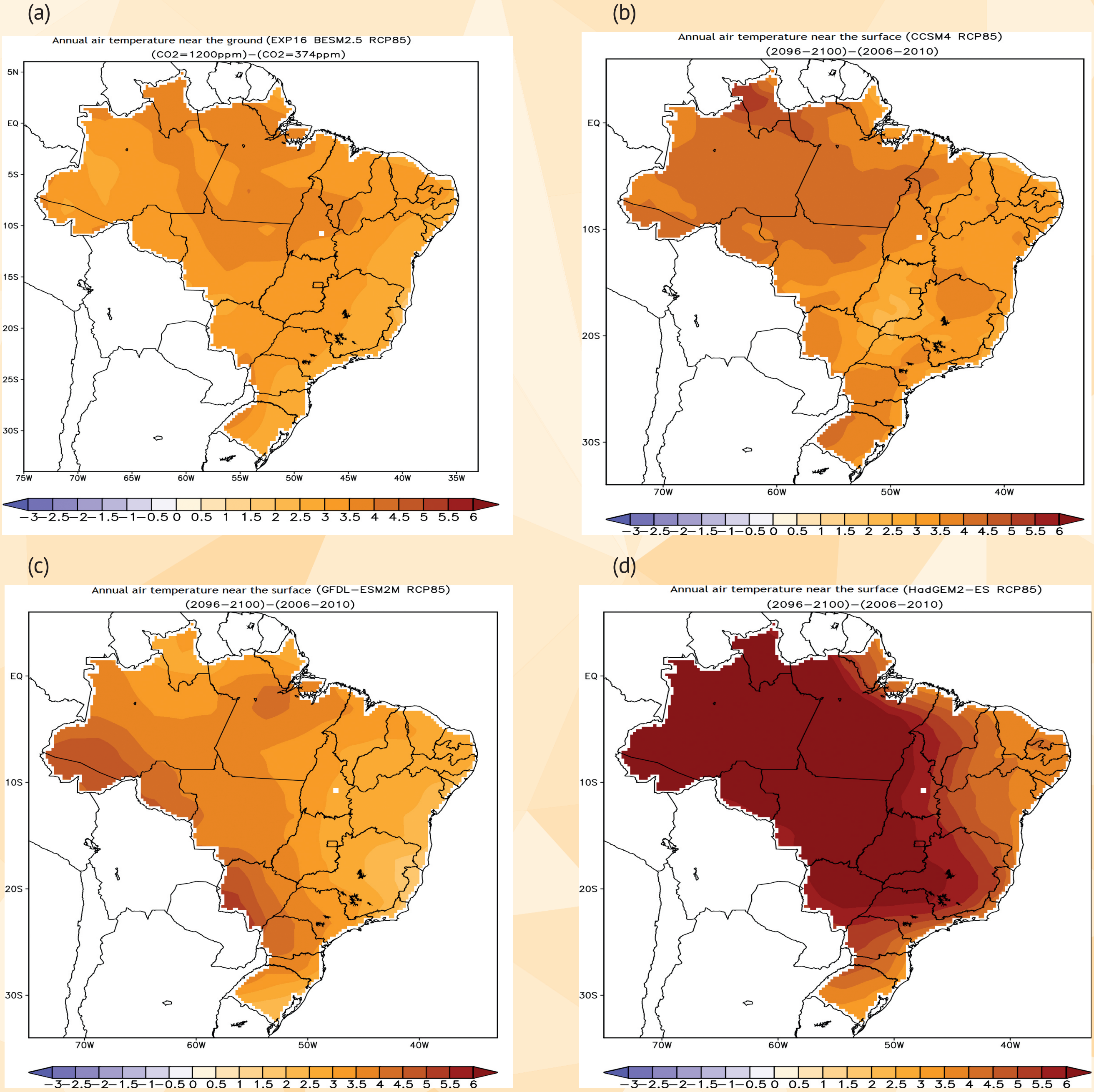
The work around BESM began with financial resources from the Brazilian government. This model has great potential to generate detailed assessments of the climate change, vulnerability and adaptation effects for Brazil. The global climate change scenarios generated by BESM are used as outline conditions for regional models, such as the Eta/INPE, aiming at studies on climate change impacts over Brazil on a watershed scale. Because it incorporates aspects of the Brazilian biomes and the effects of river discharges from the Amazon Watershed in the Atlantic Ocean, among others, the global scenarios generated by BESM will allow a thorough analysis of the uncertainties by the production of land-use scenarios, such as the impacts to global climate not only by reducing deforestation, but also by means of the reforestation of Brazilian biomes as well as integrations with a high spatial resolution.

BESM is currently integrated into a 200km spatial grid in the atmosphere and 100km in the oceans. In the near future, the model will be integrated into a 50km atmospheric grid and a 25km oceanic grid, with twice the number of levels on its vertical axis, thereby increasing by hundreds of times the resolution of the scenarios and information generated. For the purposes of distributing such huge volumes of information at hundreds of terabytes, the Earth System Grid Federation (ESGF) is being installed, which will interconnect INPE to other world centers of generation and dissemination of global climate change scenarios.

Figures 2.1 and 2.2 below depict the air temperature increase range and the changes in the rainfall pattern over Brazil for the RCP 8.5 scenario (IPCC's AR5, 2014) computed by the 2.5 version of the BESM model with Ssib surface sub-model, compared to the results of another 3 models. Figure 2.3 shows a cross-comparison of the air temperature fields near the surface among these models.

FIGURE 2.1

Difference in air temperature (°C) on the surface between the present climate condition (i.e., with concentration of atmospheric CO_2 at 374 ppm) and the future climate for the RCP 8.5 scenario (i.e. atmospheric CO_2 at 1200 ppm) in 2100

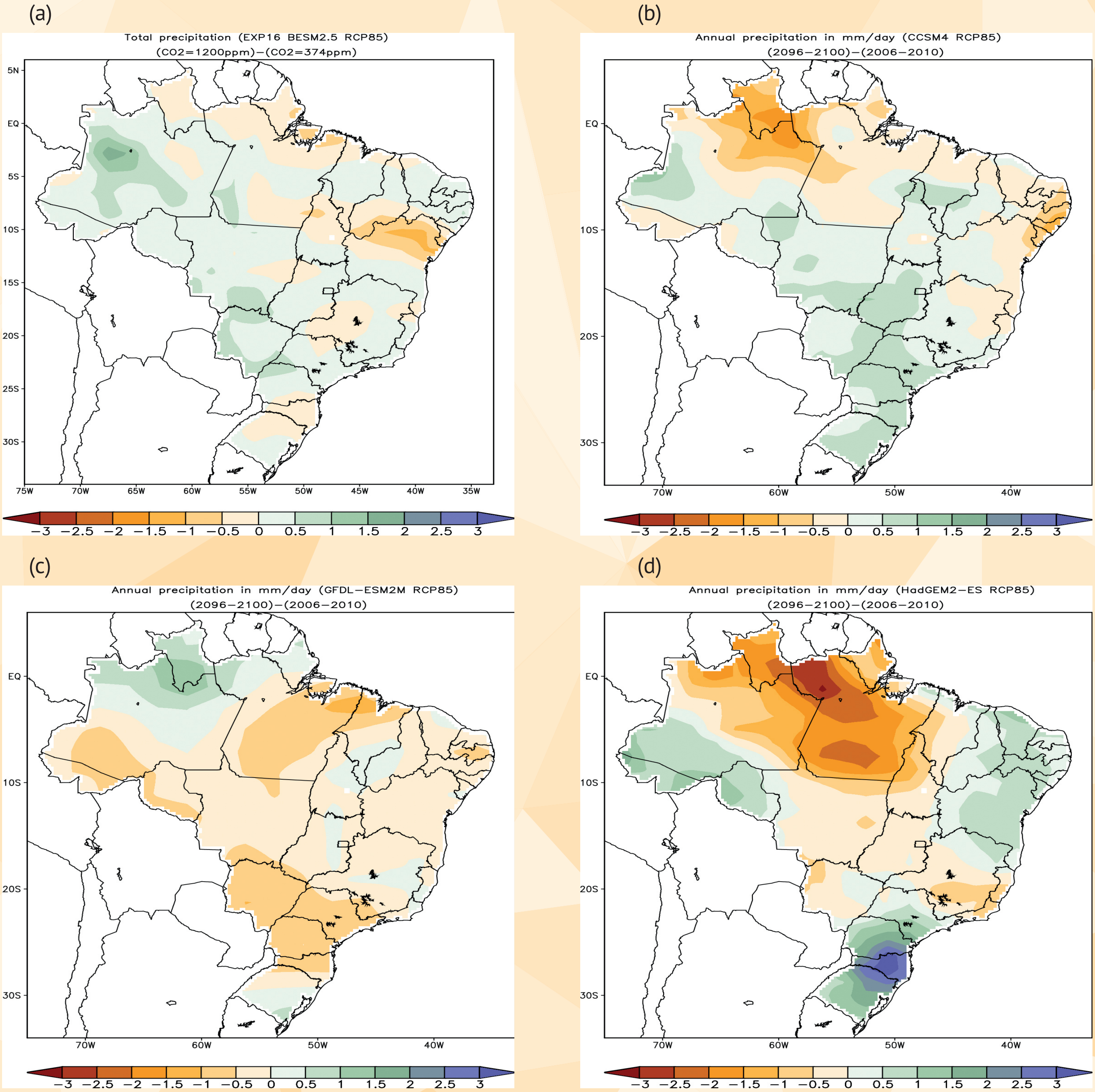


(a) INPE's BESM-Ssib V.2.5, (b) NCAR's CCSM4, (c) GFDL's CM2M and (d) HadleyCenter's HadGEM2–ES.

Source: Image by Vinicius Capistrano.

FIGURE 2.2

Difference in precipitation (mm/day) between the present climate condition (i.e., with concentration of atmospheric CO_2 at 374 ppm) and the future climate for the RCP 8.5 scenario (i.e. 1200 ppm atmospheric CO_2) in 2100

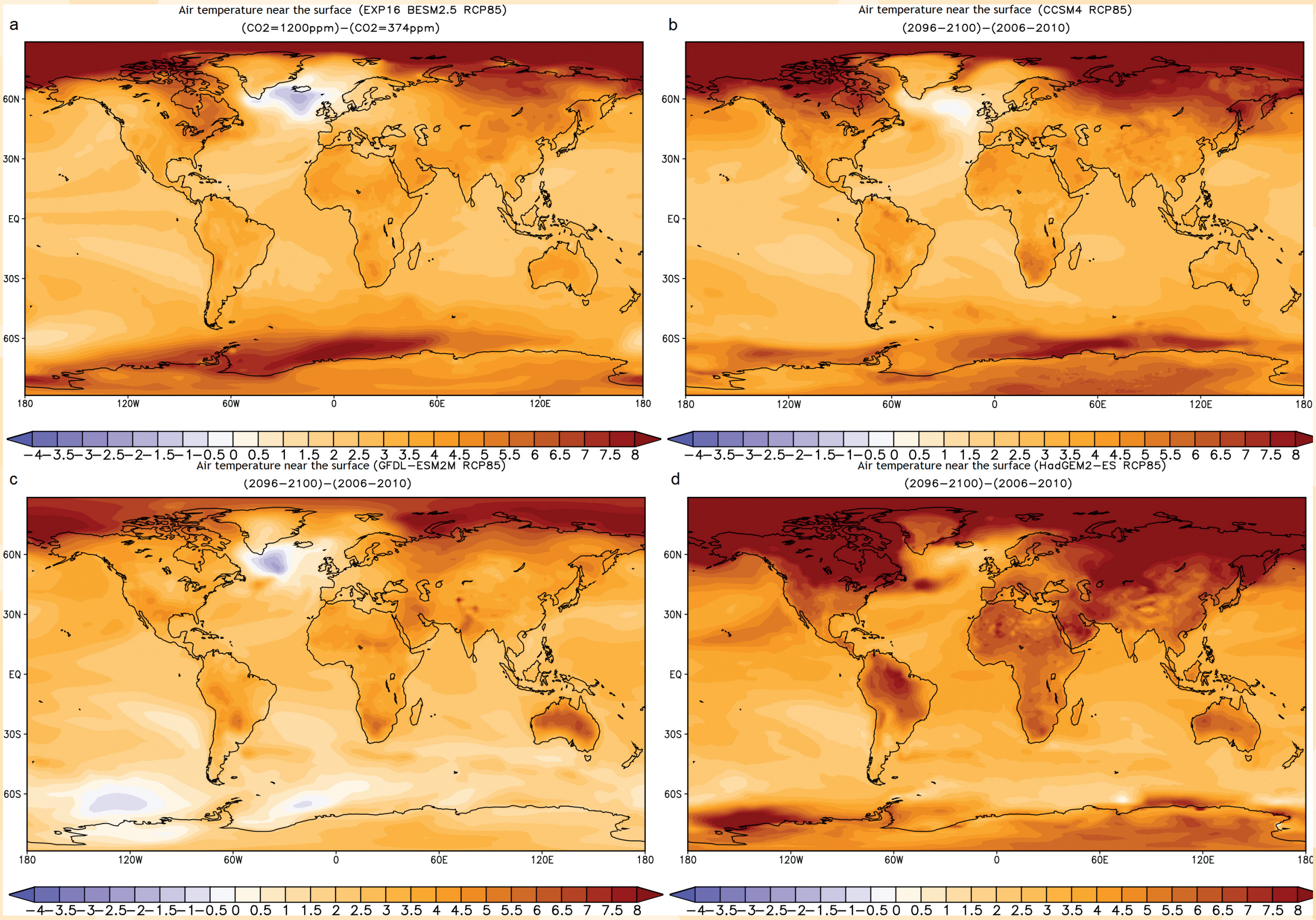


(a) INPE's BESM-Ssib V.2.5, (b) NCAR's CCSM4, (c) GFDL's CM2M e (d) HadleyCenter's HadGEM2-ES.

Source: Image by Vinicius Capistrano.

FIGURE 2.3

Variation of the air temperature near the surface as computed by the following models: (a) INPE/BESM2.5-Ssib, (b) NCAR/CCSM4, (c) GFDL/ESM2M, and (d) Hadley Centre/HadGEM2–ES, for the concentration of atmospheric CO_2 at 1200 ppmv, representative of the RCP 8.5 scenario in the year 2100, in comparison with the present climate



Source: Image by Vinicius Capistrano.

The insertion of INPE in the Earth System Grid Federation (ESGF)

The results of climate change scenarios produced by high-performance supercomputing systems generate an increasing amount of aggregated data volume, which may reach an exabyte scale within 10 years. The possibility of easily transferring such amount of data also allows, as a result, for the development of models, such as BESM, in better conditions.

In order to facilitate accessing and transferring of such amount of data, the Earth System Grid Federation (ESGF) was established by means of a partnership between the U.S. Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and the National Science Foundation (NSF), in addition to international collaboration with European and Asian countries as well as Australia. This endeavor is aimed at facilitating scientific findings in climate science through an infrastructure that allows receiving and replicating data and responding to requests from its users, who will detain some of the best-proven tools available.

ESGF is a key data-dissemination infrastructure and resource for climate simulation, observation as well as for reanalysis of climatic simulation data. It is used to store published data sets of observational nature, model input and output, product analysis, as well as other valuable scientific content, making them available to the scientific community and other stakeholders.

The creation of the ESGF-INPE integrated model, made possible through a partnership between MCTI and UNDP as part of the Project of the Third National Communication of Brazil to the Climate Convention, introduced Brazil to a worldwide network of scientific institutions, along with major climate change studies centers, universities and laboratories worldwide. Furthermore, the ESGF-INPE will enable researchers around the world to have state-of-the-art access to the global climate change scenarios generated by the Brazilian Earth System Model (BESM).

The use of ESGF infrastructure aiming at sharing climate data also implies in the reduction of risks, time costs and efforts with regard to the development of several misaligned solutions and technologies. In short, this integrated system currently in installation, named ESGF-INPE, consists of an important distribution tool of global and regional climate scenarios to the scientific community, research institutions and governments.

2.2. REGIONALIZATION OF GLOBAL CLIMATE CHANGE MODELS – DEVELOPMENT OF THE ETA METHOD

For the purposes of this Third National Communication, INPE assessed the different climate change scenarios proposed by the global models of the IPCC's AR4 and AR5 and has developed a dynamic downscaling methodology for Brazil. The dynamic downscaling is a method to reduce the climate change projections produced by global climate models in order to obtain more detailed climate projections with better spatial resolution. The improved resolution is obtained by driving the atmospheric regional models with the projections produced by global climate models. These detailed projections are more suitable for the climate change impact studies on various socioeconomic sectors (agriculture, energy, health care, water resources, etc.), indicating the vulnerability to the risks in the form of probability. Vulnerability is generally related to local scale problems.

For this purpose, INPE developed a version of the regional Eta model that is suitable for climate change studies on South America, used to operationally produce weather forecasts. The model was adapted in order to be used as a climate model to generate seasonal forecasts (CHOU et al., 2005), and was then improved for climate change studies (PESQUERO et al., 2009). This version was validated (CHOU et al., 2012) and used to produce downscaling scenarios of future climate changes (MARENGO et al., 2012a) for the Second National Communication of Brazil to the Convention. For these Third National Communication, the models used were Japanese MIROC5 and British HadGEM2–ES (CHOU et al., 2014a). Two emission scenarios were considered: RCP 4.5 and RCP 8.5. Following the trend of increasing spatial resolution of the global models, the regional Eta model increased the spatial resolution from 40 km to 20 km, thus covering an even larger area, which encompasses all South America and Central America. Also following the trend of enhancing the IPCC's 2014 AR5 models, improvements were introduced in the dynamics of the regional Eta model (MESINGER et al., 2012). The simulation of present climate (baseline), which covers the period from 1961 to 2005, employs 360 ppm in concentration of CO_2 equivalent, whereas in the simulation of future climate, from 2006 to 2100, concentrations of CO_2 equivalent were adopted and gradually increased according to RCP 4.5 and RCP 8.5 scenarios. The sea surface temperature originates from the global climate models, and is updated on a daily basis.

The improvements planned for this climate change version of the Eta model include dynamic vegetation and land-use changes, coupling with an ocean model and the replacement of the radiation scheme in order to include aerosols and chemical reactions in the atmosphere.

2.2.1. The Global Models HadGEM2-ES e MIROC5 and Regional Projection of Eta- HadGEM2-ES and Eta-MIROC5

Two global models were used as guidelines for the INPE's regional Eta model: the British Hadley Centre Global Environmental (HadGEM2–ES) model and the Japanese Model for Interdisciplinary Research on Climate (MIROC5) model, considering two emission scenarios, one optimistic and the other pessimistic, RCP 4.5 and RCP 8.5, respectively. A brief description of the global models is presented, followed by a discussion on the downscaling projections by the Eta model based on the combination of two global models and two emission scenarios.

Downscaling Projections - Eta-HadGEM2–ES and Eta-MIROC5

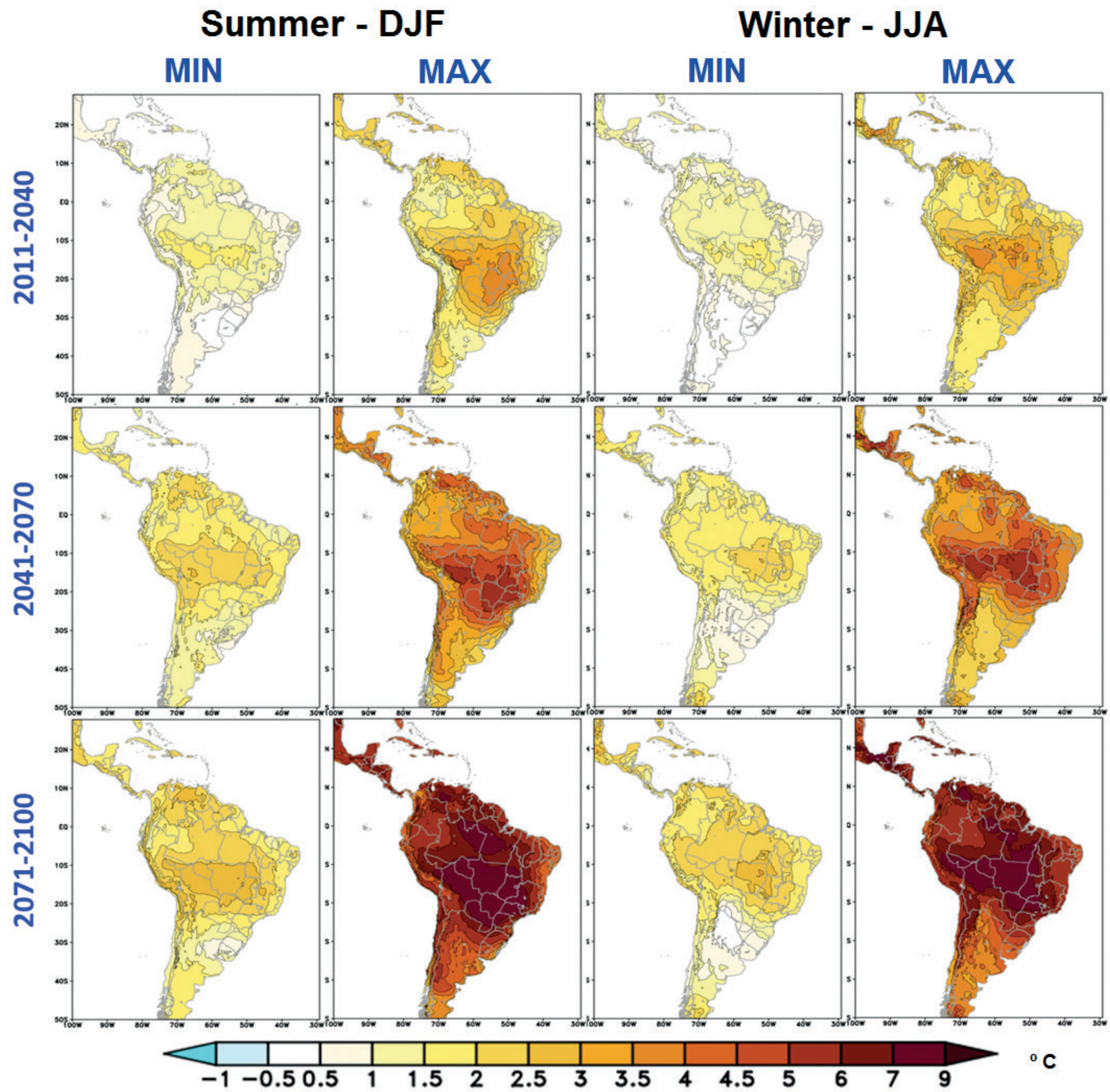
In future projections, either in RCP 4.5 or in RCP 8.5 scenarios, the response to climate change of the Eta simulations nested to the model HadGEM2–ES simulations are more intense than the simulations of the Eta nestled to the model MIROC5 (CHOU et al., 2014b).

In austral summer (December, January and February – DJF), the reduction of rainfall in the central region of South America set alongside its increase in the austral region are changes described in most of the simulations, however the Eta-HadGEM2–ES model intensifies the decrease of precipitation, while Eta-MIROC5 expands the area of increased precipitation in the south of the country throughout the years up to the end of the century. In austral winter (June, July and August – JJA), a rainfall reduction in the northern part of South America and in most of Central America is noticed.

Figures 2.4 and 2.5 show the changes in temperature and in precipitation for the two seasons of the year, summer and austral winter, in periods of 30 years, from 2011 to 2040, from 2041 to 2070, and from 2071 to 2100. The lowest and highest thresholds of the changes extracted from four simulations indicate the possible range of changes derived from these downscaling simulations.

FIGURE 2.4

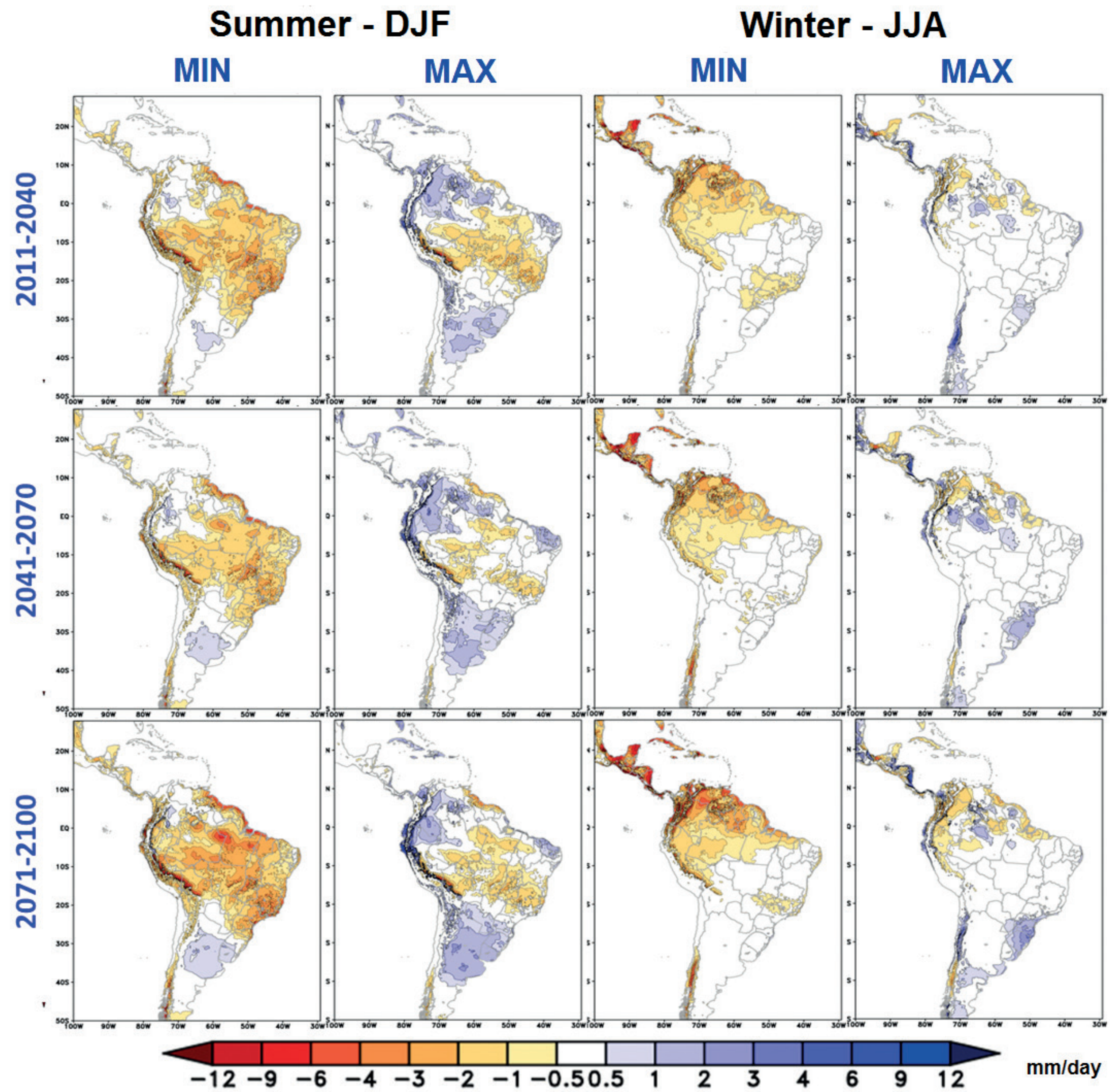
Downscaling projections of changes in temperature (°C) between baseline and different future periods – lowest (MIN) and highest thresholds (MAX) of the changes extracted from four simulations (Eta-HadGEM2–ES and Eta-MIROC5 models in the two scenarios: RCP 4.5 and 8.5) for summer (December, January and February – DJF) and winter (June, July and August – JJA)



The maximum warming in the country is located in the Central West region. These warming peaks extend to the Northern regions, the Northeast and the Southeast until the end of the 21st century. The maximum average warming at the end of the 20th century can vary between approximately 2°C and 8°C in some areas.

FIGURE 2.5

Downscaling projections of changes in precipitation (mm/day) between baseline and different future periods – lowest (MIN) and highest thresholds (MAX) of the changes extracted from four simulations (Eta-HadGEM2–ES and Eta-MIROC5 models in the two scenarios: RCP 4.5 and 8.5) for summer (December, January and February – DJF) and winter (June, July and August – JJA)



It can be observed that the zones that register the maximum decrease in precipitation are located in the Central West and Southeast regions of the country, and expand up to the Amazonian regions. The projections suggest a decrease in rainfall in the northeastern part of the Northeast during summer, and an increase in rainfall over the Southern region, up to the Southeast part of the country. The rainfall increase begins in 2011-2040 and intensifies until the end of the century.

It is important to emphasize that the Southeast region of the country is a transition region, where the rainfall regime strongly depends on the Intertropical Convergence Zone (ITCZ) during summer. If the ITCZ is positioned further to the North or to the South, it may result in positive or negative rain anomalies, causing difficulties in the simulation for the region. The uncertainty of climate projections for this region is high. The Southeast region of the country is recognized as a region of low climate predictability.

2.3. IMPACTS AND VULNERABILITY TO CLIMATE CHANGE IN BRAZILIAN STRATEGIC SECTORS

The Eta-HadGEM2–ES and Eta-MIROC5 downscaling modelings were used as basis for new assessments of the impacts and vulnerabilities on biodiversity, agriculture, water resources, energy, natural disasters and human health. Experts in each of the abovementioned sectors carried out the assessment, and presented results from climate variables (i.e., precipitation, atmospheric temperature, wind, among others) extracted from the modeling made. Thirty-year averages have been considered for the baseline (1961-1990) and future (2010-2040, 2041-2070 and 2071-2100) periods.

2.3.1. Biodiversity

The fragmentation and loss of habitat, hunting and invasion of exotic species stand out among the causes for biodiversity loss and species extinction (DIAMOND, 1984; KRAUSS et al., 2010). In recent years, however, the change in the global climate, resulting mainly from anthropogenic activities, emerges as a new issue of great relevance (THOMAS et al., 2004; LOISELLE et al., 2010). Different answers can emerge from biodiversity in face of the climate changes: migration or displacement of the species distribution toward places with more suitable conditions (HICKLING et al., 2006), adaptations to new conditions (MØLLER et al. 2008) or even extinctions (THOMAS et al., 2004).

In this context, one of the main challenges today is to understand the effects of climate change on biodiversity (CAHILL et al., 2012), especially the consequences for the future, because these are not broadly unknown, despite being recognizably negative (THOMAS et al., 2004; BEAUMONT et al., 2011).

The use of distribution modeling has increased considerably in recent years, especially because of the facility to obtain environmental data that enable the study of patterns of distribution of the species, even for future scenarios such as climate change (ELITH and LEATHWICK, 2009). The extensive use of this tool has led to the development of new techniques which, in turn, allow researchers to innovate in the approaches to their work and model more than the distribution of species, but also the distribution of ecological traits (THUILLER et al., 2006) and diversity (FODEN et al., 2013).

State-of-the-art: the effect of climate change on the Brazilian biodiversity

Several reviewed studies deal with the effect of climate change on species that are distributed on the Brazilian territory, and there is no work on current issues such as functional diversity, eco regions or ecosystems. The revised works show that the effects of climate change on the Brazilian biodiversity are mostly negative. Among the major negative consequences of climate change on the distribution of species are: the reduction of the distribution (SIQUEIRA and PETERSON, 2003; SOUSA et al., 2011; ZIMBRES et al., 2012); the displacement of the potential distribution toward anthropic areas and, therefore, not suitable for the species in the future (DINIZ-FILHO et al., 2009; SOUSA et al., 2011); and the absence of protected areas covering the future distribution of the species, ensuring their preservation in the long term (MARINI et al., 2009; FALEIRO et al., 2013; LEMES et al., 2013).

For the Cerrado and the Atlantic Forest biomes, literature appoints to the pressure of all the impacts mentioned, revealing challenges to the biodiversity conservation in these biomes. The climate change effects appear to be favorable only for Caatinga, where an increase in the distribution for the species in this biome is expected, which could serve as a refuge for the distribution of vertebrates in face of the impacts suffered in other biomes (OLIVEIRA et al., 2012). As previously mentioned, the biggest knowledge gaps refer to the Amazon, the Pantanal and the Pampa biomes, because the absence of studies entails uncertainty in the analysis of the consequences of climate change for these biomes.

Geographic distribution modeling tools were used as basic information to study the effects of climate change on the vegetation distributed over the Brazilian territory. The vegetal formations may characterize habitats for many species and, therefore, consist of a good indicator of the Brazilian biodiversity. There is a clear pattern of distribution of plant formations related to rain and temperature regimes, showing its potential to be forecast by climatic variables, as well as of being affected by future climate changes. Thus, studying the effects of climate change on the vegetation emerges as an efficient approach to infer the effects of climate change on biodiversity.

The current distribution of habitats was provided by the GlobCover project, coordinated by the European Space Agency (ESA), which provides a spatial database of the land use and coverage for the year 2009 on a global scale[72]. The vegetation coverage classes are defined in accordance with a land cover classification system (LCCS) and performed 22 classes for the entire globe, 18 of them in Brazil (Table 2.1 and Figure 2.6). It should be noted that the projection of the distribution of the use or anthropic coverage was not performed. For the purposes of this analysis, the ecological/climatic niche was considered.

72 *For more details, refer to: http://due.esrin.esa.int/page_globcover.php*

TABLE 2.1

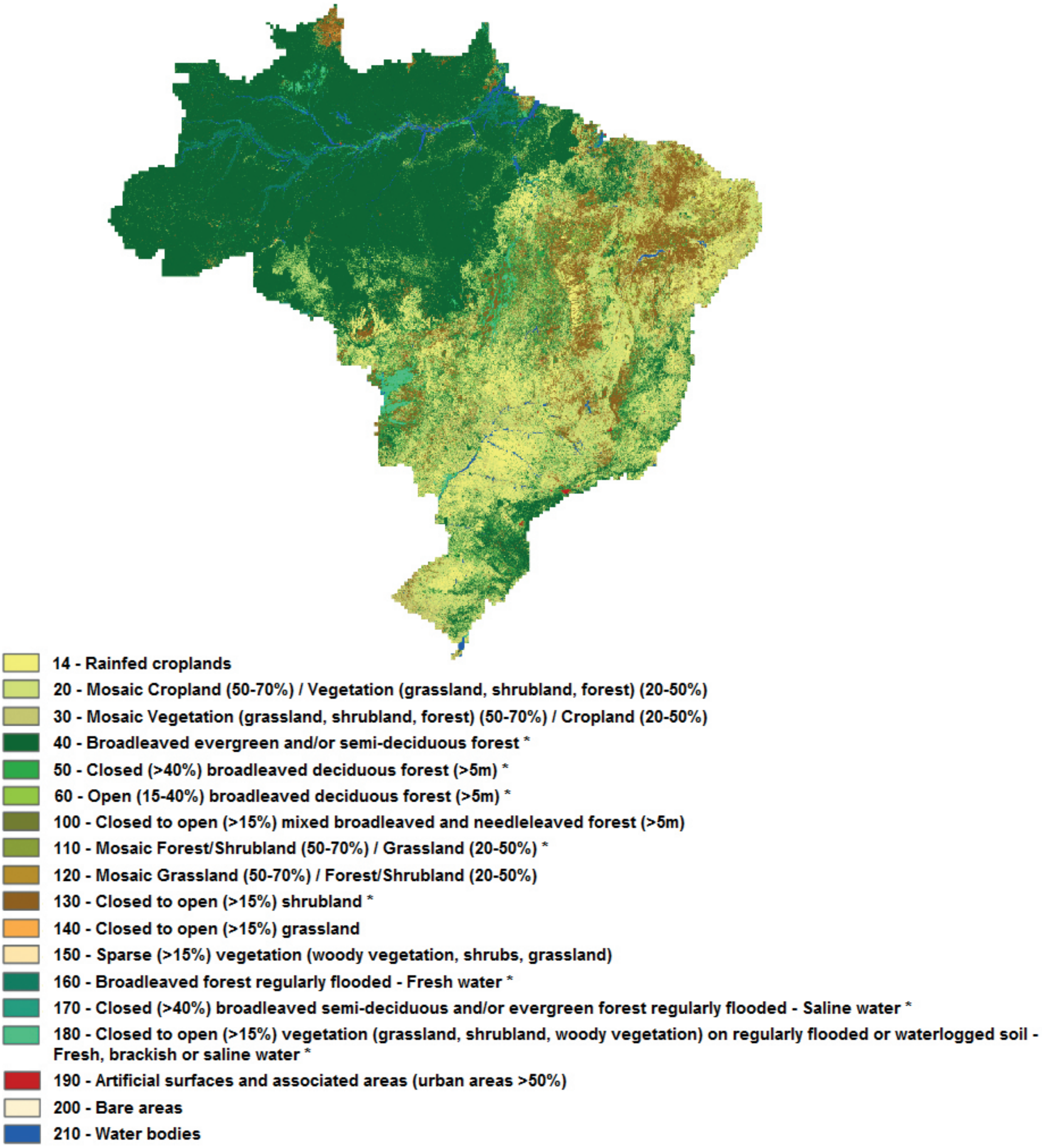
Keys of the 18 land use and cover categories in Brazil, according to the GlobCover project for the year 2009

VALUE	GLOBCOVER PROJECT CAPTIONS
14	Rainfed croplands
20	Mosaic Cropland (50-70%)/Vegetation (pasture, shrubland, forest) (20-50%)
30	Mosaic Vegetation (pasture, shrubland, forest) (50-70%)/Cropland (20-50%)
40	Broadleaved evergreen and/or semi-deciduous forest *
50	Closed (>40%) broadleaved deciduous forest (>5m) *
60	Open (15-40%) broadleaved deciduous forest (>5m) *
100	Closed to open (>15%) mixed broadleaved and needleleaved forest (>5m)
110	Mosaic Forest/Shrubland (50-70%)/Pasture (20-50%) *
120	Mosaic Pasture (50-70%)/Forest/Shrubland (20-50%)
130	Closed to open (>15%) shrubland *
140	Closed to open (>15%) pasture
150	Sparse (>15%) vegetation (woody vegetation, shrubs, pasture)
160	Broadleaved forest regularly flooded - Fresh water *
170	Closed (>40%) broadleaved semi-deciduous and/or evergreen forest regularly flooded - Saline water *
180	Closed to open (>15%) vegetation (pasture, shrubland, woody vegetation) on regularly flooded or waterlogged soil - Fresh, brackish or saline water *
190	Artificial surfaces and associated areas (urban areas >50%)
200	Bare areas
210	Water bodies

* *Vegetation and non-anthropic cover categories.*

FIGURE 2.6

Land use and coverage categories in Brazil, according to the GlobCover project for the year 2009



Source: Bontemps et al. (2010)

The environmental variables used to describe the present and future distribution of habitats have a climate nature and have been extracted from the Eta-HadGEM2–ES downscaling model.

After an evaluation of different methods and models, the artificial intelligence model Maximum Entropy Modelling – (MaxEnt) was chosen in order to assess the future distribution of habitats in the Brazilian territory (PHILLIPS et al., 2006).

The model selected as a descriptor of habitat distribution was projected in its times series, to initially provide visual information on the expansion or retraction of the habitats over time. Later, these distributions were overlapped to indicate what localities will be affected by climate change and what will remain unchanged, while maintaining their current habitat. Finally, the altered area has been measured for each biome and compared with the present and future composition of the Brazilian biomes. This way, an indication of which biomes were most affected by climate change and what will be the nature of this change was sought.

In comparing the present and future distribution for the years 2050 and 2070, we observed the Humid, Semi-deciduous and Broad-leaved Forests might have their distribution extension reduced (Figure 2.7), mainly in the northern portion of its distribution (Figure 2.8). A small expansion of distribution in the southern portion of the territory is anticipated (Figure 2.8), however these areas are not viable for the expansion of the habitat, once they are unreachable by means of dispersion, considering the duration of the study, besides being dominated by anthropic uses. On the other hand, an expansion in the distribution of Savanna and Open Formations was anticipated, mainly in the northern and western part of the Brazilian territory (Figure 2.9 and 2.10), and there is no sign of climate niche loss for the future scenarios of climate change where they occur nowadays (Figure 2.8).

FIGURE 2.7

Total area of distribution of habitats in accordance with the anticipated distribution in each climate scenario

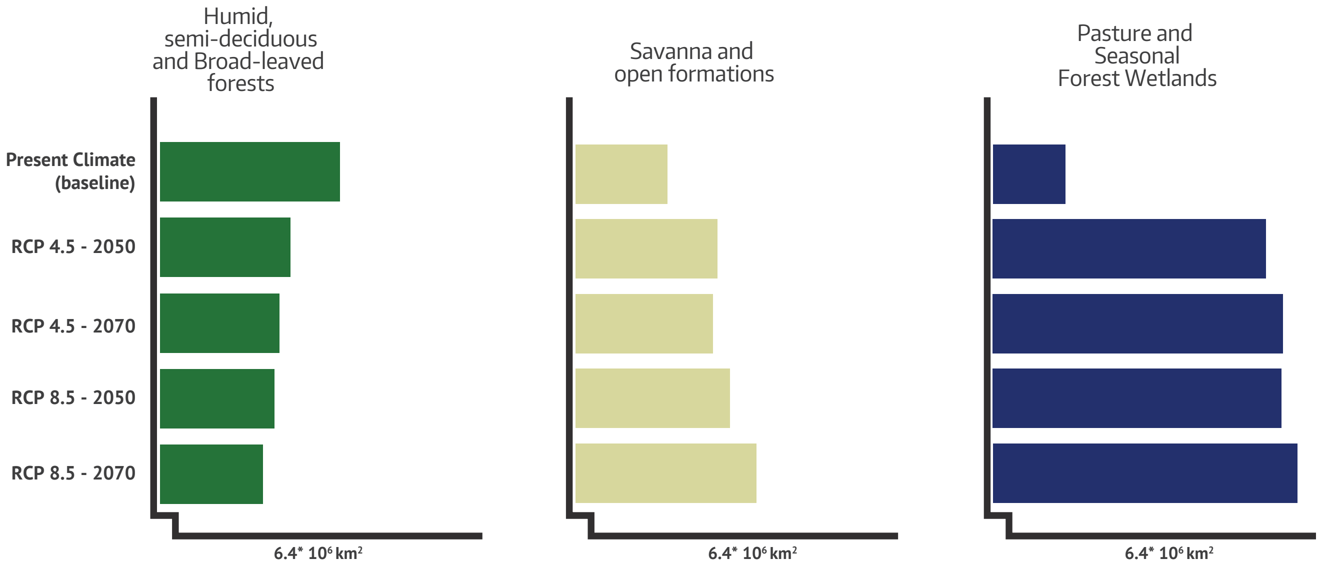
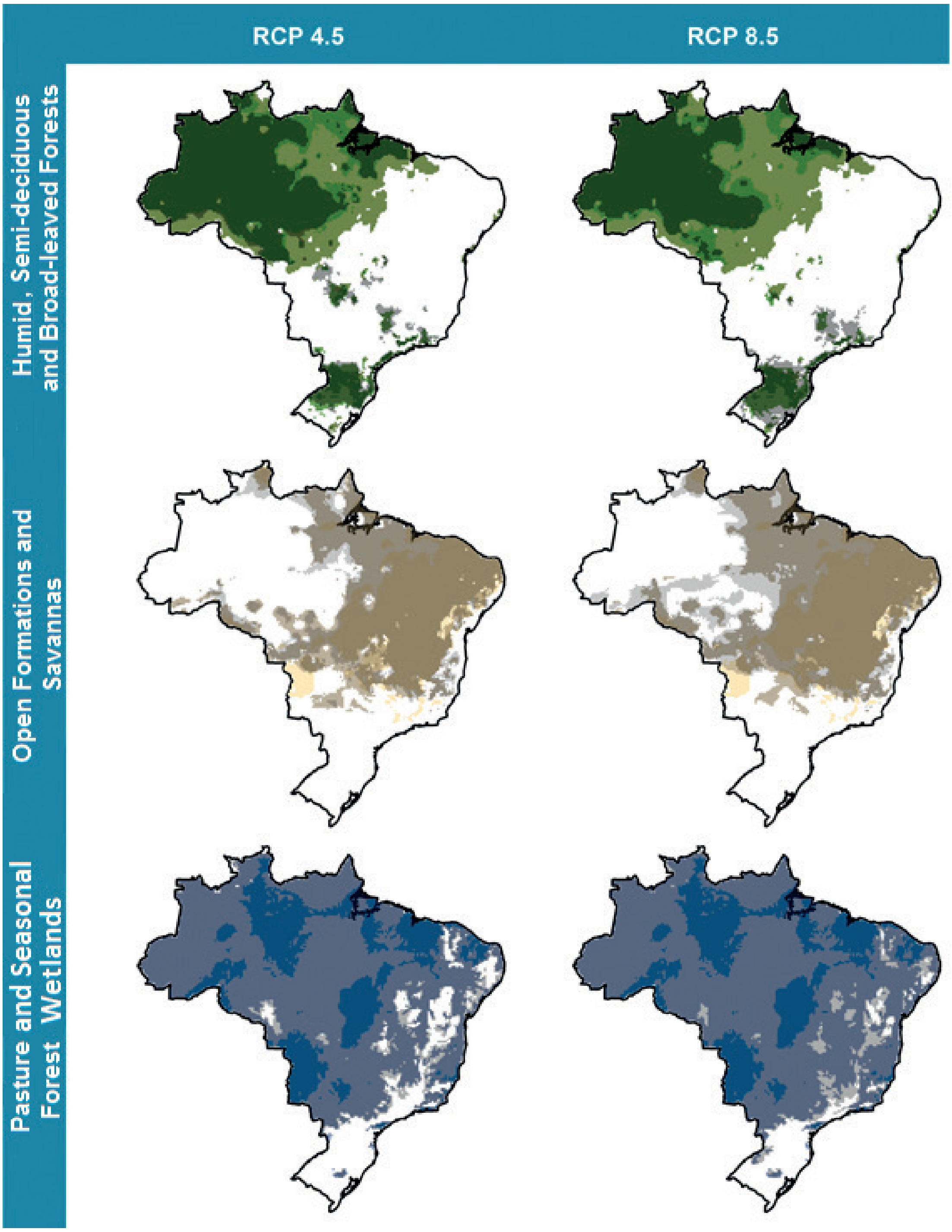


FIGURE 2.8
Map of habitat distribution in different climate scenarios



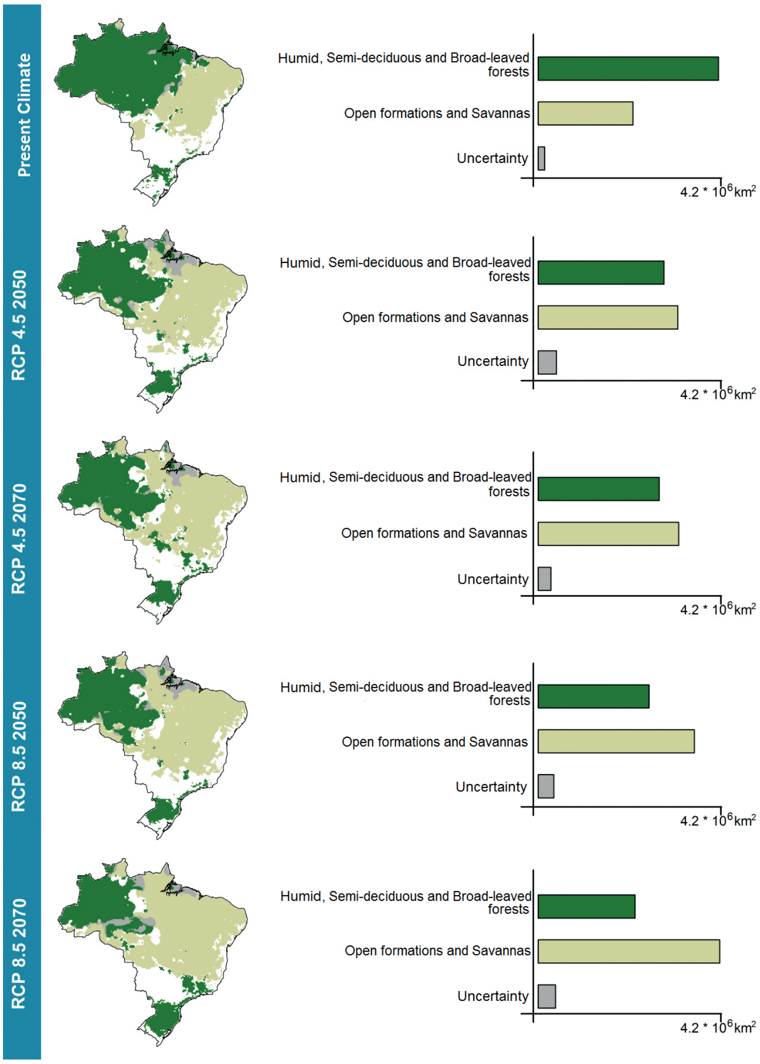
The dark areas show the overlapping of the present and future distribution, showing areas of environmental stability according to the climatic niche of habitats. Areas in gray tones show locations of potential expansion of habitats, where they will potentially occur in the future, but not at the present time. Areas in light colors show locations of habitat retraction, in which distribution loss is anticipated in a future climate scenario.

The future distribution anticipated for Pasture or Forest Wetlands (Figures 2.7 e 2.8) shows high uncertainty, and, therefore, was not considered.

In comparing the distribution of the other two habitats, Humid, Semi-deciduous and Broad-leaved forests and Savanna and Open Formations, for which robust forecast were generated, a small overlapping area is observed, which increases along the years and with changes in emission scenarios (Figure 2.9). These overlapping regions can be considered as areas of uncertainty.

FIGURE 2.9

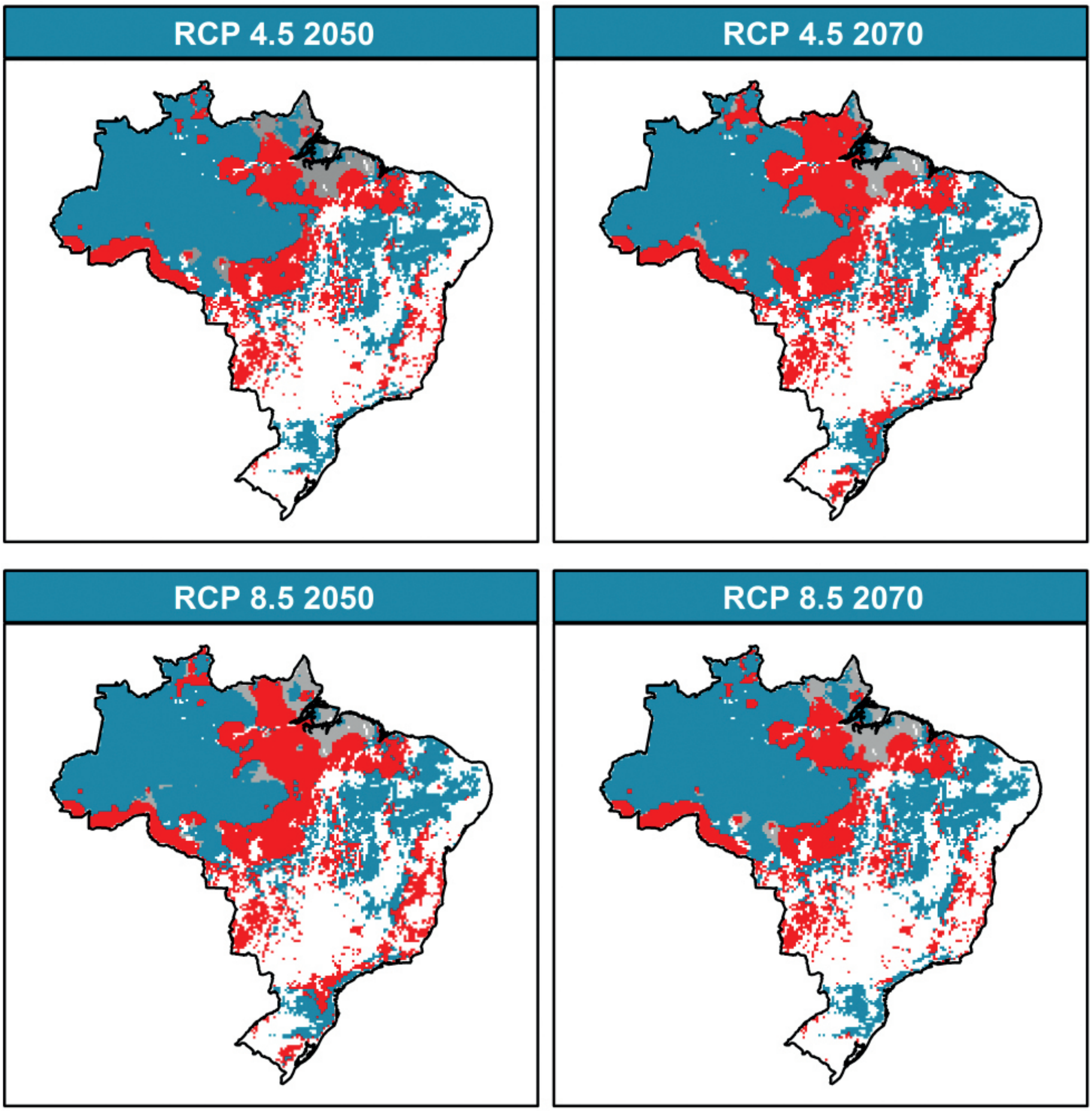
Overlap and total area of anticipated distribution for habitats in different climate scenarios



In spite of the uncertainty on the distribution of types of vegetation in some places, the predictions are quite robust from a statistical and ecological point of view, which leads to a series of highly valuable inferences. One of these inferences is the delineation of climate instability areas that will give rise to changes in the future vegetation cover (Figure 2.10). This perspective implies that a considerable proportion of the Brazilian territory will undergo changes in its vegetation cover due to climate change; this change will be, mainly, by the conversion of forest areas into savannas and areas of open vegetation (Figure 2.9).

FIGURE 2.10

Change prediction in vegetation cover for future climate scenarios

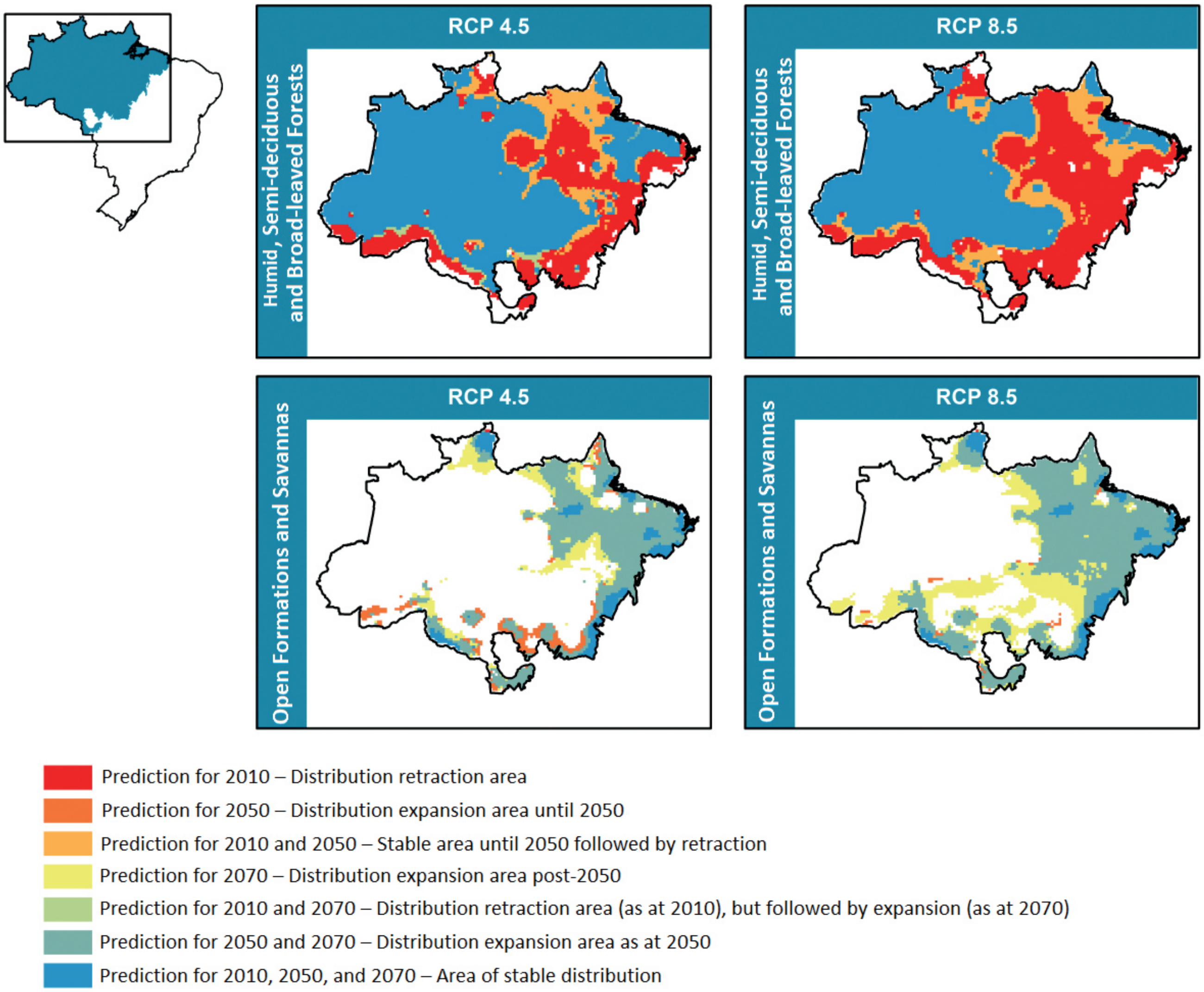


In Figure 2.10 above, the blue areas are convergence areas between present and future vegetation cover. In gray, areas presenting uncertain changes. In red, locations where changes in vegetation cover for the future scenario climate are anticipated.

The Brazilian biomes will undergo different climate change impacts. The Amazon and Atlantic Forest biomes, which have forests as predominant vegetal formations, will be the most impacted, as a retraction in distribution is anticipated for the Humid Semi-deciduous and Broad-leaved Forests. This retraction will be more intense in the Amazon (Figure 2.11), especially in its eastern portion, which is already suffering a deep impact due to habitat conversion. Apparently, the western part of the Amazon will remain stable against climate changes and the eastern part of Amazon will have its forest formation replaced by Open or Savanna Formations (Figure 2.11).

FIGURE 2.11

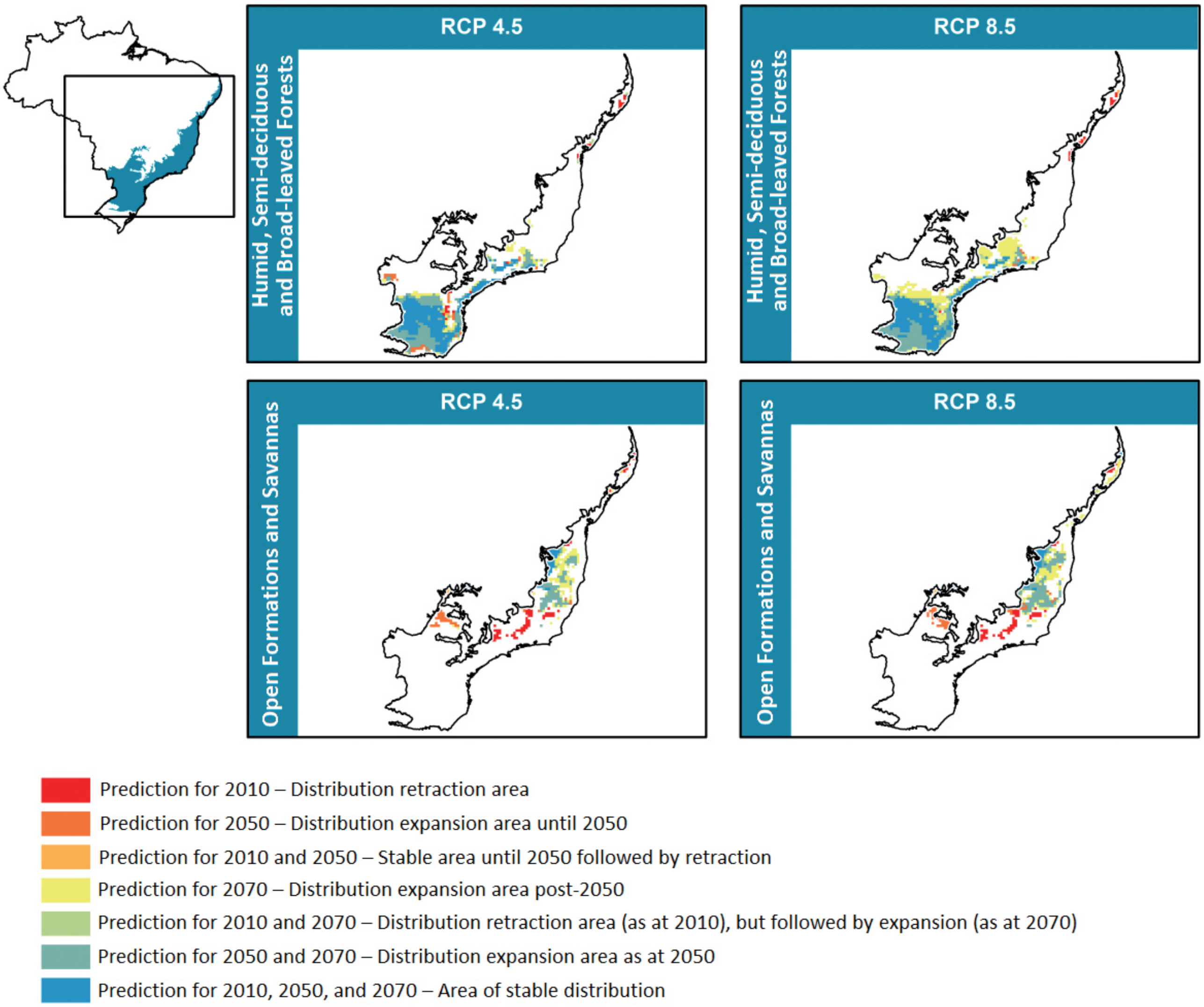
Distribution of vegetation formations in the Amazon biome against climate changes



In its turn, the Atlantic Forest biome will have a small portion of stability in its forest area, in the southern region of its distribution (Figure 2.12). However, an expansion of the forest area distribution in the south and a distribution expansion of Open and Savanna Formations in the northern portion of the biome are anticipated. Even with the anticipation of an expansion for the two types of habitat, the Atlantic Forest can be considered the biome in the most alarming condition from the conservation point of view. The expansion of vegetation, anticipated by our models, will probably not occur, because the locations are occupied by anthropic use. Thus, the additive effect of habitat loss and fragmentation, along with the changes of distribution generated by climate, make the Atlantic Forest the most threatened Brazilian biome.

FIGURE 2.12

Distribution of vegetation formations in the Atlantic Forest biome against climate changes



The Cerrado and Caatinga biomes will lose their small enclaves of Semi-deciduous Humid and Broad-leaved Forests (Figures 2.13 and 2.14). However, its vegetation, which is predominantly composed of Open and Savanna Formations, will remain stable over the years. Consequently, these biomes inspire less concern as for the impacts of climate change taking into account the distribution of habitats.

FIGURE 2.13

Distribution of vegetation formations in the Cerrado biome against climate changes

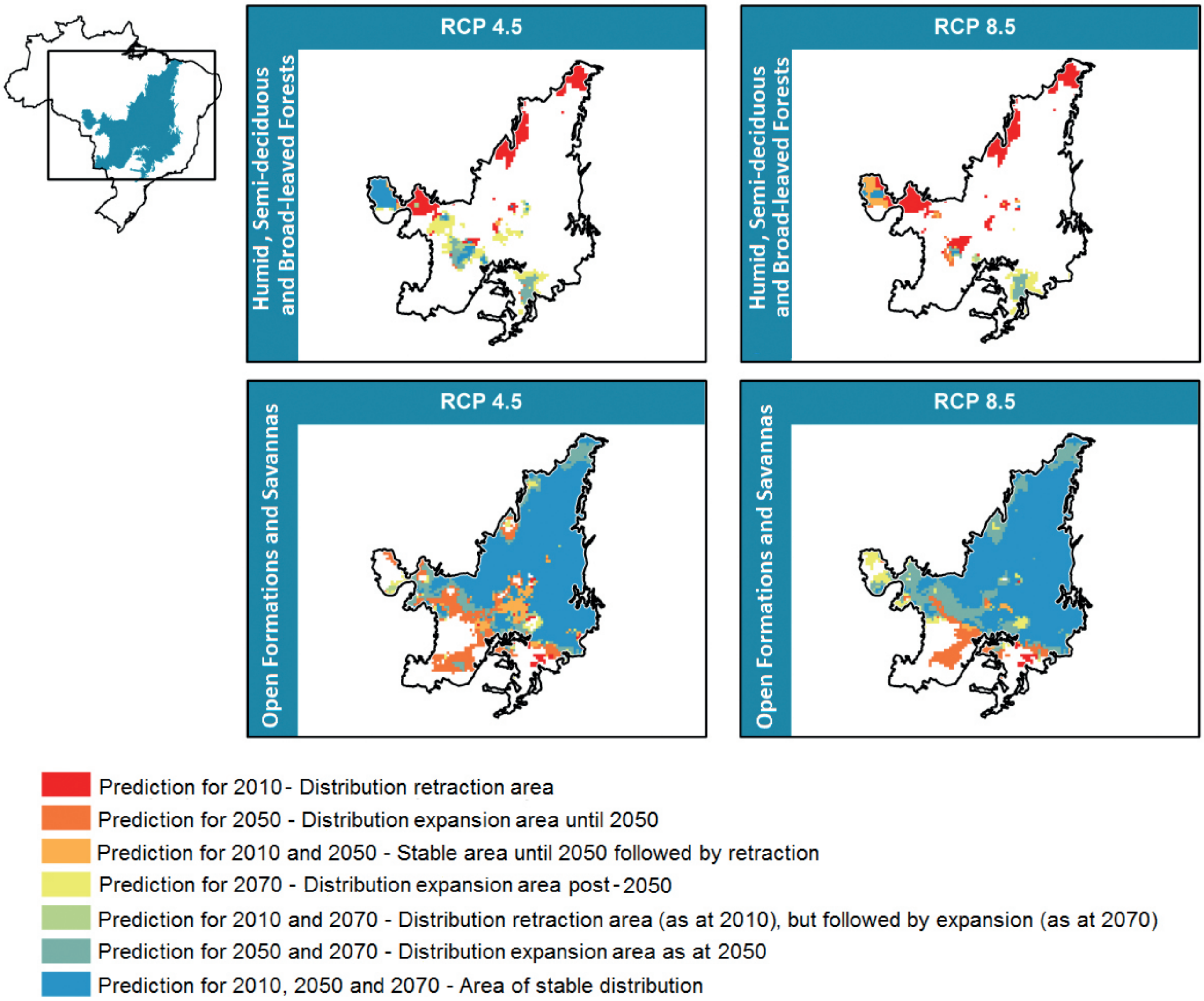
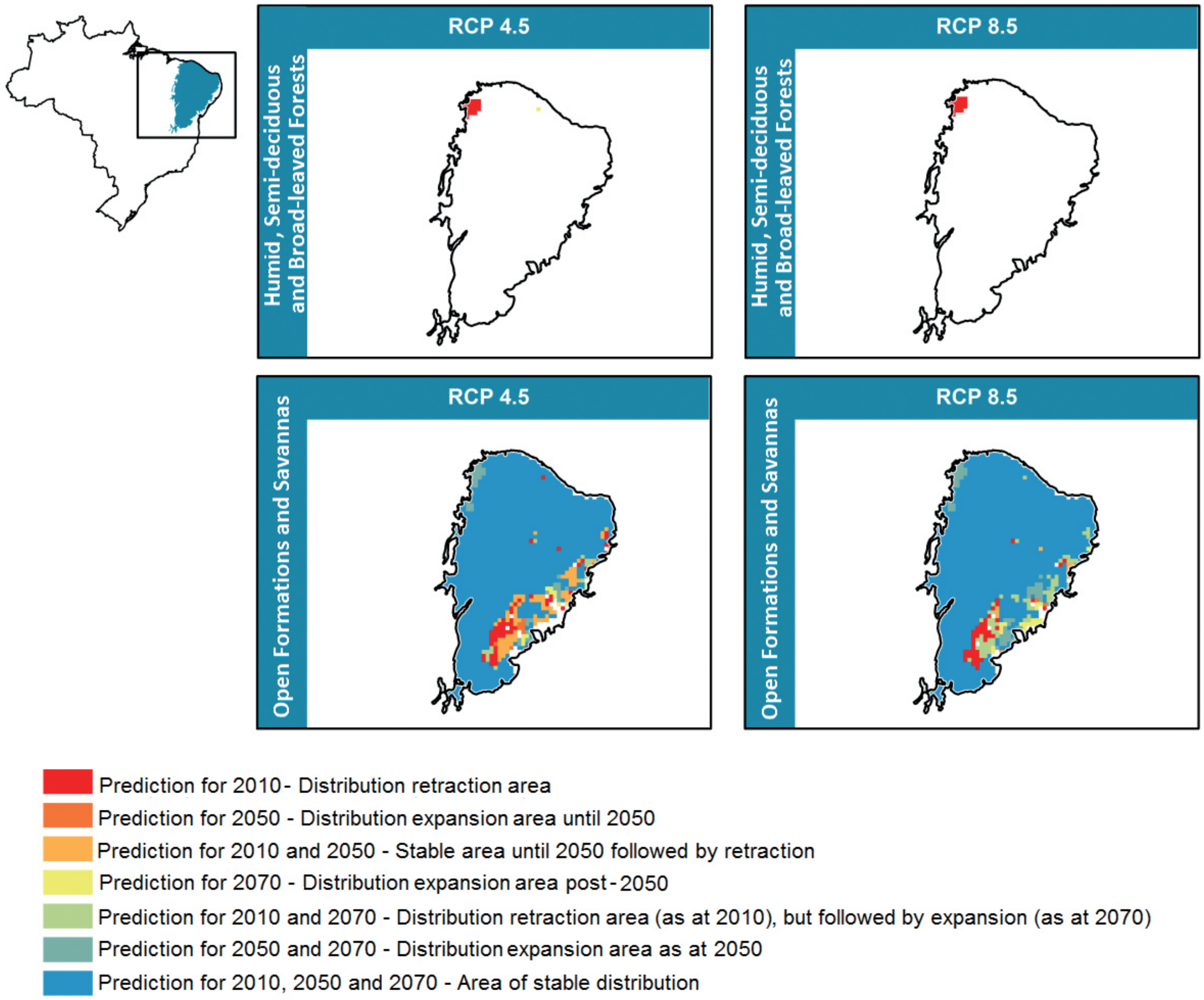


FIGURE 2.14

Distribution of vegetation formations in the Caatinga biome against climate changes



The Pantanal has no prediction for Semi-deciduous, Humid and Broad-leaved Forests for the present or future climate (Figure 2.15). Conversely, the Open and Savanna Formations will be almost completely lost. This is almost the opposite pattern to that observed for the Pampa biome (Figure 2.16), since the Open and Savanna Formations are not anticipated for any of the scenarios assessed, and the Semi-deciduous Humid and Broad-leaved Forests are lost in almost its entirety. Thus, in the Pampa biome, only a forest enclave on the northern side of the biome is anticipated, which seems to be formed due to favorable climate conditions in the future.

FIGURE 2.15

Distribution of vegetation formations in the Pantanal biome against climate changes

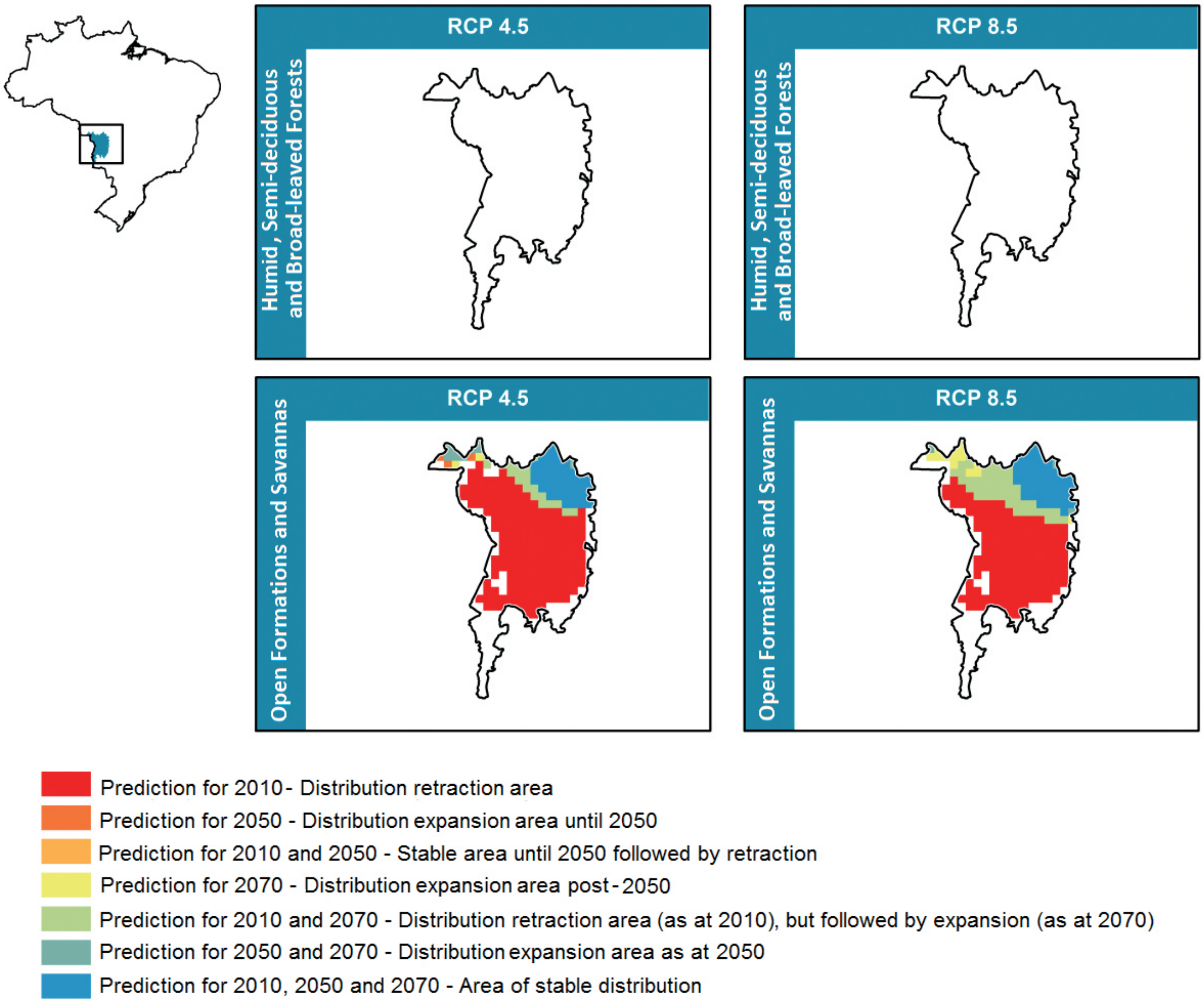
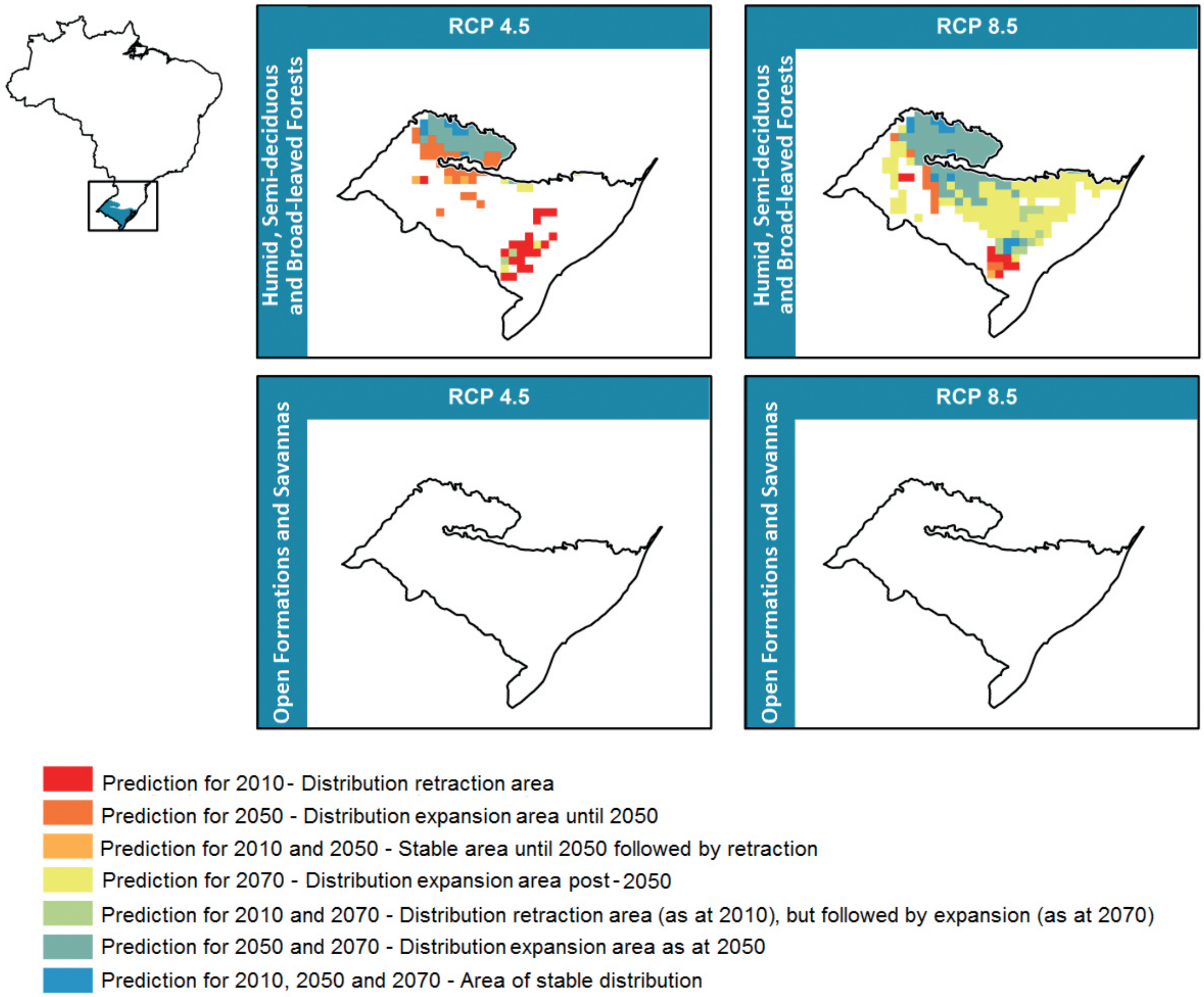


FIGURE 2.16

Distribution of vegetation formations in the Pampa biome against climate changes



Among the impacts that future climate changes can cause on the distribution of the vegetation cover in Brazil, the expansion of the Open Formations and Savanna and the retraction of the distribution of the Semi-deciduous Humid and Broad-leaved Forests are of note. These changes affect Brazilian biomes in different ways because these formations have different representativeness within them. The Caatinga and Cerrado biomes do not seem to be affected in their composition and representativeness of their formations because they are dominated by Open Formations and Savanna which apparently will have great stability in the distribution over time. The Amazon and the Atlantic Forest biomes will be the most affected due to climate change, given that their vegetation is mainly composed by forest formations in Semi-deciduous Humid and Broad-leaved Forests. This leads to the conclusion that climate changes are a real threat to the Brazilian biodiversity.

2.3.2. Agriculture

In order to assess climate change impacts on the Brazilian agriculture, data of the Eta-HadGEM2–ES were incorporated to the Scenagri system (*Simulador de Cenários Agrícolas*- Agriculture Scenarios Simulator[73]), and the incorporated data and tests were validated.

Calculations of monthly climatology for rainfall, minimum temperature and maximum temperature were held for the baseline (1976-2005) and future (2011-2040, 2041-2070 and 2071-2099) periods, as well as the calculation of the delta for precipitation, average temperature, minimum temperature and maximum temperature. Also, adjustments were made to the simulator to allow the use of alternatives to estimate solar radiation, calculation of evapotranspiration, water balance calculation and the Crop Water Requirement Index (ISNA, in the Portuguese acronym).

The methods of estimating climate risk zoning were considered as the basis of impact assessments on agriculture. To this end, the following were taken into account: the cycle, the duration of the phenological phases, the predominant types of soils, the maximum crop evapotranspiration in each ten-day period (ten days) and crop coefficients (Kc). This information was used together with the characteristics and quality of land and weather data. Zoning also included specific levels of sensitivity of crops against extreme temperatures and damp events during critical stages of their growth, based on renowned agricultural calendars.

Areas where the water stress does not prevent the germination and bloom of the seeds nor the grain filling – which are essential factors for final production – were considered as low-risk climate areas. This risk was never above 20%. Indication of low risk was determined by calculating an index corresponding to the ETR/ETM ratio (real and maximum evapotranspiration), which depends on the temperature and water availability.

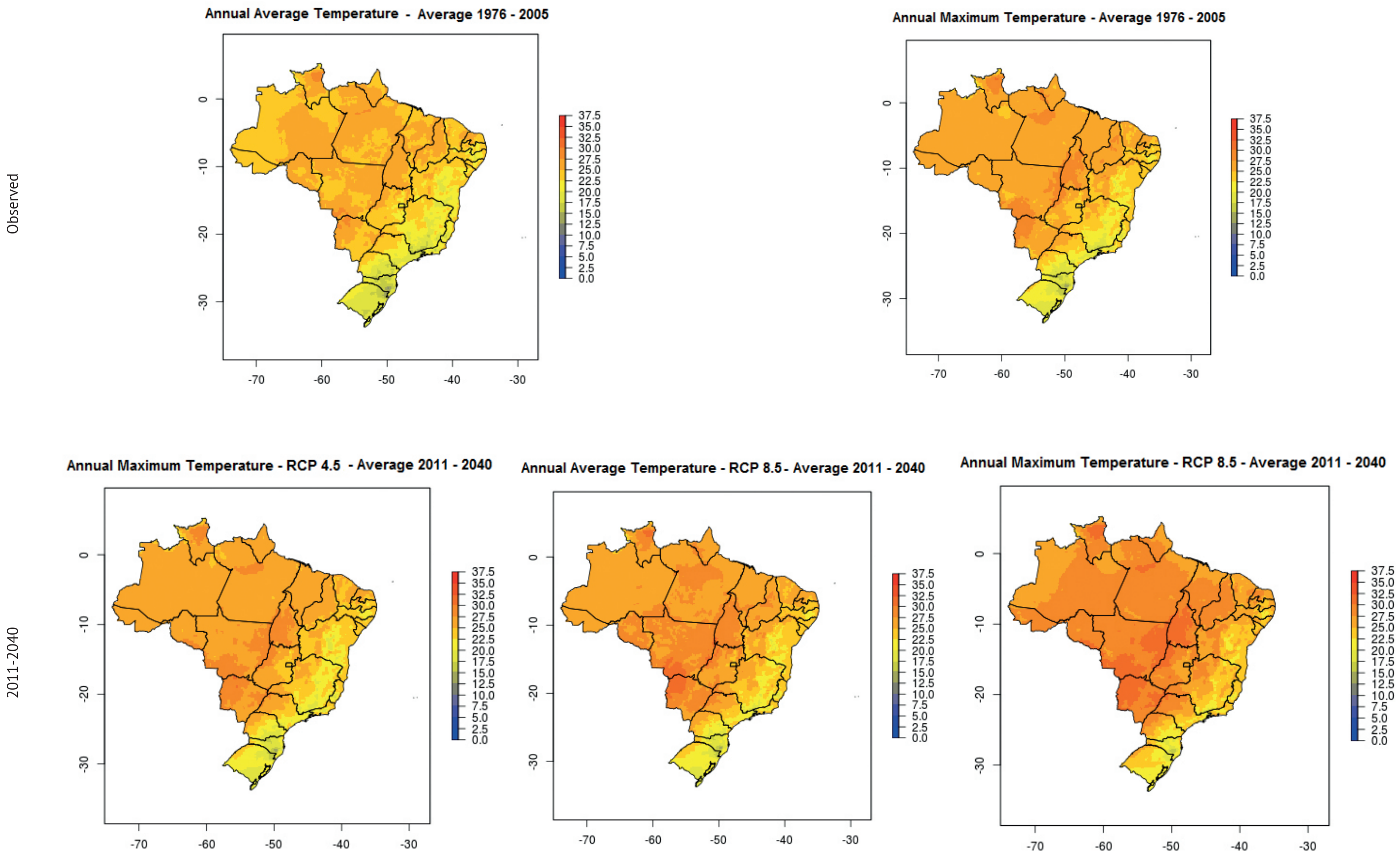
The impact in percentage terms was calculated after the simulation, between the potential area of low risk in the year 1990 and the potential areas of low risk calculated for the years 2025, 2055 and 2085. Evaluations of impacts on corn, maize, soybeans, wheat and beans – first and second harvest – were made.

The climatology of the period, analyzed for every 30-year period, is shown in Figures 2.17 to 2.20. These figures show variations of average, maximum and minimum temperature in both scenarios for 30-year periods, besides the baseline scenario (1975-2005). Temperature rise is evident, for both RCP 4.5 and RCP 8.5 scenarios. In the case of the RCP 8.5 scenario, for the period 2071-2099, the regions with the highest temperature are the Cerrado and part of the Amazon. On the other hand, in terms of rain distribution, an increasing trend in the period 2041-2070 is observed.

73 The ScenAgri is a computer system developed by Embrapa aiming at providing high-performance computing to support the researchers of the institution in the investigation of climate changes impacts on Brazilian agriculture. The system was developed based on a water balance model (known as BIPZON) and allows users to simulate future agriculture scenarios using data from many downscaled climate projections.

FIGURE 2.17

Average temperatures (observed and projected) and maximum temperatures (projected) for the RCP 4.5 and RCP 8.5 scenarios for the baseline (1976-2005) and future (2011-2040, 2041-2070, 2071-2099) periods



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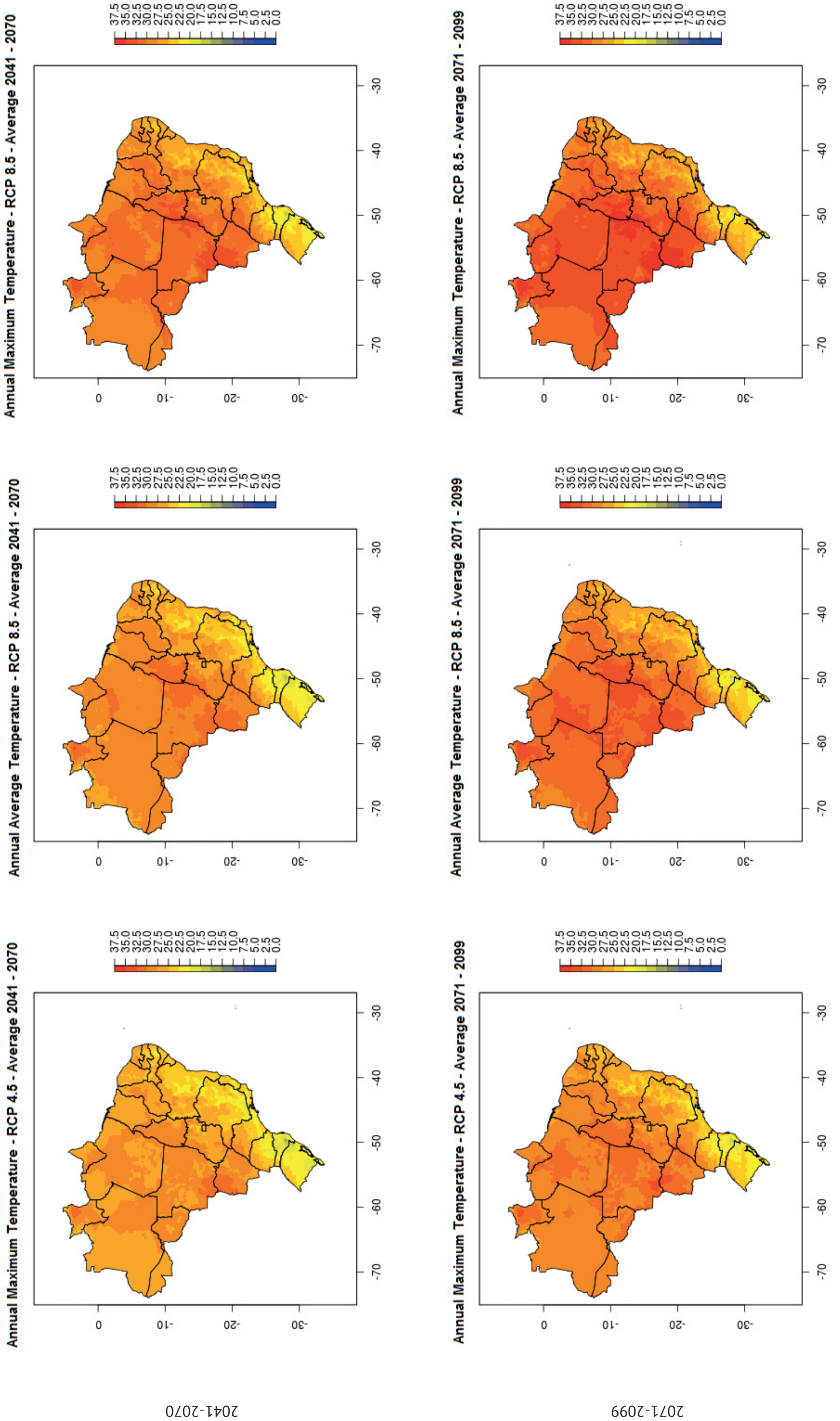
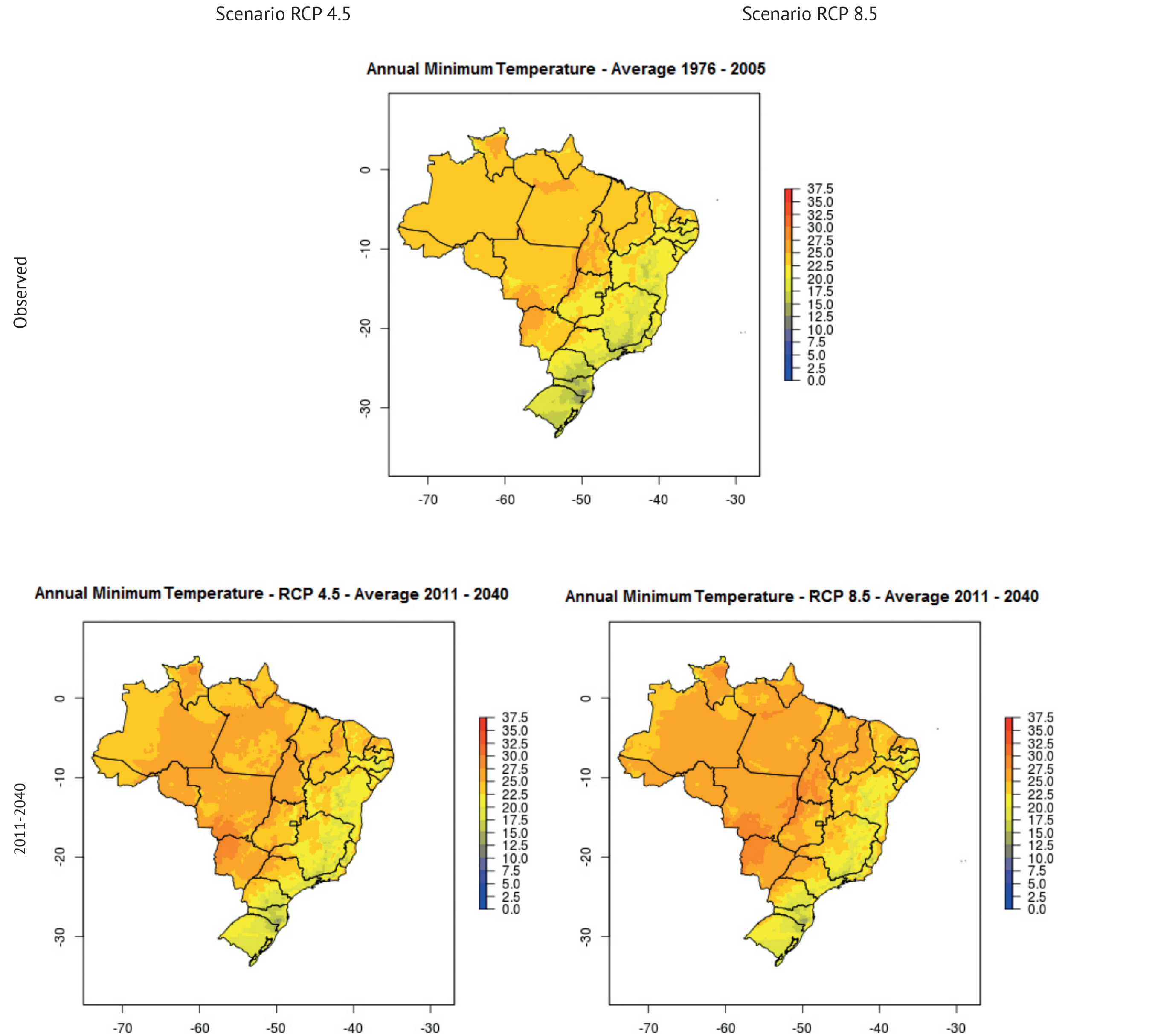

Annual Maximum Temperature - RCP 8.5 - Average 2041 - 2070
Annual Average Temperature - RCP 8.5 - Average 2041 - 2070
Annual Maximum Temperature - RCP 4.5 - Average 2041 - 2070
Annual Maximum Temperature - RCP 8.5 - Average 2071 - 2099
Annual Average Temperature - RCP 8.5 - Average 2071 - 2099
Annual Maximum Temperature - RCP 4.5 - Average 2071 - 2099
2041-2070
2071-2099

FIGURE 2.18

Observed and projected annual minimum temperature for the RCP 4.5 and RCP 8.5 scenarios for the baseline (1976-2005) and future (2011-2040, 2041-2070, 2071-2099) periods



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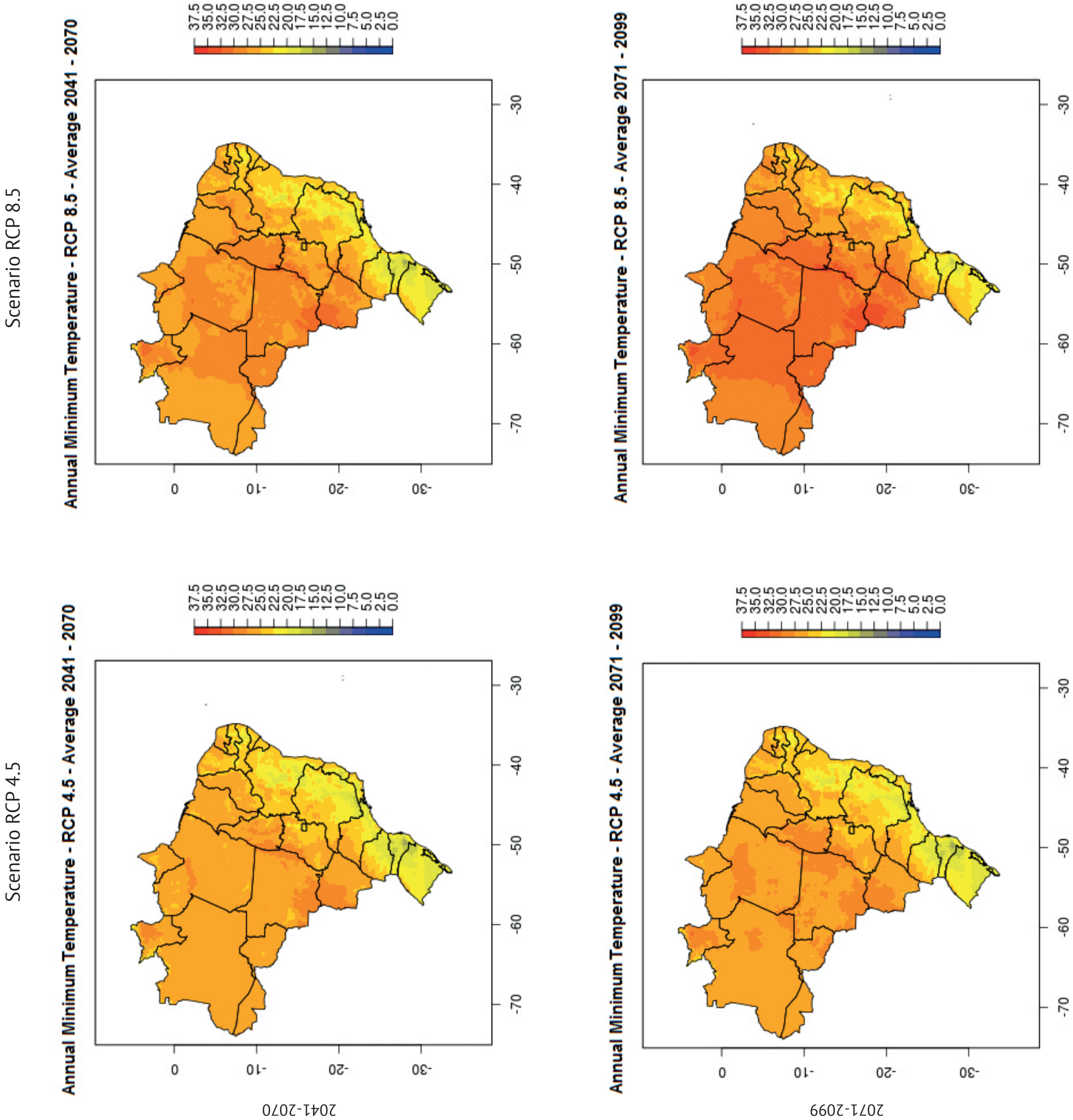
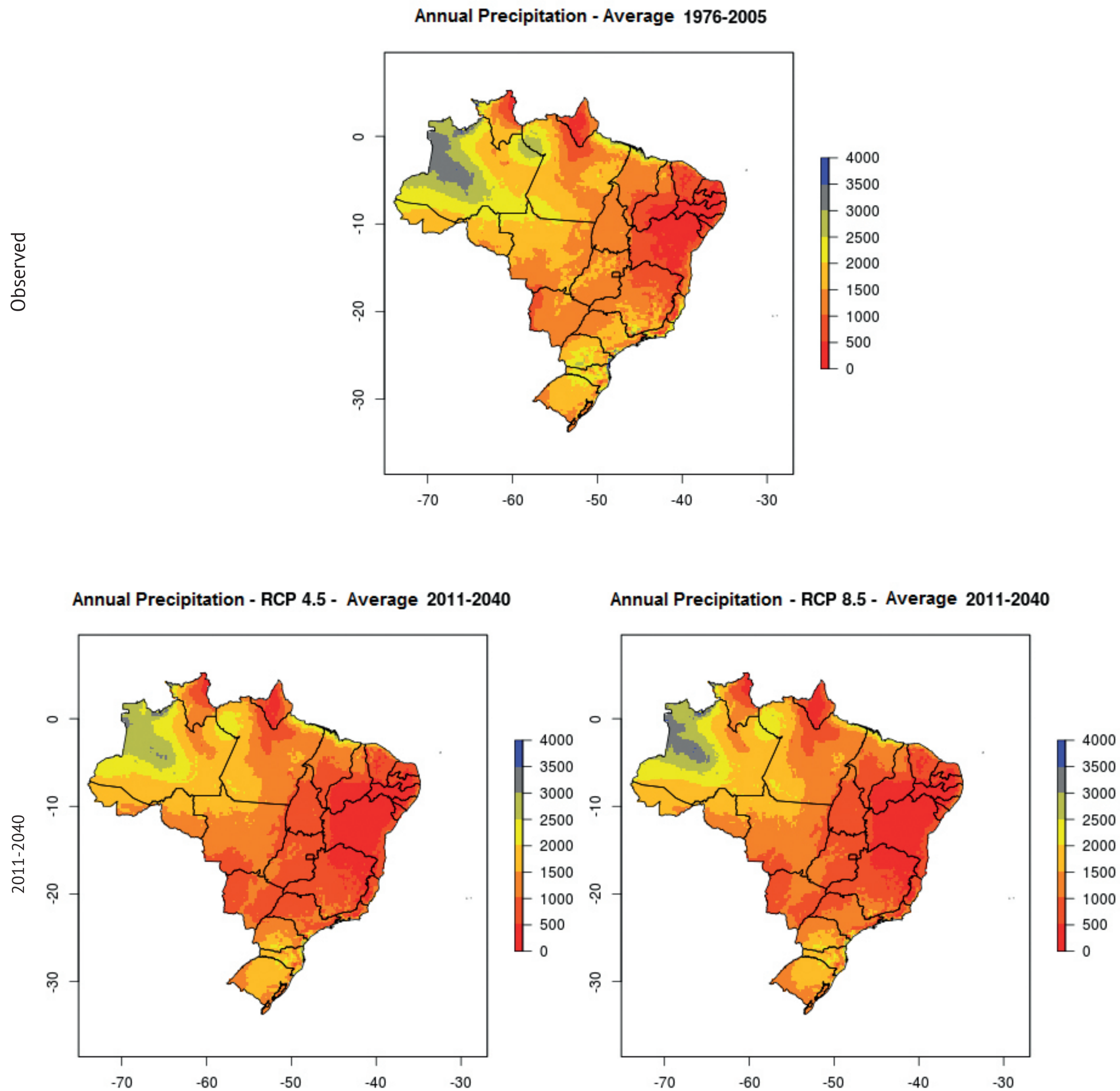

Scenario RCP 8.5
Annual Minimum Temperature - RCP 8.5 - Average 2041 - 2070
Annual Minimum Temperature - RCP 8.5 - Average 2071 - 2099
Scenario RCP 4.5
Annual Minimum Temperature - RCP 4.5 - Average 2041 - 2070
Annual Minimum Temperature - RCP 4.5 - Average 2071 - 2099
2041-2070
2071-2099

FIGURE 2.19

Projected and observed annual precipitation for the RCP 4.5 and RCP 8.5 scenarios for the baseline (1976-2005) and future (2011-2040, 2041-2070, 2071-2099) periods

Scenario RCP 4.5 | Scenario RCP 8.5



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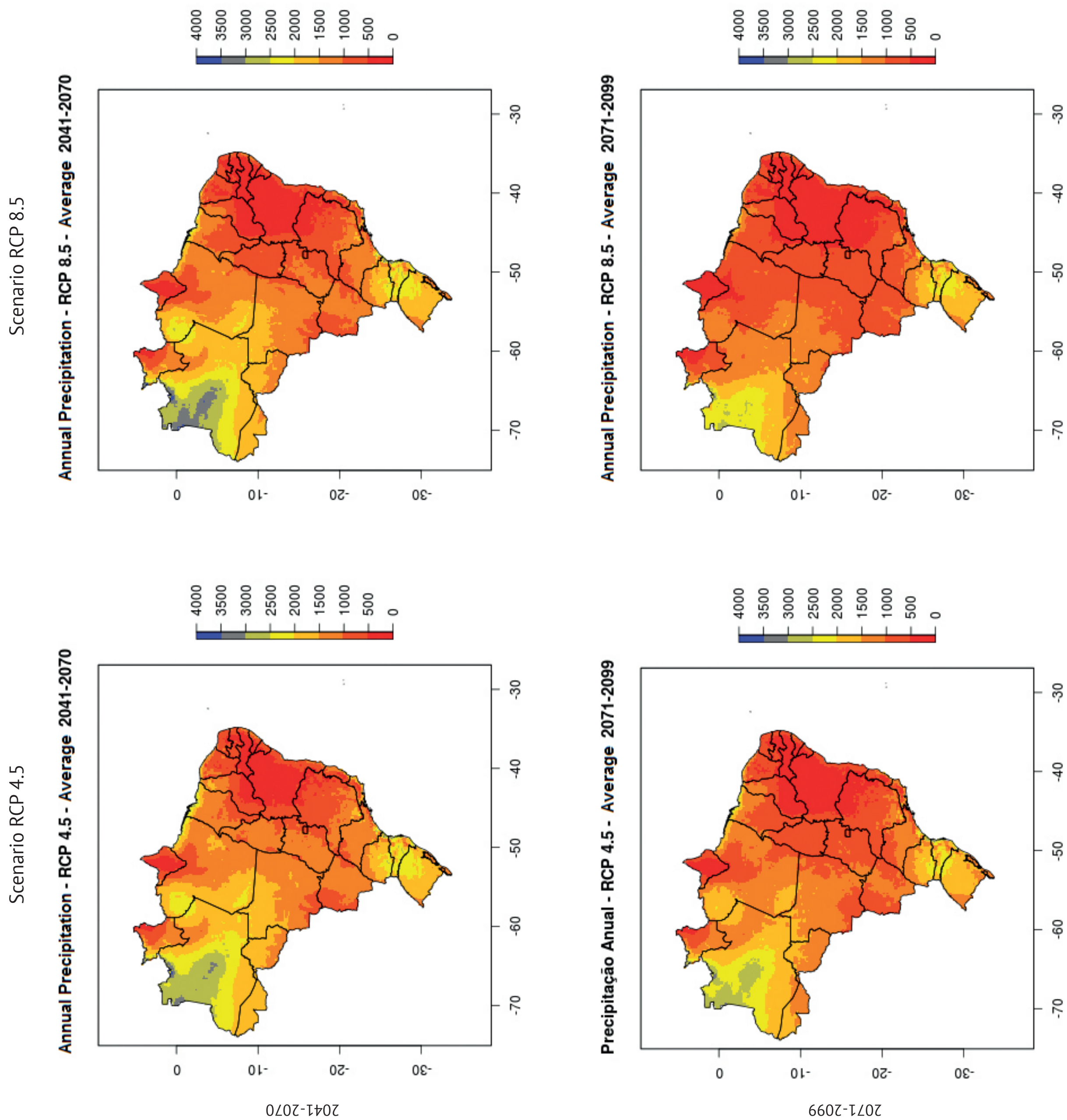
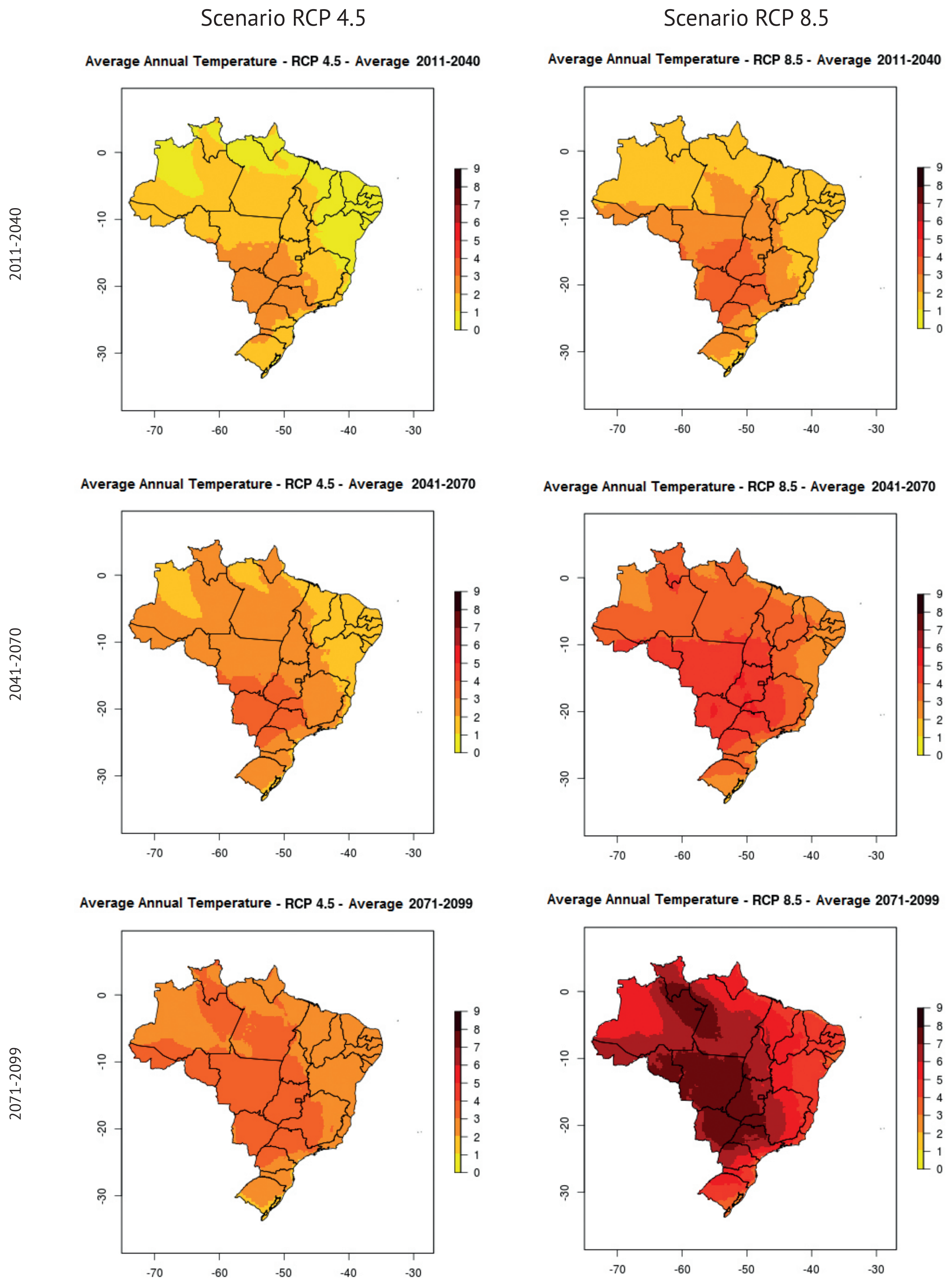

Scenario RCP 4.5
Scenario RCP 8.5
Annual Precipitation - RCP 4.5 - Average 2041-2070
Annual Precipitation - RCP 8.5 - Average 2041-2070
Precipitação Anual - RCP 4.5 - Average 2071-2099
Annual Precipitation - RCP 8.5 - Average 2071-2099
4000 3500 3000 2500 2000 1500 1000 500 0
2041-2070
2071-2099

FIGURE 2.20

Temperature increment in °C per period for the RCP 4.5 and RCP 8.5 scenarios for the baseline (1976-2005) and future (2011-2040, 2041-2070, 2071-2099) periods



In Brazil, the zoning of agricultural risks is a public policy that has been in place since 1996, and each of the 5,564 municipalities (until the year 2010) was demarcated according to cultivation suitability, considering a minimum probability of 80% to have an economically viable harvest. In 2001, Embrapa and UNICAMP developed a simulator to project agricultural risks depending on the climate and soil. This simulator was improved in 2012. At present it provides estimates involving climate impacts on more than 40 crops.

Zoning is based on a water availability index for cropland (vulnerability) and the incidence of extreme temperatures and frost as a result of low temperatures may cause crop losses. Vulnerable areas are identified and quantified based on the effect of temperature in 2025, 2045 and 2085. The principles adopted in the determination of the climatic risk are as follows:

1 The areas with minimal risk are those that do not present soil water deficiency, which results in good germination, flowering and grain filling. This risk should not exceed 20% and is based on the index of crops evapotranspiration.
2 In order to improve risk assessment, in addition to soil humidity, temperatures expected for 2025, 2045 and 2085 were also used.
3 Each low risk agroecological zone was also analyzed in relation to the following factors: soil types, slopes, legal reserves, riparian areas (APPs), indigenous areas, protected areas, thereby increasing the accuracy of the productivity estimates of crop and the probability of occurrence of climate impacts.

Data used in the simulations are shown in Table 2.2, per crop. It is worth highlighting the high uncertainty in the projections anticipated by Eta-HadGEM2–ES, as better detailed in item 2.1.

TABLE 2.2
Set of parameters used in the crop simulator

CROP	CYCLE*	CAD	ISNA
Rice	120	50	0.6
Beans Harvest 1	90	40/45	0.6
Beans Harvest 2	90	40/45	0.6
Corn Harvest 1	120	50	0.55
Winter Corn	120	60	0.55
Soybeans	125	40	0.60/0.65
Wheat	130/140	40/50	0.55

* *Cycle in days, available water capacity in mm (AWC), Crop Water Requirement Index (ISNA) in relation to ETR/ETM.*

When compared to 1990, a slight reduction of planted area of rice is expected for the periods 2025, 2055 and 2085, when using the RCP 4.5 scenario. This reduction becomes slightly more acute for the RCP 8.5 scenario. The losses are limited in irrigated areas with high precipitation.

The second corn crop, also known as *safrinha* ("little crop" in Portuguese) is a risky crop. In global warming scenarios, the risk increases substantially, as a result of temperature increase and water deficiency. This is observed in the RCP 8.5 scenario, in which production constraints are anticipated almost countrywide. In the Southern region, a favorable condition to the production would be the reduction of frosts.

For the first corn crop (summer corn crop), the reduction of the low-risk area in 2025, in the RCP 4.5, is in line with remarks made in the past 20 years. Corn can survive the RCP 4.5 scenario if well cultivated with an increase in the depth of the roots. As for the RCP 8.5 scenario, whose current emissions are keeping up its growth curve, the situation recrudesces and the loss of low risk areas can be bigger. Genetic improvement, correct soil management and biological nitrogen fixation are practices that can minimize these impacts.

The soybean crop is affected in the simulations of both scenarios (RCP 4.5 and 8.5). However, cultivars with high tolerance to drought and water deficiency will be launched on the market aiming at adapting to this scenario. Another adaptation strategy could be a change in production systems that favors water soil balance.

Bean harvest is also affected in both scenarios. This is due to temperature rise, causing abortion of flowers, and intensification of dry spells, with high water deficiency. There are heat-tolerant varieties, partially avoiding flower abortion. Water deficiency can be reduced with two actions: no tillage or irrigation. These options are valid for the RCP 4.5 scenario. For the RCP 8.5 scenario, the situation of the beans crop is even more critical, and may entail losses in low-risk areas. In national terms, the trend is to concentrate the production in the Southern region, where temperatures are mild and water deficit is reduced. Part of the south of Minas Gerais may also be maintained as a producing area.

Second beans crop is more affected than the first one. The explanation is the high water deficiency. Solutions include from drought tolerant varieties to a change of crop management, introducing integrated systems. For the RCP 8.5 scenario, the situation of is even more critical. In national terms, the trend is to concentrate the production to regions, where water deficit is reduced during the second crop. Thus, irrigation is also one of the adaptation solutions to this scenario.

2.3.3. Water Resources

Brazil, as a result of its extensive territory, has distinct climate characteristics that influence water regimes in watershed. Regions such as the semiarid Northeast, for example, are vulnerable due to the natural climate variability, high evaporation rates and low precipitation rates associated with soils that are not very shallow, which prevent the storage of water to better regulate the flow of rivers. The semi-arid region will suffer the greatest consequences in terms of reduced availability of water as a result of climate change (KUNDZEWICZ et al., 2007). Other regions of the country that had no previous frequent supply problems, now feel recurring difficulties with the lack of rain.

Different regions of Brazil have suffered consequences of extreme hydrological events such as floods in the Northeast (DANTAS et al., 2014), in the Amazon (MARENGO et al., 2012b), in the South and in the Southeast. The same occurs with events of drought in the Amazon region (TOMASELLA et al., 2013) and in the Northeast, which occurred from 2012 to 2014. One of the consequences of climate change is the intensification of precipitation extremes that may result in a reduction of the time of return to the same value of rain currently observed (IPCC, 2012).

The impact analysis was performed using outputs of the Eta-HadGEM2–ES and Eta-MIROC5. This analysis adopted an adaptation based on the National Hydrographic Division (CNRH, 2003), as shown in Figure 2.21 and

Table 2.3. It is noted that the total area of the study goes beyond the limits of the Brazilian territory because the choice was to simulate watersheds in a complete way, such as the Solimoes River, which has its sources in Peru and Ecuador. This resulted in a total simulated area of 11,535,645.0 km^2.

FIGURE 2.21
Adopted Brazilian hydrographic division

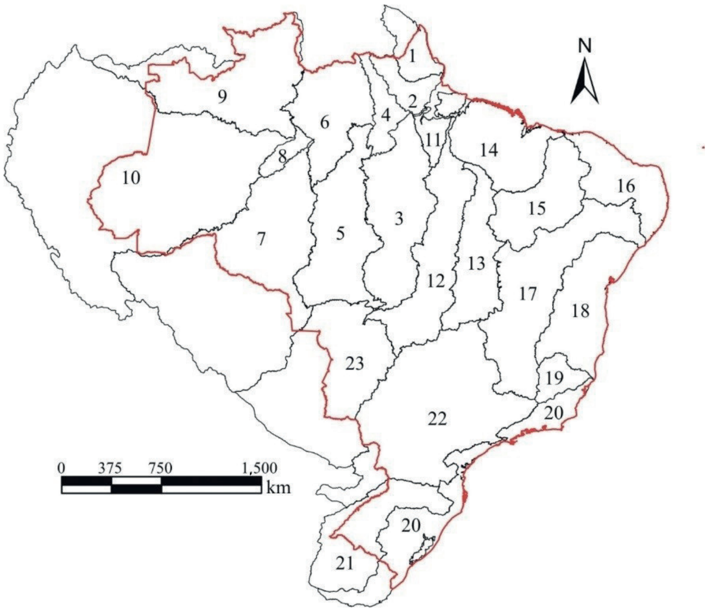


TABLE 2.3
Characteristics of hydrographic regions

NO. OF REGION	NAME	AREA (KM^2)
1	Amapá	136,955.3
2	Amazon River-Mouth	107,436.1
3	Xingu River	514,144.6
4	Amazon River-Tap/Xin	114,795.9
5	Tapajós River	495,410.0
6	Amazon River-Mad/Tap	365,603.9
7	Madeira River	1,382,298.7
8	Amazon River-Neg/Mad	56,778.7
9	Negro River	719,585.4
10	Solimões River	2,208,737.3
11	Amazon River-Xin/Toc	94,976.2
12	Tocantins River	461,375.4

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NO. OF REGION	NAME	AREA (KM²)
13	Araguaia River	305,501.2
14	Western Northeast Atlantic	355,658.3
15	Parnaíba River	330,914.1
16	Eastern Northeast Atlantic	285,467.5
17	São Francisco River	642,877.3
18	East Atlantic	391,112.9
19	Doce River	83,164.4
20	South/Southwest Atlantic	378,688.3
21	Uruguay River	350,333.5
22	Paraná River	964,114.1
23	Paraguay River	789,716.2

The variables used in the ETA model were:

- Daily precipitation
- Air temperature at 2 meters
- Net radiation: emerging surface shortwave radiation + incident surface shortwave radiation + emerging surface long wave radiation + emerging surface long wave radiation
- Relative humidity: obtained from variables and dewpoint temperature at 2 meters
- Wind speed at 10 meters: obtained from the zonal and southern wind components

The variables, except for precipitation, were used for the calculation of the potential evapotranspiration with the Penman-Monteith method. For the series of precipitation, the bias correction methodology proposed by Bárdossy and Pegram (2011) was applied. The hydrological simulation was performed with the Hydrological Model of Large Basins (MGB-IPH) (COLLISCHONN et al., 2007), is a rain-flow model distributed by cells that use a Hydrological Response Unit (HRU) based on maps of land use and soil type.

Statistics that could represent the average flow in the basins were used as indicators of impact, the maximum flows were used for flood events and the minimum flows were used for drought events (ARNELL e LLOYD-HUGHES, 2014; GOSLLING e ARNELL, 2011).

The presentation of the results in terms of spatial distribution allows the view of the impact on the entire national territory as shown in Figures 2.22 and 2.23, in which annual average runoff anomalies are presented in mm.

FIGURE 2.22

Annual average runoff anomaly for the RCP 4.5 scenario of the Eta-HadGEM2–ES model and 2041-2070 period

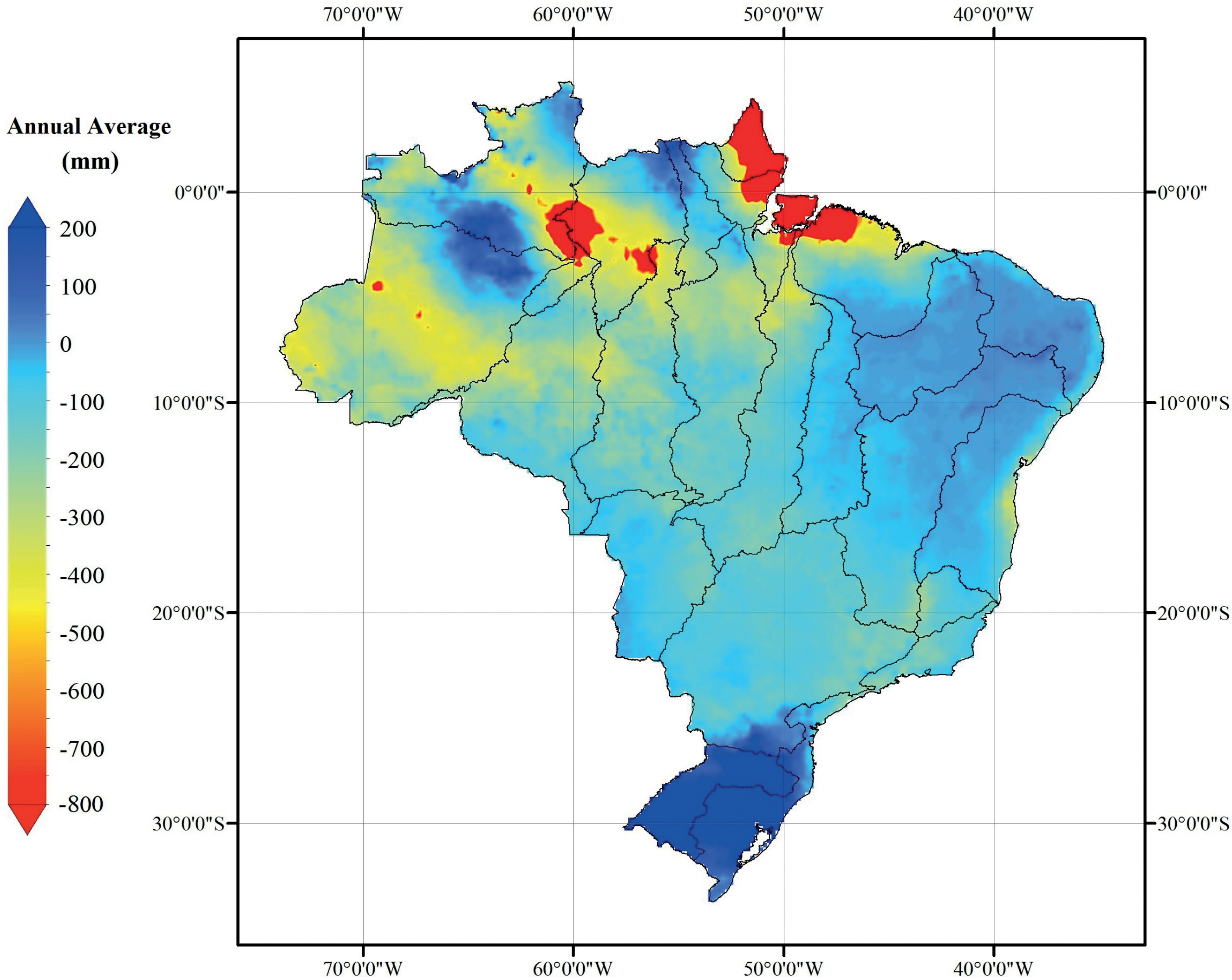
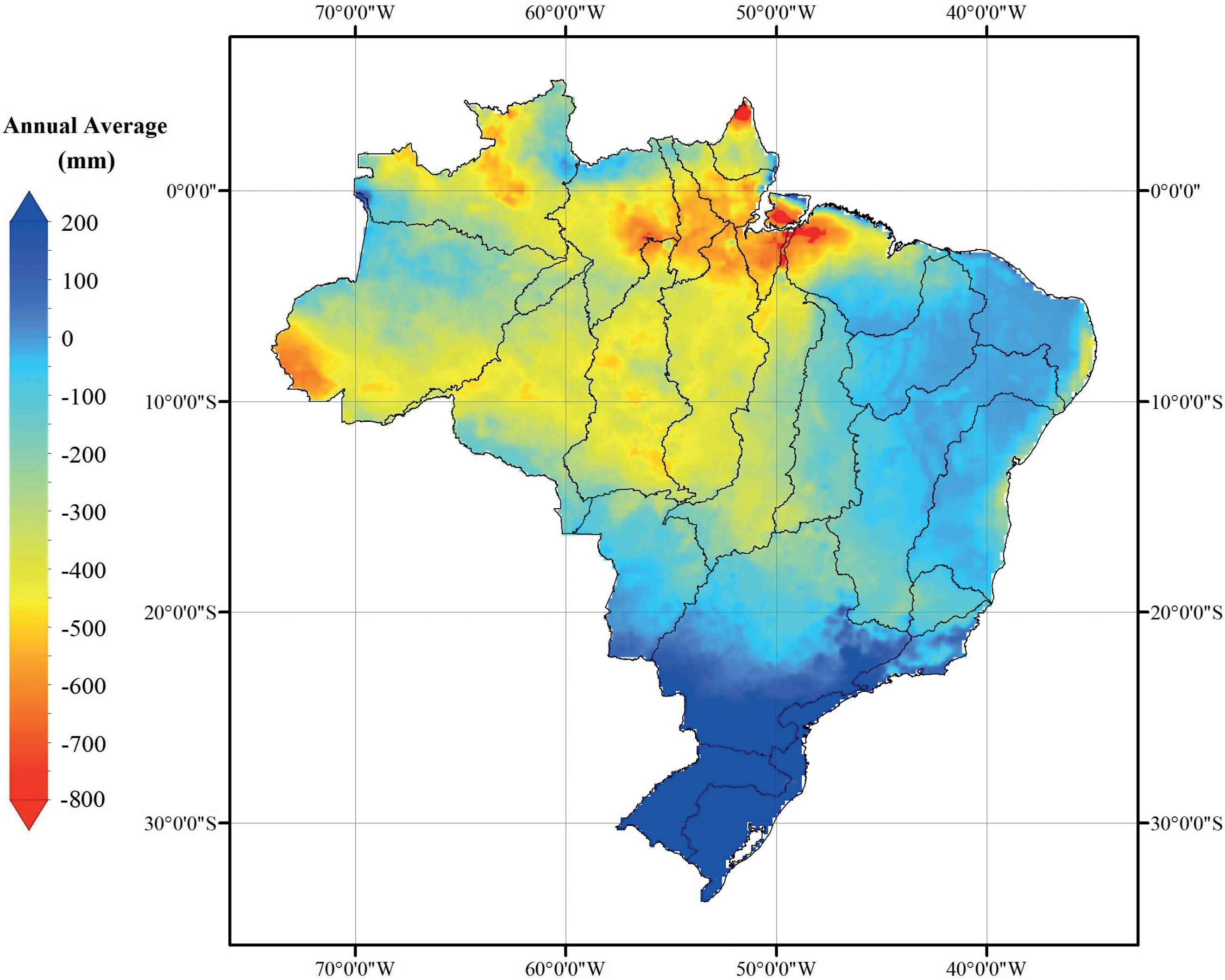


FIGURE 2.23

Annual average runoff anomaly for the RCP 8.5 scenario of the Eta-MIROC5 and 2071-2099 period



The analysis of the anomaly of the runoff in the watershed areas shows that there is a possibility of decrease in the availability of water virtually all over Brazil. The main reductions in percentage terms are in the watershed areas of the rivers Doce, Sao Francisco and East Atlantic for the Eta-HadGEM2–ES model. In the Eta-MIROC5 model, the largest reductions occur in the watersheds of the Araguaia Tocantins and Xingu Rivers. There are watersheds that behave differently depending on the horizon analysis. For example, the areas of the Uruguay and South/ Southeast Atlantic rivers have low reduction in 2011-2041 and 2041-2070 and high reduction in the period of 2071-2099. The uncertainty associated with the projections made by the models, as further detailed in Section 2.1 of this Volume, should be considered.

The statistics of extreme values show that, for the occurrences of floods considering a 20-year return time, there is a decrease in flow with the Eta-HadGEM2–ES model for the 2071-2099 period for virtually all regions. However, for the other horizons, there is significant elevation of the extreme flow until 2040, with emphasis on the regions of the Uruguay, Parana and South/Southeast Atlantic rivers. A similar behavior is observed with the results of the simulations with the Eta-MIROC5 model.

Regarding the calculation of daily runoff, associated with the minimum runoff within the hydrographic regions, a reduction is noted and it indicates an intensification of the drought periods of the hydrological regime. The largest reductions are noticed in the watershed of the Doce and Eastern Atlantic Rivers using the Eta-HadGEM2–ES model, and Araguaia, Tocantins and Xingu Rivers using the Eta-MIROC5 model. This result is similar to that observed for the anomaly of the average annual runoff.

2.3.4. Renewable energies

The assessment of renewable energies vulnerability to climate change was calculated based on climate data of the Eta-HadGEM2–ES model, considering the RCP 4.5 and RCP 8.5 scenarios, for baseline (1961-1990) and future (2010-2040, 2041-2070 and 2071-2100) periods. Reviews on the production of hydroelectric and wind energies are presented in this section.

a) Hydroelectric power

Indexes that are intended to forecast the variation of the Brazilian watershed flows regarding precipitation and the indexes of evapotranspiration estimated from latent heat flux were used to assess the vulnerability of the Brazilian hydroelectric sector to the global climate changes.

The Evapotranspiration Index is based on the precept that the changes in the physical water state from liquid to steam demands an energy consumption of 590 cal/g. Within this context it was possible to estimate the transformation of the latent heat flux into evapotranspiration, using the following conversion factors: 1W/m^2 = 0.0864MJ/m^2.day; and, 1mm/day = 2.45MJ/m^2.day (SOUZA, 2004; FAO, 1998).

The calculation of the Water Balance Index was used to correlate precipitation and evapotranspiration and, thus, to evaluate an upward or downward trend in Brazilian watersheds and, consequently, hydropower generation.

The Water Balance Index is presented in maps developed from the interpolation produced with the ArcGIS software. The maps indicate the positive or negative variation of the index (making the region wetter or drier) divided per watershed. For this purpose, the division of watersheds according to the National Department of Water and Power (DNAEE), of the Brazilian Electricity Regulatory Agency (ANEEL), was used, as shown in Figure 2.24. The water balance ratio is directly proportional to the rivers flow, which directly influences the hydroelectric potential of the region.

FIGURE 2.24

Watersheds division in Brazil according to the DNAEE

Source: ANEEL (2014).

The result of the Water Balance Index calculated in this study is shown in Figure 2.25 for the period of historical time, corresponding to the years between 1961 and 1990 and also for the future time periods (2010-2040, 2041-2070 and 2071-2100).

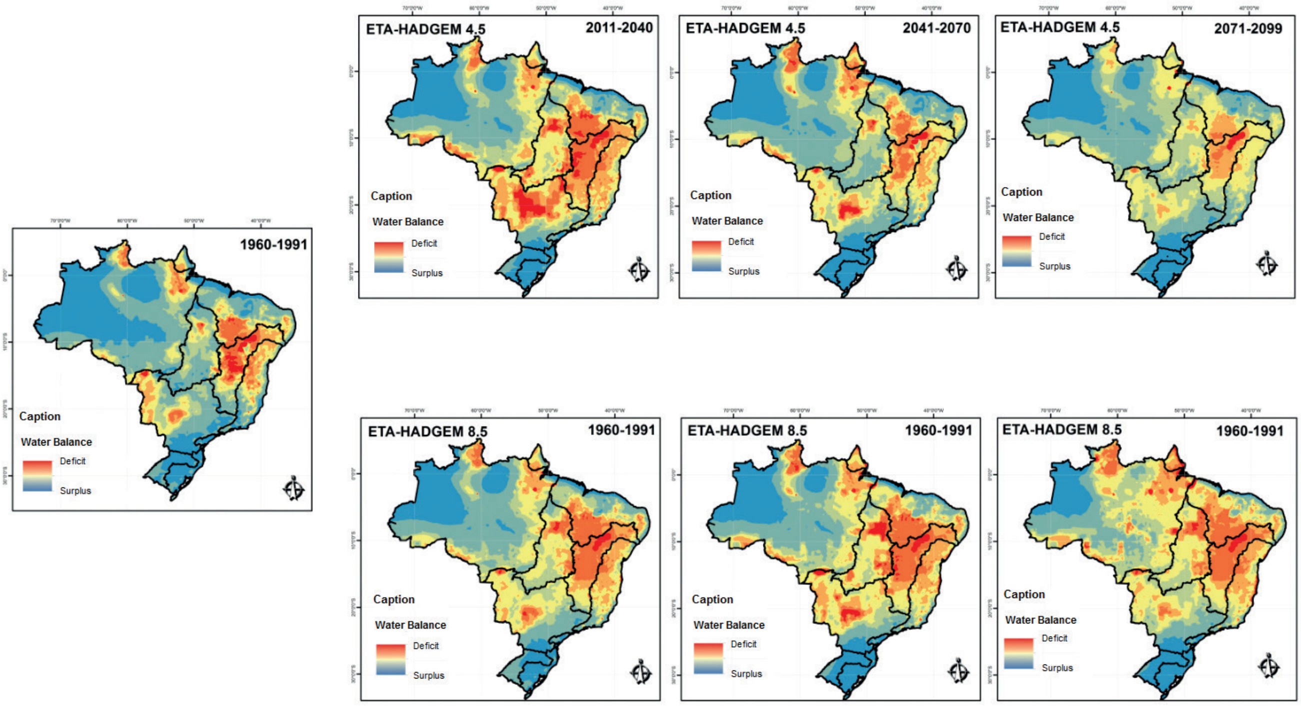
In general, an upward trend of areas with negative Water Balance Index (water deficit) is observed, tending to zero in both scenarios. The increase in the area of water deficit is larger in the most pessimistic scenario (RCP 8.5). Only in the watersheds located in the further south of Brazil (Parana and Paraguay, South Atlantic and Southeast and Uruguay) there is an upward trend in the water surplus for the projected periods.

In terms of hydroelectric production, the greater the surplus, the greater the hydroelectric production capacity of the watershed. In general, the Water Balance Index highlights a downward trend in the hydroelectric production capacity in the watersheds in the north and in the central region of the country and, at the same time, an upward trend in this potential for Brazil's southern watersheds (Figure 2.25). However, results require further research due to the uncertainties inherent in modeling, especially precipitation forecasts, with large differences between the models as described in section 2.1 of this Volume. Another issue refers to the average values of water balance. Because it is an average, it is extrapolated to the entire watershed, therefore it does not represent the reality of specific areas of hydroelectric exploitation. This caveat is especially necessary when analyzing the Amazon Watershed, due to its large size, where hydroelectric sites are located in specific regions. Since the values are general, this may imply that the modeled data has major discrepancies with respect to the actual values in these areas.

An overview of the findings shows the projection of increasing water deficit in almost all of Brazil, mainly in the central region, for years to come (period 2011-2040), followed by a slight recovery in the following periods. At the same time, the southern region of Brazil will present increasing water availability from the current scenario. These forecasts should be evaluated with caution, because a correct and robust analysis demands the consideration of the vegetation in the biomes. Vegetation has key role in the final water balance. The uncertainty of the models as described in Section 2.1 of this Volume must be considered.

FIGURE 2.25

Water balance distribution in Brazil for the historical and future periods using the Eta-HadGEM2–ES, RCP 4.5 and RCP 8.5 scenarios



b) Wind power

Production of wind power is linked to wind behavior, with speed intensity and direction as its main determinant factors (AMARANTE et al., 2001). Relief, soil roughness and other obstacles distributed along the surface can change the intensity of wind speed, becoming another important variable. Wind power density must be greater than or equal to 500W/m^2 at the height of the turbines installation, which requires a minimum wind speed of 7 to 8m/s, for it to be considered technically usable (GRUBB et al, 1993 *apud* ANEEL, 2005). Schaeffer et al. (2008) argue that the minimum considerable speed for the wind exploitation is 6 m/s and values above 8.5 m/s are considered high speed.

In order to assess the vulnerability of the Brazilian wind power sector to climate change, the Average Total Speed Index of the Winds and the Winds Intensity Trend Index by Season of the Year, which aim at predicting the variation of wind speeds throughout the national territory, were calculated.

The Average Total Speed Index was calculated by the wind speed at 100 meters of altitude due to the trend of height installation of new wind turbines between 80m and 100m. Despite the importance of the vegetation impact on climate projections of wind speed, no projection of vegetation based on the projections of the climate model used was considered, and should be included in future analysis.

The indexes of total winds speed will be presented in maps developed from interpolation, using the ArcGIS software. The wind speed classes were divided in a way to provide the analysis of the variation of areas with different winds intensities, in classes related to a higher or lower wind productivity: < 3 m/s, 3-4 m/s, 4-5 m/s, 5-6 m/s, 6-7 m/s, 7-8 m/s, > 8 m/s.

Figure 2.33 was produced with the calculation of total wind speed, showing the distribution of speeds divided by intensity classes. It is worth mentioning that the effect of total wind speed is marked down when using 30-year averages without considering seasonality. Therefore, upward trends should be adjusted.

For this reason, wind speed variation maps were produced considering seasonality. Figures 2.26 to 2.28 present maps of average variations (30 years) of total wind speed for the periods 2010-2040, 2041-2070 and 2071-2100 compared with the historic period (1961-1990) for each season (summer: December, January and February – DJF; fall: March, April and May – MAM; winter: June, July and August – JJA; and spring: September, October and November – SON) using RCP 4.5 and 8.5 scenarios, respectively.

For both scenarios, an upward trend in the wind speed intensity in the North, Northeast, and South is observed, thus defining them as potentially producing areas of wind power. The increase in winds speed is more pronounced during summer and fall for the RCP 4.5 scenario and during spring and summer in the RCP 8.5 scenario. Areas with projection of wind speed reduction can be observed mainly in the Central-west regions and in the State of Amazonas, noting that these areas will remain not having the potential to produce wind power.

It is worth noting that according to Chou et al. (2014b), the Eta-HadGEM2–ES model has the temperature overestimated in the region of the state of Amapa, which may be corresponding also to an overestimation of the wind speed in this region, because of the consequent increase in pressure. For the RCP 8.5 scenario, this trend may lead to an even greater error in this overestimation of wind power generation potential when compared to the RCP 4.5 scenario.

A more accurate assessment of the trend to use wind to generate energy would require land-use projections based on the climate projections of the model used in this study. The impacts of the land roughness on climate projections of wind speed are relevant for this type of analysis.

FIGURE 2.26

Wind speed intensity classes at 100m for present (1961-1990) and future (2010-2040, 2041-2070 e 2071-2100) periods in the RCP 4.5 and 8.5 scenarios

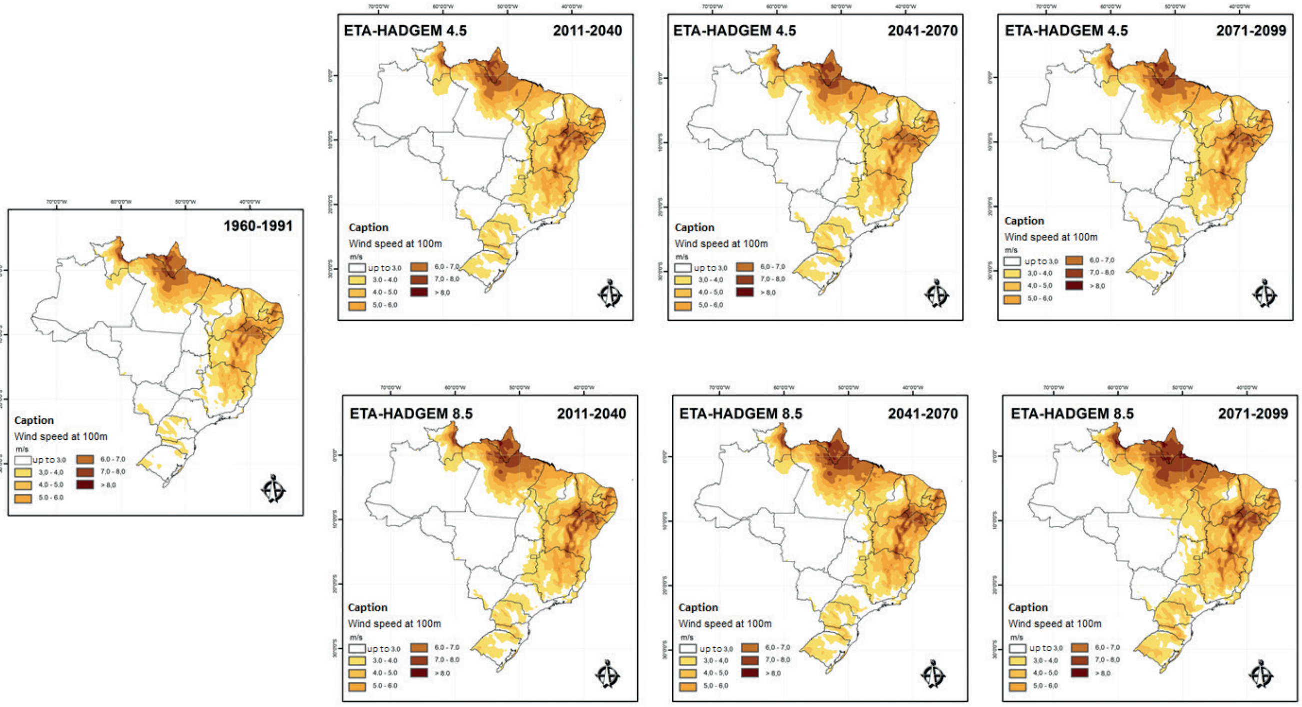


FIGURE 2.27

Wind speed variation at 100m for future periods (2010-2040, 2041-2070 e 2071-2100) in relation to the baseline (1961-1990) in the RCP 4.5 scenario of the Eta-HadGEM2–ES model

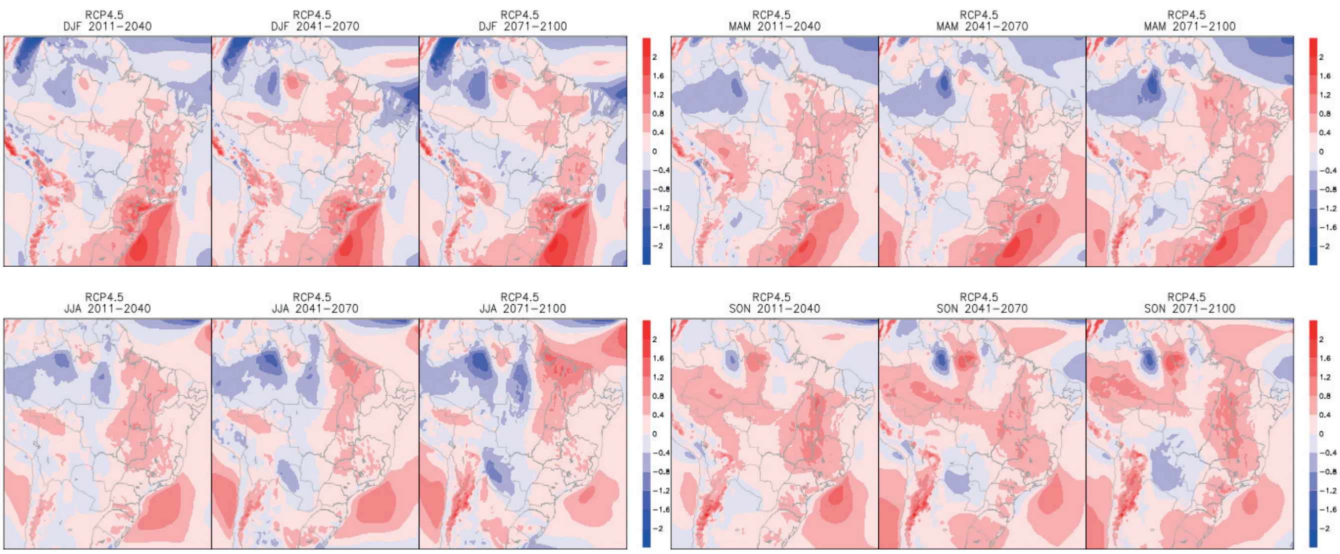
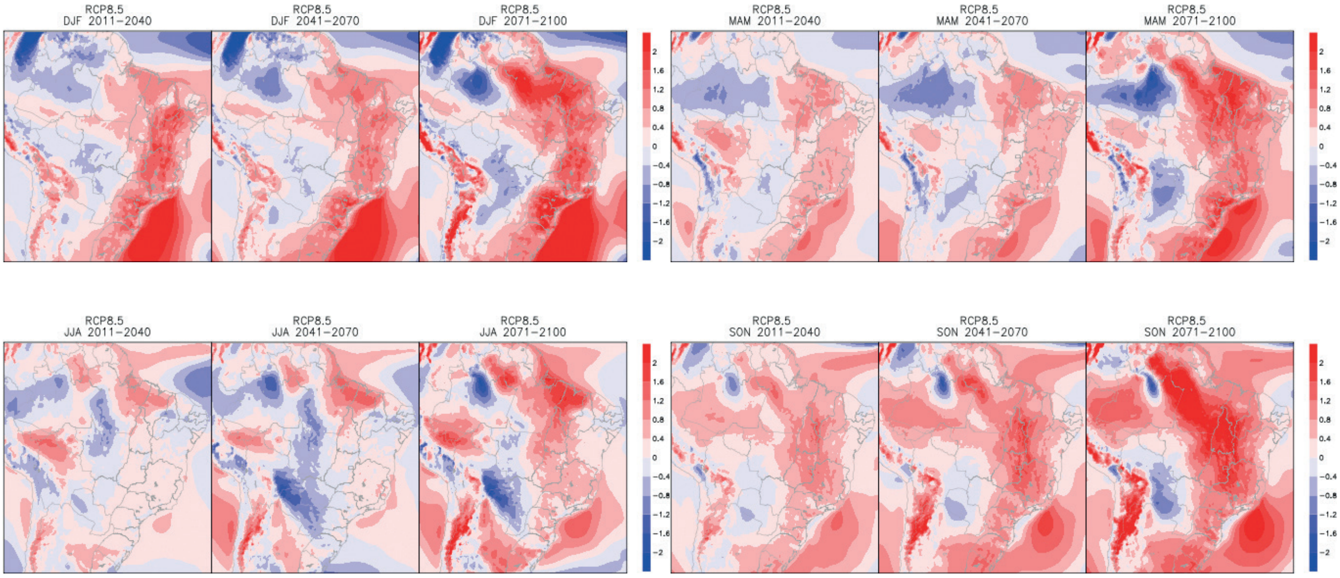


FIGURE 2.28

Wind speed variation at 100m for future periods (2010-2040, 2041-2070 e 2071-2100) in relation to the baseline (1961-1990) in the RCP 8.5 scenario of the Eta-HadGEM2–ES model



For the assessment of the potential use of wind to generate energy, the same deficiency is found. The land use and coverage for this assessment is of fundamental importance. In general, there is an increase projection of winds in the North, Northeast and South regions of Brazil. These regions may be considered as potential areas for the installation of wind farms. It should be noted that, without a great leap in the cost efficiency x benefit for the use of wind energy, this energy matrix may only be considered a complement to the hydroelectric generation.

2.3.5. Natural disasters caused by water

Natural disasters have become one the main challenges of the 21st Century, not only due to the increase in their occurrence and their magnitudes, but also for their complexity, comprehending a diversity of fields of Science to access them. In Brazil, most disasters consist of extreme meteorological phenomena, mostly involving rainfall and storms. These events are characterized by triggering intense physical and quick processes, such as mass movements and floods. The speed with which these events occur leads to a great number of people affected, making them homeless and causing many deaths (MARENGO, 2009).

This section therefore focuses on Brazilian vulnerabilities related to flooding (especially flashfloods), overflows, inundations and mass movements (especially landslides) which, annually, end up with thousands of deaths all over the globe, only behind earthquakes in the list of top killing disasters in past few years (BRASIL, 2011a). The analyzes carried out for this sector aim at collaborating with the understanding of the vulnerabilities of the Brazilian municipalities then, and only then, to support proposals for adaptation focused on minimizing the possible future impacts.

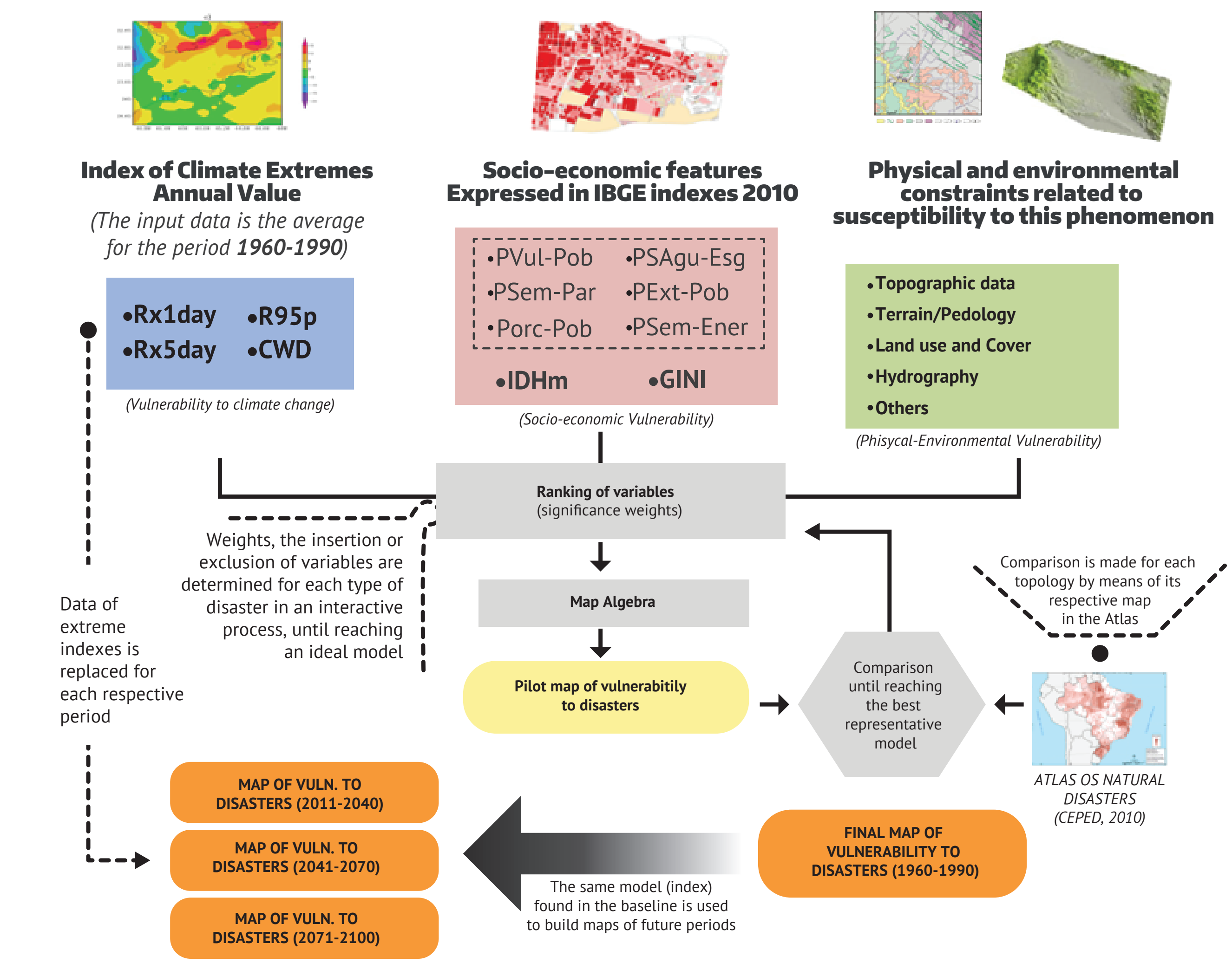
Regardless of where they occur, both these disasters have called attention also for the fact that they are affected by global climate changes, since they are directly linked with the occurrence of extreme hydrometeorological events. It is possible to note the increase of severe events related to rainfall for present climate, above all, in their amplitude in tropical and subtropical regions, such as the Southeastern and South of Brazil (MARENGO et al., 2007). As for future climate, recent studies call attention to the same trend of increased extreme climate events until the end of the 21st century in the same regions (IPCC, 2014). This means that regions with a recent history of severe rainfall events may suffer even more in the future, demanding special attention from the scientific community and from the government.

Assessment of vulnerabilities to these disasters in the future demanded the definition of indexes that approach three different dimensions: socioeconomic, climate and physical-environmental. The indexes are made of variables and sub-indexes that are aggregated through a model that relates them and, then, creates the index that represents the overall vulnerability of Brazilian cities to both types of disasters. The method is based on some important studies about the issue of natural disasters, mainly Peduzzi et al. (2009). The flow chart with methodological steps is shown in Figure 2.29.

It is noteworthy that only the socioeconomic dimension was based on a previously structured sub-index that was used both for floods and mass movements. For the other dimensions, the variables will be presented by type of disaster, in a way that their relation and the significance weights will be determined through an interactive process, in the stage of comparing with maps from the Natural Disasters Atlas (CEPED, 2012).

FIGURE 2.29

Flow chart regarding methodological steps and data used for the index construction and of vulnerability maps to natural disasters

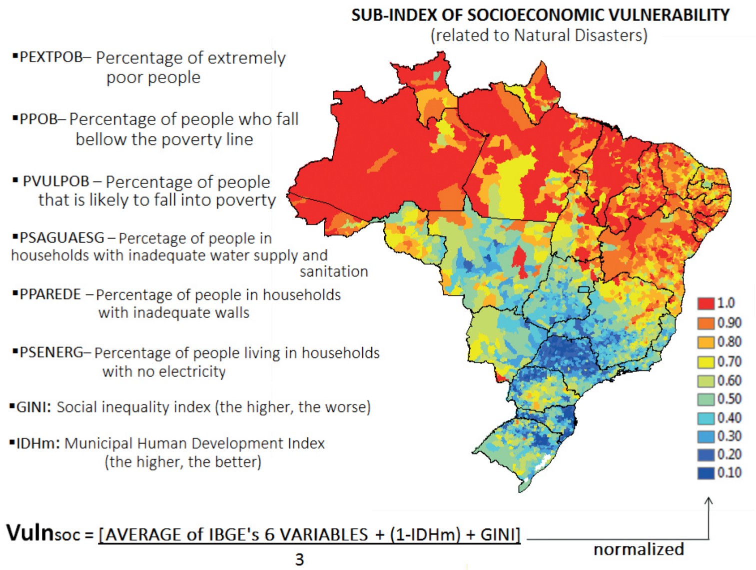


Source: Adapted from Camarinha (2014).

Socioeconomic vulnerability – floods and mass movements

The construction of the sub-index of socioeconomic vulnerability shown in Figure 2.30 was based on the database provided by the 2013 Human Development Atlas in Brazil (PNUD, 2013), as Brazil does not have a specific social database for this subject. The indicators bearing a direct relation to socioeconomic vulnerability related to natural disasters were selected from that database. The first indicator used was the Municipal Human Development Index (MDHI) , which synthesizes indicators of sub-areas (education, life expectancy, health, income, etc.), and percentages that represent the vulnerable population (that is, the percentage of people who fall below the poverty line – POB); the percentage of people that are likely to fall into poverty – PVULPOB; the percentage of extremely poor people – PEXTPOB; the percentage of people in households with inadequate water supply and sanitation – PSAGUAESG; percentage of people in households with inadequate walls – PPAREDE; percentage of people living in households with no electricity – PSENERG) and the GINI Index, which measures the degree of social inequality according to household income per capita.

FIGURE 2.30
Sub-index of socioeconomic vulnerability



Using the proposed methodology, the sub-index of socioeconomic vulnerability had a softening factor inside the total vulnerability index that was being calculated. This means that municipalities with the worst levels (higher values) have few conditions to minimize vulnerabilities that occur naturally, thus becoming more vulnerable when compared to others with better socioeconomic indicators.

Flashfloods, overflows and floodings

In order to represent the climate dimension of vulnerability to inundations, overflows and floodings, extreme rain indexes were used (maximum 1-day precipitation– RX1day; daily rainfall falling above the 95th percentile – R95P; maximum 5-day precipitation – RX5day; Consecutive WetDays – CWD). The option was to linearly normalize data on a 0.00 to 1.00 scale, in a way that all indexes would, theoretically, have a directly proportional relation with vulnerability (Figures 2.31 and 2.32).

FIGURE 2.31

Extreme precipitation indexes sourced from the Eta-HADGEM2–ES model, used to represent climate dimension of vulnerability to disasters involving flashfloods, overflows and flooding

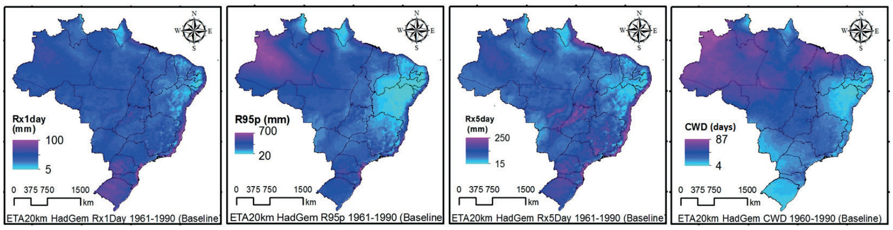
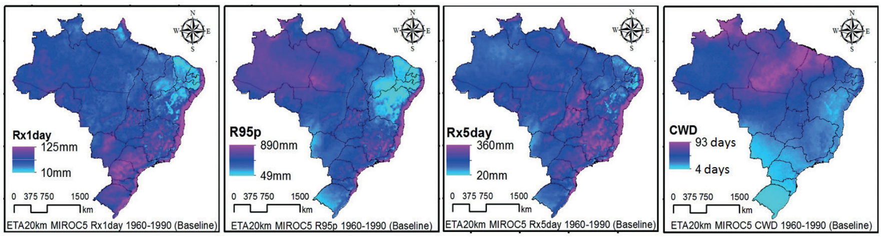


FIGURE 2.32

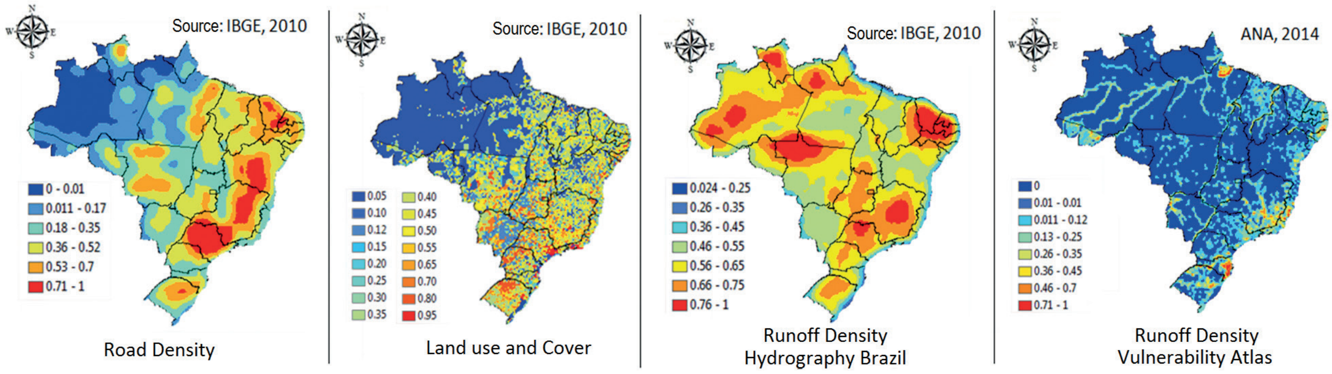
Extreme precipitation indexes sourced from the Eta-MIROC5 model, used to represent climate dimension of vulnerability to disasters involving flashfloods, overflows and flooding



In evaluating the physical-environmental dimension of the vulnerability to natural disasters involving inundations, overflows and flooding, a spatial database that could represent, at a national level, factors directly and indirectly associated to the occurrence of these phenomena was established. The result was normalized from 0.00 to 1.00 and is shown in Figure 2.33.

FIGURE 2.33

Worked and normalized database to compose the physical and environmental dimension of the vulnerability to disasters involving flashfloods, overflows and flooding

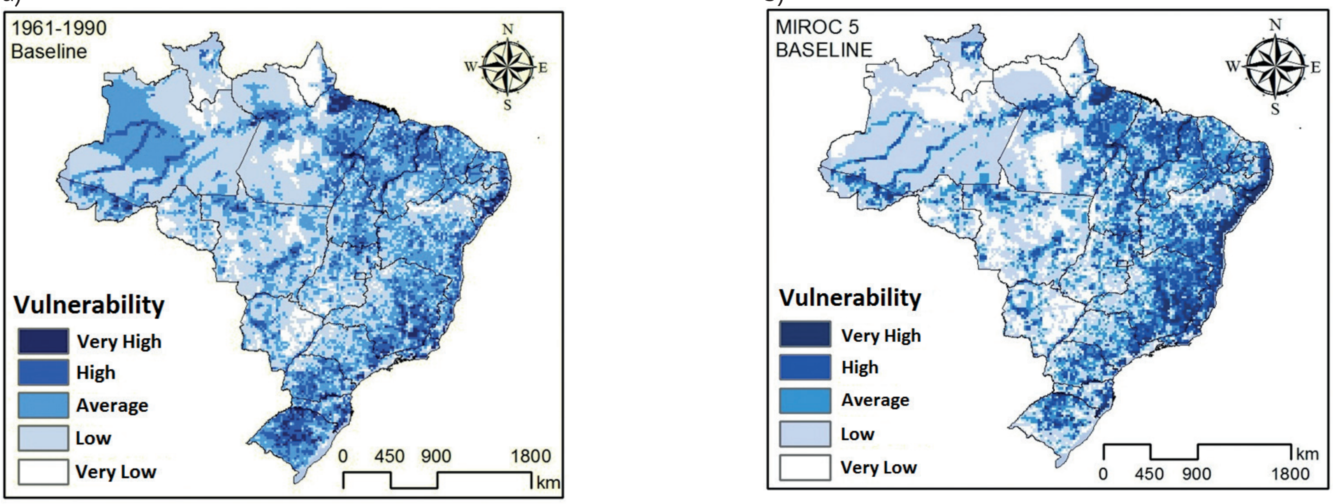


Based on the map of natural disasters caused by flashfloods and flooding in the period 1991-2010, produced by the Brazilian Natural Disasters Atlas (CEPED, 2012), led to the generation of the map of vulnerability to disasters related to flashfloods. Figure 2.34 shows vulnerability based on the Eta-HADGEM2–ES (a) and Eta-MIROC5 (b) models.

FIGURE 2.34

Map of natural disasters caused by flashfloods and floodings floods in Brazil between 1991-2010 a) data sourced from the Eta-HADGEM2–ES model, b) data sourced from the Eta-MIROC5 model

a) b)



It is noteworthy that the sub-index of socioeconomic vulnerability is a reducing factor from total index of total vulnerability to inundations. It is also important to highlight that the socioeconomic dimension, when considering inundations, can attenuate up until 50% of the natural dimensions value (climate and physical-environmental). This value was obtained by the interactive method.

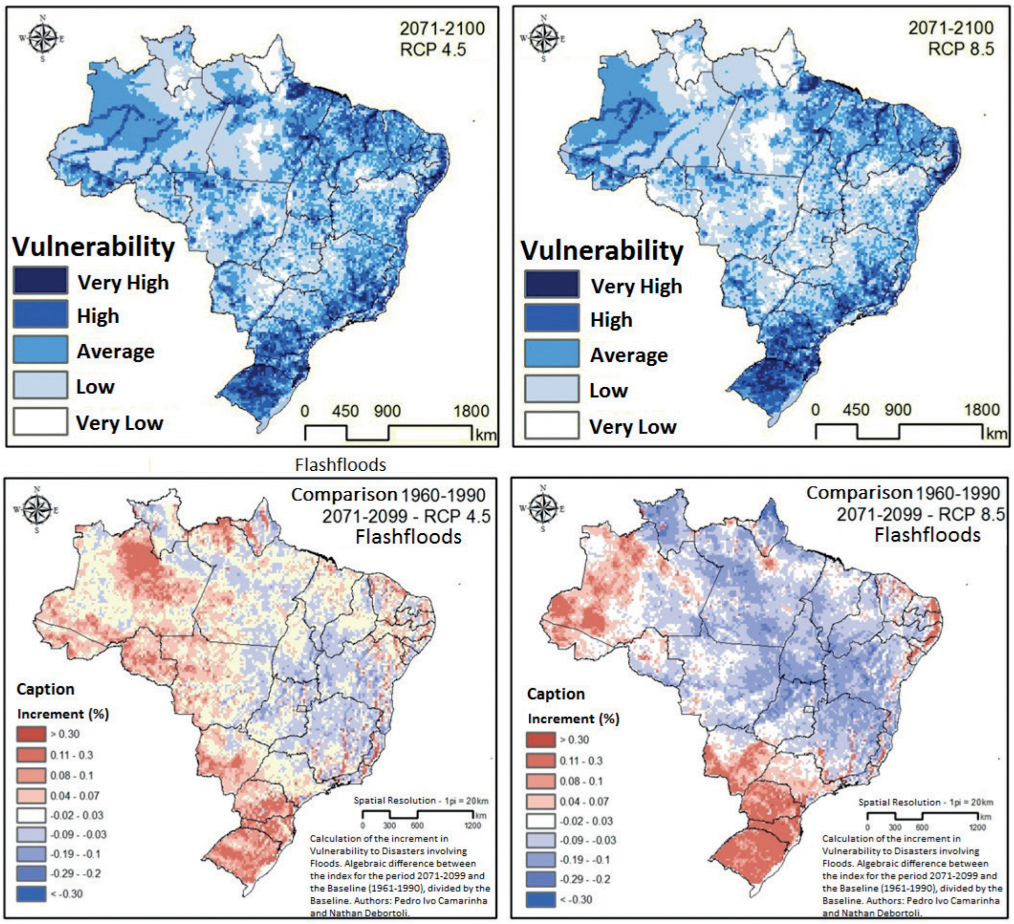
It is possible to observe that the patterns of the map developed by the application of the vulnerability index generated by the Eta-HADGEM2–ES model largely correspond to the Disaster Atlas Map. Some differences between them are also observed, especially in the state of Mato Grosso and in the Northern Region of Brazil. Basically these differences can be explained by the deficiency of the Atlas Map in presenting specific results, as it synthetized results by mesoregions. Subsequently, in many examined cases, the information related to a single municipality, or a small group of them, is extrapolated to an extensive geographical region, corresponding to the mesoregion where the municipality is inserted. This applies, for example, to the municipalities of Cotriguaçu, Alta Floresta, Nova Bandeirante and Cuiaba, which are the most relevant in the State of Mato Grosso due to, eventually, being affected by inundations, overflows and flooding. Through the elaborated index, the region occupied by these municipalities stands out in Northwestern Mato Grosso, but in the Atlas Map the entire mesoregion is featured, a fact that does not correspond to the reality of other neighboring municipalities.

In order to validate the result, in addition to the comparison with the Atlas map, a search on MUNIC (IBGE, 2013) and an extensive news survey on the Internet were performed. Among all the regions indicated as highly vulnerable on the map obtained by the index generated by the Eta-HADGEM2–ES model, only the Amazon River mouth does not correspond to reality (specifically due to being a naturally flooded region). The results of the southwestern region of the state of Mato Grosso do Sul are overestimated, as well as those of the central southern region of the state of Rio Grande do Sul. The Northwest Amazon is under-explored and under-developed, with low urbanization proportion, but may be considered a high vulnerability region, which must be observed when development and land-use changes occur.

In looking for a more accurate analysis of vulnerability evolution for the end of the 21st century, vulnerability maps for future periods were shown as increment maps (Figure 2.35). There are similarities between results when using the RCP 4.5 and 8.5 scenarios. Namely, the Central Region of Brazil, (southern region of the state of Piauí, western regions of the state of Bahia, northern and western regions of the states of Minas Gerais and Goiás) are worth mentioning, with a decrease ranging from 15% to 25%, depending on the scenario. There is an average decrease of 20% of vulnerability in the RCP 8.5 scenario for almost the entire portion of the Brazilian territory from the state of Amapá to the state of Mato Grosso, following east until the states of Bahia and Rio de Janeiro. On the other hand, in both scenarios, all the Southern Region sees a considerable increase, often exceeding 30%.

FIGURE 2.35

Maps of vulnerability to disasters related to flashfloods, overflows and flooding for the future 2071-2100 period obtained by the RCP 4.5 (left) and 8.5 (right) scenarios and Eta-HADGEM2–ES model. At the bottom: maps that represent vulnerability increases or decreases (increments) when compared to the baseline (1961-1990), for the RCP 4.5 (left) and 8.5 (right) scenarios



All these places already fit the categories of high or very high vulnerability in the baseline period, have recurrent history of inundations, overflows or floodings that have been highly impacting for society, and will most likely become even more vulnerable in the future. As for the State of Amazonas, both scenarios differ in great part of its territory. Both scenarios indicate an increase in vulnerability only in the region near Manaus (AM) and on the border with the state of Acre, but this increase does little to modify the vulnerability conditions in comparison to the baseline period, when categories transitions are taken into account. This is a region of great climatic instability, which also showed variations without standard of extremes indexes on periods between 2011 and 2100, probably with great uncertainty for these aspects.

When assessing the modeling results obtained by the Eta-MIROC5 model, the conclusion is that it better represents the distribution of vulnerability in the South, mainly in the south of Rio Grande do Sul, which was overestimated earlier.

There is also a better ability to indicate smaller vulnerability (lower category) in the western part of the Amazon, which is usually impacted by gradual floods, but overestimated by the Eta-HadGEM2–ES model in relation to flashfloods. The general map of the vulnerability index obtained by the Eta-MIROC5 model (Figure 2.34b) has a lower contrast of vulnerabilities categories in the South, Southeast and Northeast Regions, because it resulted in many locations with high and very high vulnerability. This feature can be explained because the extremes indexes obtained by the Eta-MIROC5 model reach higher upper limits. However, even if some regions are not visually consistent when compared with the CEPED Atlas, they are regions impacted by flashfloods according the MUNIC and Internet data.

After the analysis for the period of 1961-1990, the same index for future periods (2011-2040; 2041-2070; 2071-2100) was applied. The vulnerability map of flashfloods, overflows and flooding was only made for the RCP 8.5 scenario, which is on the left of Figure 2.36. The map of increments is exposed on the right side to allow a better assess of vulnerability evolution.

FIGURE 2.36

Vulnerability Map of Disasters related to flashfloods, overflows and flooding for the period 2071-2100, using climate data from Eta-MIROC5, RCP 8.5 scenario

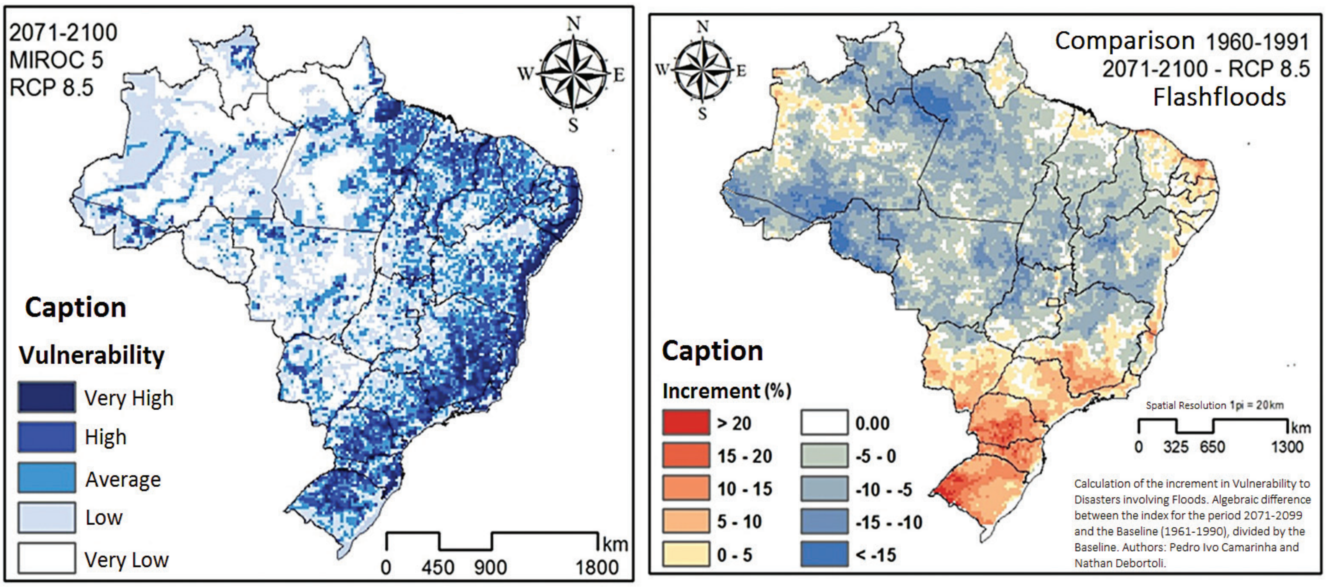


Figure 2.36 shows that the South, Southeast, and a large part of the Brazilian coast will present a higher vulnerability increase. The essential difference between the maps obtained from the two models is the significant positive increment identified by Eta-MIROC5 data in great part from countryside and south of Minas Gerais. In addition, the positive increment in western Amazon is relatively low at the end of the 21st century, while in the Eta-HadGEM2–ES results this condition is quite extrapolated. Regarding the south of Brazil, the result presented shows the positive increase with a higher contrast, highlighting the middle and southern parts of the State of Paraná, as well as the southwestern region of the state of Rio Grande do Sul. It is also worth mentioning the difference in Rio de Janeiro, which presents an attenuation on Eta-HadGEM2–ES results but clearly shows a positive increment (around 10%), in all state's regions. For other regions of Brazil, both models indicated a reduction of vulnerability to

disasters relating to flashfloods due to a decrease of extreme precipitation indexes, which is closely related to the sudden reduction in the average annual rainfall and to the increase on the average temperature.

Disasters related to Mass Movements

Climate extremes indexes calculated by the Eta-HadGEM2–ES and Eta-MIROC5 for the period of 1961-1990 were used in order to represent the climate dimension of vulnerability. Unlike the index of vulnerability to inundations, in which there was a linear normalization of extremes indexes, in this case it was necessary to categorize the continuous values of each index and weigh them (weight attribution). This step was necessary because mass movements are usually triggered from a certain threshold, so low and mean values of indexes of extremes must have smaller weights than high values (relation must not be linear). Thus, the indexes of extremes used to define the dimension of climate vulnerability were weighted as shown in Table 2.4.

TABLE 2.4
Categorization and weighing of indexes of extremes from precipitation considering vulnerability to disasters involving mass movements

RX1DAY		
CLASS		WEIGHT
MIN	MAX	
0	20	0.10
20	35	0.20
35	50	0.40
50	60	0.60
60	70	0.70
70	80	0.80
80	100	1.00

R95P		
CLASS		WEIGHT
MIN	MAX	
0	100	0.10
100	175	0.25
175	250	0.40
250	300	0.60
300	400	0.80
400	500	0.90
500	750	1.00

RX5DAY		
CLASS		WEIGHT
MIN	MAX	
0	30	0.05
30	60	0.10
60	90	0.20
90	110	0.50
110	130	0.70
130	160	0.85
160	200	1.00

CWD		
CLASS		WEIGHT
MIN	MAX	
0	7	1.00
7	10	0.95
10	13	0.90
13	17	0.80
17	20	0.50
20	30	0.40
30	40	0.30
40	50	0.20
>	50	0.15

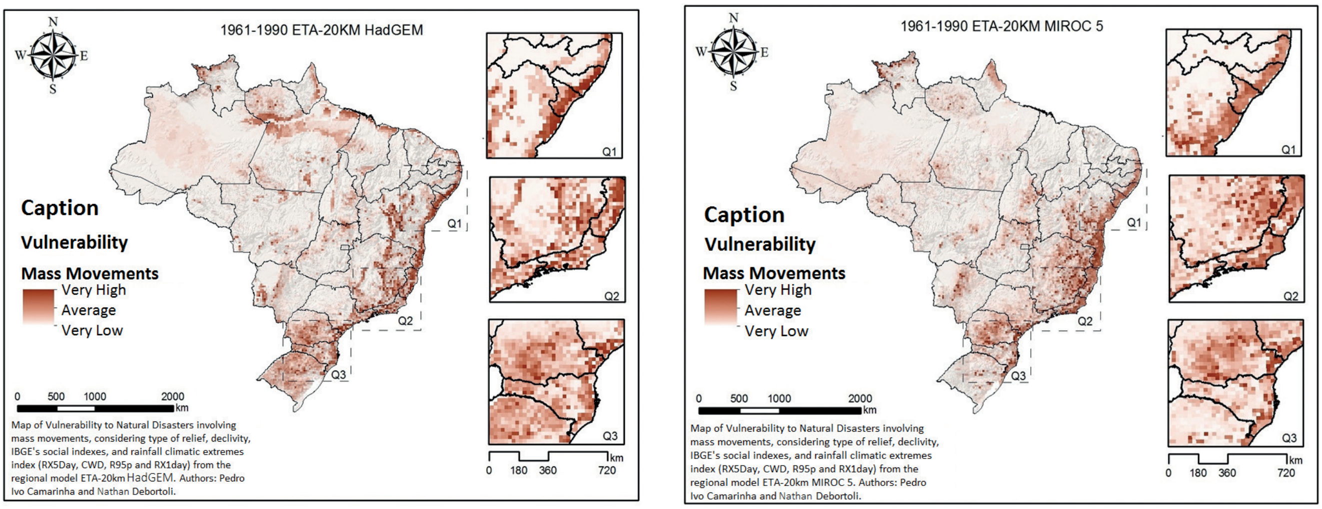
In order to evaluate the physical-environmental dimension of vulnerability to natural disasters involving mass movements, a spatial database that represents, at the national level, factors directly and indirectly associated to the occurrence of these phenomena was established. In order to achieve this, related maps and public domain data were searched, mainly those that showed the most important conditioning factors for mass movements analysis (especially landslides), which are the ones related to topography and relief.

Figure 2.37 shows the index of vulnerability to disasters related to mass movements, for the Eta-HADGEM2–ES (a) and Eta-MIROC5 (b) models, respectively. The map was obtained from the Map of Natural Disasters caused by Mass Movements in Brazil in the period from 1991 to 2010, taken from the Brazilian Natural Disasters Atlas (CEPED, 2012).

FIGURE 2.37

Map of Natural Disasters caused by Mass Movements in Brazil between 1991 and 2010. (a) Data obtained by the Eta-HADGEM2–ES model and (b) data obtained from the Eta-MIROC5 model

a) b)



It is important to highlight that the socioeconomic dimension for mass movements can attenuate up until 33.3% of the value of natural dimensions (climate and physical-environmental). This value was also obtained by the interactive method, and represents a smaller part when compared to inundations (which was 50%). This may be explained by the fact that disasters involving mass movements, especially landslides, occur more quickly and suddenly, making it harder for the affected population to overcome the impacts. Another hypothesis is that this kind of disaster presents characteristics that make it difficult to perceive the risks, making the influence of the said social aspects less effective in order to reduce the overall vulnerability.

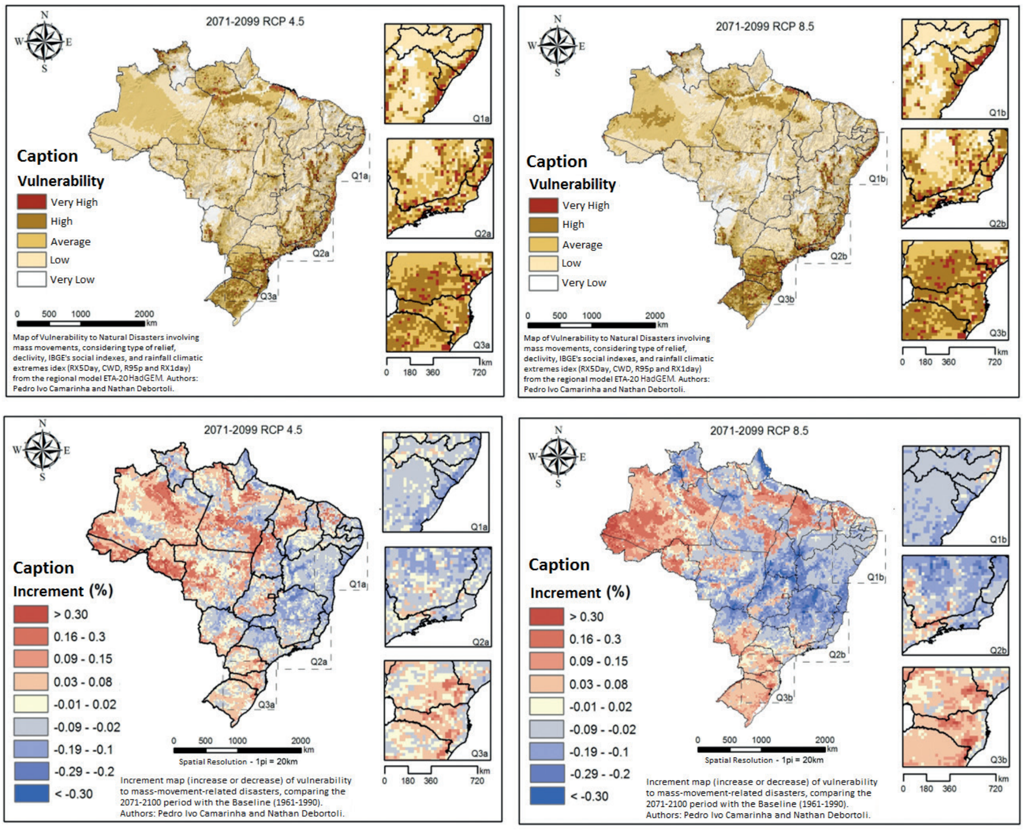
The Vulnerability Map of Natural Disasters related to Mass Movements has some noteworthy peculiarities. Unlike other types of disasters, the representation of highly vulnerable areas is demonstrated in a punctual and concentrated way, due to characteristics of physical susceptibility to mass movements, especially landslides. For this type of phenomenon, related disasters are usually characterized in places under or near steep slopes, or even in more devastating cases, widespread in sub-basins under extreme precipitation events creating mudslides and/or debris flow. Although they may have different magnitudes and impacts, in both cases, the scale for disaster occurrence is much higher (requires more detailing) than the resolution of the map generated (20km). Thus, most vulnerable locations ("very high" category) correspond to spaced points on the geographical grid and represent isolated municipalities, or a small group of municipalities, where an overlap of critical factors on physical (susceptibility), climate (extreme precipitation events) and social vulnerability dimensions occurs.

According to the Eta-HADGEM2–ES model, some regions are highlighted and continuous on the "high" vulnerability category and interspersed by the "medium" category, such as: the coastline from Paraná to south of Bahia; the coastal strip from the north of Bahia to Pernambuco; the middle of Minas Gerais towards Bahia, as well as the west and the south of the state on the border with São Paulo (Serra da Mantiqueira); some localities of Pará and north of Amapá. In general, these are exactly the same regions identified by the "Brazilian Atlas of Natural Disasters" with the highest number of occurrences. In order to identify the most vulnerable places ("very high" category) it is necessary to have a closer look in these regions. It is possible to notice that there are some points spread across the featured geographical sector and, when crossing these locations with the Brazilian municipalities grid, they coincide exactly with the municipalities with recurrent disaster scenarios involving mass movements, especially landslides, such as: Metropolitan Region of São Paulo and Baixada Santista; the north coast of São Paulo (Caraguatatuba, São Sebastião, Ubatuba and Ilhabela); the border between São Paulo and Rio de Janeiro (Cunha, São José Barreiro and Angra dos Reis); Serra da Mantiqueira (Campos do Jordao and adjacencies), the south of Minas Gerais (Extrema, Cristina, Pedralva and adjacencies); the south-west of Minas Gerais state (Delfinópolis); mountain region of Rio de Janeiro (namely Petrópolis, Sumidouro, Sapucaia and surroundings) and vicinity of Serra do Caparaó (state line of Espírito Santo with Minas Gerais), impacts on social systems are uncommon in the latter because it is a region preserved by the National Park of Caparaó.

With the model adjusted for the baseline period (climate data from 1961-1990), the same index was used to evaluate the vulnerability development of Brazilian municipalities at the end of the 21st century (2071-2100), altering only climate data. The result using data of climatic extremes of the RCP 4.5 and 8.5 scenarios of the Eta-HADGEM2–ES model is shown in the Figure 2.38. For these cases, only the climate data was changed (extremes indexes), the others were maintained constant. For comparative purposes, the increments of the future period with the baseline were also calculated. The regions that stand out are: central and southeast regions of the state of Santa Catarina, on the border with the state of Rio Grande do Sul; as well as eastern Paraná and northern coast of São Paulo and Serra da Mantiqueira, mainly the border with Minas Gerais; and also in a small area including the mountainous region of Rio de Janeiro state and its adjacent coast. These locations are characterized as disaster scenarios involving mass movements and have strong indications for a possible intensification of these disasters occurrence in the future, due to a positive increment between 5% and 15% according to the adopted model. A large area in the State of Pará and western region of the state of Maranhão also fit into this context, as they present a significant increase of vulnerability reaching 30%.

FIGURE 2.38

Vulnerability Maps of Disasters related to Mass Movements in the period of 2071-2100 obtained by the RCP 4.5 (left) and 8.5 (right) scenarios, using climate data from Eta-HadGEM2–ES. At the bottom: maps of vulnerability increments compared to the baseline (1961-1990), for the RCP 4.5 (left) and 8.5 (right) scenarios



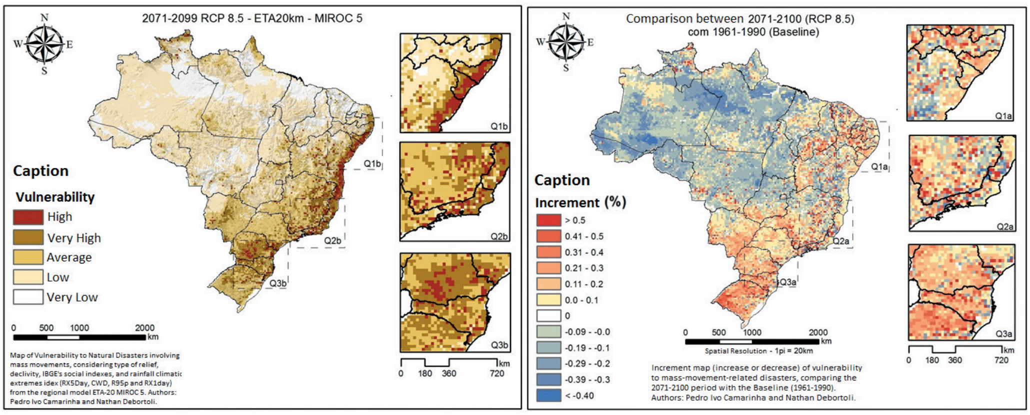
The reduction of vulnerability in the central region of the country is also noteworthy, specifically in a large part of Goias, eastern and northern parts of Minas Gerais, eastern Bahia and southeast Piauí, these regions also had a considerable decrease in the Map of Vulnerability to Inundations. Along the coastal strip going from the state of Rio de Janeiro to the state of Rio Grande do Norte, a negative increment needs to be assessed with caution. Even with evidence, from both scenarios, that these regions reduced the vulnerability to disasters related to mass movements, they were identified in the baseline period as one of the most vulnerable. Then, the indicated vulnerability reduction around 5% to 10% would not be significant to affirm that the occurrence of disasters would reduce in these areas, since they are still characterized by all other aspects of vulnerability as very vulnerable regions.

The map produced by the Eta-MIROC5 model represents very good adherence when compared to the map by CEPED Atlas, especially in the most critical areas such as: mountain areas on seacoast, mountainous region of Rio de Janeiro, mountainous region of Minas Gerais, in addition to the good definition of contrasts existing in the state of Paraná. Comparing the results from data of the Eta-HadGEM2–ES model, it is possible to observe that the result from Eta-MIROC5 data presents, in general, a better ability to represent the most vulnerable regions. It is noteworthy that MIROC-5 has an advantage because it represents better the south of Rio Grande do Sul, where this type of disasters does not occur naturally, but presents medium-high vulnerability to result using Eta-HadGEM2–ES. At a first sight, the only discrepancy, in visual aspects of analysis, is in the states of Pará and Amazonas. However, it is possible to notice on the map of Figure 2.37 that Pará presents high vulnerability in some localities in the western region.

Aiming at assessing the temporal evolution of the vulnerability index, an increment map was generated for future periods, but only the last period (2071-2100) is presented in Figure 2.39.

FIGURE 2.39

Vulnerability Map of Disasters related to Mass Movements for the future period of 2071-2100, using climate data from Eta-MIROC5, RCP 8.5 scenario



It is possible to note that there are vulnerability increments until 40% for the end of the century, according to projections of Eta-MIROC5. In this regard, the regions with high vulnerability in this period and that are likely to become more vulnerable are the mountainous region of Rio de Janeiro state, part of Serra da Mantiqueira, the countryside and south of Minas Gerais, and diverse locations on the coast. In the South of the country are the regions known for the greatest increase (50%), going from condition of "low" vulnerability in this period to "high" vulnerability in the end of the century.

Comparing with results of Eta-HadGEM2–ES, the spatial patterns of increment obtained from Eta-MIROC5 data present more spatial homogeneity for Brazil. It is important to note that almost the entire Central-West and North regions present declines around 25%, this result differs from that observed by Eta-HadGEM2–ES. Another noticeable difference is in the Northeast region, which would have attenuation according to data of HadGEM2–ES, but with a positive increment around 30% using the Eta-MIROC5. The two models converge in few localities, for example, the increased vulnerability of almost the entire Southern region and the southern part of the state of São Paulo. Meanwhile, due to a better map adherence for the baseline period, there are evidences that the more reliable prognosis for the future would be the result indicated by the map using Eta-MIROC5 (Figure 2.39).

As a synthesis of the analysis from results of the two models, the regions that require the most attention would be the mountain terrain locations along the Brazilian coast, in Minas Gerais state, continental side of Serra do Mar and Serra da Mantiqueira, the mountainous areas of the States of Santa Catarina and Paraná. For these locations, specific studies with appropriate scale should be performed, aiming at proposing effective adaptation measures (either structural or non-structural).

2.3.6. Health

Understanding the socioeconomic and access to health care conditions in Brazil is essential not only to estimate implications of climate change on health, but also to propose adaptation strategies to the new climate scenario presented by the Eta-HADGEM2–ES e Eta-MIROC5 models.

Thus, estimates of climate risk and assessments on health impacts based on downscaled projections of future warming (Table 2.5) are presented herein with the purpose of providing information that may support discussions on the effects of climate change in Brazil.

TABLE 2.5

Summary of increases on average, minimum, and maximum temperature in Brazil comparing two emission scenarios to global average of diverse global climate models (multi-model ensemble of IPCC's AR5 models)

WARMING AT THE END OF THE CENTURY		WORLD (MULTI-MODEL ENSEMBLE)	BRAZIL		
		OVERALL AVERAGE	MINIMUM	AVERAGE	MAXIMUM
HADGEM2– ES	RCP 4.5	1.1 – 2.6°C	2°C (RS)	3.18°C	4.3°C (SP)
	RCP 8.5	2.6 – 4.8°C	3.2°C (RS)	5.91°C	8.4°C (AM)
MIROC5	RCP 8.5	2.6 – 4.8°C	1.9°C (RS)	2.26°C	5.4°C (MT)

The minimum and maximum values correspond to cities with smaller and larger warming at the end of the 21st century. The State of these municipalities is identified in brackets.

In terms of climate exposure to a new climate in Brazil, it is observed that the country tends to warm more than the global average. Comparing the municipalized results of the Eta-HadGEM2–ES model with the most pessimistic average results for the global models, Brazil heats on average between 0.65°C (RCP 4.5) to 1.1°C (RCP 8.5) above the global average of the most pessimistic models. Within the Brazilian territory, this hyper-warming situation translates into a maximum registered warming of 8.4°C (RCP 8.5) in the Amazon, where deforestation is an aggravating factor for this regional warming. Another critical area is the Center-West region, followed by part of the Southeast with an immediate and alarming rise on the average temperature, which remained constant over the century. These regions have critical warming values above 4°C, even in a scenario of global sustainability, the RCP 4.5, which showed the urgency in creating plans for climate adaptation by reducing the identified environmental vulnerabilities.

Analysis and mapping of vulnerability was based on three vulnerability indexes: socioeconomic vulnerability index – IVse (describes the social, demographic and economic dimensions); access to health services vulnerability index – IVss (describes the conditions of access to the infrastructure of health services) and environmental vulnerability index – IVa (describes the environmental dimension). The goal is to show spatial vulnerability at a municipal aggregation level.

The IVse analysis indicated the North (especially the western Amazon area) and Northeast regions as the most vulnerable. Considering the risk associated to temperature and socioeconomic vulnerability, the North and Northeast regions showed high risk in the first period (2010-2040) in the RCP 4.5 scenario. In the Center-West region, the areas that are most likely to face high warming, leading to high-risk indexes in the first period, were highlighted. In this scenario, considering the current socioeconomic vulnerability, at the end of the 21st century, only a few municipalities in the South showed low climate risk. In the RCP 8.5 scenario, this situation is anticipated for the 2041-2070 period, with a risk of intensification in the Northeast coast for 2071-2099.

Regarding heat waves, the North and Northeast Regions systematically present a high risk all over the century. In the RCP 8.5 scenario, the western Amazon region is the most critical area from the climate risk point of view (IVa).

The risk associated with health services vulnerability (IVss) is higher in the countryside of the Northeast region and in western Amazon, where the IVss present high results. The RCP 8.5 scenario intensifies this pattern.

After mapping climate risk, municipalities with over 250,000 inhabitants that had a high or very high-risk rate were chosen. This approach incorporates the population factor in order to guide the elaboration of adaptation risk reduction policies in vulnerable areas that expose a larger number of people to more severe climate changes.

When evaluating the municipalities with more than 250,000 inhabitants in 2010 that had a high or very high-risk rate, it was observed that all the population of North and Northeast Region capitals would be exposed to high risk when socioeconomic vulnerability (IVse) is considered. In the Southeast, special attention should be drawn to large cities of metropolitan regions of State capitals, as well as to municipalities of Baixada Fluminense (RJ), Carapicuíba (SP), Diadema (SP), Itaquaquecetuba (SP) and Governador Valadares (MG). These high-risk urban areas are characterized as a priority to climate adaptation policies.

In order to obtain a first exploratory view of the potential epidemiological consequences of climate change projections for Brazil, three impact methodologies validated on international scientific literature and by organizations such as IPCC and WHO, were applied to the Brazilian scenario. The selected diseases represent large groups of international epidemiological classification: overall mortality due to an increase in heatwave days, mortality by respiratory diseases (chronic non-communicable diseases), dengue fever (communicable diseases) and childhood diarrhea (infectious and parasitic diseases).

When assessing the number of deaths caused by higher temperature for the 4.5 scenario of the Eta-HadGEM2–ES model, the Northeast Region showed the highest mortality increase (70 deaths/year) during 2010-2040. However, during the 21st century, the Southeast Region (State capitals) is the one that presents the greatest impact due to the increase of frequency of heatwave days. In the Rio de Janeiro state (2010-2040) and its capital (for all the periods), the heatwave death toll is 25 deaths/year, which represents an increase above 50% between 2041 and 2099. The capital of São Paulo state and the Federal District will also be highly impacted by the end of the century (40 and 30 forecasted deaths/year, respectively).

For the RCP 8.5 scenario of the Eta-HadGEM2–ES model, it is estimated an excess of 6 deaths/year between 2011 and 2040 in the Southern Region. In the analyses of heatwave, state capitals of the Northern Region contribute to the highest excessive mortality in the Northern Region when compared to other regions (17 in 2041-2070 and 13 in 2071-2099).

The increase on the frequency of heatwave days projected by the RCP 8.5 scenario impacts less the large urban areas and capitals, as observed on the risk analysis. However, it affects cities with high socioeconomic vulnerability, which may imply a bigger difficulty for population to adapt and deal with such extreme situations.

The classification used for heatwave days was conservative, and may represent an underestimation of the effect of such events. No other outcomes that also present relevant temperature effects were analyzed, such as issues involving food safety and effects of an increase on the average temperature. These surpluses represent an additional effect related to the occurrence of heat waves days. The potential of the effect of adaptation measures was not considered on the analysis.

Despite the fact that respiratory problems usually result in illness and hospitalizations but not mortality, in the average mortality rate from respiratory diseases in Brazil was 2 deaths/1,000 inhabitants, and the highest hospitalization rate was 11/1,000 inhabitants. The climate change scenarios for the period of 2071-2100 indicate an increase on the mortality risk for people with pre-existing respiratory problems (Table 2.6). For the worst scenario, the Eta-HadGEM2–ES RCP 8.5, 2071-2100 projections indicate an increase on the mortality rate by 6 deaths/1,000 inhabitants, while for the Eta-MIROC5 RCP 8.5 model (2011-2040), the scenario presents a mortality rate increase by 1.28 deaths/1,000 inhabitants. The city of Goiânia presents the higher risk for increase on mortality by respiratory diseases, as well as approximately half of the States that are part of the Brazilian Amazon (Figures 2.40 and 2.41).

TABLE 2.6

Population of children (< 5 years old), temperature difference (ts-tb), relative risks and population at risk (< 5 years old) for development of respiratory diseases in Brazil, according to climate models, scenarios and time-windows

ETA-HADGEM2–ES MODEL				
RCP 4.5				
Periods	Pop < 5 years old	ts-tb	Relative Risks	Population at risk
2011-2040	45,932,295	1.70	1.09	4,067,654
2041-2070 (capitals)	2,967,651	2.42	1.12	368,864
2071-2100 (capitals)	3,396,060	2.88	1.15	525,022
RCP 8.5				
2011-2040	45,932,295	2.02	1.11	4,893,750
2041-2070(capitals)	2,967,651	3.14	1.17	517,703
2071-2100(capitals)	3,396,060	5.20	1.28	965,677
ETA-MIROC5 MODEL				
RCP 8.5				
2011-2040	45,932,295	1.17	1.06	2,642,658
2041-2070(capitals)	2,967,651	1.82	1.1	307,556
2071-2100(capitals)	3,396,060	2.95	1.17	

The first time-window data considers all Brazilian cities. The other window shows data for state capitals only. This choice was made in order to consider population growth during the twentieth century. A municipal demographic estimation will require a more complex calculation. For projections of capitals, the same population growth rate that was predicted for the State was assumed, according to projections of the IBGE.

FIGURE 2.40

Premature mortality rates for projections of the Eta-HadGEM2–ES model RCP 4.5 scenario

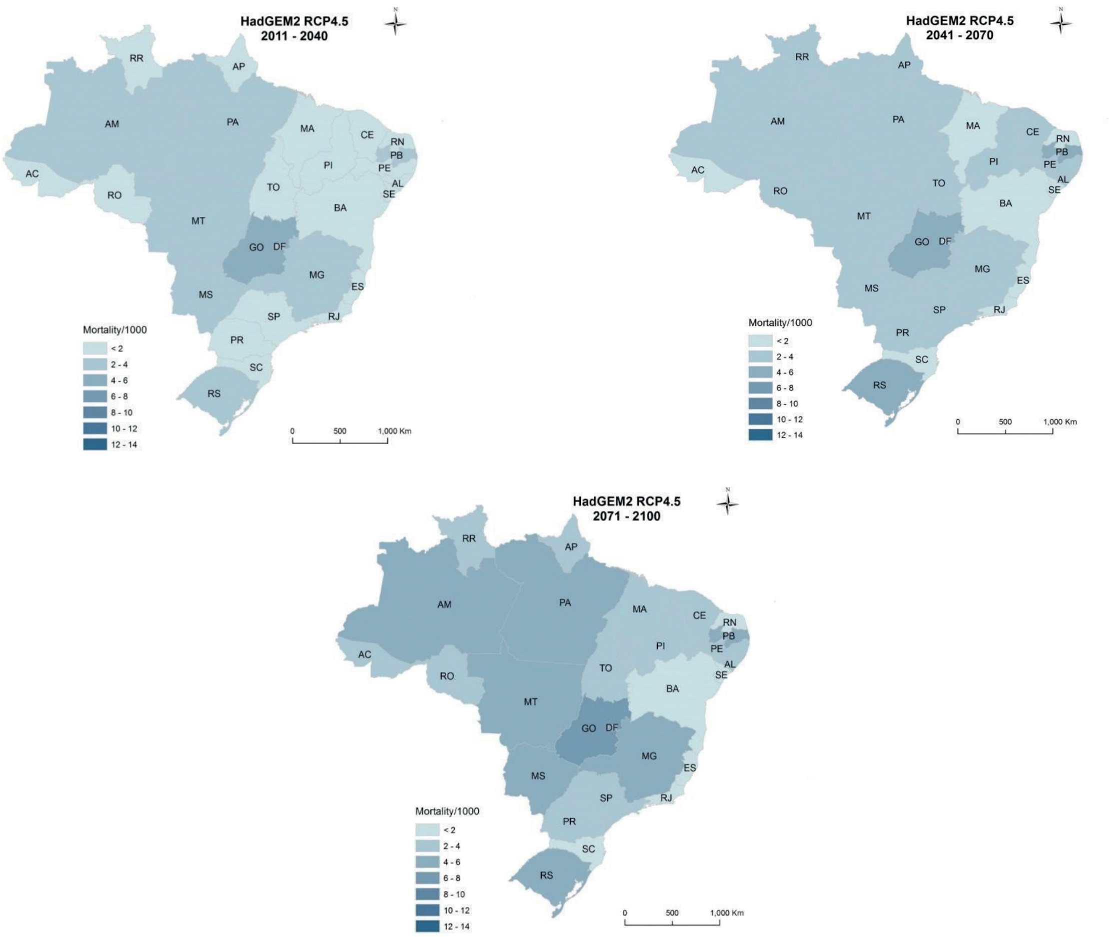
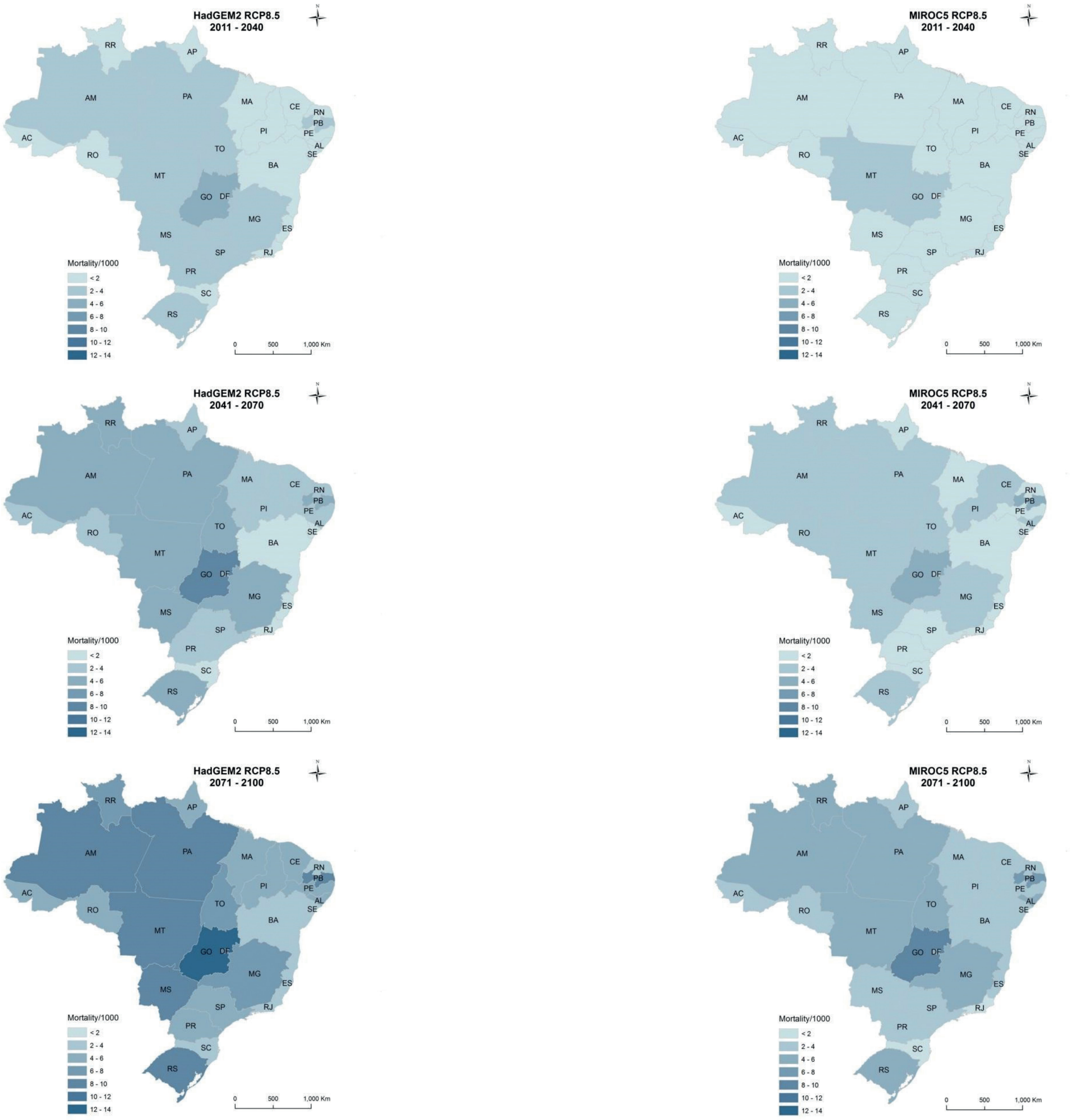


FIGURE 2.41

Premature mortality rates for projections of the Eta-HadGEM2–ES and Eta-MIROC5 models, RCP 8.5 scenario



Dengue fever and diarrhea are among the climate-change related communicable diseases that showed high incidence rates, especially in the Center-West, North and Northeast regions due to worrying sanitary situation, low schooling and basic health care attention. These illnesses are among the most sensitive ones to changes in temperature and precipitation, and are spread in areas with an exponential temperature rise (Center-West and North) and an increase in heatwave frequency (North).

Dengue fever has expanded almost nationwide, having been consolidated as endemic in a great part of the coast and center of Brazil. New outbreaks have been concentrated in climate change areas, between mesothermal and hot climates, and in the semiarid Northeast region. According to the coupled climate and dengue models, climate changes could cause the expansion of the dengue transmission area to historically colder climate areas, such as southern states and mountainous areas in the Southeast region.

The risk associated with the increase of diarrhea in children caused by temperature rise has shown rising values over the 21st century, according to projection of the RCP 4.5 e 8.5 scenarios for climate change. Estimations of diarrhea in children regarding the two global models and their regionalization show an increase of 9 to 15% for the RCP 4.5 scenario and 6 to 28% on the RCP 8.5 scenario (Table 2.7).

The convergence of the two models in relation to the results of projections increase the confidence in the proposed models and scenarios, as seen in the projections of impacts in the Center-West (highest increases) and North regions, with larger and growing risks confirming climate change in this region. The Northern Region is the second most impacted with higher Relative Risk (RR) increases.

The South and Southeast regions have high values in the 2011-2040 in both scenarios. The Eta-HadGEM2–ES model projects a higher relative risk, not observed in the Eta-MIROC5 model, where the Northern Region stands out on this time-window.

TABLE 2.7

Differences in the baseline (ts-tb), relative risks (RR) and population at risk (< 5 years old) for development of diarrhea, according to climate models, scenarios and time-windows (Center-West Region, states and state capitals)

	ETA-HADGEM2-ES MODEL						ETA-MIROC5 MODEL		
	RCP 4.5			RCP 8.5			RCP 8.5		
	2011-2040			2011-2040			2011-2040		
UF (all municipalities)	Warming °C	Relative Risks	Population at risk	Warming °C	Relative Risks	Population at risk	Warming °C	Relative Risks	Population at risk
DF	1.94	1.1	59,041	2.61	1.13	79,306	1.56	1.08	47,477
GO	2.37	1.12	170,472	3.00	1.15	216,173	1.82	1.09	131,264
MS	2.74	1.14	83,682	3.21	1.16	98,145	1.34	1.07	40,869
MT	2.29	1.11	89,231	2.93	1.15	114,036	1.79	1.09	69,741
CENTER-WEST	2.33	1.12	402,426	2.96	1.15	507,660	1.67	1.08	289,351
	2041-2070			2041-2070			2041-2070		
Capitals									
Brasília	2.86	1.14	39,425	4.66	1.23	64,090	2.77	1.14	38,062
Goiânia	3.19	1.16	15,098	5.05	1.25	23,905	3.02	1.15	14,275
Campo Grande	3.55	1.18	10,126	4.92	1.25	14,049	2.45	1.12	6,986
Cuiabá	3.33	1.17	7,047	4.97	1.25	10,505	3.08	1.15	6,507
CENTER-WEST	3.26	1.15	71,696	4.95	1.24	112,549	2.89	1.14	65,829
	2071-2100			2071-2100			2071-2100		
Capitals									
Brasília	3.73	1.19	67,252	6.97	1.35	125,889	4.47	1.22	80,672
Goiânia	4.03	1.2	23,126	7.60	1.38	43,663	4.83	1.24	27,719
Campo Grande	4.01	1.2	13,518	7.79	1.39	26,247	3.72	1.19	12,541
Cuiabá	3.95	1.2	9,924	7.86	1.39	19,737	5.01	1.25	12,590
CENTER-WEST	3.98	1.19	113,820	7.70	1.36	215,535	4.65	1.22	133,523

The first time-window data considers all Brazilian cities. The other windows are only for capital data. This choice was made in order to consider population growth during the twentieth century. A municipal demographic estimation will require a more complex calculation. For projections of capitals, the same population growth rate that was predicted for the State was assumed, according to projections of the IBGE.

Table 2.8 summarizes the results and impact methods used:

TABLE 2.8
Summary of the main influences of climate changes on health in Brazil

DISEASE	METHOD OF IMPACT	MAIN RESULTS (ETA-HADGEM2) RCP 4.5	MAIN RESULTS (ETA-HADGEM2) RCP 8.5	COMMENTS
Childhood Diarrhea (<5 years old)	+5% on risk of hospitalization per every 1°C warming (McMichael et al., 2004)	+9-15% Hospitalizations	+6-28% Hospitalizations	The Center-West and Northern Regions are the most affected in both models. Precarious conditions of sanitation, education and basic health services explain the severity of impacts.
		8.5 vs 4.5 scenario: +826,096 hospitalizations in Brazil		
Premature mortality due to respiratory diseases	6 x increase on average temperature (Aryes et al., 2009)	7/1000inhab (Goiânia)	14/1000inhab (Goiânia)	Higher mortality rates in the Center-West region, specially, in the State of Goiás, with high level of mortality.
Dengue fever	Multiple Linear Regression Model[74]	Preliminary Analysis: Expansion to the South, North and mountainous areas in the Southwest region. The 8.5 scenario shows the highest increase on probability of endemic transmission.		
General mortality due to increase of heatwave days	+4,24% x increase of heat wave days x daily mortality rate (Anderson et al., 2010)	+70 deaths/year (Northeast)	+17 deaths/year (capital cities of the North)	The Northern Region capitals presented larger increases when compared to other regions. Rio de Janeiro State presents the most worrying increases between all Brazilian states.

Knowing the unquestionable importance of socioeconomic determinants and of the access to health care for this category of assessment, it was also necessary to make a descriptive and spatial analysis of these conditions in Brazil and apply complex statistical methods to measure different levels of vulnerability in the Brazilian population.

Social and environmental impacts of the climate changes on the municipalities of the State of Rio de Janeiro

The "Climate Scenarios Index of the Vulnerability Map of the Population in the State of Rio de Janeiro to the impacts of Climate Change on the Social, Health and Environmental Areas - MVPM/RJ" (BARATA et al., 2011) was developed based on a climate indicator that synthesizes and estimates the climate differences for temperature and precipitation, presented in the Second National Communication.

In developing this climate indicator, scenarios of INPE'S regional Eta-HadCM3 for the 2011-2040 integration period were used. Subsequently, the Vulnerability Mapping of the Population of the Municipalities in the State of Rio de Janeiro (*Mapeamento da Vulnerabilidade da População dos Municípios do Estado do Rio de Janeiro* – MVPM/RJ) also used the already consolidated data and the same climate database to update its indicators, with the 2010 Census data, leading to a new version, published in 2013 (BARATA et al., 2014). The new version was used as an input for Municipal Vulnerability Index (IVM) applied for the state of Rio de Janeiro (RJ), considering the new scenarios resulted from the downscaling process of the global Eta-MIROC5 model for the RCP 8.5 scenario. The periods assessed were 2011-2040, 2041-2070 e 2071-2100.

74 Probability of permanent transmission of dengue = Temperature Coefficient + Coefficient of Precipitation + Coefficient of Population R2 = 0.62

The methodology developed involved the implementation of the health and socio-environmental vulnerability mapping in Brazil, at national and regional levels, as well as the possible effects of global climate change on health (CONFALONIERI et al., 2005; 2008; 2009). The socio-environmental and health vulnerability to climate impacts is a multidimensional phenomenon, so much so that it is represented by specific indicators in a summary form, and it should include information on different sectors, such as socioeconomic, environmental and human health data.

In this context, the Municipal Vulnerability Index (IVM) was designed to support sectoral decisions on adaptation strategies to the projected climate change effects, besides contributing to the assessment and the support for the elaboration of priority public policies conceived to increase the resilience of the population in face of the new climate scenarios.

The Vulnerability Mapping of the Population of the Municipalities in the State of Rio de Janeiro (MVPM-RJ) was established based on the IVM, which has two key metrics: the General Vulnerability Index (IVG), which reflects the condition of the municipal systems under risk of being affected by future climate, and the Climate Scenarios Index (ICC). The municipal IVG has three key metrics: Health Vulnerability Index (IVS); Social Vulnerability Index (IVSo); Environmental Vulnerability Index (IVAm). The ICC summarizes, at the municipal level, the climatic anomalies of temperature and precipitation (Figure I and Table I).

FIGURE I

Conceptual model for analysis on the vulnerability to the climate change of the municipalities of the State of Rio de Janeiro

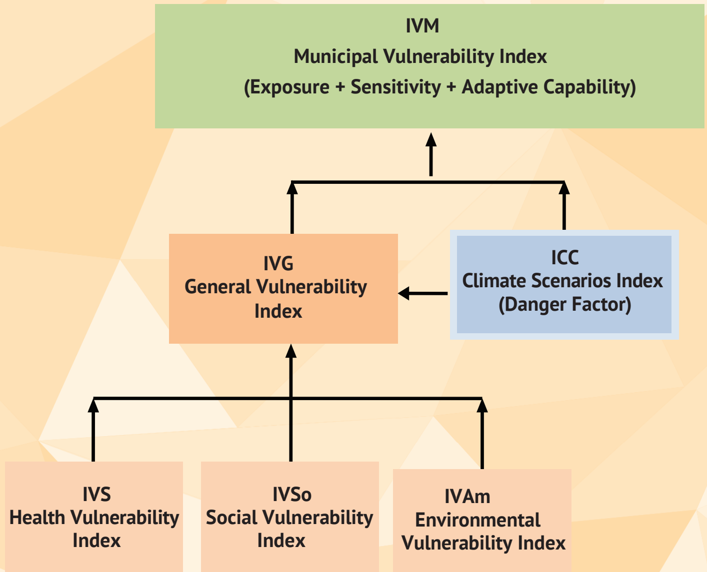


TABLE I

Composition of the Municipal Vulnerability Index of the State of Rio de Janeiro

General Vulnerability Index	**Health Vulnerability Index:** Morbidities: Dengue fever Leptospirosis American Cutaneous Leishmaniasis Mortality due to diarrhea in children under 5 years of age
	Social Vulnerability Index: Family Structure Access to Knowledge Access to Work Availability of Resources (income) Childhood and Adolescence Development Housing Conditions
	Environmental Vulnerability Index: Native vegetation cover and regeneration Biodiversity Conservation Occurrence of extreme hydrometeorological events and deaths Coastal Area
Climate Scenarios Index	**Danger Factor:** **Projected climatic anomalies**

It is currently known that many of the adverse effects of the climate change on the population's health and well-being occur in an indirect way, with mediation of environmental and social processes, and the IVM reflects this aspect. Thus, the final objective of this research was to present the relative vulnerability of the municipal population of a federative unit – in this case, the state of Rio de Janeiro – and encourage the planning, implementation and effectiveness evaluation of the measures adopted by taking into account the results presented so as to increase their resilience.

These findings reflect high levels of vulnerabilities in the municipalities of the North and the Middle Paraiba Region*, in the 2011-2040 period. In the following period, 2041-2070, there are a smaller number of municipalities with higher vulnerability values. In the 2071-2100 period, there is an intensification of such condition, with higher indexes of vulnerability in the Metropolitan Region. The same range of indexes recorded in the previous periods (2011-2040 and 2041-2070) are registered from the Lowland Countryside Region (Baixada Fluminense) to the Northwest, passing by part of the Mountainous Region and, at the same time, influencing part of the Costa Verde Region.

Partial indicators can also be used to guide sectoral policies, be them health, socioeconomic or environmental protection aspects, among others, considering not only the current situation, but also the trends indicated by the future climate scenarios.

** The state of Rio de Janeiro is divided into eight Governmental Regions. This division is provided by Law No. 1,227/87, which approved the Social-Economic Development Plan for 1988/1991. Since then, some changes have been made regarding the name and composition of such regions, which are: Metropolitan, Noroeste Fluminense, Norte Fluminense, Baixadas Litorâneas, Serrana, Centro-Sul Fluminense, Médio Paraíba and Costa Verde.*

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ANNEX

SUMMARY OF INFORMATION ON HOW THE CANCUN SAFEGUARDS WERE ADDRESSED AND RESPECTED BY BRAZIL THROUGHOUT THE IMPLEMENTATION OF ACTIONS TO REDUCE EMISSIONS FROM DEFORESTATION IN THE AMAZON BIOME BETWEEN 2006 AND 2010[75]

75 This Annex is the Brazilian submission to UNFCCC, available at: https://unfccc.int/land_use_and_climate_change/redd_web_platform/items/7282.php.

ANNEX

SUMMARY OF INFORMATION ON HOW THE CANCUN SAFEGUARDS WERE ADDRESSED AND RESPECTED BY BRAZIL THROUGHOUT THE IMPLEMENTATION OF ACTIONS TO REDUCE EMISSIONS FROM DEFORESTATION IN THE AMAZON BIOME BETWEEN 2006 AND 2010

1. INTRODUCTION

In November 2013, after eight years of negotiations, the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) defined an international architecture to provide incentives for developing countries to reduce greenhouse gas emissions from deforestation and forest degradation and the role of forest conservation, sustainable management of forests and enhancement of forest carbon stocks (REDD+).

The Warsaw Framework for REDD+ (Decisions 9-15/CP.19) establishes the main international rules and procedures for mitigation efforts in the forest sector by developing countries to be recognized by the UNFCCC and compensated through payments for performance. These decisions present definitions of aspects such as reference levels, national forest monitoring systems, results-based financing, among others.

Several definitions about REDD+ activities were included in previous UNFCCC decisions, particularly in decision 1/CP.16, which is another important milestone for REDD+.

Paragraph 72, decision 1/CP.16 requests developing country Parties, when developing and implementing their national REDD+ strategies, to address the safeguards detailed in Appendix I, paragraph 2 of decision 1/CP.16, ensuring the full and effective participation of relevant stakeholders, mainly indigenous peoples and local communities.

Paragraph 2 in Appendix I states that developing countries should promote and support the following safeguards during the implementation of the activities referred to in paragraph 70 decision 1/CP.16:

a That actions complement or are consistent with the objectives of national forest programs and relevant international conventions and agreements;

b Transparent and effective national forest governance structures, taking into account national legislation and sovereignty;

c Respect for the knowledge and rights of indigenous peoples and members of local communities, by taking into account relevant international obligations, national circumstances and laws, and noting that the United Nations General Assembly has adopted the United Nations Declaration on the Rights of Indigenous Peoples;

d The full and effective participation of relevant stakeholders, in particular indigenous peoples and local communities, in the actions referred to in paragraphs 70 and 72 of this decision;

e That actions are consistent with the conservation of natural forests and biological diversity, ensuring that the actions referred to in paragraph 70 of this decision are not used for the conversion of natural forests, but are instead used to incentivize the protection and conservation of natural forests and their ecosystem services, and to enhance other social and environmental benefits;

f Actions to address the risks of reversals;

g Actions to reduce displacement of emissions.

Decision 1/CP 16 also requests, developing country Parties aiming at undertaking REDD+ activities, in the context of the provision of adequate and predictable support, to develop a system for providing information on how the safeguards referred to in appendix I to this decision are being addressed and respected throughout the implementation of these activities.

The development of these safeguards information systems should take into account national circumstances and the respective capabilities of developing countries, whereas acknowledging national sovereignty, the relevant international obligations and agreements, and respecting gender considerations.

Decision 12/CP.17 states that the national safeguards information systems should:

a Be consistent with the guidance identified in decision 1/CP.16, appendix I, paragraph 1;

b Provide transparent and consistent information that is accessible by all relevant stakeholders and updated on a regular basis;

c Be transparent and flexible to allow for improvements over time;

d Provide information on how all of the safeguards referred to in appendix I to decision 1/CP.16 are being addressed and respected;

e Be country-driven and implemented at the national level;

f Build upon existing systems, as appropriate.

The communication from developing country Parties to the UNFCCC on how the safeguards of Cancun are addressed and respected throughout the implementation of REDD+ will take the form of a summary of information [76], which will be part of the National Communication or may be submitted voluntarily by the country via the REDD+ platform on the UNFCCC website[77]. This submission is a requirement for obtaining results-based payments, according to decision 9/CP.19, paragraph 4.

This report lays out preliminary information on how the REDD+ safeguards were addressed and respected by Brazil throughout the implementation of initiatives to reduce emissions from deforestation in the Amazon. The sources of information are diverse and were collected at different periods during the implementation of public policies that contributed to Brazil's REDD+ results presented in the REDD+ Annex submitted to the UNFCCC in December 2014.

The information presented in this summary of information on how the Cancun safeguards have been addressed and respected are strictly related to the results achieved by Brazil reducing emissions from deforestation in the Amazon biome between 2006 and 2010, having the period between 1996 to 2005 as reference, the same timeframes referred to in Brazil's Forest Reference Emission Levels to the UNFCCC[78].

The choice of this period is explained by the implementation of the Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (*Plano de Prevenção e Controle do Desmatamento na Amazônia Legal, PPCDAm*), launched in 2004, which to a great extent was responsible for Brazil's emission reductions from deforestation

76 http://unfccc.int/resource/docs/2011/cop17/eng/09a02.pdf
77 http://unfccc.int/resource/docs/2013/cop19/eng/10a01.pdf#page=33
78 http://www.mma.gov.br/redd/index.php/nivel-referencia

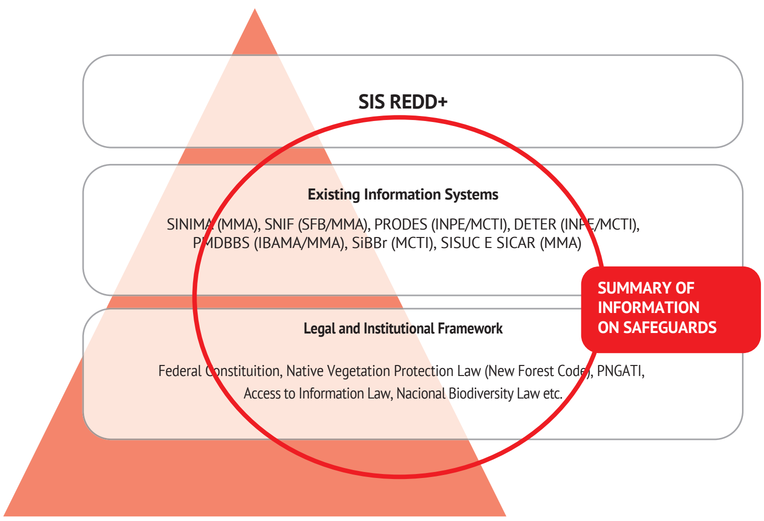
during those years. This summary also presents information on how the Cancun safeguards were implemented by the Amazon Fund investing the resources received from REDD+ payments since 2009. Additional information on how the safeguards are addressed and respected will be included in the following summaries of information, as the country submits the results achieved reducing emissions from deforestation and forest degradation in other biomes.

Preliminarily, this summary also presents information regarding the process of setting up the national REDD+ Safeguards Information System (SIS REDD+), with a view to providing transparency to this process.

It's worth noting that the summary of information and the SIS REDD+ are two distinct instruments. The first is intended to provide information on the implementation of the Cancun Safeguards with respect to the results for which payments will be claimed. Such document, presented on regular basis, offers a picture of the implementation of the safeguards, focused on REDD+ results, being a requirement to access REDD+ payments. The second is a system that, in Brazil, is still at its early stage of development and should enable the constant monitoring of the implementation of REDD+ safeguards in Brazil.

When the SIS REDD+ becomes fully operational, the country will be able to generate its summary of information from it. For the moment, however, this summary of information on safeguards had as its basis the existing sources of information (information systems, websites, reports, etc.) and the relevant legal and institutional frameworks in place. Figure A.1 below shows schematically the distinction between these two instruments.

FIGURE A.1
The national REDD+ Safeguards Information System (SIS REDD+) and the Summary of Information on Safeguards as distinct instruments



2. METHODOLOGY

This summary of information about how the Cancun safeguards were addressed and respected by Brazil throughout the implementation of REDD+ activities was built on the basis of the report Survey to identify information and sources to feed the Safeguards Information System, from April 2013, an internal document to the Ministry of Environment (MMA) developed by a panel of national experts in REDD+ safeguards (Technical Panel) created to provide a preliminary, non exhaustive, survey of information and sources on safeguards.

Most members of this *ad hoc* Technical Panel were from Brazilian civil society organizations and their selection by the MMA was based on their relevant contributions to the safeguards debate and on their availability and willingness to participate. Such format proved to be very effective and should be replicated for the development of the SIS REDD+, allowing interested experts and stakeholders to provide support to the federal government during the REDD+ SIS development process in 2015.

The work for the survey by the Technical Panel on safeguards was carried out on a voluntary basis in the course of the second half of 2012, with four meetings and the preparation of preliminary outcomes.

For identifying the relevant information and its sources, each representative of the Technical Panel had to answer a set of questions aimed at harmonizing their understanding. After that, an exercise was undertaken applying the World Resources Institute (WRI) methodology described in the report "A Framework for Designing a National System to Implement REDD+ Safeguards"[79], which seeks to map the main elements of a national safeguards information system – institutions, objectives, functions and rules. According to this methodology, goals define what the safeguards are meant to achieve. Safeguard functions are the processes by which those goals are achieved, while the rules are the institutions that operationalize the national safeguards system.

The literature consulted had as a basis the national legislation and international agreements, federal policies and programs, administrative processes, forums, committees, existing institutions and systems considered relevant to the implementation of the Cancun safeguards.

This summary was based on information from the survey report prepared by the Technical Panel. A draft of this summary was made available at the REDD+ Brazil website for contributions for two weeks, from 27 October to 7 November (http://mma.gov.br/redd/index.php/pt/salvaguardas/sum%C3%A1rio-sobre-salvaguardas) to collect inputs from stakeholders and give publicity to the process. The draft was then presented, during a meeting organized by the MMA on November 7, 2014, to the Technical Panel members and other experts referred by them, for quality control purposes. The revised document, with the inputs received through the website and from the meeting, was then forward by the MMA to the Ministry of Science, Technology and Innovation (MCTI), so that it could be incorporated into Brazil's National Communication to the UNFCCC and submitted to the public consultation process conducted by the MCTI. The report was then sent on a voluntary basis to the UNFCCC Secretariat so it could be made available through the web platform as per paragraph 3, decision 12/CP.19.

It should be noted that this summary of information presents the state of the art of the implementation of the Cancun safeguards by Brazil throughout the implementation of the actions for reducing emissions from

79 *Safeguarding Forests and People. A Framework for Designing a National System to Implement REDD+ Safeguards. Daviet & Larsen, 2012. Available at http://www.wri.org/publication/safeguarding-forests-and-people.*

deforestation in the Amazon biome (through PPCDAm) between 2006 and 2010 and the projects funded with REDD+ results-based payments received through the Amazon Fund.

This document is a non-exhaustive preliminary assessment of the implementation of the Cancun safeguards by Brazil. The goal is to take the first step towards the creation of an effective dialogue process with the Brazilian society about the implementation of Cancun safeguards and about the creation of the SIS REDD+, acknowledging that its effective implementation should rely on a gradual and participatory approach. This process is still incipient in Brazil and it demands a coordinated structure that enables the full and effective participation of all relevant stakeholders.

3. REDD+ IN BRAZIL

3.1. NATIONAL CONTEXT

Brazil is a mega diverse country with the largest continuous forested area in the world. Brazilian forests, by providing a variety of goods and environmental services, play important social, economic and environmental roles. About 60% of the country is covered by native vegetation, spread across biomes with particular sets of characteristics.

TABLE A.1
National statistics, reference year 2009

Total population (2010)	191 million
Total country area	851 million ha
Total forest covered area	516 million ha
Forested area share of total country area	60.70%
Forested area per inhabitant	2.7 ha
Natural forest areas	509.8 million ha
Planted forest areas	6.8 million ha
Federal Protected areas	74 million ha
Indigenous lands	106 million hectares
Registered public forests (2010)	290 million ha
Federal community forests	128 million ha
Public forest under forest concession	146 000 ha

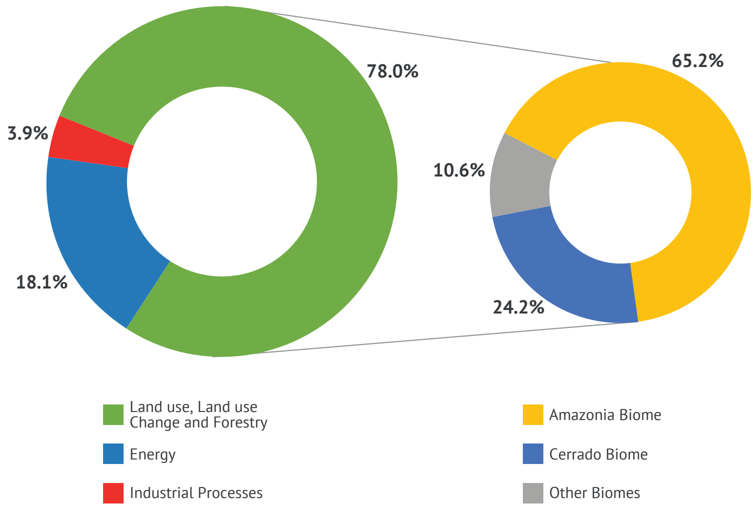
Source: Brazilian Forest Service -SFB[80]

About 78% of Brazil´s CO_2 emissions in 2000 came from the land use, land use change and forestry sector

80 *Available at: http://www.florestal.gov.br/snif/*

(LULUCF) - see Figure A.2.

FIGURE A.2
Share of total anthropogenic CO_2 emissions by sector in 2000



Source: Second National Communication to the UNFCCC

According to the Amazonian Gross Deforestation Monitoring Project (PRODES), from the National Institute for Space Research (INPE), MCTI, 2004 had the second highest annual deforestation rate on record in the Legal Amazon, reaching 27,772 km². In the same year, PPCDAm was launched, with the participation of representatives from the Chief of Staff of the Presidency of the Republic, 13 Ministries and the civil society.

Brazil has achieved significant results with its efforts to reduce greenhouse gas emissions from deforestation and forest degradation since 2006. International recognition for these efforts materializes through results-based REDD+ payments. For the purpose of earning the recognition of its REDD+ results under the UNFCCC, Brazil must, *inter alia*, present its National REDD+ Strategy (ENREDD+), undergo evaluation of its reference levels (completed for the reference level for reducing emissions from deforestation in Amazon biome in November 2014), undergo verification process of the results presented in the REDD+ Annex to the Biennial Update Report (BUR) in December 2014 and present a summary of information on how the Cancun safeguards were addressed and respected in the implementation of REDD+ activities as part of its National Communication to the UNFCCC.

The ENREDD+ was developed through a broad and participatory process initiated in 2010. The ENREDD+ aims at coordinating and promoting synergies between the National Climate Change Policy (Law No. 12.187/2009), the Native Vegetation Protection Act (New Forest Code), the plans to prevent and control deforestation in the biomes (see details on the PPCDAm in the next section) and other laws, policies and regulations that aim at reversing the loss of forests, a government priority.

Figure A.3 presents the legal and institutional framework for REDD+ in Brazil.

FIGURE A.3
Legal and Institutional Framework for REDD+

Strategic Level	PNMC, Native Vegetation Protection Law, PNGATI National Forest Fire Policy, Atlantic Forest Law, Public Forests Management Law
Tactical-operational Level	Level 1: PPCDAm, PPCerrado and PPCDs, Green Steel Sector Plan
	Level 2: ABC, PNF, Atlantic Forest Program, São Francisco Basin Revitalization Program
Funding	Amazon Fund, National Forest Development Fund, Climate Fund, Protected Areas Fund–ARPA

In the following sections and throughout this summary, the PPCDAm and the Amazon Fund will be described in detail. These are initiatives from the federal government linked to Brazil's REDD+ results in the Amazon biome since 2006.

3.2. ACTION PLAN FOR THE PREVENTION AND CONTROL OF DEFORESTATION IN THE LEGAL AMAZON (PPCDAM)

Brazilian environmental policies take into account the specificities of each biome from its formulation through its implementation. A biome is an eco-region, a set of ecosystems comprising similar vegetation physiognomic characteristics in a given region. The Brazilian biomes are: Atlantic Forest, Amazon, Caatinga, Cerrado, Pantanal and Pampa.

The first biome to have a plan to combat deforestation was the Amazon, the largest rainforest in the world. Brazil has 60% of this biome in its territory. For administrative purposes, the Brazilian government adopts the geographic region known as "Legal Amazon" to develop its initiatives, which includes portions of the Cerrado and the Pantanal biomes. PPCDAm is the main framework of actions to protect the Brazilian Amazon rainforest.

The PPCDAm is a tactical-operational plan, created in 2004, which clearly defines the actions, the responsible actors and the goals to be achieved in order to control and prevent illegal deforestation and promote sustainable regional development in the Legal Amazon. It consists of coordinated governmental efforts to facilitate the transition from the predatory growth to a sustainable development model, taking into consideration the importance of keeping forests standing, of its associated natural resources and of the promotion of economic and social means to benefit the 25 million inhabitants of the Amazon.

In order to promote the continuous reduction of deforestation and forest degradation in the Amazon, PPCDAm was structured in three thematic axes that guide government action, namely:

1. Land tenure regularization and land use planning;
2. Environmental Monitoring and Control; and
3. Fostering Sustainable Production Activities.

To implement the actions set out on PPCDAm's three axes, each participating institution channels funds from their own budget or from other sources.

PPCDAm fostered, since its creation, the development of public policies to meet the challenges of reducing illegal deforestation in the Amazon. To achieve such goal, the plan acts as an umbrella for several public policies, programs and initiatives. Among these are the following:

- *Plano de Desenvolvimento Regional Sustentável do Xingu* – PDRS Xingu ("Xingu Sustainable Regional Development Plan");
- *Plano Nacional de Promoção das Cadeias de Produtos da Sociobiodiversidade* – PNPSB ("National Plan for Promoting the Supply Chains of Sociobiodiversity Products");
- *Política de Garantia de Preços Mínimos para Produtos da Sociobiodiversidade* – PGPM-Bio ("Minimum Price Guarantee of socio-biodiversity products Policy");
- *Política Nacional de Gestão Territorial e Ambiental das Terras Indígenas* – PNGATI ("National Policy on Territorial and Environmental Management of indigenous lands");
- *Programa Agricultura de Baixa emissão de Carbono* – ABC ("Low Carbon Emission Agriculture Program");
- *Programa Áreas Protegidas da Amazônia* – ARPA ("Amazon Region Protected Areas Program");
- *Programa de Apoio à Conservação Ambiental – Bolsa Verde* ("Environmental Conservation Support Program – Green Grant" - part of Brazil without extreme Poverty Plan);
- *Programa de Manejo Florestal Comunitário e Familiar* – PMFC ("Community and Family Forest Management Program");
- *Programa de Regularização Ambiental* – PRA ("Environmental Regularization Program");
- *Programa Nacional de Fortalecimento da Agricultura Familiar* - PRONAF ("National Program for Strengthening Family-based Agriculture");
- *Programa Terra Legal* ("Regular Land Program").

Each of these governmental programs have their own resources, goals, and target groups set to converge with the objectives proposed under PPCDAm, spanning from environmental conservation to the promotion of sustainable agricultural production systems. This approach was taken after the federal government recognized that effectively tackling deforestation would entail joint and coordinated efforts in various fronts, since drivers often go beyond the environmental sector.

In addition to the federal government initiatives, the active participation of state governments through the *Planos Estaduais para Prevenção e Controle do Desmatamento* – PPCDs ("States Plan for Prevention and Control of Deforestation"), is of great importance to the implementation of the PPCDAm. The dialogue with the State governments has been gaining strength since the second phase of PPCDAm, when a coordinated strategy at the federal and state levels has become more robust with greater integration between the PPCDAm and the PPCDs.

Important results have been achieved during the first and second phases of the PPCDAm. In the Land tenure regularization and land use planning axis, 25 million hectares of Federal Protected Areas were created and another 10 million hectares of indigenous lands have been approved, mostly around the expansion front for deforestation. In addition to that, approximately 25 million hectares of state as well as municipal Protected Areas have been created since 2004, meaning that all levels of government contributed to the expansion of Protected Areas in the Amazon biome. Besides the expansion of protected areas, the Amazon Ecological-Economic Macrozoning Plan was created and 25,618 rural possessions have been georeferenced by Terra Legal.

The Environmental Monitoring and Control axis had hundreds of integrated law enforcement operations, based on technical criteria and territorial priorities, as well as significant improvement of environmental monitoring systems, which involved satellite imagery analysis, such as PRODES, the *Sistema de Detecção do Desmatamento na Amazônia Legal em Tempo Real* – DETER (Real Time Deforestation Detection System) which serves as a guide for integrated enforcement operations and, more recently, the *Sistema de Detecção da Exploração Seletiva de Madeira* – DETEX (Selective Logging Detection System), the *Mapeamento da Degradação Florestal na Amazônica Brasileira* – DEGRAD ("Forest Degradation in the Brazilian Amazon Mapping System") and the TerraClass Project to assess land use and occupation dynamics of deforested areas.

On the Fostering Sustainable Production Activities axis the highlights have been the initiatives to promote a forest economy in the Amazon, with 13,852 families cared for in projects that aim at promoting sustainable management practices in rural settlements and 13 the *Bolsa Verde* Program, whose target group is, among others, populations living in sustainable use Protected Areas. It is also noteworthy that 225,000 hectares of forests are now under concession for Sustainable Management and the creation of that the Sustainable Forest District of BR 163 has been created.

In its third phase (2012-2015), the following strategic objectives were stated for the three axes of PPCDAm (Table A.2).

TABLE A.2
Strategic objectives on PPCDAm's three axes

AXES	STRATEGIC GOALS
Land tenure regularization and land use planning	>> Promote land use planning of public lands >> Implement regional land use planning instruments to advance forest conservation >> Management of rural landholdings grid according to its diverse categories
Monitoring and Control	>> Speed up the licensing of forest management plans and forest concessions >> Improve the efficiency of law enforcement and deforestation command and control activities >> Enhance the government´s presence in the Amazon >> Reduce administrative and criminal impunity related to illegal deforestation >> Promote environmental accountability of the main supply chains related to illegal deforestation
Fostering Sustainable Production Activities	>> Promote sustainable supply chains that provide alternatives to deforestation >> Promote good practices in agriculture, including replacing the use of fire as a management tool >> Increase the wood production and trade from sustainable management of forests >> Promote environmental compliance and foster sustainable production activities in agrarian reform settlements and family farming >> Generate science, technology and innovation about the Amazon to support sustainable development

Source: PPCDAm (2012-2015)

PPCDAm identifies and addresses the drivers of deforestation, constituting the basis for REDD+ implementation. The implementation of REDD+ in Brazil in turn creates new positive incentives for the implementation of the PPCDAm through economic instruments that promote sustainable initiatives in the Amazon biome, thereby strengthening the third axis of PPCDAm (Fostering Sustainable Production Activities).

REDD+ has the potential to contribute to the permanence of the emission reductions achieved by reducing deforestation through PPCDAm, with new and additional resources to be raised internationally as results based payments. In addition to that, the lessons 14 learned in the PPCDAm serve not only to improve public policies aimed at reducing deforestation in the Amazon but also in other Brazilian biomes and tropical countries.

Once approved, the ENREDD+ will tie the tactical-operational plan defined by PPCDAm, with specific REDD+ goals defined by Brazil, namely: (i) to improve the monitoring and impact assessment of public policies for REDD+, in order to maximize their contribution to global climate change mitigation, observing the Cancun safeguards; (ii) to integrate the management structures of the National Climate Change Plan and the Action Plans for the Prevention and Control of Deforestation in the biomes, seeking the convergence between climate and forest policies at the federal, state and municipal levels; and (iii) to contribute to the mobilization of international resources at a scale that is compatible with the voluntary national commitments to mitigate greenhouse gas emissions in the Brazilian biomes by 2020, as established by the National Climate Change Policy.

3.3. AMAZON FUND

The Amazon Fund is currently Brazil's main funding instrument based on compensation for REDD+ results. Established by the Decree No. 6527 of August 1, 2008, its goal is to raise donations for non-reimbursable investments in efforts to prevent, monitor and combat illegal deforestation and to promote conservation and sustainable use of forests in the Amazon biome. Its creation was an outcome of the success achieved by the PPCDAm in reducing deforestation in the Amazon biome since 2004 and took place even before the definition of an international architecture for REDD+ under the UNFCCC.

The Amazon Fund supports projects in the following areas:

- >> Management of public forests and protected areas;
- >> Environmental control, monitoring and inspection;
- >> Sustainable forest management;
- >> Economic activities created with sustainable use of forests;
- >> Ecological and economic zoning, territorial arrangement and agricultural regulation;
- >> Preservation and sustainable use of biodiversity; and
- >> Recovery of deforested areas.

The Amazon Fund may use up to 20% of its resources to support the development of systems to monitor and control deforestation in other Brazilian biomes and in other tropical countries. The decree that created the Amazon Fund also recommends that the initiatives to be financed follow the guidelines of the Sustainable Amazon Plan and the PPCDAm.

The institution responsible for managing the Amazon Fund is the National Bank for Economic and Social Development (*Banco Nacional de Desenvolvimento Econômico e Social*, BNDES), which is also in charge of fundraising results based payments, in coordination with the MMA, and contracting and monitoring the projects and actions supported. The Amazon Fund has a Guidance Committee (COFA), which is responsible for determining the guidelines and for monitoring the projects results; and a Technical Committee (CTFA), appointed by the MMA, whose role is to attest the emission reductions achieved in the Amazon.

The cap for fundraising is set annually by the MMA, taking into account the actual emission reductions from deforestation in the previous year, after being attested by the CTFA. Based on this information, the BNDES is authorized to raise donations to the Fund and in return issue certificates recognizing the contribution of the donors to the Fund. These certificates are nominal, non-transferable and do not generate rights or claims of any kind.

Entities from governments (federal, state and municipal), public and private companies and also from the civil society can submit projects to the Amazon Fund.

The following are the social and environmental safeguards applicable to the Amazon Fund projects:

- >> Legal Compliance;
- >> Acknowledgement and guarantee of rights;
- >> Distribution of benefits;
- >> Economic sustainability, improving standards of living and reducing poverty;
- >> Environmental conservation and remediation;
- >> Participation;
- >> Monitoring and Transparency;
- >> Governance.

The document "REDD+ Social and Environmental Principles and Criteria", consolidated by Imaflora in 2010, served as a reference for defining these safeguards. The document was the result of an initiative that engaged representatives from the private sector, environmental organizations, indigenous peoples, traditional communities, smallholders and research institutions. Table A.3 presents the correlation between these Principles and Criteria and the Cancun Safeguards.

TABLE A.3

Comparative Matrix of the Cancun Safeguards and REDD+ Social and Environmental Principles and Criteria conceived by the Brazilian civil society

CANCUN SAFEGUARDS[81]	REDD+ SOCIAL AND ENVIRONMENTAL PRINCIPLES AND CRITERIA+
(A) That actions complement or are consistent with the objectives of national forest programs and relevant international conventions and agreements.	1.1 REDD+ actions shall respect the Brazilian labor legislation, including requirements on health and safety and repression of any form of slave and child labor, while respecting the distinctiveness of the organization of labor of Indigenous Populations, smallholders and local communities. 1.2 REDD+ actions shall respect the Brazilian environmental legislation. 1.3 REDD+ actions shall respect all international social, environmental, cultural, labor and commercial agreements ratified by Brazil.
(C) Respect for the knowledge and rights of indigenous peoples and members of local communities, by taking into account relevant international obligations, national circumstances and laws, and noting that the United Nations General Assembly has adopted the United Nations Declaration on the Rights of Indigenous Peoples.	2.1 There shall be the recognition and respect of the constitutional, statutory and customary rights associated with land ownership, the official designation of occupied lands, and the use of natural resources of Indigenous Peoples, smallholders, including complete respect to the UN Declaration on the Rights of Indigenous Peoples, to the FAO Treaty on Agriculture and Food, and to the ILO Convention 169. 2.2 REDD+ actions shall recognize and value the socio-cultural systems and traditional knowledge of Indigenous Peoples, smallholders and local communities. 2.3 REDD+ actions shall respect the rights to self-determination of the Indigenous Peoples and local communities. 2.4 In the areas where REDD+ actions are implemented, lawful ownership and possession rights shall be respected, as well as those rights associated with the use of land and natural resources. 2.5 There shall be formal mechanisms for conflict resolution associated with REDD+ actions, through dialogues that include the effective participation of all involved stakeholders. 3.1 Benefits generated by REDD+ actions shall be accessed in a fair, transparent and equitable form by those who hold the rights to the use of land and/or natural resources and promote activities related to conservation, sustainable use and forest restoration.

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81 The letters in parentheses in the first column refer to the text format in Annex I to the Decision 1/CP.16 of the UNFCCC.

CANCUN SAFEGUARDS[81]	REDD+ SOCIAL AND ENVIRONMENTAL PRINCIPLES AND CRITERIA+
(E) That actions are consistent with the conservation of natural forests and biological diversity, ensuring that the actions referred to in paragraph 70 of this decision are not used for the conversion of natural forests, but are instead used to incentivize the protection and conservation of natural forests and their ecosystem services, and to enhance other social and environmental benefits.	5.1 REDD+ actions shall contribute to the conservation and recovery of natural ecosystems and avoid causing significant negative impacts to biodiversity and ecosystem services 5.2 Species or ecosystems that are rare, endemic or threatened with extinction, as well as any other high conservation value attribute, shall be previously identified, protected and monitored. 5.3 In case of restoration activities in degraded areas, REDD+ actions shall use native species.
(D) The full and effective participation of relevant stakeholders, in particular indigenous peoples and local communities.	6.1 Conditions for the participation of the beneficiaries shall be ensured in all phases of REDD+ actions and in the decision making processes, including the identification, negotiation and distribution of benefits. 6.2 Decision making processes relating to REDD+ actions shall effectively ensure the right to free, prior and informed consent, considering local representatives and respecting the traditional forms of electing representatives by Indigenous Peoples, smallholders and local communities. 6.3 Populations living in areas affected by REDD+ actions shall be informed about them.
(B) Transparent and effective national forest governance structures, taking into account national legislation and sovereignty.	7.1 Beneficiaries shall have free access to information relating to REDD+ actions, in simple language, so they can participate in the decision making process in a previously informed and responsible manner. 7.2 Transparency of information about REDD+ actions shall be guaranteed, including at least those related to the methodology, location and size of the area, definition and participation of involved and affected stakeholders, activities to be executed, time length of the project and conflict resolution mechanisms. 7.3 In public lands, protected areas and in other areas that involve Indigenous Peoples, smallholders and local communities, or in REDD+ actions supported by public funds, there shall be ensured transparency of information regarding the raise, use and distribution of benefits generated by REDD+, as well as periodic financial reporting. 7.4 There shall be periodic monitoring of the social-environmental, economic and climate related impacts and benefits of REDD+ actions, while respecting the traditional way of life and practices of Indigenous Peoples, smallholders and local communities, and results of this monitoring shall be made publicly available.
(B) Transparent and effective national forest governance structures, taking into account national legislation and sovereignty	8.1 REDD+ actions shall be coordinated and consistent with national, state, regional and municipal policies and program on climate change, conservation, sustainable development and deforestation prevention. 8.2 REDD+ actions shall meet the requirements of state or national REDD+ policies. 8.3 Emission reductions and carbon sequestration generated by REDD+ actions shall be quantified and registered in a way to avoid double counting. 8.4 REDD+ government actions shall contribute to strengthen public instruments and processes for forestry and territory management.

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CANCUN SAFEGUARDS[81]	REDD+ SOCIAL AND ENVIRONMENTAL PRINCIPLES AND CRITERIA+
(F) Actions to address the risks of reversals;	4.1 REDD+ actions shall promote economic alternatives based on standing forest valorization and on the sustainable use of natural resources and deforested areas. 4.2 REDD+ actions shall contribute to poverty alleviation, social inclusion and improvement of livelihoods for people who live in REDD+ implementation areas and in areas affected by it.
(G) Actions to reduce displacement of emissions.	5.1 REDD+ actions shall contribute to the conservation and recovery of natural ecosystems and avoid causing significant negative impacts to biodiversity and ecosystem services. 8.3 Emission reductions and carbon sequestration generated by REDD+ actions shall be quantified and registered in a way to avoid double counting.

This summary of information presents some information on the Amazon Fund's safeguards procedures. The risks and impacts assessment is a major component of BNDES' review process for the Amazon Fund projects. All the projects submitted to the BNDES receive an environmental risk rating, and social and environmental recommendations to be observed during the analysis process. Across the wide array of institutions and types of projects supported by the Fund, there is an effort to ensure compliance with standards and guidelines from public policies associated with each project, while taking into consideration the territorial and social particularities of the region.

The cases in which greater territorial impact is identified, specific actions are implemented. Apart from the direct impacts, the assessment of a project aims at measuring and fostering the positive externalities or co-benefits, and avoiding or minimizing potential risks of negative impacts. The risks and impacts encountered in the project assessment are discussed with the applicants, to explore ways to eliminate or reduce them to an acceptable level. This assessment can lead to changes in the design, in the text of a given agreement with other entities or even lead to tailoring specific contractual clauses.

3.4. IMPLEMENTATION OF THE WARSAW FRAMEWORK FOR REDD+ BY BRAZIL

In early 2014, a Technical Working Group on REDD+ was established by the MMA, comprised of renowned experts in fields of climate change and forests to provide inputs for the development of high quality technical submissions and to support the federal government team during the assessment of such submissions by the experts appointed by the UNFCCC. The group had three meetings in 2014.

On June 6, 2014 in Bonn, Germany, Brazil submitted its Forest Reference Emission Level (FREL) for reducing emissions from deforestation in the Amazonia biome for REDD+ results-based payments under the UNFCCC. This submission was developed with support from the Technical Working Group on REDD+ and marked the beginning of the implementation of the Warsaw Framework for REDD+, one of the major outcomes of the COP 19 held in Poland on November, 2013.

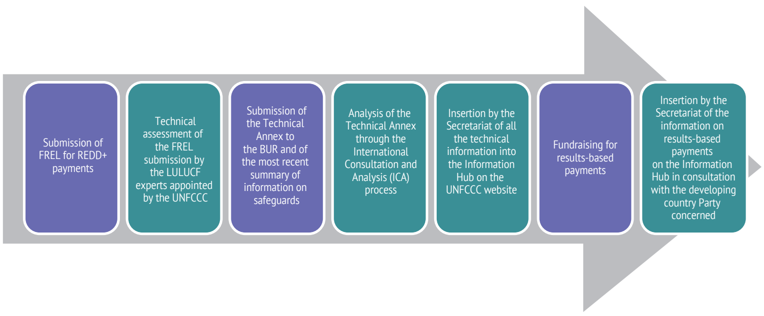
Brazil's FREL focuses on the gross emissions from deforestation, defined as clear-cutting, in the Amazon biome between 1996 and 2005. Brazil has a consistent forest monitoring time series from PRODES (INPE), which made this submission possible. Gross CO_2 emissions were spatially calculated, having as a reference the carbon map from Brazil's Second National Inventory of Greenhouse Gas Emissions, the latest available when the FREL was submitted to the UNFCCC. The submission included the carbon pools below and above ground and litter, the calculation of emissions followed the IPCC guidelines and methodologies (2003).

Between August and November 2014 Brazil's FREL underwent a rigorous evaluation process conducted by two LULUCF experts appointed by the UNFCCC. This facilitative process contributed to improve the clarity of the submission and also identified areas that will require further technical development for future submissions.

In December 2014, Brazil submitted to UNFCCC its results reducing emissions from deforestation in the Amazon biome, since 2006, through a technical annex to the BUR. The document, developed with support from the Technical Working Group on REDD+, will undergo the international consultation and analysis process (ICA) in 2015 (Figure A.4).

FIGURE A.4

Process that developing countries go through to obtain the recognition of their REDD+ results under the UNFCCC



Note: The purple boxes represent initiatives from developing countries that strive for recognition of their REDD+ results and the green boxes represent the initiatives from the UNFCCC Secretariat.

4. THE SAFEGUARDS OF CANCUN IN THE BRAZILIAN CONTEXT

Although the PPCDAm (2004) and the Amazon Fund (2008) were launched before decision 1/CP. 16 (2010), parallels can be drawn between the Cancun safeguards and the processes and actions undertaken during the implementation of activities under such initiatives. The sections below present an interpretation of the seven Cancun safeguards in the Brazilian context and a brief analysis of how they were treated throughout the implementation of the PPCDAm, which drove Brazil's REDD+ results since 2006, and the financing of projects by the Amazon Fund.

(a) That actions complement or are consistent with the objectives of national forest programs and relevant international conventions and agreements

In order to understand what this safeguard means in the Brazilian context and the means for its effective implementation, the Technical Panel sought to ascertain what are the national programs and international agreements relevant to REDD+ that have been ratified by Brazil. The Technical Panel also took into consideration administrative proceedings, institutions and working groups that could assist in ensuring consistency or complementarity with the implementation of relevant policies and international agreements.

Brazil has numerous programs and initiatives to promote the reduction of deforestation and forest degradation, conservation, sustainable management of forests and reforestation (REDD+ activities). Among them: the Federal Constitution, the Native Vegetation Protection Law (New Forest Code), National Policy on Territorial and Environmental Management of Indigenous Territories, Public Forests Management Law, National Environmental Policy, National Climate Change Policy, Amazon Region Protected Areas Program, Ecologic-Economical Macrozoning, Rural Environmental Registry, National Biodiversity Policy, Amazon Degraded Areas Recovery Program, National Community and Family Forest Management Program, National Agrarian Reform Program, Brazil *Quilombola* Program, the United Nations Declaration on the Rights of Indigenous Peoples, ILO-Convention 169, Convention on Biological Diversity, Ramsar Convention, Agenda 21, among others.

The complementarity and consistency of these actions in the Amazon biome is driven by the PPCDAm. PPCDAm aims at coordinating and directing the policies and initiatives identified as linked to the dynamics of deforestation. The three axes of PPCDAM serve as a means of harmonizing such policies.

Among those safeguards adopted by the Amazon Fund, the one concerning "Governance" is the one more closely related to this Cancun safeguard. The Amazon Fund has a Guidance Committee in its operating structure, COFA, which sets the guidelines and priorities to be adopted for analyzing project applications. One of the conditions for approval is whether projects can demonstrate clear consistency with actions planed in the PPCDAm and the PPCDs. In addition to that, the compliance with the Fund's environmental and social safeguards is assessed through the reports to monitor the project activities.

(b) Transparent and effective national forest governance structures, taking into account national legislation and sovereignty

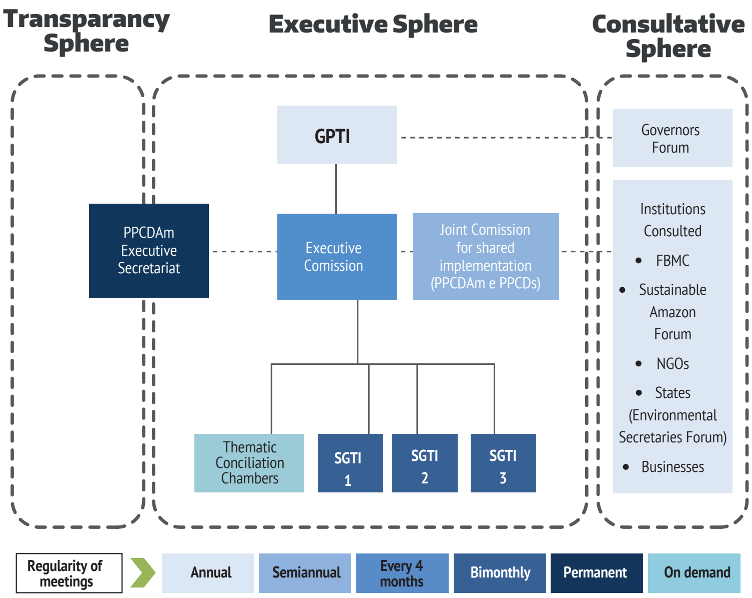
When assessing compliance with this safeguard, the Technical Panel set basic criteria for evaluating the transparency and effectiveness of existing governance structures related to REDD+ activities. Note that this set of criteria does not preclude the inclusion of new criteria, as appropriate.

The criteria were divided into two categories to ease the collection of information: (i) institutional arrangements and (ii) transparency. For institutional arrangements, the information gathered covered the composition (e.g. parity between government and civil society), regularity (number of meetings), assignments, structure, decisions guided by these structures, capillary and gender issues. Regarding transparency, information about availability and publicity of data were considered.

PPCDAm's current governance model is divided into three spheres: Executive, Consultative and Transparency (Figure A.5).

FIGURE A.5

PPCDAm's phase 3 governance structure



The Executive Sphere is where decision-making, guidance, implementation and monitoring of activities take place, whereas the Consultative Sphere promotes dialogue with State governments and civil society, which is vital to the success of the PPCDAm. The Transparency Sphere aims at giving greater publicity to the PPCDAm implementation, using several means to reach out to other government entities and the Brazilian society by publicizing the monitoring of activities carried out.

The *Grupo Permanente de Trabalho Interministerial* ("Permanent Inter-Ministerial Working Group" - GPTI) created by the Decree of July 3, 2003 is responsible for decision-making and proposing strategic measures. The GPTI consists of 17 ministries (initially they were 13) under the coordination from the MMA since 2013 (it was initially coordinated by the Chief of Staff of the Presidency).

The PPCDAm also has an Executive Committee, coordinated by the Chief of Staff of the Presidency between 2004 and 2013 and by the MMA since then. The Executive Committee is responsible for monitoring and proposing measures to overcome the challenges associated with the implementation of the activities planned under the PPCDAm and the ones defined by the GPTI. The Committee has representatives from the 22 Ministries involved. The

MMA has the role of Executive Secretariat, responsible for examining and monitoring the PPCDAm implementation. The Executive Committee is tied to the Legal Amazon Environment Secretaries Forum in a Joint Committee for Shared Implementation (PPCDAm and PPCDs).

Dialogue with civil society pervades the whole design of the PPCDAm, especially by taking advantage of already established channels such as the Sustainable Amazon Forum, which also includes representatives from the business sector. This dialogue was further developed during the technical-scientific seminars designed for deforestation data analyses. The aim is to strengthen the channels for communication with key Brazilian stakeholders in order to promote the effective implementation of PPCDAm activities.

Another innovation of PPCDAm was the creation of Subgroups for each thematic Axis, creating a space for constant monitoring and problem solving to meet the targets - although each subgroup has its own dynamics and regularity of meetings, mainly determined by how the items on the agenda progress in a subgroup.

As for the Amazon Fund, the COFA determines the guidelines for supporting projects and monitoring the results achieved. COFA has representatives from the Federal government, the State governments in the Legal Amazon region and the civil society (see composition in Table A.4 below). Voting rights in the COFA are granted only to those State governments with a PPCD. This conditionality helped the PPCDAm in getting the State governments engaged with implementing actions to reduce deforestation.

TABLE A.4
Amazon Fund Guidance Committee composition

BLOCKS	ENTITY
Federal Government	Ministry of the Environment
	Ministry of Development, Industry and Foreign Trade
	Ministry of External Relations
	Ministry of Agriculture, Livestock and Food Supply
	Ministry of Agrarian Development
	Ministry of Science, Technology and Innovation
	Chief of Staff of the Presidency of the Republic Office
	Strategic Affairs Secretariat of the Presidency of the Republic
	National Bank for Economic and Social Development - BNDES

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BLOCKS	ENTITY
Amazonian states	Acre
	Amapá
	Amazonas
	Maranhão
	Mato Grosso
	Pará
	Rondônia
	Roraima
	Tocantins
Civil Society	Brazilian Forum of NGOs and Social Movements for Environment and Development - FBOMS
	Brazilian Amazon Indigenous Organizations Coordination Office - COIAB
	National Confederation of Industry - CNI
	National Forum of Forest-Based Activities - FNABF
	National Confederation of Agricultural Workers - CONTAG
	Brazilian Society for the Progress of Science - SBPC

To ensure transparency in the Amazon Fund's decision-making processes, COFA meetings are recorded in "Technical Provisions Registries" - *Registros de Encaminhamento Técnico* (RETs) made available on the Amazon Fund's website: http://www.fundoamazonia.gov.br/FundoAmazonia/fam/site_pt/Esquerdo/Fundo/cofa.html. Furthermore, to give publicity and transparency to the projects in progress and/or in implementation, the Amazon Fund offers a section for consulting the projects approved, fortnightly bulletins with an overview of the projects submitted and annual activity reports on its website.

(c) Respect for the knowledge and rights of indigenous peoples and members of local communities, by taking into account relevant international obligations, national circumstances and laws, and noting that the United Nations General Assembly has adopted the United Nations Declaration on the Rights of Indigenous Peoples

The Technical Panel focused on determining which norms contemplate the rights of indigenous peoples, traditional communities and smallholders, as well as on the rights associated with traditional knowledge, taking into account relevant international obligations, national circumstances and law and the United Nations Declaration on the Rights of Indigenous Peoples.

Fourteen instruments that provide for rights and respect for knowledge and customs were identified, among them, the ILO Convention 169, the Federal Constitution, the National Policy on Territorial and Environmental Management of indigenous lands (*Política Nacional de Gestão Territorial e Ambiental de Terras Indígenas*, PNGATI), National Policy for the Sustainable Development of Traditional Peoples and Communities and the Indigenous Peoples Statute (Law 6,001/1973). Among the rights mapped out, some of the most important are the rights for free, prior and informed consent, rights to the territory, rights to the use of resources and benefit-sharing.

To understand how this safeguard was respected during the implementation of the PPCDAm it is necessary to evaluate how the right for free, prior and informed consent was exercised, the occurrence and allegations of environmental crimes and of violation of rights, the demarcation of indigenous and *quilombola* lands, management plans, processes submitted to the *Conselho de Gestão do Patrimônio Genético* ("Genetic Heritage Management Council" CGEN in Portuguese) from MMA's Biodiversity and Forests Secretariat.

Throughout the PPCDAm's implementation, 10 million hectares of indigenous lands were demarcated between 2004 and 2011. However, the experts from the Technical Panel pointed out that although the data on demarcation of indigenous lands is relevant to the context of this safeguard, it does not suffice for assessing its compliance. For example, there is no mention of data on conflicts and violence related to demarcation, approval and recognition of indigenous lands in the reports from the National Indigenous People's Foundation (*Fundação Nacional do Indio* – FUNAI) and civil society institutions. A more comprehensive assessment of processes that provides more details on how this safeguard is being respected is required.

The Amazon Fund, in partnership with the MMA and FUNAI, launched in May 2014, a Call for Proposals to select applicants for non-reimbursable financial support for the development and implementation of Territorial and Environmental Management Plans (*Planos de Gestão Territorial e Ambiental de Terras Indígenas* – PGTAs) in indigenous lands in the Amazon biome. This Call for Proposals contributes directly to the implementation of the PNGATI. The total amount of resources for this call is up to R$ 70 million and up to ten projects will be selected for the design and implementation of PGTAs in the Amazon. The design of PGTAs must take into consideration the document "Guidelines for designing Land and Environmental Management Plans for Indigenous Lands" by FUNAI[82].

FUNAI has actively participated in the Inter-Ministerial Working Group for the ENREDD+ and, along with the MMA, has prepared the document with the premises for developing of REDD+ activities in indigenous lands. In addition to that, throughout the 4 years of the ENREDD+ drafting process, a series of meetings with representatives from the Brazilian Amazon Indigenous Organizations Coordination Office (*Coordenação das Organizações Indígenas da Amazônia Brasileira* – COIAB) and the National Articulation of the Indigenous People of Brazil (*Articulação dos Povos Indígenas do Brasil* – APIB). The MMA's technical team participated in a series of meetings on climate change organized by indigenous representations in the Amazon states and by the FUNAI to present the context and development of REDD+ under the UNFCCC and in Brazil.

The absence of a national regulation on the ILO 169, of a forum or specific body to file representations (charges) about violation of rights in REDD+ initiatives was identified as an area that requires improvements on the Brazilian government side, for the effective implementation of this safeguard.

(d) The full and effective participation of relevant stakeholders, in particular indigenous peoples and local communities, in the actions referred to in paragraphs 70 and 72 of this decision

Processes at the federal level

Full and effective participation depends on the availability of information that is qualified, accessible, transparent and adequate to REDD+ stakeholders. The Technical Panel interpreted that a fundamental condition for the full

82 More information available at: *http://www.fundoamazonia.gov.br/FundoAmazonia/export/sites/default/site_pt/Galerias/Arquivos/Chamada_PNGATI_23_09_14.pdf*

and effective participation of stakeholders is to ensure that indigenous peoples and traditional communities have representativeness in decision-making processes for the design and implementation of REDD+ policies and initiatives. Representatives of indigenous peoples and local communities should be considered and encouraged to take leading roles in REDD+ initiatives in their territories.

During the preparation of PPCDAm's third phase, a series of meetings for designing the elements of each axis took place with stakeholders' participation. A Consultative Sphere was established in the governance structure, enabling the participation of a wide range of social sectors. The Governors Forum tied to the GPTI and to the Brazilian Forum on Climate Change at the executive level, the Sustainable Amazon Forum, NGOs, the Environment Secretaries Forum and the productive sector. It should be noted that this Consultative sphere was created and functioned solely during the preparation of the third phase of PPCDAm; it will not be in place for its evaluation.

Members of the Technical Panel point out that in spite of the opportunities opened for participation, such debates were predominantly technical. Therefore these forums do little to truly engage grassroots organizations, putting the voice and protagonism of some stakeholders in jeopardy. In recent years, thematic workshops regularly organized by FUNAI have brought basic information to this audience, enabling more qualified engagement from indigenous leaders in discussions on climate change, forests and indigenous peoples.

When considering the Amazon Fund's project proposals review process, guidance on the effective participation of stakeholders is provided by their social and environmental safeguards. COFA is structured as a tripartite committee, composed by: the federal government, state governments and civil society. Each block being entitled to one vote for the decisions.

The resolutions must be approved by consensus. COFA has representatives from the following segments of civil society: (1) *Fórum Brasileiro de ONGs e Movimentos Sociais para o Meio Ambiente e o Desenvolvimento* ("Brazilian Forum of NGOs and Social Movements for Environment and Development" FBOMS in Portuguese), (2) the COIAB, (3) the *Confederação Nacional dos Trabalhadores na Agricultura* ("National Confederation of Agricultural Workers" CONTAG in Portuguese), (4) the *Sociedade Brasileira para o Progresso da Ciência* ("Brazilian Society for the Progress of Science SBPC in Portuguese), (5) the *Confederação Nacional da Indústria* ("National Confederation of Industry" CNI in Portuguese), (6) the *Fórum Nacional das Atividades de Base Florestal* ("National Forum of Forest-Based Activities" FNABF in Portuguese).

The Fund guidelines approved by COFA state that: (1) the project must include acceptance by all partners and co-executors; and (2) projects involving traditional communities and indigenous peoples must necessarily present a document to demonstrate free, prior and informed consent from those communities or their representative institutions.

The development of the ENREDD+, by its turn, involved a broad and participatory process that lasted four years. The process began in 2010 when the federal government created three Working Groups[83] with stakeholders; they generated the "Synthesis report with multi-stakeholder input for preparing the National Strategy". The main recommendation from this dialogue with society was that the federal government should institute a formal process to develop a National REDD+ Strategy.

83 The three working groups were divided into the following areas: GT1 - Coordination, Institutional Arrangements and Participation, GT2 - Benefits Distribution, Dominion and Safeguards, GT3 - Funding Sources and Financial Mechanisms.

In the course of the process to develop Brazil´s National REDD+ Strategy, a series of formal and informal meetings were held with various segments of society, including representatives from indigenous communities, state governments, the private sector and civil society organizations. Among the opportunities for discussion, the highlights were the workshop on "The implementation of social and environmental safeguards in the ENREDD+" and the discussion about safeguards with indigenous peoples in the COIAB event held in Manaus, in 2011 (see the details in the Appendix I of this document).

All the information was made available on the MMA's REDD+ website (www.mma.gov.br/redd) to promote transparency and the participation of the Brazilian stakeholders throughout the process. It is expected that in 2015, when the ENREDD+ is launched, the dialogue process with the society will intensify.

Despite the provisions for participation both in the PPCDAm governance structure and in the Amazon Fund, some representatives of the Brazilian civil society, in response to the publication of the draft of this summary on the web (from 27 October to 7 November), emphasized that the participation of non-state and state government actors in REDD+ processes should be further fostered by the federal government [84].

Carbon projects and harmful contracts

Decision 1/CP. 16 UNFCCC brings, among other things, the definition of the scope of REDD+ actions. REDD+ results are measured and reported at the national level, based on a national forest monitoring system. On an interim basis, developing countries may opt for a sub-national implementation, being the responsibility of the federal government to communicate with the UNFCCC and to obtain the recognition for the national REDD+ results. Since Cancun, the carbon projects approach to REDD+ has been dropped.

Following UNFCCC guidance, the implementation of REDD+ in Brazil will be carried out at the biome level as an interim measure. This scale was defined for the purpose of maintaining consistency with the action plans for prevention and control of deforestation. Hence, when preparing its National REDD+ Strategy, Brazil made the option to centralize in the federal government the measuring and reporting of REDD+ results. The carbon projects and jurisdictional approaches were rejected.

Since 2009, it is noteworthy the implementation of voluntary carbon projects in Brazil and other tropical countries. In some of these voluntary carbon projects involving indigenous populations and territories, the agreements signed between indigenous peoples representatives and international private companies had unconstitutional provisions that violated the Cancun Safeguards, especially with regards to legal requirements and relevant international agreements, such as:

- >> Project activities in violation of Art. 231, § 2 of the Federal Constitution and of Art. 18 of the Indian Statute (Law 6,001/1973) that determine the right of exclusive use by indigenous peoples of indigenous lands traditionally occupied by these communities.
- >> Negotiations between the parties that disregarded the full and effective participation of relevant stakeholders, such as indigenous peoples, as well as free, prior and informed consent.
- >> Lack of evidence on record of any inclusive initiative towards indigenous communities.

84 For more details about the letter sent by the Observatório do Clima ("Climate Observatory") regarding the summary of information on the safeguards and the Brazilian government's response see:: http://mma.gov.br/redd/index.php/pt/salvaguardas/sum%C3%A1rio-sobre-salvaguardas

- Lack of evidence on record of FUNAI participating as an interested party, capable to supervise or interfere.
- Lack of any clarification on technical issues regarding the implementation of such project and on the measures to be adopted for ensuring its effectiveness in terms of emission reductions and the environmental integrity of the activities in question.
- Lack of detail about aspects related to the commercialization of carbon credits and the risks assumed by the parties in such transactions.

The need to address these cases of contracts that harm indigenous rights led Brazilian governmental agencies to organize a quick response. In 2011, FUNAI compiled a list of around 20 companies that tried to sign contracts with indigenous communities with no regard to the minimum criteria established by national legislation.

The MMA has been keeping track of some cases of foreign private companies attempts to sign illegal contracts with indigenous communities for the development of carbon projects, in collaboration with the Federal Attorney General's Office and the *Comissão Pro-Índio de São Paulo* – CPISP ("São Paulo Pro-indigenous Commission"). The surveillance proved to be successful, as in the years 2013 and 2014 fewer cases were reported.

(e) That actions are consistent with the conservation of natural forests and biological diversity, ensuring that the actions referred to in paragraph 70 of this decision are not used for the conversion of natural forests, but are instead used to incentivize the protection and conservation of natural forests and their ecosystem services, and to enhance other social and environmental benefits

This safeguard indicates that REDD+ actions should be consistent with the conservation of native forests and biodiversity, ensuring that the risk of conversion of natural forests are averted, especially in regards to the increase of carbon stocks.

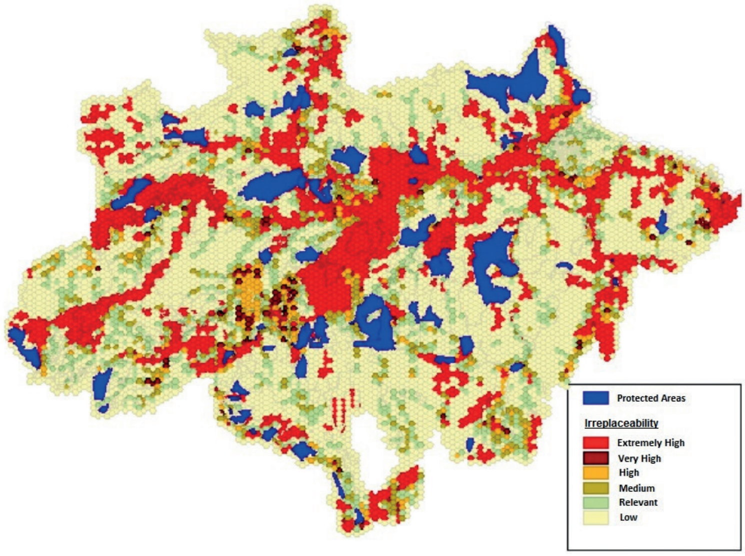
Brazil currently has specific legal instruments for biodiversity conservation, such as the *Política Nacional da Biodiversidade* ("National Biodiversity Policy – Decree 4339/2002), the *Programa Nacional da Biodiversidade e a Comissão Nacional da Biodiversidade* ("National Program for Biological Diversity and the National Biodiversity Commission" – Decree 4703/2003), Decree 2519, which enacts the Convention on Biological Diversity (CBD), the *Política Nacional do Meio Ambiente* ("National Environmental Policy" – Law 6938/1981), the *Plano Nacional de Promoção das Cadeias de Produtos da Sociobiodiversidade* ("National Plan for the Promotion of Sociobiodiverse Supply Chains" – Interministerial Ordinance by the Ministry of Agrarian Development/Ministry of Social Development/Ministry of Environment 239/2009), among others. The effective implementation of these instruments is a condition for promoting this safeguard.

Throughout PPCDAm's implementation, 50 million hectares of Protected Areas were created, 25 million by the federal government and 25 million by the State Governments.

These Protected Areas shelter high biodiversity and were created in areas under deforestation pressure (Figure A.6).

FIGURE A.6

Amazon biome map of Priority areas for conservation, according to their biodiversity and irreplaceability



Source: MMA[85]

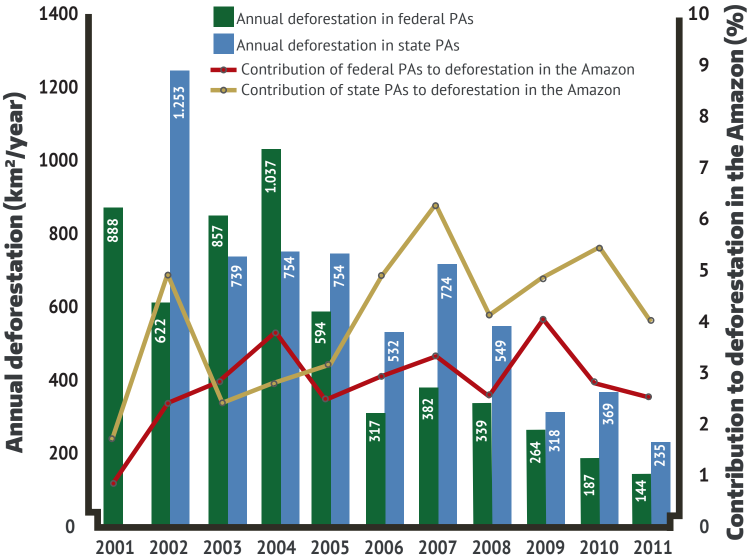
Following the trend of the Amazon biome, deforestation in Protected Areas has significantly reduced in the past decade. In 2011, deforestation in Protected Areas managed by the federal government was reduced by 86% in comparison with 2004. In state managed Protected Areas, deforestation in 2011 was 69% lower than in 2004 (MMA, 2013b).

Figure A.7 shows the historical deforestation series in federal and state Protected Areas in the Amazon (2001-2011). The contribution of federal Protected Areas to the total deforestation in the period remained below 4% for federal areas and 6% in state areas throughout the whole period.

85 *Available at: http://www.mma.gov.br/estruturas/chm/_arquivos/biodiversidade31.pdf*

FIGURE A.7

Deforestation in Protected Areas in the Brazilian Amazon



Despite the significant areas designated as Protected Areas in the Amazon biome - which can stop land grabbing, an initial step in the deforestation process - Technical Panel members pointed out that an important step for the respect of this Cancun safeguard is the full implementation and consolidation of protected areas and their surroundings.

As for the Amazon Fund, respect for this safeguard is expressed in its lines of action. The Amazon Fund must support, among other categories, (1) Management of public forests and protected areas; (2) Recovery of deforested areas; and (3) Conservation and sustainable use of biodiversity. The conservation and recovery of natural ecosystems, biodiversity and ecosystem services is essential to the very existence of the Amazon Fund.

(f) Actions to address the risks of reversals

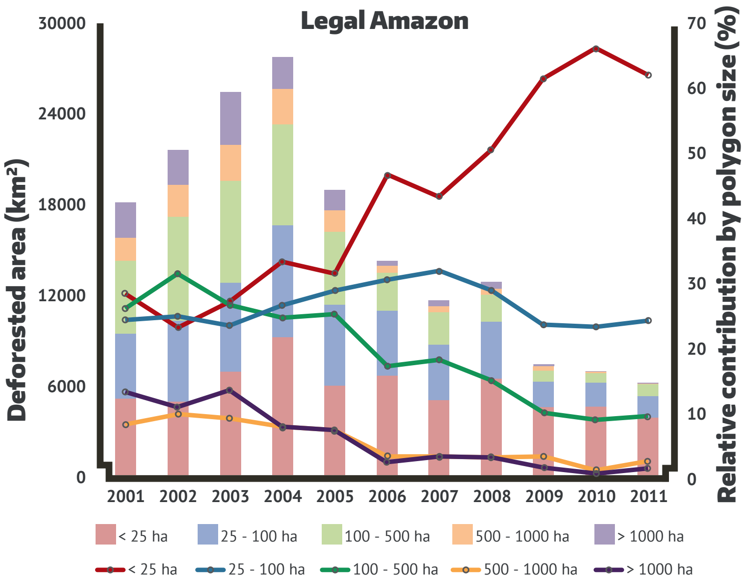
Among Brazil's existing instruments to ensure the continuity of the REDD+ results achieved, are the Native Vegetation Protection Law (New Forest Code), which states that landholders should keep 80% of the area of a property covered with native vegetation, as Legal Reserve, in those rural properties located in originally forested areas; the *Programa de Fomento às Atividades Produtivas Rurais* ("Fostering Rural Productive Activities Program" - Law No. 12,512/2011); and the programs and vegetation monitoring systems that assist in the enforcement and implementation of existing laws (Project PRODES, DETER, etc.).

REDD+ results-based payments are a key incentive to address the risk of reversal. The emission reductions results from the Amazon biome were largely achieved through the environmental monitoring and law enforcement activities financed by the federal budget.

At present, deforestation affects predominantly areas smaller than 25 hectares (Figure A.8), which impairs the effectiveness of the command and control approach. Land management initiatives and fostering sustainable production activities (PPCDAm's axes 2 and 3) become more and more relevant. In this context, it is necessary to create new and additional incentives for achieving a paradigm shift in the regional economy, thus ensuring the permanence and expansion of REDD+ achieved results. This paradigm shift can be triggered with investments made with REDD+ results based payments received.

FIGURE A.8

Deforested areas by polygon size in the Brazilian Amazon



(g) Actions to reduce displacement of emissions

Initiatives to eliminate leakage risks should include a robust, comprehensive and constant monitoring of the forest cover, ensuring the environmental integrity of REDD+. In Brazil, just as with the reversal safeguard, PRODES data provides information on the scale of implementation of actions to combat deforestation – i.e. within the Legal Amazon. The Federal Government established, with Decree 6321, of December 21, 2007, a number initiatives to prevent, monitor and control illegal deforestation in the Amazon.

Besides monitoring deforestation, Brazil also has a forest degradation monitoring system for the Amazon biome. INPE developed the DEGRAD to map the occurrence and 32 progression of degraded areas in the Amazon using satellite imagery (Landsat-class, with spatial resolution of up to 30 meters).

DEGRAD has a time series with annual data for the period 2007-2013. The maps generated by DEGRAD, with evidence of forest degradation, are also available to the public as part of INPE's open data distribution policy (http://www.obt.inpe.br/degrad/). The causal relationship between the reduction of deforestation in some areas and the increase in forest degradation in other areas cannot be determined. Table A.5 presents DEGRAD and PRODES 2007-2013 data to assess the extent to which the areas affected by forest degradation in a year are converted to clear-cut in subsequent years.

TABLE A.5

Share of degraded areas identified by DEGRAD that were subsequently converted to clear-cut (deforestation) and included in the PRODES, 2007-2012

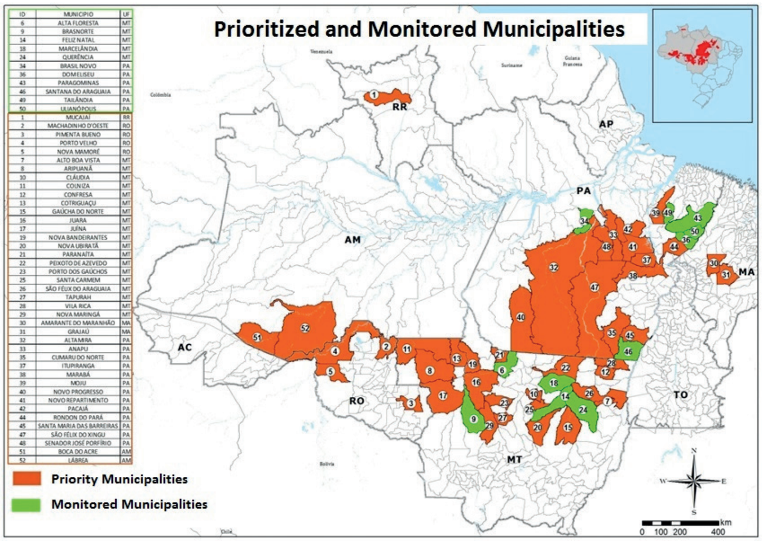
%CONVERSIONOFTHEAREADEGRADED(DEGRAD)TOCLEARCUT (PRODES)		PRODES (YEAR)					
		2008	2009	2010	2011	2012	2013
DEGRAD (year)	2007	12	2	2	2	1	2
	2008		1	2	1	1	1
	2009			2	2	2	2
	2010				3	1	2
	2011					2	4
	2012						4

One of the initiatives in place to ensure the permanence of the reductions achieved in the Amazon biome and to reduce the risk of leakage is the Priority Municipalities List. The name of this initiative is due to the fact that these municipalities will be prioritized by measures to integrate and improve monitoring and control actions from federal bodies, land tenure and land use planning actions and incentives to environmentally sustainable economic activities (Figure 9).

Art. 2 of Decree 6,321/07 states the MMA is responsible for issuing an annual Ordinance with the list of municipalities considered as priorities for prevention and control of deforestation in the Amazon. The criteria for listing a municipality are: (1) total area of forest cleared in the municipality; (2) total area of forest cleared in the last three years; and (3) increases in the rate of deforestation in at least three out of the last five years.

FIGURE A.9

Priority and monitored municipalities



Besides the Ordinance with the list, an Ordinance defining the criteria for municipalities to leave the priority list is also published in the *Diário Oficial* (the government's official communication channel).

Once listed, the municipality will be monitored and receive support from the federal government in the implementation of actions aimed at reducing deforestation rates, whereas seeking to facilitate the transition to a sustainable based economy. As a result, it is expected that the municipality can be taken out from the list, being reclassified as a municipality where deforestation is monitored and under control.

Improving the forest monitoring systems for other biomes is a fundamental step to ensure the effective implementation of this safeguard. Brazil is planning on expanding its forest monitoring system for the Amazon (PRODES) to other biomes. It is expected that by 2016 Brazil will have a national forest monitoring system that provides data on an annual basis.

To date, monitoring data for the Cerrado biome from the *Projeto de Monitoramento do Desmatamento dos Biomas Brasileiros por Satélite* ("Project of Satellite Deforestation Monitoring of the Brazilian Biomes" PMDBBS in Portuguese) indicates that a reduction of deforestation took place in that biome in 2009 and 2010 compared to the average area measured between 2002 and 2008. However, such data still requires improvements, which is why Brazil chose to submit only the Amazonian deforestation reduction results at this moment.

Moreover, the ENREDD+ aims at expanding Brazil's REDD+ actions from the biome (PPCDAm and PPCerrado) to the national level, in order to avert the risk of carbon emissions leakage coming from REDD+ activities. Brazil is also investing on the expansion of the Amazon monitoring system to all biomes.

5. EXISTING INFORMATION SYSTEMS IN BRAZIL

The information gathered by the Technical Panel described a series of information systems and databases already established in Brazil, which can meet the information systems requirements for some of the Cancun Safeguards, although in an independent and uncoordinated manner. They should eventually serve as a basis to feed the SIS REDD+.

Table A.6 presents Brazil's main existing environmental information systems, which can be used and/or adapted for data collection to feed the SIS REDD+. It is necessary to analyze these systems and their implementation in more detail, in order to provide inputs for identifying potential interoperability opportunities with the SIS REDD+.

TABLE A.6
Relevant environmental information systems for the REDD+ SIS

SYSTEMS	GOAL	TYPE OF INFORMATION
SINIMA (MMA)	Information management under the National Environmental System.	Environmental licensing (PNLA), net carbon emissions (PNIA).
SNIF (SFB/MMA)	Identification, recording and analysis of information related to natural and planted forests of Brazil (SINIMA integrated).	Stocks, structure, diversity, distribution, forest dynamics and forest-based supply chains, licenses to clear native vegetation, management plans.
PRODES (INPE/MCTI)	*Satellite Monitoring of vegetation cover, with regular reports to society.*	*Annual deforestation rates in the Amazon.*
DETER (INPE/MCTI)	*Warning system to assist environmental enforcement and deforestation control.*	*Monthly report of clear-cut areas and areas in process of forest degradation by deforestation.*
PMDBBS (Ibama/MMA)	*Satellite Monitoring of vegetation cover*	*Deforestation data on the Cerrado, Caatinga, Atlantic Forest, Pantanal and Pampas biomes (periods: prior to 2002 and between 2002 and 2008).*
SiBBr (MCTI)	*To integrate information from several national and foreign sources, providing inputs for research and support for formulating and implementing public policies.*	*Biodiversity and Brazilian ecosystems*
SISUC (Collaborative public system)	*Assessment, planning and environmental monitoring, in order to strengthen participatory management and to advance social control.*	*Environmental services, nature conservation, human welfare, agro-extractive production, participatory management.*
SICAR *(MMA)*	Integrate spatial information on rural landholdings to ensure the implementation of the Native Vegetation Protection Law	Information from the Rural Environmental Cadastre.
SNIRH *(ANA)*	This is a broad collection system, treatment, storage and retrieval of information on water resources and intervening factors for its management.	

Note: The systems already in full operation are in italics.

The SIS REDD+ shall:

>> Be national, simplified, reliable, comparable and cost effective.

>> Be created and implemented by the Brazilian government and coordinated by the MMA.

>> Be periodically reviewed and adapted to new challenges and priorities.

- >> Ensure transparency, understanding, effectiveness and consistency.
- >> Be an online system that integrates information on how the REDD+ safeguards are implemented, promoted and respected.
- >> Support REDD+ initiatives, and support decision makers in the creation and implementation of public policies.

6. DEVELOPING AND IMPLEMENTING BRAZIL'S NATIONAL REDD+ SAFEGUARDS INFORMATION SYSTEM (REDD+ SIS)

In 2015, Brazil will initiate the development of the SIS REDD+. This process will draw upon this summary of information on safeguards and on the dialogue processes with relevant stakeholders.

Arranging information of diverse nature and from different sources is a challenge for the implementation of the SIS REDD+. It is necessary to make use of different computational resources to automate data provision to the SIS, which would entail a gain in quality and timeliness of information. To ensure proper functioning of the SIS REDD+ careful consideration is necessary from the time of its planning, through its computer modeling, to the validation of its functionality and its routine maintenance stage.

Integrating different sources of information will be the first step in the development of the SIS REDD+, to ensure better availability of information and reduce operation costs. The development of an integrated information system depends, among other factors, on establishing connections between its modules with the existing databases and information systems (interoperability). Investigating the best way to establish such integration between systems is a complex step for the SIS REDD+ construction, due to the diversity of information and of implementation status of the information sources readily available.

Throughout the time preceeding the introduction of this information system in its digital and open for analyses format, descriptive information on how the safeguards are being implemented in Brazil will continue to be available on Brazil's REDD+ website (http://mma.gov.br/redd/index.php/pt/salvaguardas/o-que-sao-salvaguardas).

APPENDIX I

REDD+ IN THE BRAZILIAN CONTEXT

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REDD+ IN THE BRAZILIAN CONTEXT

Social and Environmental Principles and Criteria

In 2009, several organizations meeting at the Katoomba Seminar held in Cuiaba, decided to start a process for developing social and environmental safeguards for REDD+ programs and projects in Brazil. The event enabled the production of a document to provide references for developing and implementing forest carbon projects, government REDD+ programs and for independent evaluation and validation of REDD+ projects in Brazil.

The process of conceiving the document comprised the following steps:

- >> Creating a multistakeholder steering committee for development and revision of the Principles and Criteria;
- >> Development of the first version of the Principles and Criteria by this committee;
- >> Submission of the first version to public consultation for a period of 150 days (December 1st, 2009, to April 31st, 2010), open to all sectors of society concerned with the subject;
- >> Holding regional meetings in the Amazon with representatives of traditional communities and Indigenous Peoples to present the document and record the contributions from these stakeholders;
- >> Meetings with several stakeholders involved in or affected by REDD+ issues in Brazil to present the document and record their contributions;
- >> Preparation of the final version of the Principles and Criteria by the steering committee, incorporating all the comments received during the public consultation period.

As a result of this process, the following eight principles and criteria have been defined:

1 Legal Compliance: meeting the legal requirements and relevant international agreements;
2 Rights Recognition and Guarantees: recognizing and respecting the rights to lands, territories and natural resources;
3 Benefit Sharing: fair, transparent and equitable distribution of the benefits resulting from REDD+ actions;
4 Economic sustainability, improvements in quality of life and poverty alleviation: contributing to diversify the economic and sustainable use of natural resources;
5 Environmental conservation and recovery: contributing to the conservation and recovery of natural ecosystems, biodiversity and environmental services;
6 Participation: participation of stakeholders in the development and implementation of REDD+ actions and in decision making processes;
7 Monitoring and transfer: full availability of information related to REDD+ actions;
8 Governance: promoting better governance, coordination and alignment with national, regional and local policies and guidelines.

Developing the ENREDD+ (2010-2014)

Between July and December 2010, the MMA coordinated a dialogue process that supplied the initial inputs for developing Brazil's ENREDD+. With the schedule of activities set, four meetings were held and three working groups organized to address the following topics:

>> GT1: Coordination, Institutional Arrangements and Participation
>> GT2: Benefits Sharing, Dominion and Safeguards
>> GT3: Funding sources and Financial Mechanisms.

The working groups open to public and private organizations consisted of 120 representatives from 58 institutions. In December 2010, each group presented a report of their contributions to the process of drafting the ENREDD+, as well as valuable context information. The final report titled "REDD+: Synthesis Document with multi-stakeholder inputs for the preparation of a National Strategy", has as its main elements:

>> Identifying REDD+ related federal public policies and state initiatives;
>> Assimilating the social and environmental principles and criteria proposed by Brazilian civil society REDD+;
>> Preliminary analysis of operational principles for a REDD+ mechanism;
>> Identifying possible funding sources and financing mechanisms for REDD+ activities;
>> Proposal of a tentative schedule for the development of the ENREDD+.

The synthesis document provided guidance to MMA's coordination work as of 2011, which had been assigned by the Executive Group on Climate Change (GEx), by means of coordinating an Interministerial Working Group on REDD+ (GT REDD+) for drafting the National SREDD+ Strategy (ENREDD+). Since then, the activities have involved building understanding among the Ministries, dialogue with civil society through meetings and thematic workshops, and inputs provision, in the form of specific studies.

During this period, even prior to the approval of the Warsaw Framework for REDD+, the issue of the safeguards was discussed by the federal government with various stakeholders at different moments, obtaining important input from the workshop on the Implementation of Social and Environmental Safeguards in the ENREDD+, held in Brasilia in November 2011. Approximately 60 participants from various civil society organizations attended the event to: (1) identify the main risks associated with the implementation of REDD+ in Brazil; and (2) formulate recommendations on the implementation and the approach for REDD+ safeguards in Brazil, based on their experiences.

Throughout the two days of work, the group shared their visions and experiences, which resulted in recommendations about the public consultation process for Brazil's ENREDD+. The main guideline stated that regional workshops should be organized, in order to seek integration with other agendas and to optimize the discussion forums at events already programed.

In 2012, the MMA assembled the Technical Panel with experts from civil society whose goal was to address the issue of the safeguards in the Brazilian context. The details from this study have been reported by this summary.

State frameworks for REDD+

Since 2009, the Brazilian government received demands from Brazilian stakeholders to institutionalize REDD+ operation in the country, which also included a great deal of expectations. Some viewed this as a way to give legitimacy to the initiatives already underway, others as a means to provide structure for operating in a voluntary market for REDD+ projects.

While the process to develop the ENREDD+ was underway at the federal level, the states turned their attention to building their own legal frameworks for climate change and forests.

The study *REDD* +: "Initiatives and Challenges for the integration of sub-national and national policies in Brazil", commissioned by the MMA in 2012, aimed at presenting an overview of the status of climate change, environmental services and REDD+ related policies and initiatives, in seven out of the nine states in the Brazilian Amazon.

In addition to identifying the actions in place, a section that discusses the challenges of integrating national and sub-national policies is among the main elements from this study. It is possible to draw a parallel between the challenges identified and specifically two of the safeguards of Cancun:

- Complementarity or consistency with policies, programs and international agreements: it is necessary to harmonization commitments to reduce deforestation made on the federal and state level.
- Benefit sharing and social and environmental impacts on local communities: the study states as a recommendation that the funds originating from REDD+ initiatives must be equitably distributed among the social actors involved. It should also be ensured that initiatives to promote forest conservation do not generate negative social and environmental impacts on local communities whose livelihoods dependent on natural resources.

APPENDIX II

AMAZON FUND'S SOCIAL AND ENVIRONMENTAL SAFEGUARDS

APPENDIX II

AMAZON FUND'S SOCIAL AND ENVIRONMENTAL SAFEGUARDS

Transcribed below is the information provided by the Amazon Fund on its safeguards.

The texts are available in Portuguese at:

http://www.fundoamazonia.gov.br/FundoAmazonia/fam/site_pt/Esquerdo/Fundo/Salvag

uardas

i Legal Compliance

BNDES adopts, in accordance with its general rules, several procedures to verify legal compliance and the eligibility of beneficiaries, which are also applicable to the projects submitted to the Amazon Fund. Among these procedures, we may highlight:

- >> Eligibility checking to verify whether an applicant is listed on the Registry of employers convicted for keeping workers under conditions analogous to slavery;
- >> Applicants must present documents certifying that they have not received any administrative sanction or been sentenced with a final decision from the Judiciary on cases related to gender or racial discrimination, child or forced labor, moral of sexual harassment or environmental crimes;
- >> Beneficiaries must abide, during the term of the contract, to the legislation applicable to persons with disabilities; and
- >> The environmental license for project installation, officially published, must be presented, whenever it is applicable to a given intervention type. As well as keeping all operations in accordance with the obligations prescribed by the environmental agencies during the term of the contract.

ii Acknowledgement and guarantee of rights

Acknowledgement and respect for rights related to land tenure and use of territories and natural resources are guiding principles to the Amazon Fund, the Priority Guidelines include:

- >> Consolidate protected areas, especially the Conservation Units for Sustainable Use and Indigenous Land (A2.d);
- >> Defining a destination for Public Forests that have not yet been assigned one, with priority to community forest initiatives (A2.e); and
- >> Efforts to address illegal appropriation of land, to promote land-title regularization and land-use planning, preferably in areas with a higher concentration of wealth and/or conflicts (A2.f).

iii Distribution of benefits

The commitment to fair, transparent and equitable distribution of benefits is among the Amazon Fund guidelines. In order to achieve that the following criteria have been established:

- Implement payment for environmental services systems associated with the maintenance of and/or increase in forest coverage and/or forest and agro-forestry systems (A2.b);
- Projects with economic purposes should deliver collective and public use benefits (B14); and
- Concentration in the allocation of resources should be avoided, no states or category of applicants (public agencies, research institutions, civil society organizations etc.) should be privileged (E1 and E2).

iv Economic sustainability, improving standards of living and reducing poverty

Cracking down on illegal deforestation is not enough. Building decent alternatives for employment and income generation is essential in the Amazon, while placing environmental and social sustainability as central issue.

In line with this need, the Amazon Fund gives priority to sustainable productive activities and scientific and technological development projects that can facilitate the development of a suitable development model for the region. The guidelines set out the following priorities:

- Promote and increase the scale of production of timber and non-timber forest products from sustainable forest management, including management plans, research, innovation, science and technology dissemination, market development, training and qualification (A2.a); e
- Projects involving direct benefits for traditional communities, agrarian reform settlements and small landholders/family farmers (A4).

v Environmental conservation and restoration

Among the Amazon Fund's attributions, established by the Presidential Decree 6,527 of 2008, are (i) management of public forests and protected areas; (ii) restoration of deforested areas; and (iii) the conservation and sustainable use of biodiversity. The conservation and restoration of natural ecosystems, biodiversity and ecosystem services is fundamental to the Amazon Fund's very existence. Therefore when structuring the Amazon Fund's Logical Framework, an instrument that supports planning, management and monitoring of impacts, the following aspects have been contemplated:

- Expansion of protected areas;
- Consolidate the management of public forests and protected areas; and
- Support for the restoration of deforested and degraded areas, rendering them suitable for economic use or ecological conservation.

Accordingly, the Amazon Fund's guidelines set as priorities:

- Consolidate protected areas, especially the Conservation Units for Sustainable Use and Indigenous Land (A2.d); and
- Develop and implement recovery models for Permanent Protection Areas (APPs in Portuguese) and Legal Reserve (both are provisions from the Forest Code), with an emphasis on economic use (A2.c)..

vi Participation

The COFA is responsible for establishing the Amazon Fund's Guidelines and Criteria for Selection, as well as for approving the Amazon Fund's Annual Report and the communications on resource allocation. It is structured as a tripartite committee, composed by: the federal government, state governments and civil society. Each block is entitled to one vote and the decisions are reached by consensus.

The COFA also has the role of ensuring the initiatives supported by the Amazon Fund are consistent with its goals, with the policies from the PPCDAm and PPCDs and the Sustainable Amazon Plan strategic guidelines.

The Amazon Fund's guidelines, approved by this committee, state that:

- Projects must include an agreement between all partners and co-executors (B2); and
- Projects involving traditional communities and indigenous people must necessarily present documents to certify the free, prior and informed consent from these communities or their representative institutions. (B3)

vii Monitoring and transparency

Being a donation only Fund, the full disclosure of information on its actions and on supported initiatives is essential.

In order to meet this condition, the Amazon Fund publishes a full annual report of its activities the "Amazon Fund's Annual Report", which after being approved by the COFA is made available on its website in three languages (Portuguese, Spanish, and English).

The Amazon Fund also provides information on projects proposals, their status in BNDES' assessment process, the total budget that they have applied for, their purpose, as well as detailed information about the projects under implementation. This information can be found on its website, which also provides detailed monthly project portfolio bulletins and newsletters covering Fund related issues, events and activities.

Two external audits are carried out annually: a financial audit and a compliance audit, to verify and certify the accounting and financial management of the Fund's resources and its correct allocation.

The Fund's guidelines state that supported projects must:

- Offer some platform to publicize their implementation on the Internet (B11);
- Include measurable results indicators that are directly related to the Amazon Fund's goals (B1);

viii Governance

An important feature of the Amazon Fund is its sound governance, which is due to its integration into one of the largest development banks on the global stage, but also to its effective instruments for participation, monitoring and transparency. Such efforts are extended to the projects supported, with a view to promote better governance in their structures and alignment and integration with national, regional and local policies and guidelines.

Besides the COFA, the Amazon Fund has a Technical Committee that assembles notorious experts in forest carbon emissions, whose main task is to verify and attest the measurements of reduced emissions from deforestation carried out by the MMA. The results are then used to back the Amazon Fund's annual fundraising efforts.

The Fund has set in its guidelines the following conditionalities and priority criteria:

- Projects must present clear evidence that they are consistent with PPCDAm and PPCDs' actions (B5);
- Projects must present clear evidence that they are consistent with the Sustainable Amazon Plan (B6);
- Priorities:
  - Provide support for structuring the state agencies responsible for environmental management (A2.g);
  - Provide support to the implementation of municipal monitoring and environmental enforcement systems (A2.h);
  - Help the development and integration of control systems for forest management, for rural properties environmental licensing process and for tracking the chain of custody of agricultural, livestock and forestry products (A2.i);
  - Supporting more comprehensive and robust deforestation and forest degradation monitoring systems (A2.j); and
  - Projects involving actors from multiple sectors, i.e. public sector, private sector, NGOs or local communities, shall have a shared governance structure (A3).

APPENDIX III

SUMMARY OF THE RESULTS FROM THE SURVEY ON THE INFORMATION AND SOURCES REQUIRED FOR THE SIS REDD+ AND RECOMMENDATIONS FROM THE PANEL OF EXPERTS TO THE MMA

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SAFEGUARD	INSTRUMENTS	WHAT SHOULD BE DONE	SOURCES	INFORMATION DESCRIPTION	OPPORTUNITIES FOR FURTHERIMPROVEMENT
Complementarity or consistency with policies and programs	19 relevant instruments have been identified. e.g. CBD, Ramsar Convention, Forest Code, National Protected Areas Registry (SNUC in Portuguese), *Programa Nacional de Florestas* ("National Forest Program"), PGTAs.	Assessment of goals, targets, content and implementation of these instruments in order to identify complementarity and consistency with REDD+ actions. Promote federative integration.	Public institutions related to the implementation of these instruments, as well as national communications, committees, commissions and working groups.	Consistency and complementarity between the instruments and REDD+ actions. Assessment of the Implementation of Forest Concession Plans, PGTAs, protected areas management plans etc.	There is no provision analogous to the PGTA for territorial and environmental management on *Quilombola* areas. There is no guarantee that these instruments will be implemented.
Transparent and effective governance structures	22 relevant structures have been identified (the focus was on committees only). e.g. Interministerial Committee on Climate Change, Public Forests Management Committees, PPCDAm's and PPCerrado's executive committees, PAs's Management Boards, PNGATI management Committee, ombudsmen.	Identify and assess the availability of relevant information.	Activity reports, meeting minutes, reports, bulletins and websites published by these structures. Independent systems.	Composition, structure (e.g. joint), regularity of meetings, attributions, decisions guided by these structures, capillarity, gender issues, data disclosure.	Implementation of the *Lei de Acesso à Informação* ("Access to Information Law") which makes online information disclosure by public institutions mandatory.
Rights and respect for knowledge	14 instruments have been identified, they address rights and respect for knowledge and customs, biodiversity conservation and benefit-sharing. e.g. ILO 169, CBD, The Federal Constitution, PNGATI, the National Biodiversity Policy.	Ensure that REDD+ policies, programs and projects are in line with established rights. Evaluate whether the ombudsman model is suitable for REDD+. National regulation of ILO 169.	Public institutions related to the implementation of these instruments, as well as committees, commissions and working groups. Independent systems.	Evaluating the implementation of free, prior and informed consent, complaints and incidents related to environmental offenses and violation of rights, indigenous and *Quilombola* lands demarcation, PAs management plans CGEN proceedings.	Lack of national regulation on the ILO 169, lack of a forum or specific body to file representations (complaints) about violation of rights in REDD+ initiatives.

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SAFEGUARD	INSTRUMENTS	WHAT SHOULD BE DONE	SOURCES	INFORMATION DESCRIPTION	OPPORTUNITIES FOR FURTHER IMPROVEMENT
Participation, voice and empowerment	8 instruments for participation have been identified. e.g. Regulation on public consultation processes, ILO 169, *Lei de Acesso a Informação* ("Access to Information Law"), ombudsman systems, and social control forums.	Regulating the ILO 169, Integrate REDD+ related Information on the SIS REDD+, integration with the Office of the Comptroller General (CGU in Portuguese) for conflict resolution.	Public institutions related to the implementation these instruments, as well as monitoring centers and forums, working groups, committees and national funding agencies.	Projects with provisions for participation from indigenous peoples and traditional communities, registered REDD+ initiatives, training opportunities, complaints and how they have been address, as well as related indicators.	Create a body or specific instance for conflict resolution in the national REDD+ governance structure.
Biodiversity and benefit-sharing	15 instruments have been identified. e.g. CBD, Forest Code, SNUC, National Biodiversity Policy, *Lei da Mata Atlântica* ("Atlantic Forest Law"), *Lei de Gestão de Florestas Públicas* ("Public Forest Management Law").	Implement the CAR and PRA, fauna and flora inventories, provide positive incentives for REDD+, identify priority areas for conservation, creation and implementation of protected areas, national or regional biodiversity monitoring.	Secretariats and departments of public institutions related to the implementation of these instruments, as well as national communications, committees, commissions and existing systems.	Number of CAR and PRA, number of priority areas identified, management plans, Protected Areas Management Boards created, lists of endangered species, CGEN proceedings, Community forest concessions, and PES programs for biodiversity	Legal framework for protecting Genetic Resources and Traditional Knowledge, previous assessments and monitoring of biodiversity. Effective instruments for local development for the buffer areas of PAs.
Keep forests standing	12 instruments have been identified. e.g. Ramsar Convention, Forest Code, National Climate Change Policy, Lei da Mata Atlântica ("Atlantic Forest Law"), ENREDD+, Amazon Fund and Climate Fund.	Assessing the implementation, scope and impact matrix of these instruments.	Public institutions related to the implementation of these instruments, as well as committees, commissions and working groups. Independent systems.	Annual rate of deforestation, Ramsar sites, PAs management plans, licenses to clear vegetation, CAR and PRA data, sustainable management of forests plans and PES programs for carbon.	Consolidation at the federal level of data on the licensed areas cleared in all states. Annual rate of deforestation in all biomes. Setting targets for native forests recovery and data collection.
Carbon emissions displacement	9 instruments have been identified. e.g. Forest Code, Environmental Licensing, vegetation monitoring systems, ENREDD+.	Monitoring the rural landholdings registered on the CAR, impact assessment of the Sustainable Forest Management Plans (PMFS in Portuguese), and assessment of Economical-Ecological Plans (EEZs).	Secretariats and departments of public institutions related to the implementation of these instruments, as well as committees, commissions and working groups. Independent systems.	TerraClass Project data (biennial), State EEZs, PMFS licenses and plans under implementation, priority municipalities list.	Updated DEGRAD data, systems or analysis to assess emissions displacement.

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