REPUBLIC OF BURUNDI

MINISTRY OF ENVIRONMENT,
AGRICULTURE AND LIVESTOCK

THIRD NATIONAL COMMUNICATION ON CLIMATE CHANGE (TNCCC)

BUJUMBURA, OCTOBER 2019

FOREWORD

Burundi as a Party to the United Nations Framework Convention on Climate Change (UNFCCC) is committed to honoring its commitments and complying with the requirements of the said Convention, including those set forth in Articles 4 and 12.

Indeed, a National Climate Change Policy and a Strategy was prepared in 2012, following the submission of its Second National Communication on Climate Change in 2010 and on the eve of its accession to the 2015 Paris Agreement through it the country presented his determined contributions at the national level, to demonstrate his willingness to support the global effort to reduce anthropogenic greenhouse gas emissions and strengthen the climate resilience of its citizens.

Towards the end of 2015, Burundi started the implementation of the project: "Third National Communication on Climate Change" with the technical and financial support of the Global Environment Facility through the United Nations Program for Environment, its Executing Agency. We solemnly express our feelings of deep gratitude. With this national communication, we have just updated the measures that are undertaken in the mitigation of anthropogenic emissions of greenhouse gases and adaptation measures as well as the national needs in clean technologies. We invite the Technical and Financial Partners to support them to reinforce the initiatives already undertaken to address the food insecurity and poverty that have been accentuated by the vagaries of climate.

We commend the tireless efforts of the Government of Burundi, which on the eve of COP 24 held in Katowice has again shown its willingness to contribute to the reduction of anthropogenic greenhouse gas emissions by, among other things, Reforestation program "EWE BURUNDI URAMBAYE".

The Government of Burundi strongly supports solidarity in the fight against climate change and pledges to continue the unconditional measures identified in the form of its Nationally Determined Contributions.

Ultimately, reducing the effects of climate change is an unavoidable challenge that is why we encourage the international community to reinforce efforts already made to mitigate the anthropogenic greenhouse gas emissions that are at its core. Origins, and to support adaptation efforts for vulnerable countries, including our own.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PICTURES

ACRONYMS AND ABBREVIATIONS

°C	: Degree Celsius
ABER/BREA	: Burundian Rural Electrification Agency
ACSA/CAHA	: Community Animal Health Agent
AEP /DWS	: Drinking Water Supply
AFAT	: Agriculture, Forestry and other Land Use
APD/ODA	: Official Development Assistance
BAD/ADB	: African Development Bank
BAU	: Business As Usual
BEI/AIB	: African Investment Bank
BJA /BRS	: Bujumbura Reference Station
BM/WB	: World Bank
BPEAE/POEAL	: Provincial Office of the Environnement, Agriculture and Livestock
BUCECO	: Burundi Cement Company
CC	: Climate change
CCUNCC/UNFCCC	: United Nations Framework Convention on Climate change
CDC	: Comunal Community Development Committee
CDFC	: Family and Community Development Centers
CEP/RWH	: Rain water Harvesting
CFCIB/FCCIB	: Federal Chamber of Commerce and Industry of Burundi
CH_4	: Methane Gas
CHE/HEPS	: Hydroelectrical Power Station
CIRGL/ICGLR	: International Conference on the Great Lakes Region
CKZ/CRS	: Cankuzo Reference Station
CN/NC	: National Circumstances
CNA/NCB	: Normal Course of Business
CNE/NCE	: National Commission for the Environment
CO_2	: Carbonique Gas
COMESA	: Common Market of Eastern and Southern Africa
COP	: Conference of the Parties
CSC /CCS	: Carbone Capture and Storage
CSLP/SFCP	: Strategic Framework to Combat Poverty
CSLP II	: Strategic Framework to Combat Poverty IIndGeneration
CTD/TDA	: Technical Development Advisor
CTS/FTC	: Follow-up Technical Committee
DCNCC /SNCCC	: Second National Communication on Climate Change
DGE	: General Directorate of Livestock
DGEE	: Directorate General of Water and Energy
DGFE	: Directorate General of Forests and the Environment
DGGM	: Directorate General of Geology and Mines
DGREA	: General Directorate of Water Resources and Sanitation
DSNIS	: Direction of the National System of Sanitary Information
DSS	: Decision Support System
ECO_2	: CO_2 Equivalent
EDS/DHS	: Demographic and Health Survey
EIE	: Envoronmental Impacts Studies
FAO	: Food and Agriculture Organization
FEM/GEF	: Global Environment Facility
FIDA /IFAD	: International Fund for Agriculture Development

FNECC/NFECC	: National Fund for Environment and Climate Change
FVC/GCF	: Green Climate Fund
GES	: Green House Gases
Gg	: Gigagram
GIEC/IPCC	: Intergovernmental Panel on Climate Change
GIRE/IWRM	: Integrated Water Resources Management
GIZ	: Deutsche Gesellschaft für Internationale Zusammenarbeit
GSZ/	: Gisozi Reference Station
Ha	: Hectare
HAE/AEH	: Anti-Erosive Hedge
IBN/NBI	: Nil Bassin Initiative
IDH/HDI	: Human Development Index
IEC/IEC	: Information, Education, Communication.
IGESGHGI	: Greenhouse Gases Inventory
INMO/NII	: National Institution of Implementation
INECN	: National Institute for Environment and Conservation of Nature
IPCC	: Intergovernmental Panel on Climate Change
IRAZ	: Institute of Agronomic and Zootechnical Research
IRRI	: International Rice Research Institute
ISABU/IASB	: Institute of Agronomic Sciences of Burundi
ISTEEBU/ISESB	: Institute of Statistics and Economic Studies of Burundi
JICA	: Japanese International Corporation Agency
KCl	: Potassium Chloride
Km^2	: Square Kilometer
KWH	: Kilowatt hour
LDCF	: Least Development Countries Fund
LEAP	: Long-range Energy Alternatives Planning System
MAG/AM	: Acute Malnutrition
MATTE	: Ministry of Spatial Planning, Tourism and the Environment
MEEATU	: Ministry of Water, Environment, Land Management and Urban Planning
MESRS/MHESR	: Ministry of Higher Education and Scientific Research
MIILDA	: Mosquito Net Impregnated with Long-acting Insecticide
MINAGRIE	: Ministry of Agriculture and Livestock
MINEAGRIE	: Ministry of the Environment, Agriculture and Livestock
MININTER	: Interior Ministry
MINISANTE	: Ministry of Public Health and the fight against HIV / AIDS
MSP	: Ministry of Public Security
MW	: Megawatt
N_2O	: Nitrous Oxide
OAP	: Support Organization for Self-Promotion
OBPE	: Burundian Office for the Protection of the Environment
IOM	: International Organization for Migration
OMM	: World Meteorological Organizations
WHO	: World Health Organization
ONATOUR	: National Office of Peat
NGO	: Non-Governmental Organization
PAGIRE/APIWRM	: Action Plan for Integrated Water Resources Management
WFP	: World Food Program
PANA	: National Action Plan for Adaptation to Climate Change
PDDAA/CPDAA	: Comprehensive Program for the Development of Agriculture in Africa

PDNE/NWMP	: National Water Master Plan
PEV /EPI	: Expanded Program on Immunization
PFC	: Communal Platform
PFN	: National Platform
PFP	: Provincial Platform
GDP	: Gross Domestic Product
GSP	Global Support Program
PIUP	: Industrial Processes and Product Use
PK	: Kilometer Post
PND	: Burundi National Development Plan
PNE/WNP	: Water National Partnership
PNIA/NAIP	: National Agricultural Investment Program
PNIA	: National Agricultural Investment Plan
UNDP	: United Nations Development Program
UNEP	: United Nations Environment Program
PPP	: Public Private Partnership
PRG/GWP	: Global Warming Potential
PSA	: Adaptation Strategic Priorities
PTF/TFP	: Technical and Financial Partners
RC/GD	: Growth Delay
RCP	: Representative Concentration Pathways
REDD	: Emissions Reduction from Deforestation and Forest Degradation.
REGIDESO	: Burundi National Water and Electricity Authority
RN	: National Road
RRC	: Disaster Risk Reduction
Ru-Pz01	: Rumonge Piezometer number 0
SAN/	: Burundi Strategy of Agriculture
SAP /EWS	: Early Warning System
SAR	: Second Assessment Report
SETEMU/MTSA	: Municipal Technical Services Authority
SNPACC	: National Strategy and Action Plan on Climate Change
SNPA-DB	: National Strategy and Action Plan on Biological Diversity
SNPA-LDS	: National Strategy and Action Plan to combat Soil Degradation
SNPGRC	: National Strategy for Prevention and Management of Risks and Disasters
SOSUMO	: Moso Sugar Company
SPTDD	: Societies, Powers, Territories and Sustainable Development
t/ha/an	: tonne per hectare and per year
TCNCC	: Third National Communication on Climate Change
Tj	: Terajoule
Tmax	: Maximum Temperature
Tmin	: Minimum Temperature
UE	: European Union
UNESCO	: United Nations Educational, Scientific and Cultural Organization
UNICEF	: United Nations Children's Funds
US$	: United States of America Dollar
UTCATF/LULUCF	: Land Use, Land Use Change and Forestry Change
VIH/SIDA	: Human Immunodeficiency Virus / Acquired Immunodeficiency Syndrome

EXECUTIVE SUMMARY

I. NATIONALES CIRCUMSTANCES

Burundi is a country located on the borders of Central Africa and East Africa. Its surface covers 27,834km² of which 25,000 km² are terrestrial. It extends between 29.00 ° and 30.54 ° East and parallels 2.20 ° and 4.28 ° south. It is surrounded to the north by Rwanda, to the South-East by the United Republic of Tanzania and to the West by the Democratic Republic of Congo. With Gitega, the political capital and Bujumbura, the economic capital, Burundi is 2100 km from the Atlantic Ocean and 1100 km from the Indian Ocean.
Despite its modest size, Burundi is distinguished by its diversity of relief and its landscapes. The mio-pliocene tectonic revolution is indeed responsible for the strong regional opposition of the large collapse ditch where Lake Tanganyika and the plains of Imbo on one side (774 and 1000 m altitude) are lodged, Mumirwa fault escarpments (1000 to 2000 m) and meridian mountain ranges on the other side (2000 and 2670 m altitude).
The central plateaus, which cover most of the country, are located between 1350 and 2200 m altitude. Finally, the depressions of the East, the Kumoso located between 1200 and 1400 m and the great depression of Bugesera in the Northeast with altitudes between 1350 and 1550 m and extending to neighboring Rwanda. These morpho-structural predispositions already explain the fragility of the entire ecosystem in the face of extreme weather events related to ongoing climate change.
The distribution of large landforms accurately reflects that of the country's climatic diversity, resulting in an uneven distribution of rainfall in the area, despite the modest territorial dimensions of the country. Geographical areas also influence thermal variations. The higher regions experience on average colder temperatures than the lowlands.
In general, in Burundi, the monthly average maximum temperatures are highest at the end of the dry season (September), which varies from 25 ° C (Imbo region) to 15.7 ° C (Mugamba region) while averages Monthly minimum temperatures are lowest during the dry season (July) and range from 23.3 ° C (IMBO region) to 13.9 ° C (Mugamba region).

As for hydrology, Burundi has abundant water resources. It belongs to two major African watersheds namely, the Nile basin with an area of 13,800 km² and the Congo River basin with an area of 14,034 km². In most parts of Burundi, there is a dense network of permanent watercourses and many drainage axes.

Burundi is very rich in natural lakes including Lakes Tanganyika, Cohoha, Rweru and Rwihinda. Lake Tanganyika, located at 774m altitude and 677km long, is the second deepest lake (1470m) in the world, and the largest freshwater reservoir in Africa (18880km3). It is also a reservoir of biodiversity hence its classification as a heritage of humanity.

Regarding demography, the country had 11.2 million inhabitants in 2016; this size of the population makes Burundi one of the most densely populated African countries, with an overall density of 392 inhabitants / km².
The Burundian economy is dominated by the primary sector, which accounts for nearly half of the Gross Domestic Product (GDP) and contributes nearly 80% of export earnings; the secondary sector (industry and crafts) represents only 17 to 18% of GDP while the tertiary sector represents only about one third of GDP. The current structure of production, dominated

by subsistence farming, makes the economy very vulnerable and fragile because it depends on the weather conditions.

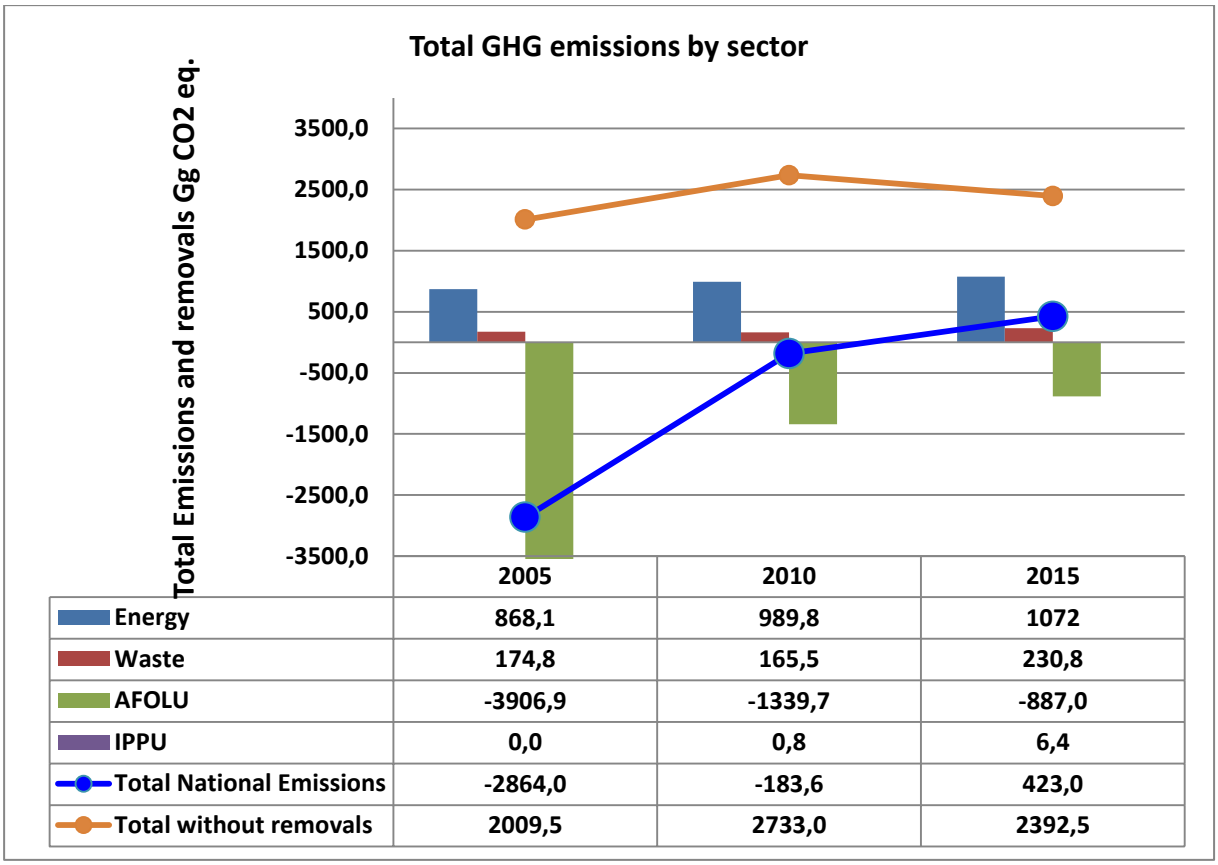
On the side of the legal and institutional environment framework, Burundi has a national climate change policy whose overall objective is to promote climate resilient development; with structures enabling it to fulfill its mission of planning and coordinating environmental restoration activities.

II. THE NATIONAL INVENTORY OF GREEN HOUSE GAS

The third green house gas inventory covers the selected years 2005, 2010 and 2015.
Four categories, namely: (1) energy; (2) Industrial Processes and Product Use (PIUP); (3) Agriculture, Forestry and Other Land Uses (AFOLU) and (4) Wastes were considered for this inventory. It takes into account the direct gases namely (i) carbon dioxide (CO_2), (ii) methane (CH_4) and (iii) nitrous oxide (N_2O).

Trends in total emissions by sector

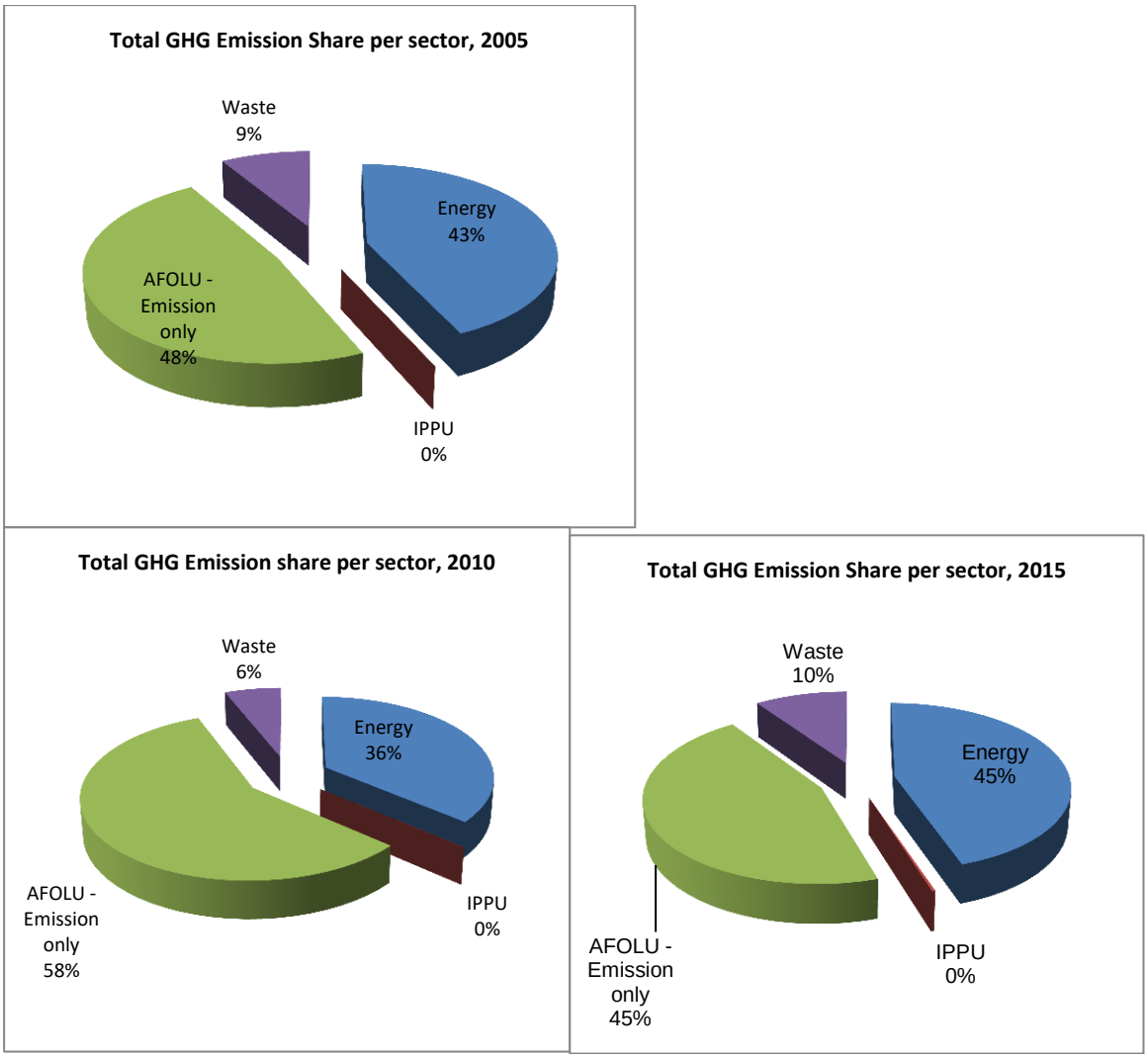
The figure below shows the quantity of aggregate emissions and removals from Burundi between 2005 and 2015. The aggregate emissions without removals were characterized by an increase, while the sink potential decreased. It can also be noted that the peak of emissions without absorptions was observed in 2010 with 2733.0 Gg. of ECO_2. The main cause of the increase in emissions is economic growth, deforestation and the conversion of forest land and grasslands to cultivated land during the 2005-2015 period. Nevertheless, an economic recession was observed in the years close to 2015 resulting in a **gradual** reduction in total emissions.



	2005	2010	2015
Energy	868,1	989,8	1072
Waste	174,8	165,5	230,8
AFOLU	-3906,9	-1339,7	-887,0
IPPU	0,0	0,8	6,4
Total National Emissions	-2864,0	-183,6	423,0
Total without removals	2009,5	2733,0	2392,5

Trend in total GHG emissions by sector

With regard to the share of emissions by sector, the AFOLU sector (emissions only) increased from 48% in 2005 to 58% in 2010, then decreased to 45% in 2015. The energy sector is 43% in 2005 and 36% in 2010, then reached 45% in 2015. The waste sector is between 6 and 10%, while the PIUP accounts for less than 1% of total national emissions.



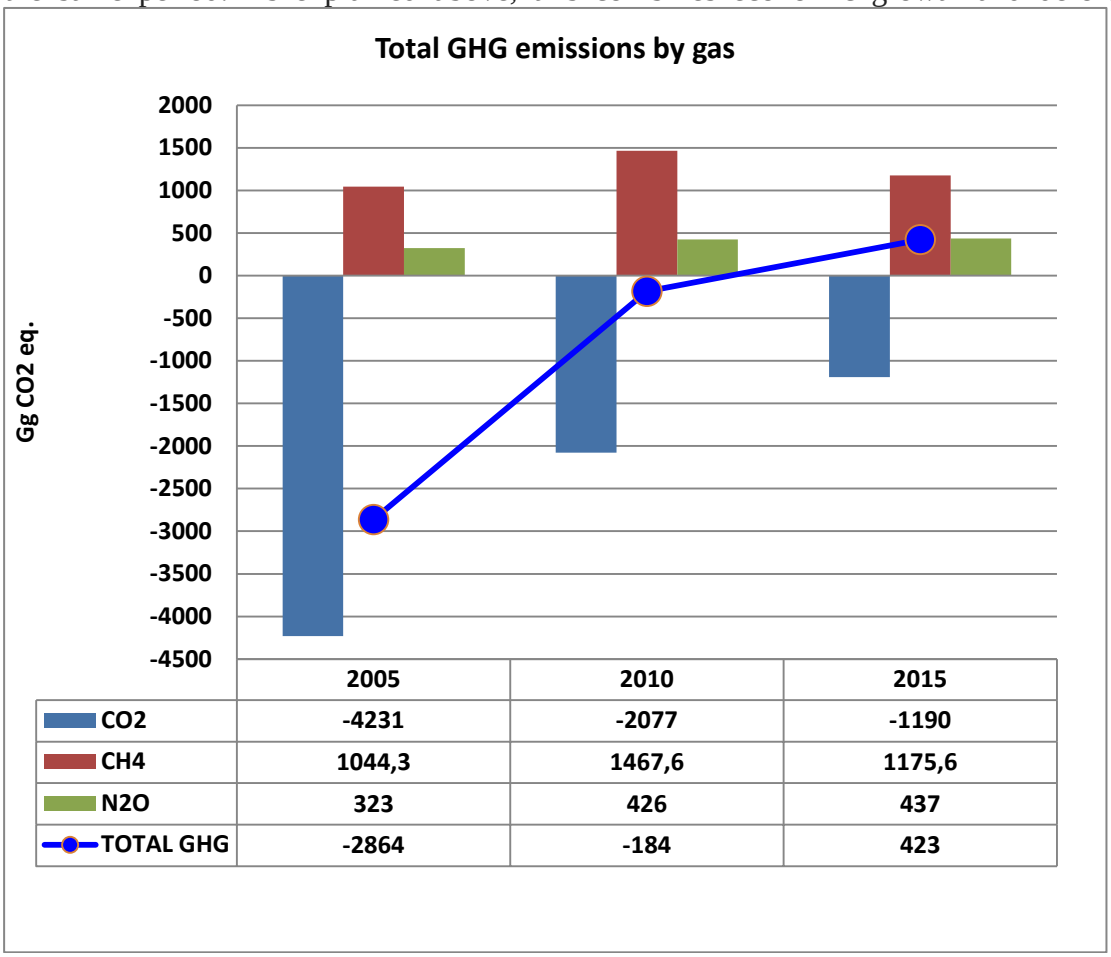
GHG emissions by sector

Trends in gas emissions

The trend in gas emissions indicates that the dominant GHG is CO_2, ranging from -4 231 Gg of ECO_2 to -1 190 Gg of ECO_2. The main contribution to CO_2 emissions / sequestration comes from the AFAT sector. Methane (CH_4) is the second gas emitted. Its quantity was 1,044.3 Gg of ECO_2 in 2005, 1,467.6 Gg of ECO_2 in 2010 and 1,175.6 Gg of ECO_2 in 2015. The main contributor to CH4 is AFAT-agriculture, Energy-Other sectors (use of biomass). As a result, the main emitting sector in Burundi is AFAT, followed by the Energy sector. The third gas emitted is N_2O and its main contributions come from waste (treatment and waste disposal) and energy-other sectors (biomass combustion).

The net CO_2 emissions are negative for the entire inventory period, which means that Burundi is a sink from 2005 to 2015. However, Burundi's sink potential has decreased by 40.15% from 2005 to 2010 and then 32.45% from 2010 to 2015. For CH_4, it increased by 40.5% from 2005 to 2010 and then reduced by 19.9% in 2015. Finally for N_2O, it increased by 32% from 2005 to 2010 then 2.6% from 2010 to 2015. It should be noted that the growth of aggregate emissions from 2005 to 2010 is also reflected in the growth of gas emissions by gas during

the same period. As explained above, this combines economic growth and deforestation.



	2005	2010	2015
CO2	-4231	-2077	-1190
CH4	1044,3	1467,6	1175,6
N2O	323	426	437
TOTAL GHG	-2864	-184	423

Trends in gas emissions

III: GENERAL DESCRIPTION OF MEASURES TAKEN OR ENVISAGED TO APPLY THE CONVENTION

III.1. PROGRAMS CONTAINING MEASURES TO FACILITATE APPROPRIATE ADAPTATION TO CLIMATE CHANGE

General context of climate change in Burundi and the most vulnerable sectors

At present, climate change has already caused obvious and radical consequences for the socio-economic life of the populations whose sectors most affected are agriculture, energy, water resources, forest ecosystems and landscapes, the health sector as well as the transport and infrastructure sector.

Changing climate patterns such as increased rainfall and heat, as well as catastrophic situations, make Burundi more vulnerable and affect the country's development efforts. They produce such disastrous consequences that materialize in the fall of agricultural and animal production, loss of life, repeated floods and droughts, increased risk of disease, increased food insecurity, malnutrition, soil erosion, pollution of water resources, destruction of human habitat and public and private infrastructure etc.

Priority activities identified to address future climate change in different sectors

In the case of climate change, everyone tries to adapt and the search for solutions is mostly for the modification of practices to try to spread the risks. Given the various impacts of climate hazards, strategic adaptation measures have been proposed in various sectors as shown in the table below:

Strategic adaptation measures in different sectors

Sector	Sous-secteur/domaine	Strategic adaptation measures
Agriculture, Livestock and Fisheries	Agriculture	1. Good practices for water and soil conservation in areas highly vulnerable to landslides and erosion 2. Promote, encourage and support community adaptation strategies. 3. Promotion of the use of organic fertilizer (green manure, manure); 4. Promotion of conservation agriculture in areas at high risk of drought; 5. Research on Crops adapted to Climate Change; 6. Production and availability of quality seeds in seed centers; 7. Development and popularization of technological practices appropriate to climatic hazards; 8. Develop a strategy that would allow the continuous supply of marsh water, particularly reforestation and contour tracing.
	Livestock	1. Training of breeders and field staff on environmentally friendly farming techniques; 2. Promote the breeding of small ruminants; 3. Dissemination of Law No1 / 21 of 4 October 2018 on "permanent stabling and prohibition of the straying of domestic animals and the backyard in Burundi", with a view to enabling effective membership; 4. Develop a regionalization project for farms; 5. Put in place incentive measures for breeders who want to practice modern breeding; 6. Promote the production of livestock feeds;
	Fisheries	1. Improving the resilience of aquatic and terrestrial ecosystems to the impacts of climate change and climate variability; 2. Improvement of knowledge bases and mechanisms for monitoring and information management in the fisheries

		sector; 3. Improve the management of urban water drainage systems, watersheds and rivers to avoid pollution of Lake Tanganyika; 4. Strengthen sustainable fisheries management mechanisms; 5. Protection and appropriate management of critical habitats, including lake buffer zones, spawning grounds, and pelagic areas, including the establishment of protected areas; 6. Quantitative study of the current status of biodiversity species in lakes to predict their evolution in the face of climate variability; 7. Disseminate or strengthen fisheries legislation and conventions and ensure that they are respected.
Energy	-	1. Development of new hydropower plants and rehabilitation of existing plants by including flood protection systems for these facilities and access roads, 2. Development of biogas digesters in communities, 3. Electrification of isolated sites by solar photovoltaic systems, 4. Research on wind and geothermal potentials for the production of electrical energy, 5 Support to produce briquettes from organic waste, 6. Popularization of improved wood and charcoal fireplaces 7. Capacity building of all stakeholders for good planning and monitoring of climate change adaptation projects.
Water resources	Policy	Integrate climate and environmental issues into water and sanitation improvement strategies
	Planning	1. Collaboratively establish territorial water and sanitation diagnostics that consider climate risks and water resources data 2. Develop and implement risk assessment plans to be updated and describe the procedures to be followed in case of emergency for service managers, managers and users of water and sanitation services 3. Provide accompanying measures: training of actors on the consideration of climate risk, user awareness on the promotion of sanitation and water saving
	Works	1. Carry out studies prior to new water and sanitation installations about climate requirements, 2. Introduce incentives to professionals in the sector to encourage high-performance companies that take climate risks into account, 3. Doubling the site monitoring systems of a quality control system integrating the issue of climate risk, for the robustness of structures confronted with climatic hazards
Forest	Contribution to	. Valuing lignocellulosic waste for energy purposes

ecosystems and landscapes	low carbon development	2. Promote rational use and energy saving; particularly through the dissemination and dissemination of improved stoves; 3. Promote peat carbonization techniques to enable its use in alternative households to wood and charcoal; 4. Support ongoing reforestation programs by focusing on watershed protection and the provision of fuel for the population; 5. Change behaviors to improve energy efficiency and enhance the social value of natural ecosystems, such as forests, in effect adapting to the reality of climate change.
	Analysis of the priority actions of the national policy forester of Burundi	. Identify and disseminate forest species adapted to climate change; 2. Recover and reforest illegally occupied spaces; 3. Arrange watersheds to control erosion; 4. Spread early and adapted silvicultural varieties to climate change; 5. Promote research in forestry / agroforestry especially with respect to species adapted to different agro-ecological zones and climate change; 6. Define the rights and obligations of stakeholders to manage forest resources rationally through participatory management, 7. Develop and implement appropriate lumber standards for different uses to best value the wood resource and produce quality lumber; 8. Popularize new wood processing techniques; 9. Make wood by-products and waste products profitable for rational use of forest products; 10. Promote techniques for making brick and tiles that consume little wood; 11. Popularize and disseminate improved stoves; 12. Discourage unsuitable uses of wood eg Promotion of the use of metal scaffolding instead of wooden poles in buildings
Climat, Météorologie et hydrologie		1. Extension, rehabilitation and modernization of meteorological, climatological and hydrological observation stations 2. Capacity building in weather, climate and hydrological modeling, 3. Capacity building to cover all aspects of agro-meteorological assistance.
Health	-	1. Develop a joint operational plan for environmental health; 2. Develop a health and environment research program 3. Establish a coordinating body for health and environment, including sectoral programs and monitoring and evaluation systems; 4. Integrate health and environmental aspects into the

		poverty reduction strategy framework; 5. Identify global national indicators for monitoring health and environment programs; 6. Develop a specific legal framework for the link between health and the environment, the assessment of the health impact; 7. Establish the health impact study through appropriate tools in the context of environmental and social impact studies; 8. Provide specialized, material and financial human resources to environmental health research structures; 9. Allocate the substantial budget for health and the environment.
Transport and buildings	Transport	1. Protection of access channel and port basin; 2. Construction of a protective wall between the port basin and the mouth of the Ntahangwa River; 3. Dredging of the basin of the port of Bujumbura; 4. Deflection of the Ntahangwa River back into its original bed at its mouth in Lake Tanganyika; 5. Diversion of the gutter collecting the wastewater from the Buyenzi market and entering the port basin; 6. Development of an annual road maintenance program within the road office; 7. Allocate an enough budget for emergencies that may occur during the year; 8. Put in place effective measures to rehabilitate the existing network in order to adapt transport infrastructures to climate change.
	Buildings	Integration of adaptation measures and specific risks of each building into building projects.

III.2. PROGRAM CONTAINING MEASURES TO MITIGATE CLIMATE CHANGE

The mitigation analysis is specifically targeted at the most appropriate measures according to current and projected national circumstances up to the 2030s, the period covered by this study.

Mitigation measures are identified for each sector in the following lines
Energy Sector.

i) Large-scale promotion of improved wood-fuel and charcoal stoves;
ii) Carbonization of peat to make it usable by households;
iii) Replacement of biomass boilers with electric boilers;
iv) Construction of new hydroelectric plants;
v) Increase in traffic lights that regulate road traffic because they decrease.
The heavy traffic is one of the causes of high fuel consumption.

Agriculture Sector

i) Reduce CH_4 emissions from enteric fermentation by improving animal feed by improving the genetic characteristics of animal reproduction for better animal production efficiency;
ii) Capturing CH_4 from manure management systems to produce energy (Biogas),
iii) Reduce CH_4 through changes in irrigated rice cultivation practices,
iv) Reduce N_2O emissions through improved application of urea fertilizers.

Land Use change and Forestry

i) Activities that avoid the emission of carbon emissions, such as the conservation and protection of forests,

ii) Activities that increase carbon stocks, namely reforestation and agroforestry.

iii) Sustainable forest management

- Through the substitution of this product by other fuels and
- Improved equipment used for wood processing and energy production (improved wood and charcoal fireplaces).

Industrials Processes and Products uses Sector

i) Replace old technologies with clean technologies,
ii) Promotion of research and innovation initiatives in the industrial sectorSecteur

Waste Management

(i) Recycling solid waste into usable products,
(ii) Methanization of fermentable waste for biogas production,
(iii) Composting of organic waste
(iv) Treatment and recovery of liquid waste in all urban centers

IV: OTHER RELEVANT INFORMATION TO THE ACHIEVEMENT OF CONVENTION OBJECTIVES

IV.1. STUDY ON THE IDENTIFICATION AND ASSESSMENT OF TECHNOLOGY NEEDS TO FACE UP TO CLIMATE CHANGE

The technology assessment presented in this report focuses on sectors that are considered vulnerable or impacting on climate change. These sectors are: Agriculture, Energy, Water Resources, Infrastructure (including transport), Human Health, Forests and Woodlands and Waste Management.

Adaptation technologies for the agricultural sector

For effective adaptation to climate change in the agricultural sector, a range of adaptation tools, including behavior modification, management options and technologies, should be considered. This section provides examples of specific technology tools that can be used as part of an integrated adaptation approach, including: (i) increasing crop resilience, (ii) reducing water use and wasting water in agriculture, (iii) enhance adaptation to floods, and (iv) protect livestock from the impact of climate change.

Adaptation technologies for the water resources sector

The impact of climate change on water resources can be divided into three categories: too much water, not enough water and degraded quality. It is expected that most areas will experience extreme dry and wet conditions, forcing the country to cope with floods and droughts. Both extremes can lead to water stress.
Adaptation technologies to reduce the vulnerability of the water resources sector to the impact of climate change are proposed: i) rainwater harvesting, ii) aquifer recharge, iii) doubling reservoirs to reduce infiltration, iv) provide a forest cover to recharge aquifers, v) establish a weather monitoring network, vi) implement an active leak detection program, vii) desalination, viii) wastewater treatment at the point of use, (ix) remedy leaks and ruptures of walls, x) flush waterways and xi) remove flow obstructing materials.

Adaptation technologies for the energy sector

In Burundi the major impacts related to climate change in the energy sector are:
- the more frequent shutdown of some hydroelectric plants in service following the exceeding of the operating thresholds due to rainfall deficit and prolonged drought
- total siltation of some dams as a result of increased erosion due to increased precipitation leading to the total shutdown of some hydroelectric plants
- a larger deficit in the electricity sector leading to real electricity supply problems in the various socio-economic areas of the country;
- a widespread problem of lack of firewood and charcoal due to increased and combined pressure of human activity and increasing temperatures and a change in biomass growth rates.

Thus, the following technologies for adaptation to climate change in the energy sector are proposed: i) low wind speed wind turbines like those with a vertical axis, ii) decentralized production system, iii) photovoltaic systems at the community level and family, iv) Pico hydropower plants, v) improved carbonization furnaces, vi) improved stoves, biomass briquette press, vii) Intelligent control of peak load, viii) low consumption lamps, ix) Intelligent Control devices lighting, x) equipment with low energy consumption etc.

Adaptation technologies for the transport sector and infrastructure.

Extreme events (fires, floods, landslides, mudslides, etc.) and the debris that accompanies them can block roads and bridges permanently or temporarily. Erosion and landslides leading to failure of embankments and foundations will damage and disrupt infrastructure and services.
Transportation technologies for the following mitigation and adaptation to climate change are proposed: cement-based composite, intelligent transportation system, active motion damping system, meteorological network installation, and smart transportation systems**.**

Adaptation technologies for the human health sector

The potential adverse health effects of climate change span a wide range and include more direct effects. These include deaths and injuries resulting from extreme events (eg floods, prolonged heat waves), changes in the extent and seasonality of climate-related health hazards (decreased safety and availability of water and air quality), incidence of water-borne and vector-borne diseases (eg malaria, cholera, etc.).
Human health technologies for climate change mitigation and adaptation include: (i) flood-proof drinking water wells, (ii) sanitary flood sanitation, (iii) disease surveillance systems, (iv) sanitary latrines against flooding; (v) mosquito nets with durable insecticides; (vi) disease surveillance systems and rapid diagnostic tests.

Adaptation technologies for the forest resources sector

Climate change presents enormous challenges for forests and people.
Adaptation and mitigation are the two main responses to climate change, mitigation seeking to combat its causes and adaptation to reduce its impacts. In the forestry sector:

- Mitigation strategies include reducing emissions from deforestation; reducing emissions from forest degradation; strengthening the role of forests as carbon sinks; substitution of products, for example the use of wood instead of fossil fuels for energy production, or the use of forest products in place of materials whose manufacture would cause high greenhouse gas emissions;

- Adaptation includes interventions to reduce the vulnerability to climate change of forests and the populations that depend on them.

In general, impacts of climate change on silvicultural production and forest ecosystems vary according to the species in place, the ecological environment, and the responses to adaptation**.**

So to reduce these impacts, the following technologies are proposed:

i) natural regeneration, ii) assisted reconstitution of natural stands, iii) densification of biomass for the production of briquettes to replace charcoal and firewood, iv) establishment of a seed bank for agroforestry trees, v) planting alignment trees, vii) planting soil-fixing grasses, viii) plant breeding, ix) installing firebreaks

ii) Adaptation technologies for the waste management sector
In Burundi, the population does not have access to a garbage collection service and the service is irregular where it exists as in certain districts of the city of Bujumbura. The Buterere wastewater treatment plant is no longer functioning properly. There is also toxic gas emissions from the decomposition of hazardous, biomedical waste that is usually incinerated in incinerators in hospitals and health centers when they exist.

To address these impacts some solutions are proposed among others:

i) the development of controlled landfills in urban centers and recovery of methane, ii) the biomethanisation of biodegradable waste, iii) the lagooning of wastewater and iv) densification vegetable waste for the production of fuel briquettes.

IV.2. PROGRAM FOR PUBLIC AWARENESS, EDUCATION AND TRAINING ON CLIMATE CHANGE IN BURUNDI

The present program is intended for all Burundians, without any distinction so that he can be informed and know that climate change is a reality and do enormous damage in the world, especially in Africa and Burundi, but that the management of their harmful effects must be a challenge every day.

State of play of public awareness on climate change

According to the survey conducted with the public, the results showed that, on the whole, all the people surveyed are aware of the phenomenon of climate change and its consequences. The population notes the irregularity of the rains and the damage that affects the infrastructures. They indicate that they are very concerned about this phenomenon and that climate change should be a priority in Government projects.
Nevertheless, the interviews made it clear that the public's knowledge is very vague. In general, the public does not understand the causes, indicators and possible coping mechanisms. Groupes cibles de sensibilisation
The first priority is the mobilization of high-level support because the formulation of adequate legislation and its implementation depend on the involvement of the executive and the legislature. Then, it was mentioned the need to sensitize the decision makers of the key ministries, the parliamentarians, the senators but also the administrative ones at all the levels (national, provincial and communal), the private sector, the industrialists, the civil society, the confessions religious. . The same goes for journalists who should also be trained in these topics to better address and convey them. It is essential to identify and set up platforms at the hill level to serve as a relay for local and everyday sensitization in rural communities.

Channels of communication and awareness

Sensitization at the highest level of the Government should go through an organization of regular meetings of policy makers and Ministers in sectors vulnerable to climate change, parliamentarians and senators to ensure a greater political weight to these issues but also by mobilization financial and technical partners both internally and externally for adaptation to climate change.
The staff from different ministries and administrators at different levels should be sensitized including universities, NGOs by promoting high-level scientific and technical research to compare results, approaches and analyzes of options for complementarities and synergies of sectors.
To reach the widest audience, radio remains the most efficient vector in Burundi. They are numerous and widely listened to. Information can also go through strong social and local structures.

PUBLIC AWARENESS PROGRAM ON THE PROBLEMATIC OF CLIMATE CHANGE
The overall objective is to contribute to the reduction of anthropogenic greenhouse gas emissions and the adaptation of Burundian society to the effects of climate change as well as the reduction of damage and losses caused by extreme climate events through improved, systematic information, education and communication.

The main activities of this program will be contained in the following four components:

i) Awareness raising and education on GHG mitigation and climate change adaptation whose main activities are to organize training, sensitization and information sessions for ministry and administrative officials at all levels; mass awareness sessions for the population, organize training sessions for journalists to raise awareness and transmit key messages through the various media
ii) Development of political, legal and institutional bases to promote regular information and awareness-raising meetings for policy-makers, parliamentarians, senators and ministers from sectors vulnerable to climate change so that they know that climate change is a problem common and transversal Development of a Climate-Resilient and Low-Carbon Development Strategy;
iii) Strengthen the capacity of the Ministry of Education to include subject content in education programs
(iv) Capacity building of actors by developing a fund mobilization strategy to operationalize action plans.

V. DIFFICULTIES AND GAPS AND RESOURCES, FINANCIAL, TECHNICAL MEANS AND CAPCITY NEED TO REMEDY TO CLIMTE CHANGE

Technical, institutional, financial and educational gaps and constraints were identified for the different sectors including agriculture, climate and meteorology, energy, transport and infrastructure, water resources, waste management, health and forestry. Measures and solutions to deal with them have been proposed by sectoral experts.

CHAPTER I: NATIONAL CIRCUMSTANCES

I.1. Introduction

In Burundi, climate change is a reality. Its impacts on people, property and the environment have increased significantly over the last 10 years. Several regions have experienced rainfall deficits that have resulted in the aggravation of severe drought, the significant reduction of major wetlands and the drying up of several rivers and lakes. Also, the torrential rains, the extreme temperatures, the violent tropical storms, the hail, are also so many climatic phenomena which marked the growing vulnerability of our country.

In fact, the dramatic increase in loss of life, falls in agricultural production, malnutrition, increased risk of disease, loss of biodiversity are all consequences registered in Burundi following the severe climate disruptions.

National circumstances present geographical features, climatic factors, natural resources, legal framework profile, institutional and legal, climatic profile, demographic and socio-economic profile, all likely to be affected by climate change or reduce opportunities to adapt to climate change. This chapter constitutes the basis of analysis for the various sectoral studies, in particular the inventories of Greenhouse Gases, the vulnerability and adaptation studies as well as the mitigation studies carried out under the United Nations Framework Convention on Climatic changes.

I.2. Geographic location

Burundi is a country located on the borders of Central Africa and East Africa. Its surface covers 27,834 km² of which 25,000 km² are terrestrial. It extends between 29.00 ° and 30.54 ° East and parallels 2.20 ° and 4.28 ° south. It is surrounded by Rwanda to the North, the United Republic of Tanzania to the South-East and the Democratic Republic of Congo to the West. With Gitega, the political capital and Bujumbura, the economic capital, Burundi is 2100 km from the Atlantic Ocean and 1100 km from the Indian Ocean.

Figure 1 : Administrative Map of Burundi

I.3. Relief: modesty and morphological diversity

Despite its modest size, Burundi stands out for its diversity of landforms and landscapes. The mio-pliocene tectonic revolution is indeed responsible for the strong regional opposition of the great collapse ditch where Lake Tanganyika and the plains of Imbo (774 and 1000 m of altitude) lie, the fault escarpments of the Mumirwa (1000 to 2000 m) and meridian mountain chains on the other (2000 and 2670 m altitude). The central highlands, which cover most of the country, are located between 1350 and 2200m altitude. Finally, the depressions of the East, the Kumoso located between 1200 and 1400 m and the large depression of Bugesera in the Northeast with altitudes ranged between 1350 and 1550 m and extending to neighboring Rwanda.

These morpho-structural predispositions already explain the fragility of the entire ecosystem in the face of extreme weather events related to ongoing climate change.

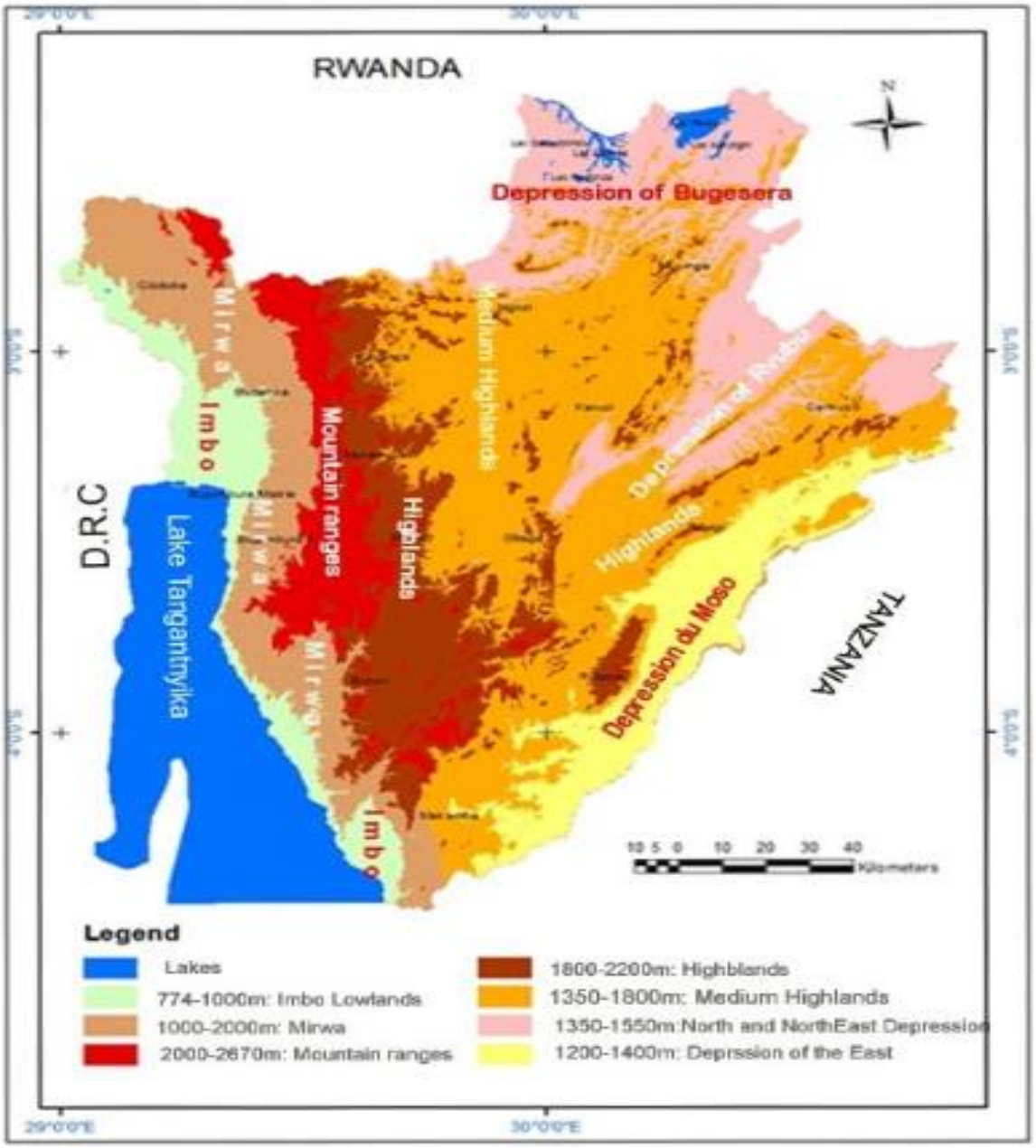


Figure 2 : Relief Map

I.4. Climate diversity

The distribution of large landforms accurately reflects that of the country's climate diversity.

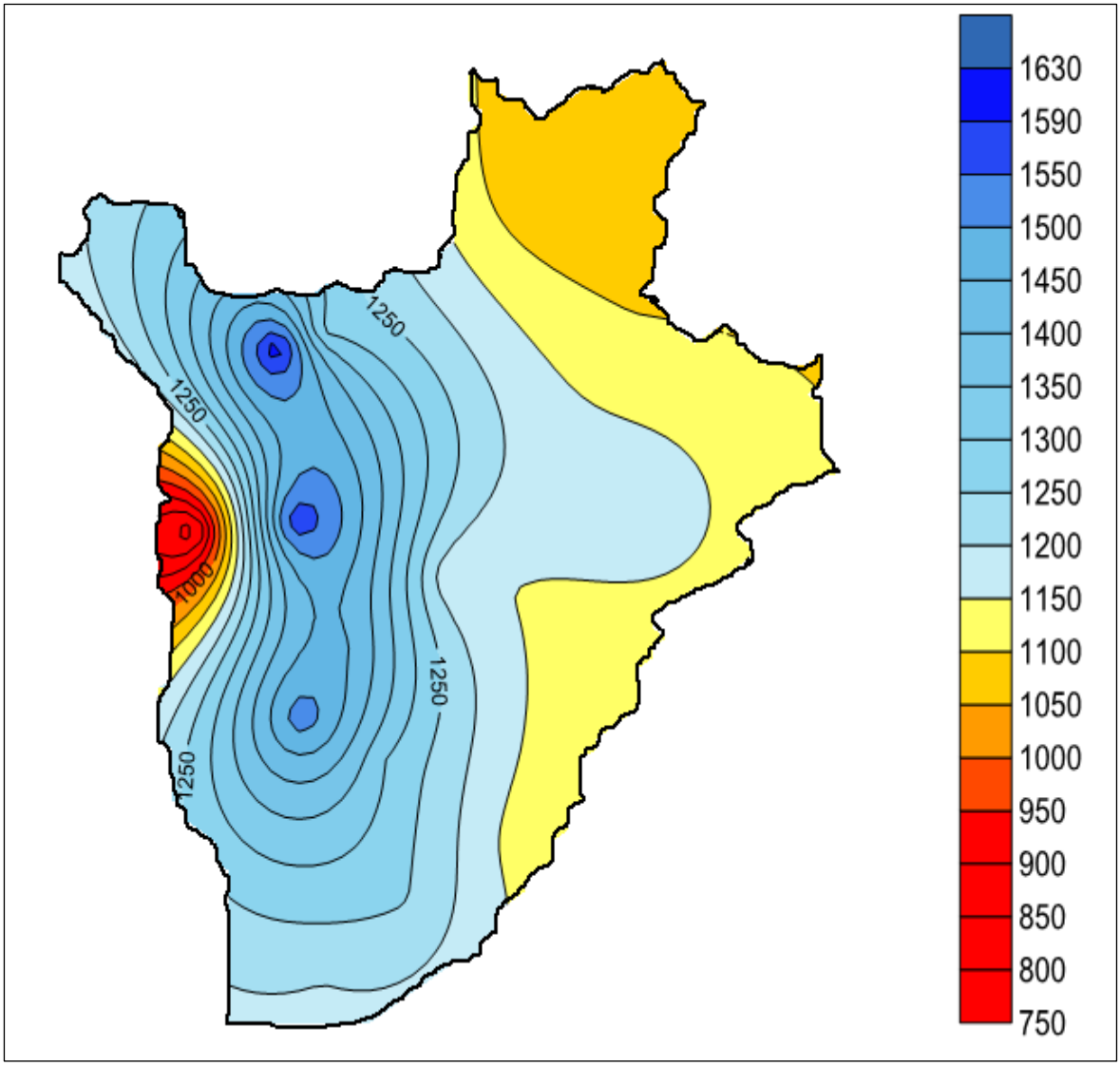


Figure 3 : Map of the Rainfall distribution in mm

This map confirms that the distribution of rainfall is uneven in the space despite the modest territorial dimensions of the country. The amount of rainfall varies between 1628.7mm and 768.5mm. In general, precipitation increases with altitude. The maximum has been observed in the high-altitude areas (the Mugamba region) and is decreasing in this region to the East, West and South. The maximum (normal 1981-2010) was recorded in the Mugamba region at the Rwegura station and the Minimum in the Imbo region at the Bujumbura Airport station.

According to the 1981-2010 IGEBU normal data, it was in the month of November that the greatest number of rainy days (14 to 22 days) were observed in Bugarama (Mugamba region). The minimum number of rainy days (14 days) was recorded at Kinyinya Station (Kumoso Region). Gisozi and Bujumbura Airport stations are taken as highlands region of reference for the first and lowlands for the second.
According to the IGEBU, the standardized precipitation indices made it possible to analyze the behavior of the Bujumbura rainfall trend during the period 1931-2015.
The humid phases of the decades 1936-1945, 1946-1955, 1956-1965 and 1966-1975 are observed.

These decades were followed by a succession of dry decades (1976-1985, 1986-1995 and 1996-2005) with a record of lower rainfall (a deficit of 113 mm (year average)) during the decade 1996-2005. An inter-normal analysis of precipitation shows us a succession of the wet period respectively 1931-1960, 1941-1970, 1951-1980, 1961-1990; with a record of higher rainfall during the regular 1951-1980 followed by the normal 1961-1990. These wet periods were followed by the succession of dry periods (normal 1971-2000, 1981-2000 and 1996-2015.

The Gisozi reference station also shows that the standardized rainfall indices make it possible to analyze the behavior of their trends during the period 1931-2015. There are three wet periods in the decades 1936-1945, 1956-1965 and 2006-2015 and five dry periods (1946-1955, 1966-1975, 1976-1985, 1986-1995 and 1996-2005) with a record of rainfall during the decade 1986-1995. An inter-normal rainfall analysis showed an increasing record in the 1961-1990 period and a decreasing record during the 1971-2000 period.

Despite its small size, Burundi also has thermal variations according to its geographical areas. The higher regions experience on average colder temperatures than the lowlands.
The analysis of changes in average temperature, maximum and minimum inter-decadal shows that warming began with the decade 1986-1995, the record of warming appeared respectively during the 2006-2015 decade followed by the decade 1996- 2005. The record of the average of the maximum temperature was recorded during the decade 1996-2005 and the average of the minimum temperature was observed during the decade 2006-2015. All the temperature analysis (analysis of interannual, inter-decadal and inter-normal temperature trends) show that the temperatures recorded at the Bujumbura station are trending upwards.

At the Gisozi station, the analysis of the evolution of temperature shows that the more pronounced rise in temperature began around 1994 with a delay of one year compared to the Bujumbura station. The record of the rise of the average temperature appeared during the decade 1996-2005 followed by the decade 2006-2015. The annual average temperature warming record was recorded in decreasing order in 1998, 2010 and 2015. The annual maximum temperature warming record was recorded respectively in decreasing order in 2015 followed by the three years that occupy the 2nd place (1998, 2005, and 2010). While the analysis of the evolution of the inter-decadal average temperature shows that the warming record appeared during the decade 1996-2005 followed by the decade 2006-2015. All temperature analysis (analysis of interannual, inter-decanal and inter-normal temperature trends) show that the temperatures recorded at the Gisozi station are trending upwards.

The average annual air temperature increases as altitude decreases. The highest annual average is 25 ° C (normal 1981-2010 in September) recorded at the Bujumbura station in the Imbo plain, while the lowest is 13.9 ° C (normal 1981-2010 in July) recorded at the Mpotsa-Tora station in the Mugamba region.
In general, average monthly maximum temperatures in Burundi are highest at the end of the dry season (September), which varies from 25 ° C (Imbo region) to 15.7 ° C (Mugamba region) while averages monthly minimum temperatures are lowest during the dry season (July) and range from 23.3 ° C (IMBO region) to 13.9 ° C (Mugamba region).

The table 1 summarizes the results provided by the IGEBU on climatological data recorded in so-called regional reference stations.

The temperature trend analysis shows that in Burundi in the Imbo region, a sustained increase temperature started during the period 1990-2015. A very sharp increase in temperature was recorded during the period 2005-2010.

This period holds the record of very hot years respectively in decreasing order 2010, 2005, 2009 and 2007 while the years that hold the record of cooling are respectively 1971, 1967, 1975, and 1974. In this region, a record of the increase in the number of hot days (Tmax ≥ 25, Tmax ≥30, Tmax≥32, Tmax≥35) was recorded during the period of the decade 2006-2015.

Table 1 : Average climatological data over different periods for three reference stations including Bujumbura (BJA), Gisozi (GSZ), Cankuzo (CKZ)

	1936-1945			1946-1955			1956-1965			Average 1966-1975			Average 1976-1985			1986-1995			1996-2005			2006-2015			2015		
	BJA	GSZ	CKZ	BJA	GSZ	CKZ	BJA	GSZ	CKZ	BJA	GSZ	CKZ	BJA	GSZ	CKZ	BJA	GSZ	CKZ	BJA	GSZ	GSZ	BJA	GSZ	GSZ	BJA	GSZ	GSZ
Annual average temperature										23.6			24	16.4	19.8	24.3	16.5	19.7	24.6	16.7	19.1	24.7	16.6	19.8	24.4	17.1	21.1
Average annual maximum temperature										29.1			29.5	21.9	24.9	29.7	22.0	25.1	30.2	22.2	25.8	30.1	22.2	25.9	30	22.8	26.1
Average annual minimum temperature										18			18.6	10.9	14.8	18.8	11	14.5	19.1	11.3	12.4	19.4	11.1	13.8	18.8	11.4	16.2
Total annual rainfall (in mm)	837.3	1495		850.4	1554.5		880.1	1480.7		851.9	1463.4		795.5	1428	1240.6	767.7	1434.5	1253.8	692	1632.3	1090.8	883.8	1490.8	1185.0	778.7	1789.3	1083.5
Annual number of days of rainfall	123	165		145	196		148	202		158	180		145	175	143	143	169	140	109	182	131	133	179	135	130	178	127
Annual number of days of high heat (max ≥25)														109	173.6		121	192.4		168	239.9		124	248.2		26	262
annual number of days of high heat (max ≥30)										103.1			117.0	0	5	136.0	0	19	156.4	0	54	195.0	0	47	60	0	11
annual number of days of high heat (max≥32)										86			146	0	5	197	0	19	315	0	54	50.9	0	47	29	0	11
annual number of days of high heat (max≥35)										1			1	0	0	0	0	0	3	0	0	4	0	0	0	0	0

I.5. Hydrology

Burundi has abundant water resources (Figure 4). Burundi belongs to two major African river basins namely, the Nile basin with an area of 13,800 km² and the Congo River basin with an area of 14,034 km². In most parts of Burundi, there is a dense network of permanent watercourses and many drainage axes.

It is important to emphasize strongly that the dividing line of the waters of the two basins of the Congo and the Nile is not identical with the Congo-Nile Ridge whose southern limit stops at the Ridge Mukike. In fact, this watershed line continues in the central Bututsi hills, which presents a true flattening surface and continues in the Buyogoma highlands.

In southwestern Burundi, the main rivers originate in South Mugamba and East Bututsi. They pierce mountain chains, also of meridian direction, exploiting tectonic fractures to finally pour into Lake Tanganyika.
In the context of climate change, the hydrographic network of Burundi constitutes a vulnerability factor according to natural predispositions on the one hand, such as geology, topography, climatic variability; and human activities on the other side. These are responsible for the degradation of the soil and the disappearance of the plant cover.

In plains and depressions, floods and landslides are common whenever torrential rains fall in parts of the country. The torrential nature of the Mumirwa watersheds is a permanent threat for Burundi. Finally, rainfall deficits cause sometimes catastrophic decreases in river flows, which puts the agriculture, energy and health sectors in difficulty.
Burundi is very rich in natural lakes including Lakes Tanganyika, Cohoha, Rweru and Rwihinda.

Lake Tanganyika, located at 774m altitude and with a length of 677km, is the second deepest lake (1470m) in the world, and the largest freshwater pool in Africa (18880km3). It is also a pool of biodiversity hence its classification as a heritage of humanity. Unfortunately, it is threatened by the various pollution caused by man and climate change.

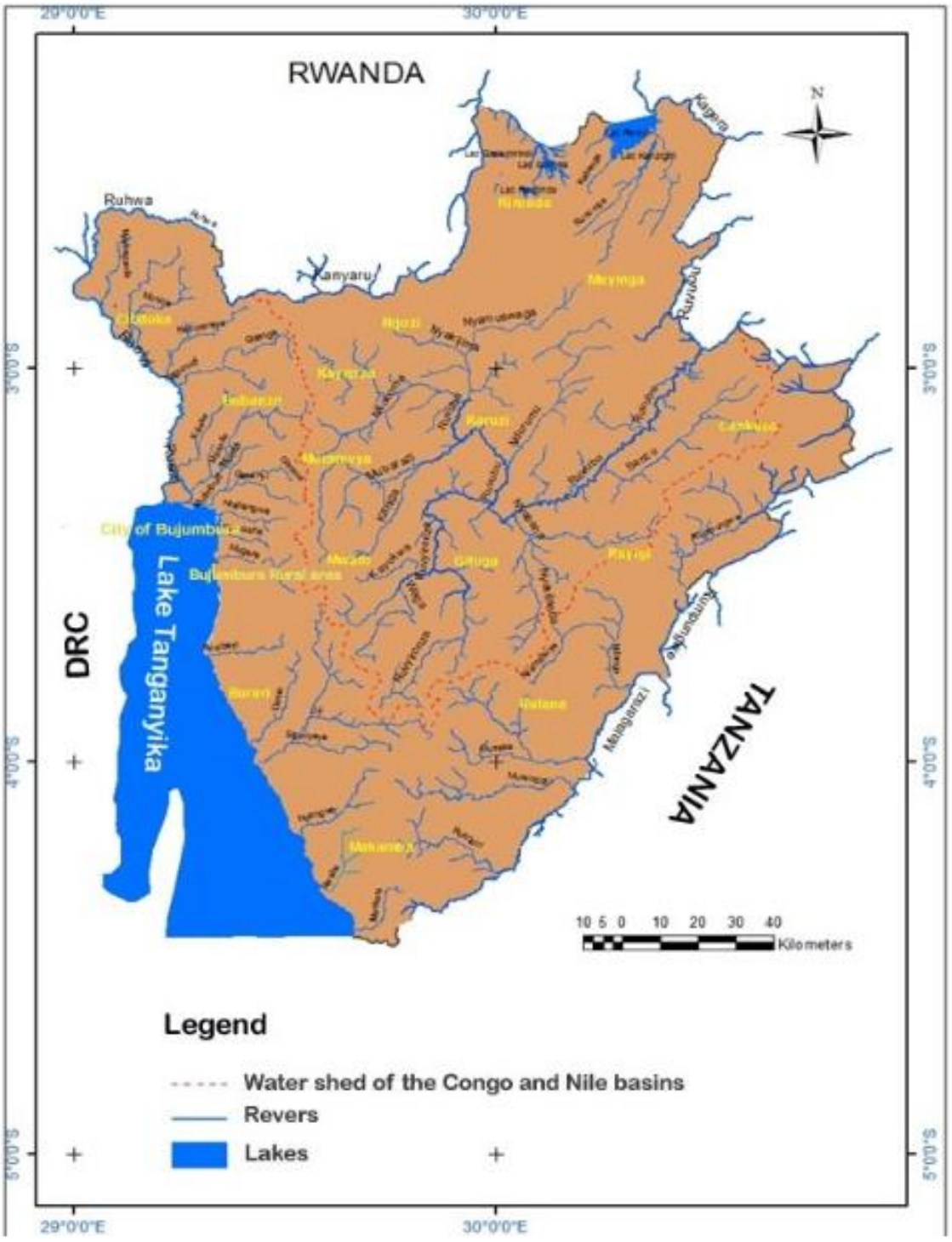


Figure 4 : Hydrographic Map

I.6. Legal, institutional and political framework for climate change in Burundi

1.6.1. Current situation with regard to climate change in Burundi

As soon as Burundi ratified the United Nations Framework Convention on Climate Change (UNFCCC) on April 6, 1997, it committed itself to establish, implement, publish and update national programs, and where appropriate measures to mitigate climate change by taking into account anthropogenic emissions by their sources and the uptake by their wells of all greenhouse gases not regulated by the Montreal Protocol, as well as to facilitate appropriate adaptation to climate change.

Burundi, despite the challenges it faces, including the fight against poverty, the restoration of peace, the fight against illiteracy, the improvement of health and food security, it has undertaken actions on the environmental level in order to wait the objective of the UNFCCC.

In fact, a reforestation program was instituted more than 3 decades ago throughout the national territory and at least two thousand hectares are covered each year by new plants in order to increase the sinks of greenhouse gases.

Also, watershed protection against erosion and marsh development has become a priority for all community-level projects carried out as part of bilateral or multilateral cooperation.

However, the increased need for wood energy and charcoal remains a major handicap in this program, which means that the introduction of other forms of energy is still very important for the preservation of forest ecosystems.

I.6.2. Political framework

Burundi has a national climate change policy whose overall objective is to promote development that is resilient to climate change. Its specific objectives are summarized as follows :

i. Provide a framework for the integration of climate change considerations into different sectoral policies and development planning at all levels;

ii. Strengthen the legal and institutional framework for effective coordination and implementation of adaptation and mitigation actions;

iii. Promote the adoption of technology and approaches that improve resilience to climate change;

iv. Promote and support incentives and other economic instruments for investment in low-carbon development;

v. Strengthen adaptive capacity and improve collaboration, cooperation, synergy; partnership for the implementation of adaptation and mitigation actions by all stakeholders.

The national strategy and its action plan on climate change published in 2013 come to operationalize policy and complete the various programs and activities of various sub-sectoral policies and strategies relating to agriculture, forestry, energy, health, water resources, landscapes and natural ecosystems.

The objective of the climate change strategy is to strengthen Burundi's capacity and resilience to address the challenges of climate change. To achieve this objective, the actions that the Government intends to undertake are structured around 7 strategic axes of the National Climate Change Policy, namely:

i. Adaptation and management of climate risks;

ii. Reducing greenhouse gas emissions and promoting low-carbon development;

iii. Promotion of research and development and adherence to clean technologies;

iv. Capacity building ;

v. Knowledge management and communication ;

vi. Involvement of gender, youth and vulnerable groups;

vii. Financing mechanisms.

Finally, the political tools available to the country are defined by the National Development Plan (2018-2027), the 2025 vision, the sectoral policy of the Ministry having the Environment in its attributions, the National Strategy and Action Plan in terms of Biological Diversity, the National Water Policy, the Strategy for Risk Prevention and Disaster Management, the National Strategy to Combat Desertification.
The negative impacts of climate change are likely to continue for decades, even though greenhouse gas emissions are still minimal for Burundi. Thus, adaptation to the effects of climate change is of paramount importance and therefore a priority for our country.

I.6.2. Institutional Framework

The Ministry in charge of the Environment is responsible for coordinating the implementation of the National Policy, the National Strategy and the Action Plan on Climate Change. In addition, since 1980, Burundi had an institution responsible for collecting climate data. It is the Geographical Institute of Burundi (IGEBU) whose head at the highest level is at the same time the focal point of the United Nations Framework Convention on Climate Change at the national level. The Ministry having the Environment in its attributions, created in 1988, has gradually acquired structures enabling it to fulfill its mission of planning and coordinating environmental

restoration activities. The last structure recently created in 2014 is the Burundian Office for the Protection of the Environment (OBPE),
the deputy focal point of the United Nations Framework Convention on Climate Change at the national level.
The missions of this Office are mainly:

- Ensure the implementation of the obligations arising from international environmental conventions and agreements of which Burundi is a member;

- Monitor and evaluate development programs to ensure compliance with environmental standards in the planning and execution of all development projects that may have a negative impact on the environment and climate; and

- Put in place mechanisms to mitigate and adapt to climate change

OBPE has two departments, one in charge of reforestation programs and the monitoring of the implementation of the national forest policy and the other in charge of the environment and climate change. The latter is leading projects to develop national communications on climate change.

It is also called to:

- Coordinate the updating of greenhouse gas inventories;

- Coordinate all interventions in the field of climate change;

- Monitor daily the implementation of the national policy, the strategy and the action plan on climate change by the various stakeholders;

- Promote research and development on climate change.

In addition to the Ministry of the Environment, other Ministries are involved in the management of natural resources and are also involved in climate change issues. These include:

- Ministry of Hydraulics, Energy and Mines, with responsibilities in the preparation of national communications on climate change because it holds all data related to energy throughout the national territory;

- Ministry of Public Health and the fight against AIDS, with hygiene responsibilities, sanitation and drinking water quality standards;

- Ministry of Commerce, Industry and Tourism, with responsibilities in industrial planning and raising awareness of those responsible for these industries to monitor and limit the smoke emissions that are the basis of greenhouse gases;

- Minister of Transport, Public Works, Equipment and Spatial Planning which holds the number of vehicles and their state of defect which affects the air pollution.

- Ministry of Foreign Affairs which has the responsibility to follow the clauses of the various international conventions and agreements related to climate change;

- Ministry of Finance, Budget and Economic Development Cooperation which is in charge of financing climate change adaptation and mitigation programs as well as the Government's counterparts for the implementation of the United Nations Framework Convention on Climate Change;

- Ministry of Public Security and Disaster Management, which is in charge of risk and disaster management, including those resulting from climatic hazards.

- Interior Ministry, the Patriotic Education and Local Development, which has the management of the communes and Provinces in his attributions.

I.6.3. Legal framework

It should be noted that since the creation of the Ministry of the Environment in 1988, the Government of Burundi has begun the process of drafting laws related to the protection of the environment and its natural resources.

They are the Followings :

- The Environmental Code which was promulgated by the law n ° 1/010 of June 30th, 2000.

- Decree No. 100/241 of 31 December 1992 regulating the disposal of waste water in urban areas.

- Decree No. 100/292 of 16 October 2007 on the creation, mission, composition, organization and operation of the National Platform for Disaster Risk Reduction and Disaster Management,

- Law No. 1/07 of July 15, 2016, revising the Forest Code which regulates the use of woodlands of the private domain of the State or municipalities.

Although these texts were promulgated, they remained ineffective in the field of climate change because of the lack of implementing texts, on the one hand, and because they were not sufficiently popularized and made known to stakeholders at the sectoral level; on the other hand.Among the legal tools that the country can rely on to combat climate change, it is worth mentioning the international conventions ratified by Burundi. These are: The United Nations Framework Convention on Climate Change; the Convention to Combat Desertification, the

Convention on Biological Diversity, the Vienna Convention for the Protection of the Ozone Layer and the RAMSAR Convention on Wetlands.

I.7. Demography and its links with Climate Change

The interrelationships between population pressure, chronic rural poverty, and climate change justify state intervention in demographic variables.
Indeed, the population policy aims at a coherent set of political, administrative, economic, social, cultural and environmental measures adopted by the Government. The main goal is to get people to adopt behavioral changes aimed at modifying or maintaining the observed trends of fertility, mortality, nuptiality and / or migration, so that the demographic characteristics of the population that result, be able to contribute, or facilitate the achievement of poverty reduction goals through the fight against climate change.

The demographic situation in Burundi is characterized by rapid population growth estimated at 2.4% per year on average, a consequence of high fertility. This growth creates serious challenges in the areas of agriculture, environment, health, education, employment, housing, etc.

The 2008 General Population and Housing Census and the 2010 Demographic and Health Survey highlighted the critical demographic challenges facing Burundi. These challenges are: high population density, overweight of young people, high fertility and mortality, and rapid population growth.

Despite its limited area (27,834 km²) and its particularly rugged ground, the country has 11.2 million inhabitants in 2016; this size of the population makes Burundi one of the most densely populated African countries, with an overall density of 392 inhabitants / km².
This density is more worrying as 9 out of 10 people live in rural areas. High density causes excessive population pressure on the environment and natural resources that aggravates the vulnerability of the natural environment to climate change and traditional lifestyles that do not respect the environment.

The main consequences resulting from this demographic pressure coupled with the harmful impacts of climate change include:

- the fragmentation of family farms which causes the degradation of cultivable soils accelerated either by excesses or rainfall deficits. Average farm size fell from 1.04 hectares per household in 1973 to less than 0.5 hectares in 2009;
- the occupation of marginal lands exposed to very high risk of erosion in the current context of climate change in Burundi;
- multiplication of land conflicts associated with changes in the boundaries of family or public properties following the happening of exceptional rains;
- the degradation of the environment of natural ecosystems and its impacts on the regulation of local Burundian climate;
- pressure on private and community infrastructure as a very important underlying factor in climate disaster risk;

- the protection and rehabilitation of the environment is severely compromised by the triple relationship between land use planning, climate change and disaster risk.

Therefore, it is understandable that the preservation of the environment and sustainable land management in the face of a real population explosion remains a major challenge for the Government and grassroots communities. This is why a land code was adopted in 2011.

I.8. Sectors Influencing Climate Change

Through the first two national communications on climate change and the present, agriculture and energy are the most emitting sectors of GHGs while the forest sector is a potential sink for GHGs. Mitigation studies that have been conducted in the same framework have proposed a number of mitigation measures that for the most part are poorly implemented.

I.8.1. Agriculture and Livestock.

Agriculture is one of the most vulnerable sectors to the impacts of climate change because it depends on rainfall.
It should be noted that the current national agricultural policy contributes to the implementation of mitigation measures for this sector as well as the adaptation measures proposed in the context of national communications:
- improving the composition and use of livestock feeds;
- strengthening of manure management systems and the practice of composting;
- the fight against on-site combustion of crop residues;
- the introduction of short-term crops such as vegetables, some rice species, potatoes, bananas, mushrooms, etc ...
- the practice of small irrigation

I.8.2. Energy Sector

Burundi's energy situation reflects the image of its level of economic and technological development in view of its very low rate of access to energy services, in this case electricity.
Access to enough energy is essential to meet needs related to: (i) mechanization of agriculture and conservation of agricultural products; (ii) the extraction and processing of ores; (iii) the development and diversification of economic activities; (iv) a better business climate conducive to private sector investment and; (v) improvement of health and education systems.
In Burundi, the achievement of these objectives is strongly compromised by the insufficiency of the production of electrical energy.
The mitigation measures identified in previous communications, and the implementation of which has been initiated, are:
- the use of wood-saving equipment and charcoal as households improved wood and charcoal;
- the introduction of solar energy and the proliferation of hydroelectric plants.

I.8.3. Land Use, Land Use Change and Forestry.

Burundi has forests covering about 172,000 hectares, representing 7% of the national territory, including 103,000 ha occupied by natural forests and 69,000 ha of artificial forests. The annual rate of deforestation is now 9%. The causes are mainly the pressure on the forest resources caused using wood as the main source of energy and by the search for new farmland. The bush fires are also wreaking havoc in the country, burning every year large areas of wood.

The mitigation measures identified in the SNCCC are as follows and currently being implemented include:
- Intensification of food crops and promotion of cover crops;
- The fight against erosion;
- The promotion of breeding in permanent housing and
- Dissemination of improved coal fires

An economic study of cost evaluation after the adoption of mitigation and adaptation measures to climate change is of great importance to motivate all Burundian society to change its behavior.

I.9. Most vulnerable Sectors to Climate change

Changes in rainfall patterns and rising temperatures have negative impacts on the livelihoods of the Burundian population. The sectors identified as most vulnerable are: (i) agriculture and livestock, (ii) health (iii) energy; (iv) water resources; infrastructures, transport, natural ecosystems (including forest and biodiversity).

I.9.1. Agriculture Sector

In the agricultural sector, the impacts of climate change are manifest in two key aspects. During the last ten years, there has been a decline in agricultural production as a result of total or partial destruction of the fields, either due to rainfall deficits or excess rainfall, often combined with hail and violent tropical storms. In the first case, it is the prolonged drought that manifests itself mainly in the provinces of Kirundo, Cibitoke, Bubanza, Makamba and Bujumbura. In the second case, excess rainfall causes the same effects of massive destruction of crops in the plains of Imbo or in the lowlands of the central highlands of the country. Heavy rains, strong winds and hail destroy not only the fields, they also accelerate soil degradation. These climatic phenomena have the effect of maintaining food insecurity for a growing number of households and the malnutrition that is gradually becoming a real public health problem in Burundi.

I.9.2. Health and Nutrition Sector

The sudden increase in temperature, deficits or excessive rainfall have always favored the resurgence of tropical diseases with vector and non-vector transmissions. Mismanaged floods and lack of water are the source of dirty hand diseases. In fact, diseases attributable to climate change are associated with the deterioration of access to drinking water and insufficient vector control.

I.9.3. Energy Sector

The impacts of climate change in the energy sector are being addressed because of their negative and heavy effects on both the national economy and the environment, not to mention the serious consequences in the lives of urban households. These impacts are observed especially with less rainfall that feed the river flows, dams hydroelectric: Rwegura, Mugere, Marangara, Kayenzi and Buhiga.

As the rapid urbanization of Burundi has not been accompanied by new sources of energy, the over-exploitation of hydroelectric power plants combined with the effects of climate change and changes in the forest environment has led to the reduction of the dam about 10 m as in 2008, which is close to the level of the intake, that is to say the shutdown of the plant.

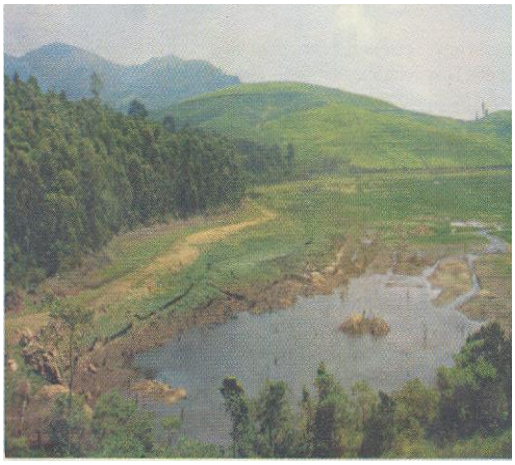
The photos below show the fluctuation of the level of RWEGURA reservoir and its environment at the level of the spillway in relation to rainfall.

Picture 1 : Dam level of Rwegura CHE in 2004

Picture 2 : Dam level of Rwegura CHE in 2007

Picture 3 : Dam level of Rwegura CHE in 2008

Picture 4 : Dewatering of the reservoir lake of Rwegura CHE in 2008



This is a situation perfectly similar to that of February 2017.

I.9.4. Infrastructure Sector

The impacts of climate change also affect infrastructures following the torrential rains that cause floods, high winds and landslides. Their rehabilitation weighs heavily on the national economy. Indeed, the severity and frequency of natural disasters has been steadily increasing in Burundi over the past two decades due to climate change, in addition to poorly planned urbanization, population pressure on natural resources, and widespread degradation of soil following the anarchic exploitation of mines and quarries.

By way of illustration, the landslides and floods caused by the Gikoma, Gasenyi / Gatunguru, Kijejete, Rutunga and Nyaruhongoka ravines during two successive years of 2014 and 2015 cost the lives of more than 100 people, and the thousands of displaced. Road infrastructure, markets, water and electricity supply networks, schools and churches have been destroyed.
In the city of Bujumbura and surrounding areas, floods and landslides continue today and are causing the destruction of many residential plots.

Picture 5 : Example of threat of destruction of Kigobe houses

I.9.5. Natural Resources Sector

Burundian environmental management is currently facing formidable challenges such as explosive demography coupled with widespread rural poverty; the destruction of forest ecosystems; soil erosion; the reconversion of marshes into agricultural lands; deterioration of aquatic ecosystems; exploitation of mining quarries tending towards real ecological disasters; and climatic disturbances illustrated by floods, landslides, severe droughts and epidemics of malaria, meningitis and other vector-borne diseases. Nevertheless, for the sake of presenting the Burundian ecological context, we limit ourselves to these three main concerns:

a. Massive deforestation and its consequences.

It is now widely accepted that the Burundian environment is seriously threatened, as the once flourishing landscapes are now disturbingly degraded and offer pathetic images.
Therefore, the deforestation of nature reserves such as Kibira and Ruvubu Park and others, requires attention, as their destruction is accompanied by irreversible environmental impacts thus compromising the sustainable development of the country.

For example, the area of Kibira, the most important national reserve, was estimated at more than 50,000 ha during its protection status in 1934.

With the creation of INECN in 1982, its area had already fallen to 40,000 ha. Currently, the area of Kibira is not well known. However, an estimated 10,000 to 12,000 ha have been lost in the last ten years.

On its own, the establishment of the industrial tea block in Teza in 1963 and its gradual expansion until 1977 has reduced Kibira by an area of 600 ha. However, it is well known today that Kibira represents both the most important natural heritage for Burundi and is above all a real water tower for the two largest watersheds in Burundi. That is, the Congo Basin in the West and the Nile Basin in the East. If this deforestation is expected to continue at this alarming rate, the runoff coefficient would become higher compared to the infiltration coefficient of rainwater, which would inevitably reduce the aquifer that feeds the many water sources both west and east of Congo Nile Crest.

b. Degradation of Agricultural lands

For the past two decades, land degradation has taken a very worrying pace over the entire Burundi Nile watershed. It is indeed one of the most painful observations of the Burundian environment, given the current rate of intensity of soil erosion in these various forms.

The explosive population pressure observed throughout the country and the major cause of land losses and quantities very impressive. It is currently estimated at 400-700t / ha / year of lost land in the highlands. It is well over 1000t / ha / year in the more mountainous reliefs. It is also one of the biggest causes of desertification in Burundi. Deforestation related to the search for agricultural land and the high dependence of households on wood as the sole source of energy for domestic use continue to exacerbate this situation.

The use of wood energy by the population often irreversibly reduces the afforestation and forests that are essential for soil protection and the regulation of local climate. The steep slopes, the intensity of climatic aggressiveness and especially the non-overlapping crops make this situation worse. 70% of land in the central highlands are not protected.

Rural women as the main manager of natural resources should play an active and participatory role in the management, conservation and protection of the environment. However, this requires enough training and education to intervene in decision-making.
The problem is particularly critical in some areas where the soil remains occupied by crops without the possibility of fallowing.

c. Degradation of wet, terrestrial and aquatic ecosystems.

The degradation of wetland, terrestrial and aquatic ecosystems is another major concern for the environment in Burundi.

In 1979, Burundi had a cover of 120,000 ha of marches, 35% of which were in use at that time. In 1990 the exploited area of marshes reached 40%. By the year 2000, marshes reconverted to agricultural land already accounted for nearly 70% of the total marsh area.

Similarly, farmers in the fear of hunger, do not hesitate to appropriate messy reserve land, which normally were the private domain of the state.

The overgrazing of marshes during the dry season causes soil compaction and sometimes an often-irreversible destruction of vegetation. Significant wetlands have been destroyed as a result of the extraction of building materials such as clay for the manufacture of bricks and tiles or for the manufacture of other handicrafts.

The consequences of the anarchic exploitation of the marshes can be of a big invoice on several environmental aspects, especially their dryness related to the hydrological imbalances, the destruction of the biodiversity, the regulation of the floods which is dangerously compromised, and finally the impoverishment of the resulting in the fall of agricultural production.

In Bugesera, the most important aquatic ecosystems are represented by Cohoha, Rwihinda, Kanzigiri, Rweru and Gacamirindi lakes.
Currently, the only lake with official protection status is Rwihinda Lake, known as the Bird Lake. The main objective was to protect its rich ornithological. Rwihinda Lake once attracted many domestic and foreign tourists, curious about the diversity of migratory bird species.
The habitat of these migratory birds is endangered if nothing is done to federate protection efforts. But the biggest threat remains coastal agriculture and in particular the climatic disturbances of the last ten years.

The impacts of climate change have led to a decline in fish production as a result of changes in the ecological conditions of lakes due to increased water temperature and pollution due to excessive inputs of sediments, fertilizers and other products used in agriculture as well as industrial waste.

The unfortunate consequences of the anarchic exploitation of these wetland and terrestrial ecosystems could be the drying up of swamps and lakes with irreversible losses of fertile land, flora and fauna.

I.10. Climate change effects on the national economy

Climate change is a formidable economic problem for Burundi as it seriously undermines its human development efforts in all key sectors of national life. The country faces immense emergency financial needs to rehabilitate the environment and the socio-economic infrastructures destroyed following the climatic hazards; and specially to deal with the famines and epidemics that mainly affect the most vulnerable populations.

Since September 2015, more than 4 million people have been affected by torrential or heavy rains, water deficits, high winds, floods and landslides. These climatic events have destroyed 30,000 hectares of crops and 5,000 homes. They also damaged more than 300 classrooms and about 50 bridges.

All key sectors of the Burundian nation are directly affected by the impacts of climate change. Therefore, adaptation to climate change should be one of the highest priorities for this country for community resilience.
First, there are recurring droughts that have already hit most of northern Burundi. In the north of the country, at the end of 2005 and the beginning of 2006, the drought was declared a national disaster and cost a colossal sum of 71 billion Burundian francs (approximately 45.8 million USD) in the name of national solidarity.

The massive displacement of Burundian populations left to Rwanda and Tanzania to survive was a consequence of a completely new development in Burundi.
Floods and landslides cause terrible economic losses in Burundi.
As a reminder, the February 2014 floods caused by the Gasenyi and Gikoma ravines cost a total of **BIF 7 billion** for infrastructure (that is 0.18% of GDP).

In 2015, floods and landslides in Rutunga and Nyaruhongoka were national natural disasters that resulted in economic losses of more than BIF 3 billion and more than 1,400 homeless people.

CHAPTER II: NATIONAL GREENHOUSE GAS INVENTORY

II.1. Introduction

This chapter presents the Greenhouse Gas (GHG) inventories for the period 2005 to 2015 with selected years 2005, 2010 and 2015. It was prepared in line with articles 4 and 12 of the United Nations Framework Convention on Climate Change (UNFCCC) and the Guidelines for National Communications of non-Annex I Parties of the UNFCCC, adopted in decision 17/ CP. 8, which state that non-Annex I Parties should include information on a national inventory of anthropogenic emissions by source and absorption by sinks of all GHGs not controlled by the Protocol of Montreal, within the limits of their possibilities, using in its preparation the comparable methodologies promoted and approved by the Conference of Parties (COP).[1]
Responding to the obligations incurred by signing the Framework Convention, the Republic of Burundi submitted its Initial National Communication (INC) in November 2001 and Second National Communications (SNC) in June 2010.

II.2. Overview of the inventory

The national GHG inventory (NGHGI) includes four categories, namely (1) Energy; (2) Industrial Processes and Product Use (IPPU); (3) Agriculture, Forestry and Other Land Use (AFOLU) and (4) Wastes. It takes into account the following direct gas, namely (i) carbon dioxide (CO_2), (ii) methane (CH_4) and (iii) nitrous oxide (N_2O.
The methodology adopted was based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and GHG emissions and removals were computed through the 2006 IPCC inventory software. A Tier 1 approach was used for all categories.

II.3. Brief description of institutional set ups

The UNFCCC Focal Point, the Ministry of Environment, Agriculture and Breeding (MINEAGRIE) through its Burundian Agency for Environment Protection (OBPE) coordinated the preparation of the Third National Communication (TNC) in collaboration with other Ministries and Government Institutions, Private Sectors, Academia and NGOs. A GHG Inventory Team was set-up to collect data and make a GHG inventory. A dedicated team, comprising members of key institutions, was responsible for data collection and entry into the IPCC 2006 software.

[1] UNFCCC, 2004. "Reporting on climate change - User manual for the guidelines on national communications from non-Annex I Parties to the UNFCCC". Climate Change Secretariat, Germany, p. 1.

The following table shows the lists of institutions participated into development and validation of sectoral reports.

Table 2 : Lists of institutions participated into development and validation of sectoral reports

Sectors	Institutions contributing to the development of the GHG inventory report	Institutions contributing to validation of sectoral reports
Energy	Directorate General for Energy and Cabinet of the Minister in charge of Energy	• General Directorate of Energy and Cabinet of the Minister in charge of Energy, • Directorate of Forestry • Cabinet of Ministry of Agriculture and Livestock, • General Directorate of Agricultural Planning and Livestock, • General Directorate of Livestock, • Soil fertilization Directorate Rice Cultivation office, • Sugar cane office, • Environment and Climate Change Division • Geographical Institute of Burundi, • Cabinet of the Ministry of Trade and Industry • Industry Division • Chamber of trade and Industry • Ministry of Education, Higher Education and Scientific Research • Craftsmen's associations for recycling plant waste • Association of craft manufacturers of improved stoves • Directorate General of Water Resources and Sanitation • Burundian Office for Environment Protection (OBPE) • Palm Oil Agency • MOSO Sugar Company • Brewing Company of Burundi
Forestry	Directorate of Forestry	
Agriculture	General Directorate of Agricultural Planning and Livestock	
Industrial Process and Product use	Division of Environment and Climate Change	
Waste	Division of Environment and Climate Change	

II.4. Data collection

The Division of Environment and Climate Change, who is the institution leading the GHG inventory was responsible for coordinating the activities related to data collections, identification of relevant stakeholders and preparation of capacity building exercises. The data collection process was led by the Team Leaders (TLs) of each concerned sector. In the event where data was not available to the dedicated team, the data were estimated using expert judgement.

Initial technical and quality evaluation of the data was done by the dedicated team. The database created within the IPCC software was settled up during the review workshop conducted in March 2019 by the Expert selected by the Global Support program of the UN Environment.

The institutions involved in data collection, verification and data entry in IPCC software are provided in the Table 2. The National Experts Team from public institutions in collaboration with public and private institutions increases access to information. Establishing direct contact with these institutions also proved essential in obtaining unpublished data previously collected solely for internal purposes.

Table 3 : Institutions contributing to the GHG inventory

Sector	Sub-sector	Category code and name	Emissions/sink sources	
			Sources	Activity data type
Energy	Fuel Combustion Activities	1.A.1 - Energy Industries	Energy producing industries	Diesel Lubricant bagasse
		1.A.2 - Manufacturing Industries and Construction	Manufacturing plants, construction company	Oil Diesel Lamp oil / mixture oil/ cleaning Lubricant Bitumen Cotton lugs Wood
		1.A.3 - Transport	Transport (road, aviation, maritime)	Oil Diesel, gazoline Lubricant Diesel fuel Kerosene
		1.A.4 - Other Sectors	Hotels, hospitals, military and police camps, prisons, schools with	Diesel, Oil, Lubricant, Peat, Wood, Lamp oil, Wood, Charcoal, Diesel fuel

Sector	Sub-sector	Category code and name	Emissions/sink sources	
			Sources	Activity data type
			boarding, universities, households, Farming factories, Companies with agricultural Machinery, Fishing activities	
Industrial Processes and Product Use	Mineral Industry	2.A.2 - Lime production	Lime production	Quantity of lime produced
		2.C.1 - Iron and Steel Production	Iron and Steel Production	Quantity of Iron and Steel Produced
Agriculture, Forestry, and Other Land Use	Livestock	3.A.1 - Enteric Fermentation	Cattle, Sheep, Goats Pigs, Poultry	Data on dairy cattle / dairy cows, Other cattle Sheep, Goats Pigs, Poultry
		3.A.2 - Manure Management	Cattle, Sheep, Goats Pigs, Poultry	Dairy cattle / dairy cows, Other cattle Sheep, Goats Pigs, Poultry
	Land	3.B.1 - Forest land	Forest lands and their related conversion	Data on areas of public and private forest land, timber harvested and used for energy and / or non-energy purposes. Other data include areas of pastures, cultivated land, and peatlands
		3.B.2 - Cropland	Cropland and their related conversion	
		3.B.3 - Grassland	Grassland and their related conversion	
		3.B.4 - Wetlands	Wetlands and their related conversion	
	Aggregate sources and non-CO2 emissions sources on land	3.C.1 - Emissions from biomass burning	Cultivated Land remaining Cultivated	Amount of biomass burned during the removal of leaves by fire prior to harvest from the area occupied by the cane.
		3.C.2 - Liming	Use of lime in agriculture	Liming data
		3.C.3 - Urea application	Use of urea in agriculture	Quantity of urea applied
		3.C.4 - Direct N2O Emissions from managed soils	Use of NPK in agriculture	Quantity of NPK applied
		3.C.5 - Indirect N2O Emissions from managed soils	Use of NPK in agriculture	Quantity of NPK applied
		3.C.6 - Indirect	Cattle,	Dairy cattle / dairy

Sector	Sub-sector	Category code and name	Emissions/sink sources	
			Sources	Activity data type
		N2O Emissions from manure management	Sheep, Goats Pigs, Poultry	cows, Other cattle Sheep, Goats Pigs, Poultry
		3.C.7 - Rice cultivations	Rice plantations	Areas of annual rice harvest and the time of the vegetative cycle
	Other	3.D.1 - Harvested Wood Products	Wood materials	Quantity of harvested Wood Products
Waste	Solid Waste Disposal	4.A - Solid Waste Disposal	Unmanaged waste disposal sites (Municipal solid waste)	Quantity of solid waste
	Wastewater Treatment and Discharge	4.D - Wastewater Treatment and Discharge	Domestic wastewater; Industrial wastewater	Quantity of liquid waste

II.5. Brief description of methodology

The National Greenhouse gases inventory is structured to match the reporting requirements of the UNFCCC for the categories (sectors) mentioned in section 2.2., each of which are further subdivided into sub-categories. Emissions of direct GHGs (CO_2 and CH_4, N_2O) were not directly measured but were estimated through the application of methodologies used to calculate emissions for activity data /natural phenomena occurring in the different sectors, such as amount of fuel consumed in electricity generation or area of forests by tree species and climate zone.

The estimation of the emissions and removals were computed using the IPCC (2006) methodologies where generally the activity data was multiplied by emissions/removal factors.

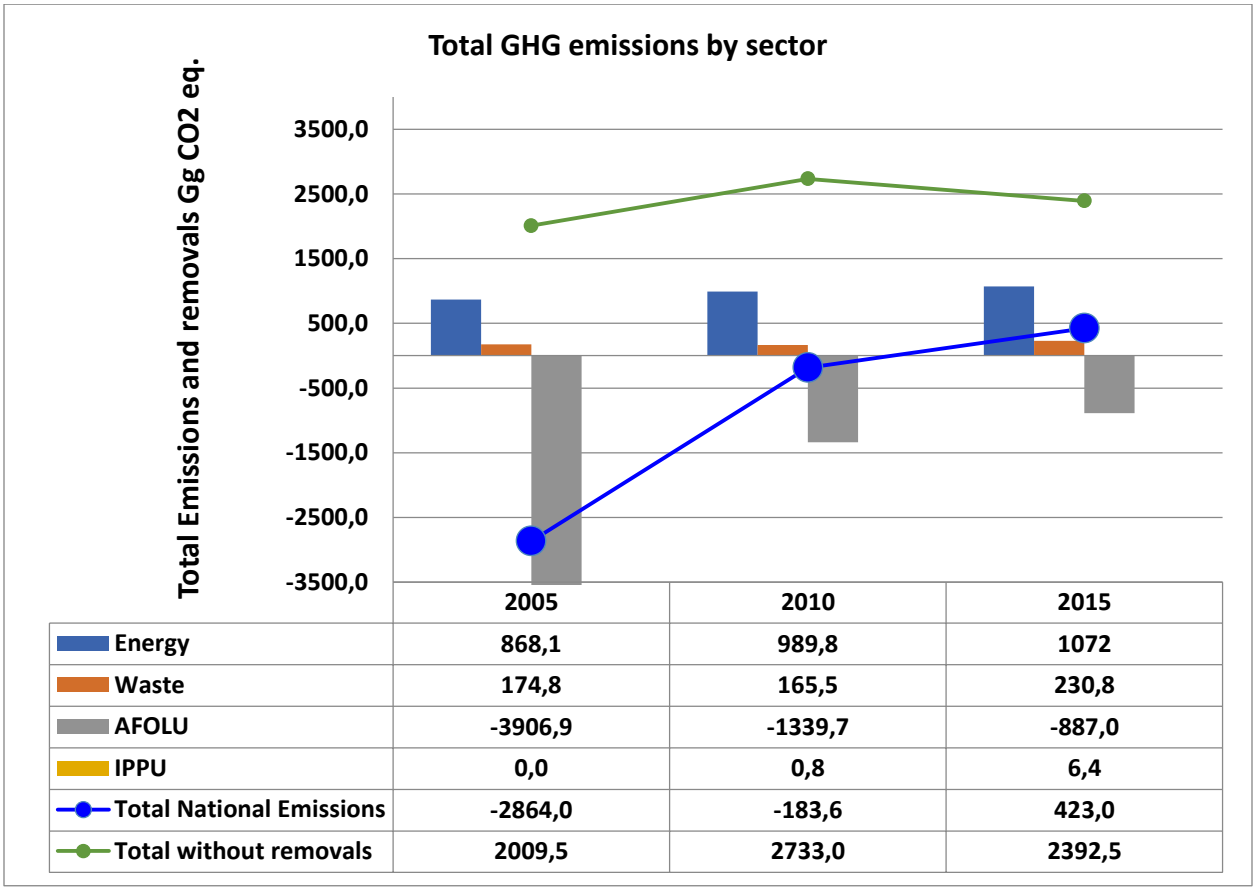
Generally, Tier 1 methodology demands a minimum data with some provided emission factors (coefficients), often referred to as default values. Depending on the IPCC specific category and sector, Tier 2 requires more disaggregated data and/or country specific emissions factors. Tier 3 method is a much detailed data at the country specific level and may also involve modeling and continuous and regular measurements.

For Burundi Third National Communication, Tier 1 and Tier 2 were not attempted. More details on methodology are described in section of emission trends per sector.

II.6. Summary of emissions trends

The figure 1 below provides the quantity of aggregated emissions and removals of Burundi from 2005 to 2015. The aggregated emissions without removals were characterized by an increase while the sink potential declined. As results of both, the total national emissions increased.
From the same figure, it can be also noted that the pic of emissions without removals were observed in 2010 with 2733.0 Gg. Of CO2 eq.

The main cause of emissions increase is the economic growth with observed recession in the years close to 2015 causing a gradual total emission reduction, deforestation observed during the period of 2005-2010 and the conversion of forest and savannah land into crop land. In fact, according to different sources, the annual growth rate of GDP was 4.75 in 1998 (Burundi first inventory year), 0.90 in 2005, 3.79 in 2010 and -3.90 in 2015 due to the socio politico conflicts. The rate average on the four inventory yeas is 2.77. For the entire period 1998-2017, there is an annual average of 2.49.



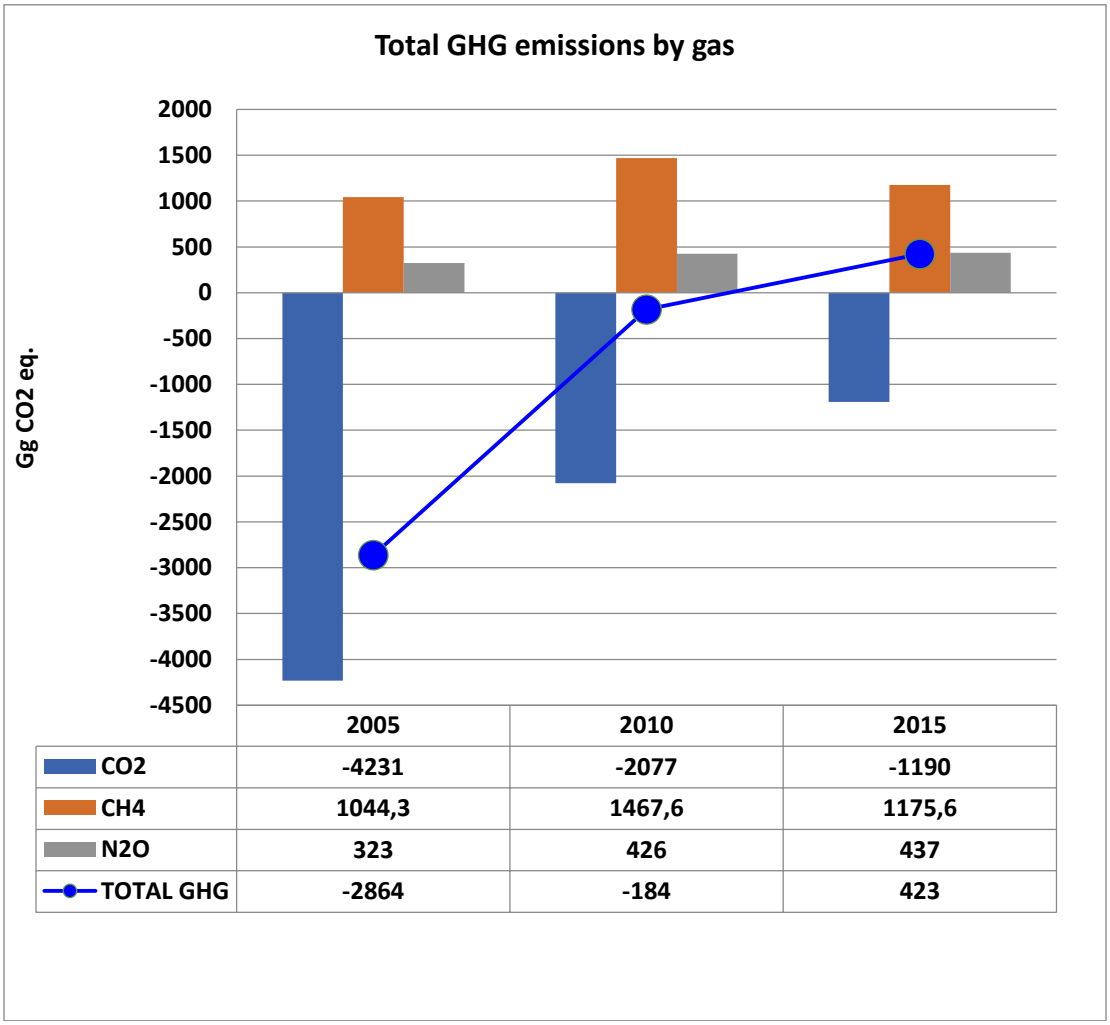
	2005	2010	2015
Energy	868,1	989,8	1072
Waste	174,8	165,5	230,8
AFOLU	-3906,9	-1339,7	-887,0
IPPU	0,0	0,8	6,4
Total National Emissions	-2864,0	-183,6	423,0
Total without removals	2009,5	2733,0	2392,5

Figure 5 : Total GHG Emission per sector and trend (see details in annex)

The trend per gas indicate that the dominant GHG was CO_2 which ranges between -4,231 Gg of CO_2 eq. and -1,190 Gg of CO_2 eq.. The main contribution to CO_2 emissions/sequestration comes from AFOLU sector. The methane (CH_4) is the second emitted gas. Its quantity was 1,044.3 Gg of CO_2 eq. in 2010, 1,467.6 Gg of CO_2 eq. in 2010 and 1,178.6 Gg of CO_2 eq. in 2015. The main contributor to CH_4 is AFOLU-agriculture, Energy-Other sectors (use of biomass). Therefore, the main emitting sector in Burundi is AFOLU followed by the Energy. The third

emitter gas is N_2O and its main contributions come from Waste (Waste treatment and discharge) and Energy -Other sectors (biomass burning).

The balance of CO_2 is negative for the whole period of inventory meaning that, Burundi is a sink from 2005 to 2015. However, the sink potential of Burundi reduced by 40.15% from 2005 to 2010 then by 32.45% from 2010 to 2015. Concerning CH_4, it has increased to 40.5 % in 2010 and then reduced by 19.9 % in 2015. Lastly for N_2O, it has increased by 32 % from 2005 to 2010 then by 2.6% from 2010 to 2015. It can be observed that the aggregated emissions growth from 2005 to 2010 is as well reflected by gas per gas emission growth in the same period. As explained above, this combine both economic growth and deforestation.



	2005	2010	2015
CO2	-4231	-2077	-1190
CH4	1044,3	1467,6	1175,6
N2O	323	426	437
TOTAL GHG	-2864	-184	423

Figure 6 : Trends of emissions per gas

Concerning the emissions share per sector, the share of AFOLU (Emission only) increased from 48% to 58% in 2010 and then decreased to 45% in 2015. The share of the energy sector decreased from 43% to 36% in 2010 and then increased to 45% in 2015. The share of waste sector ranges between 6 and 10% while the IPPU represents less than 1% share into national emission totals.

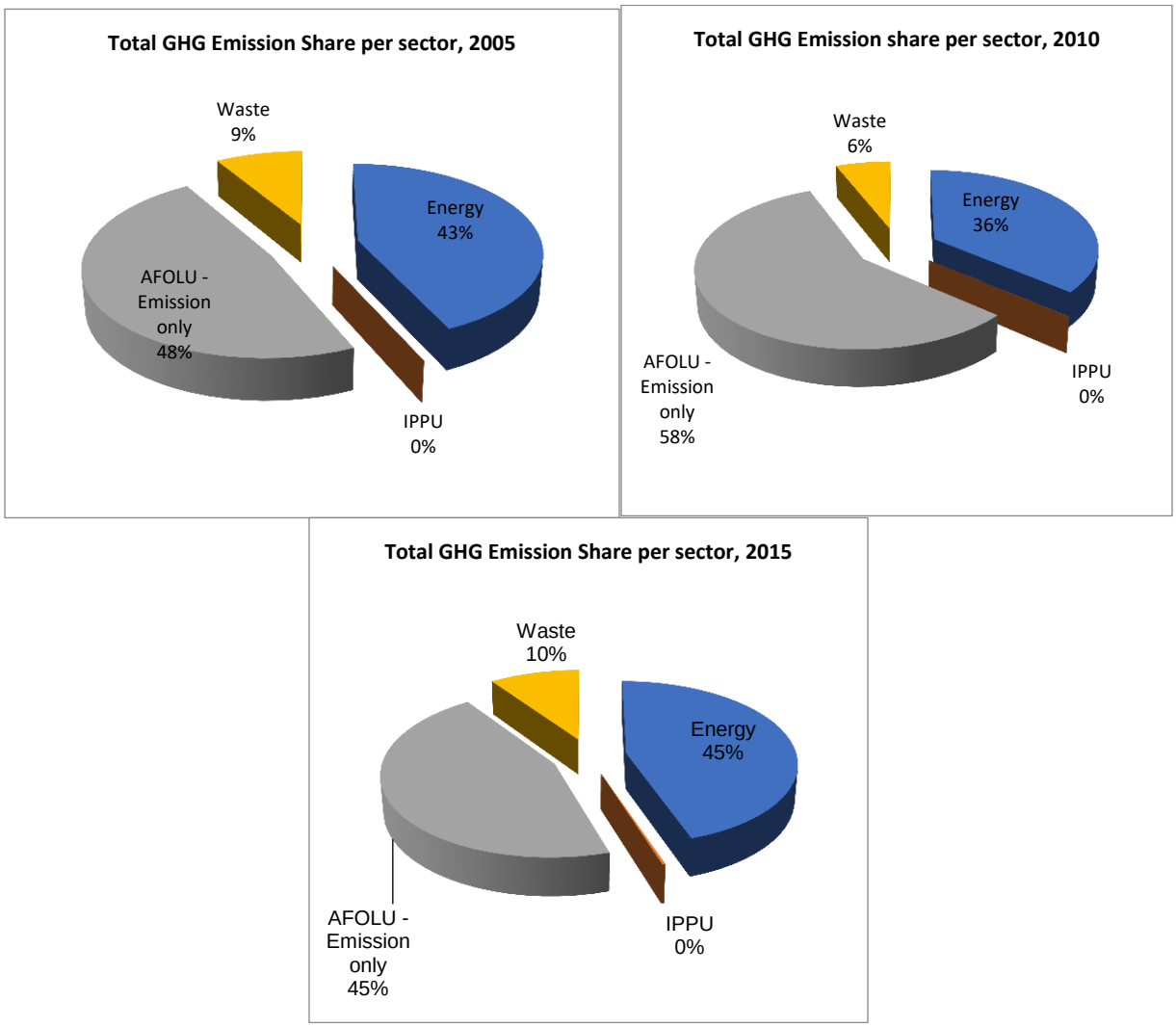


Figure 7 : Share of GHG Emission per sector

II.7. Key category analysis

A Key Category Analysis (KCA)[2] was carried out to determine the sectors or subsectors and the GHGs that are important in the inventory and that needs more focus for accurate calculations.

[2]A *key category* is one that is prioritized within the national inventory system because its estimate has a significant influence on a country's total inventory of greenhouse gases in terms of the absolute level, the trend, or he uncertainty in emissions and removals. Whenever the term *key category* is used, it includes both source and sink categories (IPCC 2006 – V1 sect 4.1.1.)

This assessment is a listing of all those categories that cumulatively account for up to 95% of the total inventory when summed up in descending order of magnitude.
The key category assessment with AFOLU-Removals including carbon sinks (forests) and includes values relating to estimated carbon removals in the AFOLU sector, taking into consideration the quantified values without consideration of the sign (removals are normally considered as being equivalent to negative emissions).

Considering categories which are represented in all 3 inventory years: 2005, 2010 and 2015, it can be noted that 7 categories are considered as key in Burundi. Those include :

(i) Forest land Remaining Forest land;
(ii) Other Sectors – Biomass (both CH4 and N2O)
(iii) Land Converted to Cropland
(iv) Enteric fermentation ;
(v) Rice cultivations
(vi) Harvested wood products ;
(vii) Road Transport

Details are in table 3 below and in annex 2

Table 4 : Results from the trend assessment of key categories

N°	IPCC Category code	IPCC Category	Greenhouse gas	2005	2010	2015
1	3.B.1.a	Forest land Remaining Forest land	CARBON DIOXIDE (CO2)	X	X	X
2	1.A.4	Other Sectors - Biomass	METHANE (CH4)	X	X	X
3	3.B.2.b	Land Converted to Cropland	CARBON DIOXIDE (CO2)	X	X	X
4	3.A.1	Enteric Fermentation	METHANE (CH4)	X	X	X
5	3.C.7	Rice cultivations	METHANE (CH4)		X	X
6	3.D.1	Harvested Wood Products	CARBON DIOXIDE (CO2)	X	X	X
7	1.A.4	Other Sectors - Biomass	NITROUS OXIDE (N2O)	X	X	X
8	1.A.3.b	Road Transportation	CARBON DIOXIDE (CO2)		X	X

II.8. Emissions trends per sector

II.8.1. Energy sector

The energy sector in Burundi as a whole is characterized by the predominance of consumption of biomass products in the form of wood and charcoal, both in rural and urban areas. These two forms of energy alone account for 96.7% of the national energy balance.
Other forms of energy occupy only 3.3% of which petroleum products 2.5%, electricity 0.5% and the rest (solar, biogas, peat) represents only 0.3%.

Energy Sector is the second emitter after Agriculture, forestry and other land use. The subsector of "Energy-Other sectors" includes the biomass consumption (among others domestic cooking) occupying the biggest share ranging between 87% and 89% from 2005 to 2015. As for cooking, the majority of population still relying on firewood and charcoal, therefore, the increase of emission in this subsector and consequently for the whole energy sector is linked to day to day livelihood of population.

For estimation of emissions attributable to Energy sector, the methodology applied was documented from 2006 IPCC guidelines, Volume 2. As from 2006 IPCC guidelines, the data required by each tier are described below:

Table 5 : Data type per tiers for Energy sector

Tiers	Data type	Comment
Tier 1	• Data on the quantity of fuels burned; • Default emissions factors	These data was used
Tier 2	• Data on the quantity of fuels burned; • Specific emission factor for the country	This factor does not exist in Burundi.
Tier 3	• type of fuel - combustion technology; • operating conditions; • control technology; • The quality of the maintenance; • The age of the equipment used to burn the fuel.	These types of data doesn't exist in Burundi

Therefore, although the energy sector has two categories contributing to national emission totals, the Energy sector used tier 1 among the above three levels. The Tier 1 is the best option responding to national realities according to the 2006IPCC guidelines.

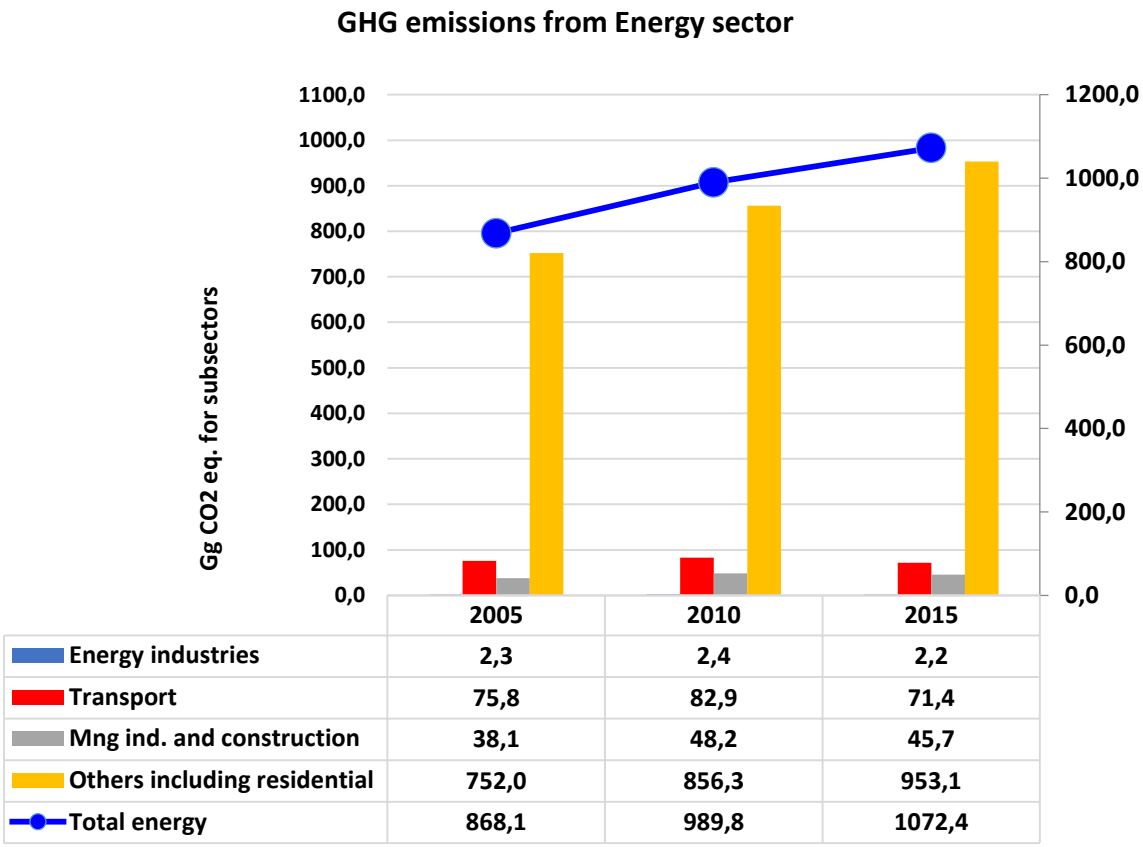
Within the Energy sector, the following subsectors are considered in the estimation of GHG emissions:

- Stationary combustions
- Energy Industries;

- Manufacturing and construction industries;
- Commercial and institutional sector;
- Agriculture, Forestry and Fisheries Sector;
- Residential sector.
- mobile combustions related to transportation

The data was expressed in a unit mass, but these same data should be converted into an energy unit from which the team used the conversion factors found in the 2006 guidelines, Volume 2, Chapter 1, and Table 1.2. Compared to the emission factors mentioned in the 1996 IPCC Guidelines, some emission factors in the 2006 IPCC Guidelines are new while others have been revised.

The emission of energy varies from 868.1 Gg of CO2 eq. to 1072.4Gg of Co2. eq. The Energy-Other sectors sub-sector is the largest contributor. Its emissions range from 752 Gg of CO2 eq. to 953 Gg of CO2 eq. representing 87% to 89% of total energy emissions. With less than 10% and emissions laying between 75.1 Gg and 82.8 Gg of CO2 eq. the second share of energy emissions goes to Transport sub-sector. The emissions from Transport sub-sector are directly linked with the economy economic fluctuation. In fact, from 2005 to 2010, these emissions increased from 75.1 Gg of CO2 eq. to 82.8 Gg of CO2 eq. and then decreased to 71.4 Gg of CO2 eq. Same as Transport subsector, the emissions from manufacturing industry and construction (3rd emitter in the energy sector with share of 4-5%) increased from 38.1 Gg of CO2 eq. to 48.2 Gg of CO2 eq. them fall to 45.7 GG of CO2 eq. The energy industry is the last sub-sector with 2.2 – 2.4 Gg of CO2 eq. and less than 1% share of the whole energy emission. Figures 3 and 4 below shows the trends of emissions for Energy and shares per sub-sector.



	2005	2010	2015
Energy industries	2,3	2,4	2,2
Transport	75,8	82,9	71,4
Mng ind. and construction	38,1	48,2	45,7
Others including residential	752,0	856,3	953,1
Total energy	868,1	989,8	1072,4

Figure 8 : Trend of emissions for the energy sector

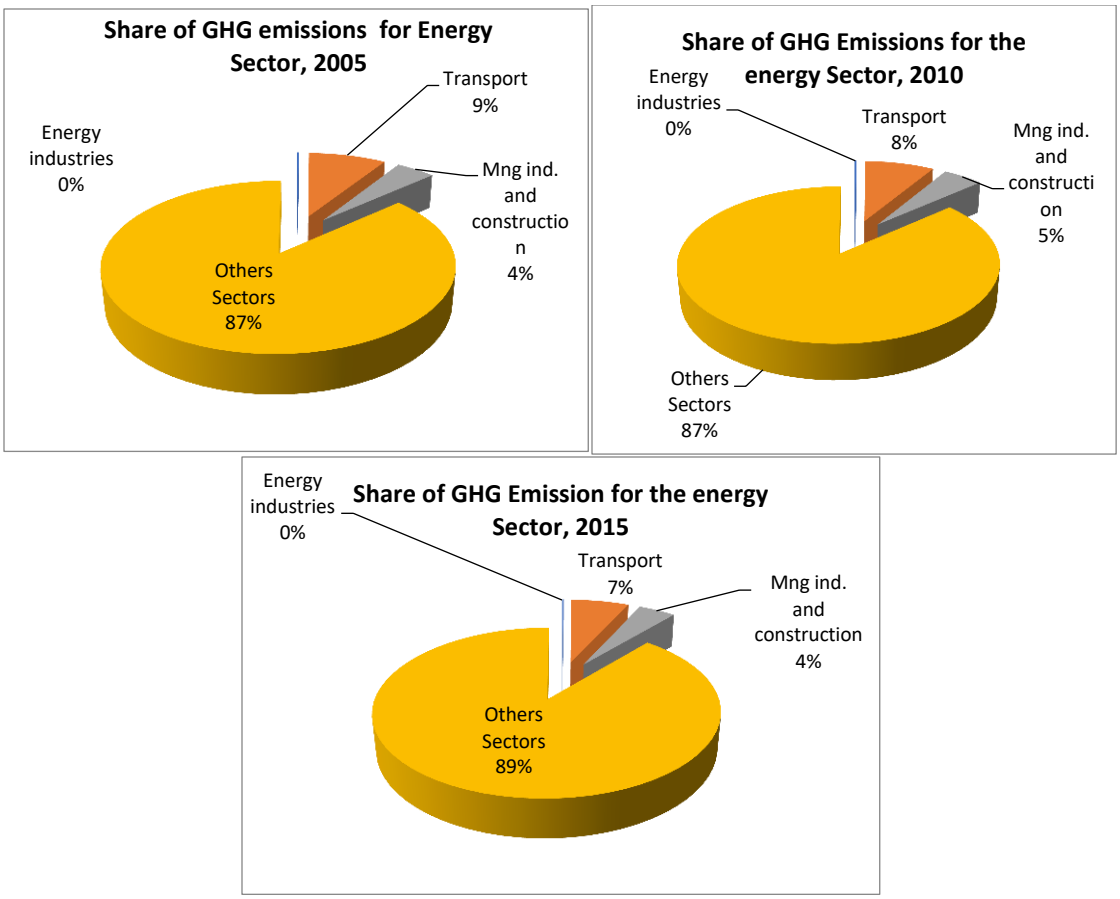


Figure 9 : Share of emissions for the energy sector

II.8.2. IPPU Sector

The Industrial Processes sector of Burundi mainly concerns the agro-processing industries, the metal industry, the mineral industry as well as the category of small and medium-sized enterprises These industries include the sugar company (SOSUMO), the beverage company (BRARUDI), the lime and cement production (BUCECO). Emissions from cement production are not calculated because, as per IPCC guidelines, the clinker and clinker used in these companies are imported.

No key category identified in IPPU sector. The GHG inventory for IPPU sector was conducted by applying Tier 1 of 2006 IPCC methodology and 2006 IPCC software.

This sector is the least important one in terms of the magnitude of emissions in Burundi. Very few IPCC categories in this sector emit GHGs and the highest emissions ever estimated is 6.4 Gg CO_2 eq. in 2015 (Figure 5). So far two sub-sectors contribute in GHG emission including Metal industry (iron and steel production) and mineral industry, with 6.2 Gg of CO2.eq. The Metal industry is the main emitter in the IPPU sector, and its data were recorded only in 2015.

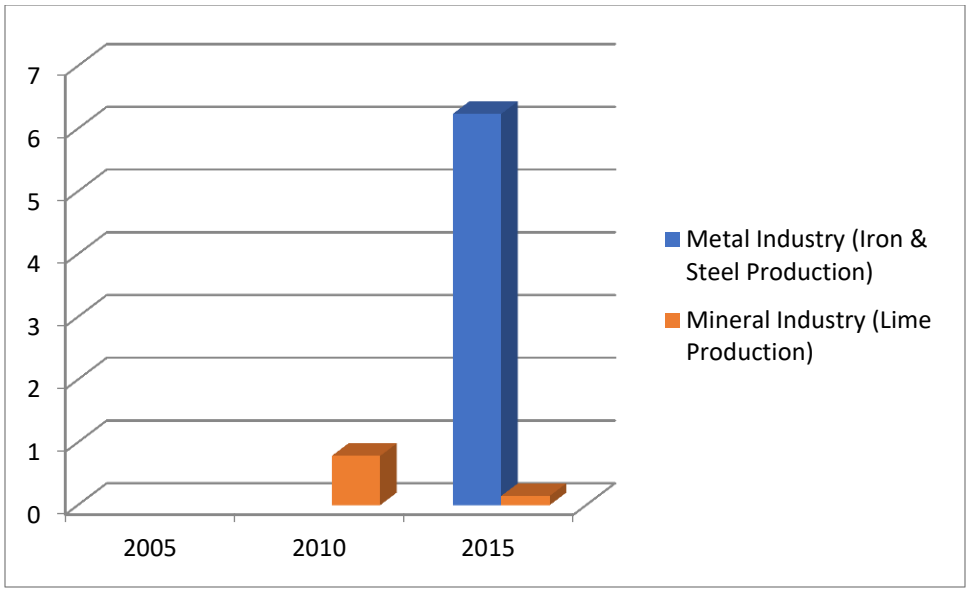


Figure 10 : Trend of emissions from the IPPU sector

II.8.3. The AFOLU Sector

a) Summary description of Agriculture in Burundi

The Burundian economy is essentially based on subsistence agriculture, characterized by a very large agricultural population (more than 90% of the total population), a fragmentation of farms (average below 0.5 ha) and very low productivity. During the last decade corresponding to the crisis exit period with the Arusha Peace and National Reconciliation Agreements of 2000, there has been a relative improvement in the economic situation, but it has remained fragile with a GDP of US $ 286 in 2014-2015 (2015 NAIP Evaluation Report). According to the 2017 HDI report, the level of poverty has not improved from 2006 to 2015 (HDI = 0.404 in 2015 increased to 0.270 in 2016 and the country ranks 184th out of 186 in the world rankings).

In fact, the growth rate of agricultural production (2%) was lower than the population growth rate (2.6%), almost 75% of the population lives below the poverty line (less than $ US / day and per capita) and 85% of households experience food insecurity on a daily basis (source: 2015 NAIP Assessment Report)

Livestock play a very important role in the Burundian farming system. The country has about 1,200,000 farms of which 700,000 are breeding. Of these farms, 20% own cattle, 45% small ruminants, 5% pigs and the rest practice mixed farming (Primary Characterization of Cattle and Goats, FABI 2013).

b) **Summary description of forestry and other land use**

b. 1. Forest lands

In terms of greenhouse gases and removals from lands, there are 5 categories in Burundi: (i) forest lands; (ii) cultivated land (Crop land); (iii) pastures and savannas (grassland); (iv) Settlement lands; (v) Wetlands including: swamps, lakes, rivers

In Burundi, two categories of forest are distinguished, namely natural forests and artificial forests. All natural forests cover nearly 240,716 hectares or 8.6% of the national territory (MEEATU, 2013) while the second category is close to 128,375 hectares or 4.6% (SNPAP, 2013). The agro-forestry, fodder and fruit trees and shrubs cover nearly 60,000 ha.

b.2. Cultivated land/Crop lands

The cultivated lands carry food and commercial crops in both marshes and hills. In terms of area, hill food crops cover about 30% of the country's total area, cash crops 4%. The marshes used for agricultural purposes cover 3%. These soils are relatively fertile. They also have aluminum toxicity; 36% of Burundi's soils are acidic. In order to compensate for low soil fertility and inadequate organic manure, farmers are expanding the area under cultivation on land designated for other uses. They also resort to the use of mineral fertilizers. In order to reduce the acidity of these soils, they use organic and limestone amendments. These practices constitute sources of carbon dioxide emissions, notably nitrogen hemi-oxide.

b. 3. Pastures and savannas

Pastures are land reserved for the grazing of domestic cattle; they are generally herbaceous. But some pastures carry a few feet of trees. Pastures cover 28% of the national territory, or 779,352 hectares (MINAGRIE, 2008). Most of them consist of hyparrhenia and eragrostis lawns or loudetia eminii and Brachiaria eminii.

b. 4. Settlement lands

Housing, housing size and building materials are different depending on whether you are in a rural or urban area and by province to a lesser extent. No national service has data on areas covered by dwellings and in rural areas; the area occupied by dwellings is included in the area of cultivated land while cities cover more or less 25,000 hectares.

b.5. Wetlands

Wetlands include cultivated and uncultivated marshes, lakes and rivers. A small part of the wet marsh is protected while the rest is assigned to agriculture, the exploitation of clay and peat.

The total area of marshes is estimated at 26,021 hectares (MEEATU, 2000). Protected marshes cover 7,113 hectares of which 3,779 are located in the Ruvubu and Rusizi National Parks.

The current peatland area is 14 428 ha, of which 1400 ha (1140 ha in Buyongwe) have been used for peat extraction since 1977 (MEEATU, 2000) and (MEE, 2005). The area already exploited is estimated at 284 ha (MEE, 2010).

C) Methodology

Out of seven Key categories, 5 are from AFOLU sector. Those include: (i) Forest land Remaining Forest land; (ii) Land Converted to Cropland; (iii) Enteric fermentation; (iv) Rice cultivations; (v) Harvested wood products. However, as country-specific values for emission factors and conversion factors are not yet available in Burundi, the IPCC methodology and IPCC version 2006 software has been applied to calculate emissions. Therefore, it should be noted that the Tier 1 methodology, emission factors and default conversion factors according to the IPCC Guidelines for GHGs have been widely used.

For Forestry and other land uses subsector, the method used to calculate greenhouse gas emissions is called the "Gain-Loss Method". It is defined and described in the 2006 IPCC Guidelines. The IPCC Guidelines, 2003 and 2006 and the FAO Guidelines for FRA 2010 (FAO, 2008) have been consulted for the selection of activity data and emission factors.

D) Summary of emission estimates in AFOLU

The sector of Agriculture Forestry and Other Land Use (AFOLU) doubles its importance in Burundi for following reasons:

- It is a sink of carbon: This sector sequesters 4,873.5 Gg of CO_2 in 2005, 2917.2 Gg in 2010 and 1,970.0 Gg in 2015.
- It is the emitter number ones since its emission are almost half of all total emissions in Burundi.

The table 6 below shows the emissions of AFOLU including AFOLU-Emission only, AFOLU removals, Total AFOLU, total emissions without removals and total national emissions for illustrating the weight of AFLU emission and removals in national totals.

Table 6 : Summary of AFOLU emissions compared with national totals

Years	AFOLU - Emissions only	AFOLU - Removals	AFOLU Total	Total emissions without removals	Total National Emissions
2005	966.6	-4873.5	-3906.9	2009.5	-2864.0
2010	1576.9	-2916.6	-1339.7	2733.0	-183.6
2015	1083.0	-1970.0	-887.0	2392.5	423.0

Concerning the carbon sequestration, the concerned categories are forest land and harvested wood products. The total removals (Table 5 above) reduced by 40.15% from 2005 to 2010 and

by 32.8% from 2010 to 2015. This is due to massive deforestation and land conversion observed since last 25 years ago.

The fact of this deforestation and land conversion is highlighted in Burundi detailed report GHG inventory validated in March 2018 and following are key points to be noted:

- The analysis of data from survey and from different reports produced from 1990 to the present shows that the area covered by public forests is reducing while the number of population is growing. Compared with 1990 (Forest Department, 1990), the total area of public afforestation in 2010 in full becomes lower, a decline of 11,547.40 hectares.
- In addition to the wooded area, the results of this survey indicate that the total area of forest and forest converted to other uses between 1985 and 2005 is estimated at 31116 hectares (CNTB[3], 2005).
- Like forests, grassland areas have been reducing since last 25 years. The main causes of the regression of pastures and grasslands are the extension of crops and afforestation. According to the ISABU[4], 1998 (Agricultural Service Publication No. 23), pasture land decreased from 1,250,000 in 1954 to 940,000 hectares in 1998, or about 300,000 hectares lost in 44 years. However, according to the projections made on the basis of the evolution observed between 1970 and 1987, the pasture area in 2005 is estimated at 912,000 hectares with an average annual decrease estimated at 4,059 hectares.

The emission from AFOLU (emissions only) are dominated by those from the IPCC sub-sectors namely cropland, enteric fermentation, aggregated emissions from soil management &rice cultivation and manure management.

From 2005 to 2015, the emissions from these subsectors increased in first 5 years (2005-2010) and then decreased in following 5 years (2010-2015). The variation of emissions per sub-sector is described below:

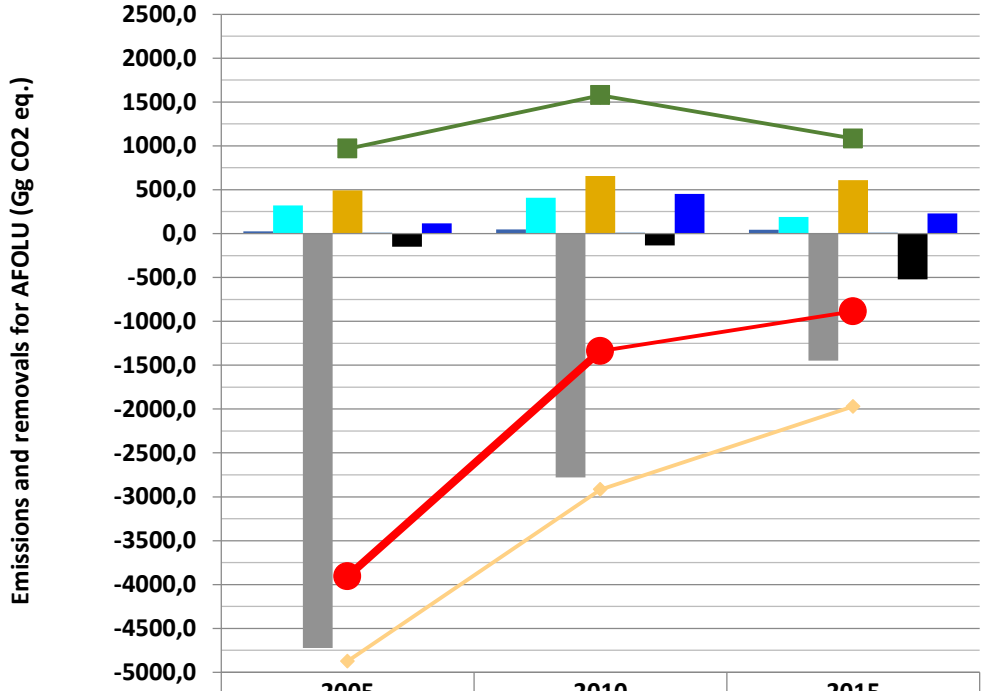
- The emissions from cropland rose by 33.5% from 2005 to 2010 and the fall by 6.8% from 2010 to 2015. This was due to the conversion of pastures and grassland into cropland as explained in paragraphs above. The emission shares for Cropland varies from 51% in 2005, 41% in 2010 and then 56% in 2015
- The emissions from enteric fermentation and rose by 27% from 2005 to 2010 and then fall by 53% from 2010 to 2015. This was due to the change of the number of cattle. In fact, while the number of dairy caws increased from 7,420 in 2005 to 7,568 in 2010 and then 34,367 in 2015, the number of other cattle increased from 461,393 to 295,739 then decreased to 195,836. The emission shares for enteric fermentation varies from 33% in 2005, 26% in 2010 and then 18% in 2015;
- The aggregated emissions from soil including those from rice cultivations increased by 291.2% then decreased by 49.5%. This was due to increased areas for rice cultivation from 25,524 ha to 68,560 ha (from 2005 to 2010) and decreased to 48,589 ha (from 2010 to 2015). The shares of aggregated emissions from soil cultivation varies from 12% in 2005, 29% in 2010 and 21% in 2015;

[3] Commission Nationale des Terres et autres Biens

[4] Institut des Sciences Agronomiques du Burundi

- The manure management and wetland are less important with emission shares of 3-5% and 1% respectively.

The figures 11 and 12 below shows the trend of emissions and shares of AFOLU sub-sectors



	2005	2010	2015
Manure	26,3	48,1	44,0
Enteric	322,5	410,2	189,5
Forest land	-4722,4	-2780,6	-1447,1
Crop land	490,8	655,4	610,4
Wet land	11,6	11,6	11,1
Harvested wood products	-151,0	-136,1	-522,9
Agregated soil incl. rice cultivation	115,4	451,6	228,0
Total AFOLU	-3906,9	-1339,7	-887,0
AFOLU -Removals	-4873,5	-2916,6	-1970,0
AFOLU - Emissions only	966,6	1576,9	1083,0

Figure 11 : Trends of GHG emissions from AFOLU Sector

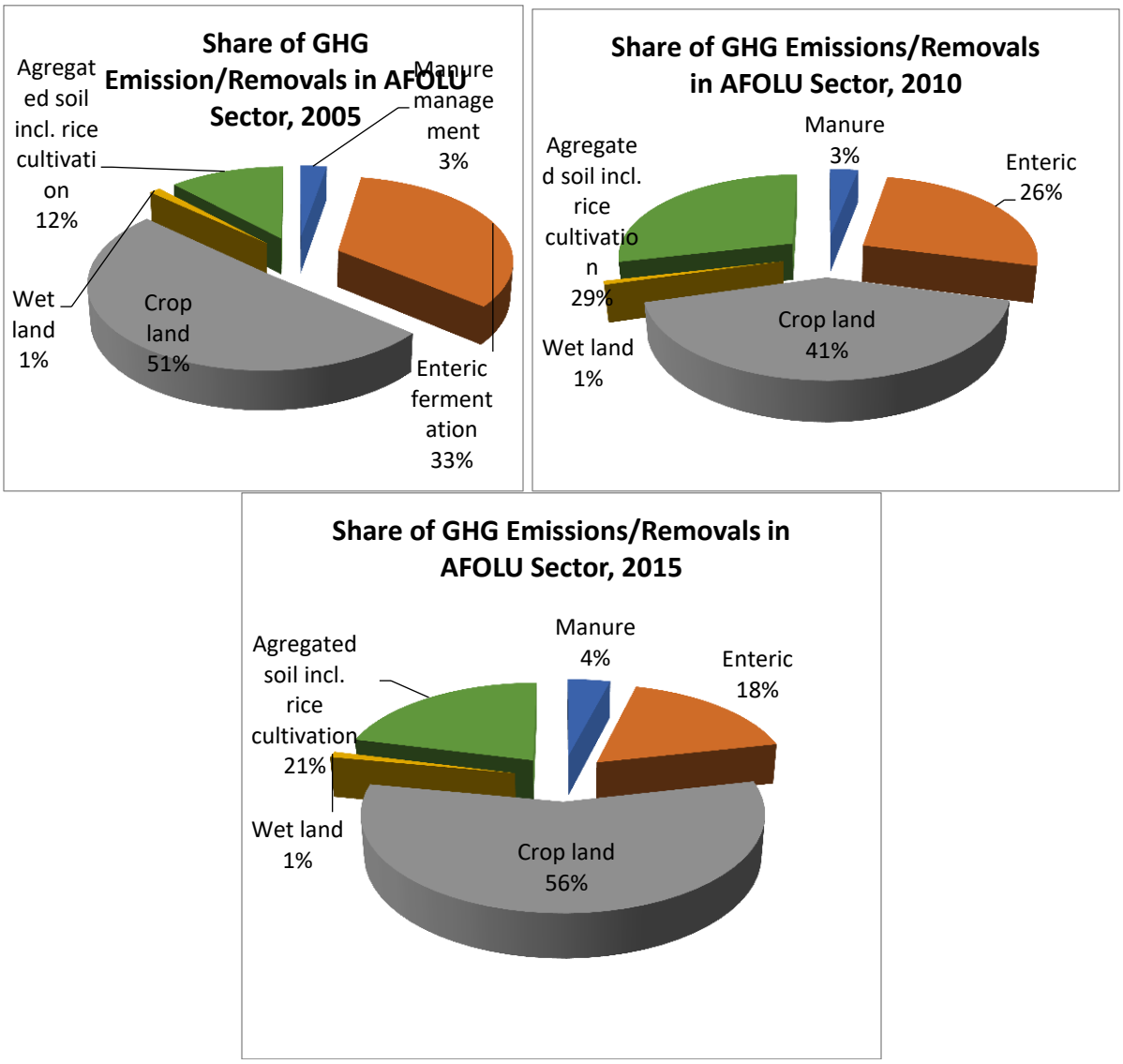


Figure 12 : Emission shares for AFOLU sector

II.8.4. Waste sector

In Burundi, emissions from waste sector are dominated by those from Waste treatment and discharge. Solid waste management appears to be negligible. In the 18 Provinces of the country, only the Province of Gitega and the Bujumbura City Council have appropriate services for the removal of garbage in the cities. In addition to that, it is only from 2010 with the involvement of private companies in the collection of waste that the rate of removal of rubbish in Bujumbura Town Hall has raised.

At the time SETEMUs[5] collected only 8% of DSMs before they ceded this task to private operators and collection of municipal solid waste improved significantly from 8% to 46%.

The emissions from incineration and open burning of solid waste as well as from biological treatment of solid waste were not estimated due lack of data.

The types of waste for which GHG emissions were estimated in Burundi can be described and classified as follow:

a. Municipal solid waste

In Burundi, there is no identification and separation of waste. Waste are discarded in bulk and others are composted for use as organic manure. In Bujumbura City they are evacuated to the Buterere dump and inside the country waste are evacuated to anarchic dumpsite outside the cities.

Although data on the quantity of waste is available for Bujumbura City, the following estimates were made based on the national conditions and IPCC default data:

- An inhabitant of the city of Bujumbura produces on average 0.6 kg / day or 217 kg / year (in May 2011), of which 57% is fermentable waste, compared to 43% of non-fermentable waste.
- Non-fermentable waste consists mainly of glass (15%), plastic bags and bottles (8%), paper and cardboard (6%) and 5% of metal objects.
- Wood and its derivatives represent 3% and textiles 4%.
- Biomedical and other hazardous waste products were also estimated at 2%.

b. Domestic and commercial liquid waste:

In Bujumbura City, domestic and commercial liquid waste are connected to the network of the public sewage treatment plant of Mubone and inside the country, they are dumped in rivers or in lost wells,

c. Industrial liquid waste: the industries of the Bujumbura City Council are connected to the network of the public sewage treatment plant of Mubone while inside the country this waste is dumped in the neighboring rivers. Some industries / manufacturing units pre-treat their effluents before connecting them to the public grid or discharging them into streams.

c. Emissions for Waste sector

No key category identified in waste sector. The GHG inventory for waste sector was conducted by applying Tier 1 of 2006 IPCC methodology and calculation were conducted through combined IPCC excel sheets and expert judgment and 2006 IPCC software.

[5] Service Techniques Municipaux

From 2005 to 2010, emissions from waste sector vary from 174.8 Gg of CO_2 eq. to 230.7 Gg of CO_2 eq. as indicated below by figure 13. The wastewater treatment and discharge covers almost all 100% of emissions from Waste sector.

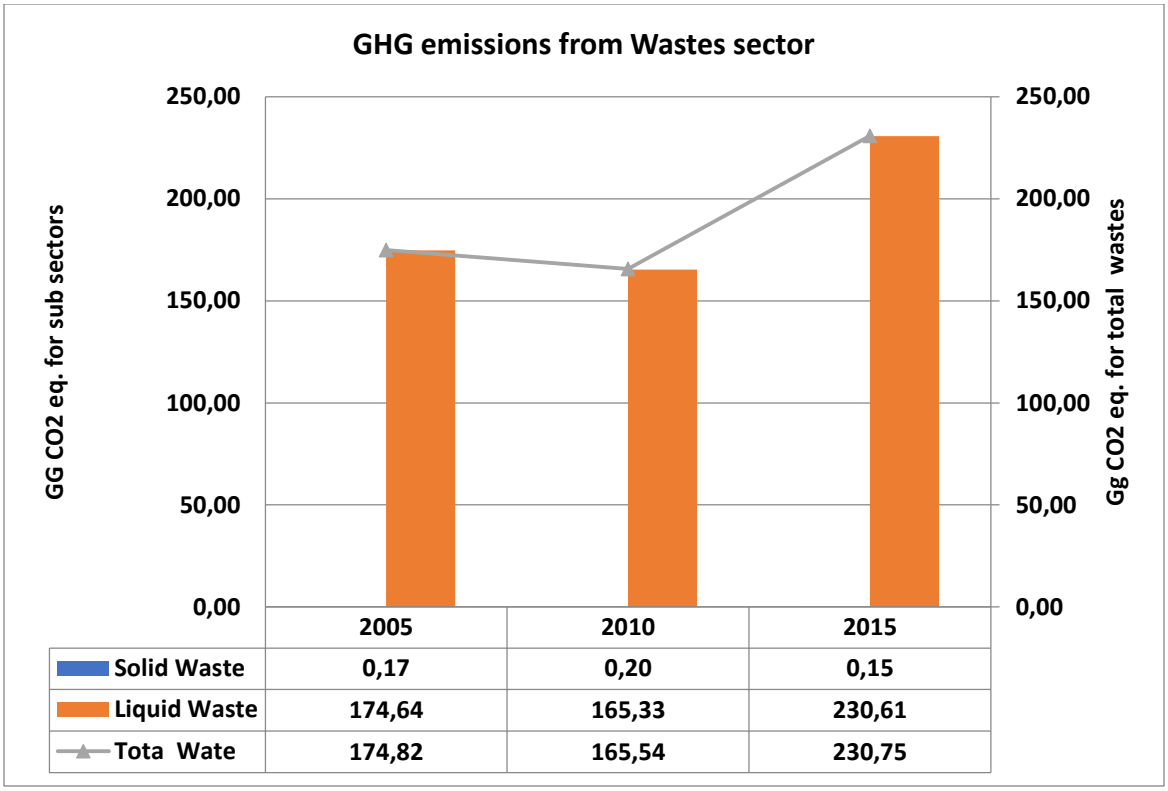


Figure 13 : Trends GHG emissions from Waste Sector

II.9. Quality Assurance and Quality Control procedures (QA/QC)

IPCC Guidelines 2006 recommend that quality control be exercised by comparing emission results using alternative approaches, comparing results and investigating anomalies. They also recommend that control includes review of emission factors, verification of activity data to ascertain source of data, reliability, and distinction in use where applicable, and to ensure avoidance of double counting.

II.9.1. Quality Control

For quality control

- A retreat was organized from 6 to 12 November 2016 to prepare the field data collection. Each team read the 2006 guidelines and determined the work methodology, the activity data source sectors and the survey sheet to collect reliable data.

- A workshop to validate collected data was held on in Bujumbura

- Another retreat was held from April 2 to 6, 2018 for the various sectors in charge of inventory to present their interim report and made constructive comments for each sector to improve its interim report.

- From 16th to 18th August 2018, a workshop was held to validate inventory sectoral reports at the national level or experts from the sectors that prepared the inventory, experts from the data-holding institutions and other experts from the other institutions. Partners met to check whether the data used was suitable.

II.9.2. Quality assurance

The inventory reports and the compiled report of sectoral reports were sent for analysis and comments to the Global Support Program (GSP) under UNEP and UNDP. The GSP identified an Expert who analyzed the reports initially, dealt with national experts online, and then spent a whole week with the experts who drafted the sector reports.

During the one-week workshop, the following improvement were made:

- Developed the final database file (*.mdb file);
- Conducted Uncertainty assessment;
- Conducted Key Category analysis;
- Developed an excel sheets for results/graphs analysis;
- Developed completeness table;
- Developed the future improvement of GHG inventory;
- Developed draft plan for both GHG chapter being used for the current TNC report and future National Inventory report

II.10. General uncertainty assessment

As defined in the volume I of IPCC 2006 Guidelines the uncertainty is the lack of knowledge of the true value of a variable. Uncertainties are associated with accuracy and variability.

Burundi doesn't have any study on uncertainty neither for activity data, nor for emission factor. For this reason, default values of uncertainty were used and provided by 2006 IPCC guidelines.
The results of uncertainty assessment from 2005 to 2015 for Burundi are follow:

- The uncertainty in total inventory is 22.092
- The trend uncertainty is 17.192

II.11. General assessment of the completeness

A complete inventory refers to an inventory which includes estimates for all relevant sources and sinks and gases, and that covers all the applicable geographic area of the country concerned.

As far as possible the national inventory strives to include the most complete picture of emissions and removals from all known sources and sinks within the whole territory. Assessments of completeness for each sector have been provided and the table in Annex 1 below shows General assessment of the completeness.

II.12. Planned improvements

GHG inventory reporting requires detailed activity data collection and estimation of country-specific emission factors. Therefore, National GHG inventory requires continuing need for improving its quality. The improvement plan was developed and validated during the workshop conducted from 11th to 15th March 2019. Bilateral and multilateral financial supports are required to support Burundi for improvement of GHG inventory as detailed below. The implementation time of identified improvement is set to short-term, mid-term and long-term period.

II.12.1. Planned improvement on the methodology and institutional arrangement

Referring to 2006 IPCC Guidelines for National Greenhouse Gas Inventories, the level of inventory reporting depends on the data quality and methodology employed categorized as Tier 1, 2 or 3. Despite the progress made by Burundi GHG Inventory Team for improvement in data and methodology, there is a huge scope for improvement in upcoming Biennial Update Report and Fourth National Communication Report.

Following are activities proposed to be handled in short to medium term:

- Development of successive inventory time series from 2005 to the latest year closer to the publication year of the report;

- Conduct survey for disaggregated data
- Conduct uncertainty assessment;
- Conduct overall check of inventory;
- Development of national emission factors

From the above proposed improvements, the highest priority is the development of successive inventory time series from 2005. The second priority will be given to survey for disaggregated data, the third priority national is uncertainty assessment and lastly the development of national emission factors.

During the development of the Third National Communication report, a ministerial order to institutionalize inventories has been drafted and will be presented to the Cabinet Meeting of Ministers for approval before the end of 2019.

II.12.2. Planned improvement on Capacity building

Despite the knowledge acquired during the preparation of Burundi Third National Communication Report, there are still need for more capacity and empowerment of staff and institutions. The duration of training would be at least two continuous weeks including theoretical training and practical exercise and will cover, amongst others:

- Approach to data collection ;
- Methodology development ;
- Key Category Analysis ;
- Trend Assessment ;
- Quality Control ;
- Uncertainty Assessment ;
- Completeness Assessment
- Use of software, including IPCC, GIS and others
- Report writing

All key topics of capacity building enumerated above are require in short term.

II.12.3. Planned improvement in Energy sector

The Burundi inventory report highlight that activity data although available but not sufficient. It was mostly observed the absence of disaggregated data. Therefore, following data were identified to be collected through survey:

a) Collect data on liquid fuel consumption in road, aviation and water transport as well as fuel consumption in households, institution and off-grid industries;
b) Collect data on biomass consumption in industries, commercial institutions (like restaurants) as well as wood fuel for charcoal production;
c) Collect data on characteristics of vehicles, motorcycles, trucks and airplanes;
d) Develop and assess national emission factors and physical characteristics for liquid fuel, solid fuel and gaseous fuel and related burning technologies used.

Data collection (surveys) are planned in short to mid-term period while the development and assessment of national emission factors and physical characteristics energy are planned in from mid to long term periods.

II.12.4. Planned improvement in IPPU sector

Hydrofluorocarbons, perfluorocarbons and hexafluoride have been underestimated as their potential sources are negligible. In short-term, Burundi is planning to improve GHG inventory by considering those gases.

II.12.5. Planned improvement in AFOLU sector

During assessment of planned improvement of AFOLU sector, it was noticed the insufficient data on forest cover in Burundi. Therefore, following recommendations were summarized:

a. A national forest inventory is needed,
b. The assessment of the standing stock is also necessary.
c. Updating the Soil Map of Burundi,
d. A general agricultural census is required,
e. A primary and secondary characterization of the livestock is required for moving towards tier 2 of the methodology for calculating GHG emissions;
f. Determination of specific emission factors in Burundi by research institutions (ISABU, FABI, etc…),
g. Access to COLLECT-EARTH satellite data (FAO-Google software for activity data collection)

While the first and the last are good to be implemented in short to mid-term, the remaining activities are recommended in mid to long term.

II.12.6. Planned improvement in Waste sector

Although Burundi has good and verified activity data for both solid waste and liquid waste, the uncertainty for emissions results for waste sector were so large and it is recommended the improvement in review and verification of methodology in future GHG inventory of Burundi

This activity is planned in short term period.

II.13. Procedures for data collection and archiving

Inventory data are collected at the level of the National Statistical Institution (ISTEE-BU), at the level of the Central Bank and other international organizations such as FAO and at the level of the data holders directly.

An institutional arrangement for the sustainability of data collection sectors is being formalized by a Decree which is in the process of adoption.

As for the archiving, it is done by USB Softuaire, printed documents and on the OBPE website (www.obpe.bi).

CHAPTER III: GENERAL DESCRIPTION OF MEASURES TAKEN OR ENVISAGED TO APPLY THE CONVENTION

III.1. Programs containing measures to facilitate appropriate adaptation to climate change

III.1.1. General Context of climate change in Burundi and the most vulnerable sectors

The adverse effects of climate change that Burundi faces are mainly due to the concentrations of greenhouse gases emitted into the atmosphere. At present, these climatic changes have already had obvious, radical consequences for the socio-economic life of the populations whose sectors important for their survival are the most affected. These are agriculture, energy, water resources, forest ecosystems and landscapes, health as well as transport and infrastructure. Changing climate patterns such as increased rainfall and heat, as well as catastrophic situations, make Burundi more vulnerable and will affect the country's development efforts. They generate such disastrous consequences that materialize in the fall of agricultural and animal production, the loss of human lives, the repeated floods and droughts, the increase of risks diseases, the destruction of the public as well as the private infrastructures without forgetting the environmental degradation.

III.1.1.1. Vulnerability of the country to climate change

The impacts of climate change induce extreme vulnerability that is multisectoral at the national level, although the sequences differ spatially and temporally from one region to another. Periods of water shortage have led to prolonged droughts at different times and in different parts of the country, from the 1917s to present, thus causing serious consequences for the socio-economic life of the populations. Flooding cases resulting from excess rainfall are also observed from day to day. The impacts resulting from these climatic events have serious consequences for the lives of citizens who are becoming more and more vulnerable. The most obvious cases of vulnerability resulting from these climatic events are the displacement of families following periods of repetitive famine, the persistence of malnutrition following the loss of agricultural production and which finally call for cases of humanitarian interventions.

Some phenomena such as floods and desertification (drought) have pushed and continue to push part of the population to move.
Since 2005 to present unfortunate events continue to shake Burundi. In fact, in late 2005 and early 2006, in the north of the country, drought was declared a national disaster with mass departures of Burundian populations to Rwanda and Tanzania.
During 2006 and 2007, severe floods affected most of the country. The provinces of Kayanza, Ngozi, Ruyigi, Bururi, and Makamba have been particularly affected.

In 2009, torrential rains of two weeks threatened almost the entire territory. The Imbo plain on the shores of Lake Tanganyika, the Mumirwa overlooking the plain, the Buyenzi region and the Central-East of the country in the Mugamba and Kirimiro regions have been affected.

In 2010, torrential rains fell on the city of Bujumbura, and many floods had appeared. The Bujumbura International Airport has been affected by the floods of the Mutimbuzi River.
In 2011, torrential rains fell on the capital of Bujumbura causing heavy floods in three urban municipalities of Ngagara, Cibitoke and Kinama and causing significant damage.
In February 2014, following the floods in the North of Bujumbura Town neighborhoods, and surrounding Gatunguru nearly 1,000 houses collapsed, 20,000 people were left homeless, and 77 deaths were recorded.
In February 2015, following the landslides mixed with the floods in Nyaruhongoka and the Cashi and Gitaza localities in Rumonge province; 20 people died, and more than 300 houses destroyed.
In June 2015, floods were observed in the provinces of Cibitoke, Bubanza, Bujumbura Rural, Rutana and Rumonge. Since September 2015, more than 4 million people have been affected by torrential or heavy rains, water deficits, high winds, floods and landslides. These climatic events have destroyed "30,000 hectares of crops and 5,000 homes. They also damaged more than 300 classrooms and about 50 bridges. More than 42,000 people have been displaced by natural disasters and are still in humanitarian need in the provinces of Kirundo, Makamba, Bubanza, Cibitoke and Ruyigi.
In November of the same year, with the El Nino phenomenon, floods affected at least 30,000 people, including 52 deaths.
In April 2018, torrential rains fell in almost all provinces of the country, causing serious damage to all aspects of the country's socio-economic life. Faced with such a situation, many areas of life are vulnerable, and the impacts sometimes become very important.

In May 2018, landslides in and around Nyaruhongoka along the RN3 to Rumonge Province resulted in the destruction of approximately 422 residential houses, resulting in the displacement of 2,642 households, 7 schools and 7 churches taken away, 57 fields of crops destroyed and about 7 dead and 5 wounded.

Conscious of these variables atrocities induced by the ever increasing climatic changes over the years, adaptation proves to be a strategically essential answer.

III.1.1.2. Efforts to adapt the country to climate change

Climate change is a reality in Burundi. The consequences for the survival of communities are worsening day by day when adaptation measures are unavoidable and should be a national priority.
In the conditions of climate change, everyone (and especially the country people) are trying to adapt. People usually start by changing their technical practices. Farmers change varieties (search for precocity as a factor of adaptation to the decrease of rainfall). Cultural practices are also changing in terms of dates of implementation and techniques used and, in some places, we are witnessing the abandonment of tillage. The use of the means of production (labor, inputs) is reasoned to consider the risks: this is reflected in some cases by intensification, elsewhere by the concentration of means on "safer" spaces (considering the availability waters).

Among the breeders, we notice, on the one hand, the change in herd structure, especially the distribution between species (goats, sheep, cattle), and, on the other hand, the modification of the fodder calendars based on the Herd mobility: change of grazing areas and / or dates of movement.

In other cases, the search for solutions is often outside of agriculture, with the search for other non-agricultural jobs which is at the origin of the internal and external migrations observed today.

At the decision-making and institutional level, adaptation efforts are also mobilized despite their inefficiency and manifest themselves in the implementation of legal texts, strategies and plans that propose adaptation solutions, in order to mitigate the risks brought about by these climate changes. This is how we put in place the following tools:

- The National Action Plan for Adaptation to Climate Change (PANA 2005),
- The National Strategy and the Climate Change Action Plan (2012-2025) with the overall objective of guiding the Government and other partners to adopt and implement measures to combat the adverse effects of climate change.
- National Climate Change Communications, which provided an opportunity to strengthen national capacities in greenhouse gas inventory, mitigation analysis, vulnerability and adaptation to climate change,
- The National Communication Strategy for Climate Change Adaptation (2014-2018) aimed at contributing to the sustainable adaptation of Burundian society to the effects of climate change and the reduction of damage and losses caused by events extremes, through improved and systematic communication.

III.1.2. Regions or areas of high vulnerability to climatic hazards for different sectors.

III.1.2.1. Vulnerable areas in the agriculture sector

In climate change vulnerability studies, the results highlight areas vulnerable to erosion and drought. This helped to identify "hot-spot regions" in terms of Burundi's vulnerability to the consequences of climate change.

a. Vulnerable Areas to Erosion

Three sub-watersheds of 4th or 5th order ("mini-basins") vulnerable to the current variability to future climate change have been identified within the "hot-spot regions" in order to benefit from specific adaptation measures.
These three sub-basins are in the municipality of Mutambu (disappearance of at least 30% of the woody groves and galleries between 2012 and 2014 with an erosion rate of 200 to 400 tonnes / ha / year in the non-planted agricultural fields) and in Isare municipality of

Bujumbura province and Marangara municipality in Ngozi province (with an erosion rate of about 70 tons / ha / year).

b. Vulnerable Areas to drought

Areas of Burundi listed as vulnerable to prolonged drought are particularly the Bugesera region in the north and the Imbo plain in the west:

- ✓ The Bugesera region is already experiencing periods of severe weather disruption over the past two decades, resulting in a decline in agricultural production followed by famine and migration of people to neighboring countries, Rwanda and Tanzania.
- ✓ The lowlands of Imbo are located between 774 m and 1000 m altitude. They are divided into 3 distinct groups, the low Rusizi plain with 20 to 25 km wide and 35 km long and the plain of Rusizi with 50 km long and the plain of Lake Tanganyika, which is a sidewalk 120 km long, sometimes stretching a few hundred meters wide.

In addition to the regions threatened by intense erosion and drought, there are other regions at high risk of flooding whose impacts weigh heavily on agricultural production, fish farming and social life. These are among others the plain of Imbo, marshes and shallows.

n the livestock sector, the regions identified as the most vulnerable are those highly threatened by drought.
The growing vulnerability of the country to the effects of climate change increases the degradation of natural resources and therefore greatly affects the livestock sector because the animals are mostly found in critical conditions due to the lack of sufficient and adequate food and this has a direct impact on the breeding of farm animals, which has a serious impact on the food security of the population.

Impacts due to climate change also do not save aquatic ecosystems. Identification studies of vulnerable areas to climate change target the main areas such as:

- **Stratum I cover the sites of Gitaza, Magara, Nyaruhongoka and Kabezi.**

These areas often experience multiple disasters caused by both torrential rains and high winds. These disasters include landslides and floods that induce all forms of pollution without forgetting the consequent destruction of spawning areas.

- **Stratum II cover the Kagongo and Rumonge areas.**

This area is often the scene of very violent winds that, when they blow, material and human damage are enormous. Losses in human lives at the level of fishermen are often noted. This locality seems to be the most vulnerable zone to known climate hazards in the fishing sector in Lake Tanganyika.

- **Stratum III cover the Muguruka area.**

These are mostly strong winds with torrential rains that are observed in this locality. These also cause enormous damage to the fishing communities especially that they appear at night

during fishing. In general, all mouths of tributaries of Lake Tanganyika are vulnerable to climatic variability.

- **Northern Lakes**

At the lakes of Northern Burundi, the high vulnerability is observed in Lake COHOHA where strong winds and prolonged drought periods have often caused many fishing equipment damage and biodiversity (loss of fish biodiversity). It is also important to mention the case of Lake Gacamirindi, which tends to dry up and tends to disappear on the map.

III.1.2.2. Vulnerable areas in the energy sector

Recent studies on climate change and various reports on climate events in Burundi show that Burundi is vulnerable to climate change in the area of hydropower generation and the availability of wood energy resources and of its derivatives.
The most vulnerable regions to erosion, especially in the provinces of Bujumbura, Bubanza and Cibitoke which are the most vulnerable. Given that the plants with a large national production capacity including RWEGURA (18MW) and MUGERE (8MW) and hydropower plants under construction like MPANDA (10.4MW), KABU 16 (20MW) are in these regions, the Energy sector is highly exposed to siltation and flooding if adaptation measures are not taken.
Recent observations show that hydropower plants have been damaged in some parts of the country where these rainfall events have been very pronounced. Among others, we will mention :

- Sailing of the Ndurumu plant in Buhiga;
- Flooding of the termal power plant in 2017 in Bujumbura;
- Flooding of the Ruvyironza hydropower plant in 2014, 2016 and 2018;
- The reduction of the electricity production of the entire national electricity production system following the drought and the rainfall deficit, in particular the production of the Mugere Hydroelectric Power Station (a 20% decrease in 2017), CHE Ruzizi II (decrease of 32%) and 14% decrease in the Ruzizi I hydroelectric plant;
- Reduced load operation or shut down for some hydroelectric plants (Marangara case until 2016).

III.1.2.3. Vulnerable areas in the water resources sector

Depending on the degree of sensitivity to climate change, Burundi can be divided into 6 vulnerable eco-climatic zones including:
- **The Imbo plain to the west**: is a hot region, characterized by high temperatures, high evaporation, low rainfall and low water retention capacity. The current situation of water resources in this region is experiencing a gradual decrease of water resources in rivers as reported in the first National Communication.

The vulnerability of this area of the water resources point of life includes a lack of drinking water for the population of the region and a proliferation of waterborne diseases such as cholera and bacillary dysentery.
The Mirwa Escarpment: this is a steep intermediate region between the Imbo Plain (774-1000 m) and the Congo-Nile Ridge (2000-2670 m). Its vulnerability is since its terrain is very rugged. The hydrography is quite dense with many torrential streams running through the region. Access to drinking water is limited by habitat dispersed on a steep slope and water resources in this region follow the same rate of decline as described in the 1st and 2nd National Communications.

- Congo Nil Ridge: This ridge is the asymmetric and irregular peak of Burundi: in the west it dominates Lake Tanganyika by more than 1000 m, in the east it is attached to the central highland without a clear escarpment. The altitude of the ridge varies from 2000 m to 2670 m (Mount Heha). Its climate has an average rainfall of between 1400 and 1600 mm with average annual temperatures ranging from 18˚C to 15.8˚C. Declining water resources in this region, as in the whole country as described in the initial national communication, affect agricultural production, although not to the same extent as in other parts of the country.

- Central Highlands: This region is characterized by a multitude of hills separated by valleys with flat, marshy and increasingly drained bottoms. Rainfall is rather satisfactory in quantitative terms, but its temporal distribution causes a problem. The dry season tends to become longer than before, sometimes totaling 5-6 months without rain. Any climate disturbance affects negatively water resources, and thus has adverse effects on the lives of a highly dense and illiterate population.

- Kumoso Depression: This region is characterized by sparse vegetation reminiscent of the semi-arid regions of neighboring Tanzania. The hydrography is very sparse, the sources of drinking water are rare and far apart from each other. The average rainfall is about 1200 mm / year, while the average temperature exceeds 21 ° C, resulting in an increased loss of water by evaporation. The vulnerability of this region is based on:

- The drying up of shallow water sources;
- Decrease of agricultural production with risk of famine;
- Lack of drinking water within a reasonable distance;
- - Hygiene problem for an illiterate population, resulting in waterborne diseases (bacillary dysentery, cholera);
- - Generalized monetary poverty and increased dependency on humanitarian assistance.

- The Bugesera Depression in the Northeast: This region covers a large part of Kirundo province and a small part of Muyinga province. It is characterized by a low rainfall (1059.7mm / year according to the 1981-2010 normal) and an average air temperature (21 ° C) resulting in a loss of available water by evaporation. For nearly two decades, the region has been experiencing a major disruption of the climate regime, which is reflected in the late start of the rains, with the result, the decline in agricultural production has resulted in famine, loss of life and livestock, displacement of populations. The adverse effects of this situation on the region have resulted in:

- The lack of water for all uses;
- Loss of agricultural production followed by famine and subsequent loss of life;
- Malnutrition in both adults and children;
- The flight of populations to neighboring regions or countries in search of better living conditions;
- The use of humanitarian assistance to rescue survivors;
- The mobilization of national solidarity to help the affected populations of Kirundo and Muyinga;
- Environmental degradation due to deforestation, bush fires, erosion, lowland floods, crop loss and other related phenomena;
- The decrease in biodiversity due to the lowering of the water level of the lakes.

III.1.2.4. Vulnerable areas in the forest ecosystem sector and landscapes

❖ In the plain of Rusizi, following overgrazing and repeated bush fires, the groves of Cadaba farinosa and Commiphora madagascariensis, which gradually replace the forest at Hyphaene, give way to cleared lawns.

❖ In the open forest regions, the dominant species of the genera Brachystegia, Julbernardia, Isoberlinia being very sensitive to fire, logging and fire finally favor savannah plants without a forest destination or simply leave rocky deserts.

These fires induce a regressive evolution leading to grassy savannahs at Hyparrhenia and Loudetia, which in turn give way to bare stretches of slugs or lateritic cuirasses very rich in termite mounds.

❖ Afforestation is also under increasing pressure from the population in search of fuelwood, timber and new farmland. Knowing that the rate of consumption is 1.26 m3 per person per year, the lack of alternative energy to wood energy will continue to increase deforestation in the country.

❖ As a result of heavy rainfall, forest tracks and culverts will suffer destruction due to landslides. For landscapes, flooding in the lowlands will be more frequent and widespread. In the mountainous Mirwa watersheds, soil erosion and landslides will be magnified. Following heavy rainfall, the level of Lake Tanganyika will rise.

❖ In the event of prolonged drought, some species of fauna and flora ecosystems will disappear due to drying of the plant cover with the possibility of new species including plant pests. For landscapes, the level of Cohoha, Rweru, Rwihinda and Kanzigiri lakes in the Bugesera Depression will drop further with the increase in drought. The lowering of

these lakes will lead to loss of biodiversity in the pelagic zone as well as a significant decrease in fish production.

III.1.2.5. Vulnerable areas in the health sector

Many important diseases are very sensitive to changing temperatures and rainfall patterns.

a. Vulnerability to Malaria

The stratification of malaria has identified 8 provinces at risk of epidemic, it is the provinces of Gitega, Karusi, Kayanza, Muramvya, Muyinga, Mwaro, Ngozi and Kirundo where 56% of the population live. It should be noted that malaria is prevalent in other provinces under endemic-epidemic mode with seasonal peaks (April-May-June and October, November and December).

b. Vulnerability to malnutrition

Malnutrition remains a real public health problem and is sensitive to the effects of climate change. The study of the evolution of the acute malnutrition in Burundi of 2010-2018 lets us note that the malnutrition remains high in 2018 in the provinces of Ruyigi, Ngozi, Karusi and Mwaro but also that the prevalence rate is as high among boys than girls.

III.1.2.6. Vulnerable areas in transport and buildings

a. Transport field

Transport infrastructure is more sensitive to extreme weather than a change in climate averages. Several road networks damages have been recorded and in various parts of the country where degradations have occurred following torrential rains which have caused:

- The infiltration of water at the slopes level, which later weaken and undergo repetitive slips;
- The flood of sanitation facilities such as the bridge, scuppers and gutters;
- Weakness in the foundations of the roadway;
- The degradation of the wearing course.

Thus, we count precisely :

- The RN 1 national road has already experienced many critical points since 2012 following torrential rains;
- The National Road N ° 3 (RN3: Bujumbura-Rumonge-Nyanza-lac) incessantly undergoing various damages all along its trajectory following the climatic events marked mainly by torrential rains;
- The threats of destruction of the National Road N ° 9 (RN9: Bubanza-Ndora) with cracks on the road at PK 4 + 860;
- The Bujumbura-Cibitoke road in Bukinanyana town in Nyandago primary school (PK27 + 800), landslides of the embankment overhanging the road continue to make the road impassable;

- The National Road N ° 10 (RN10: Bubanza-Kayanza) is not also saving the damage that affects the other road networks and phenomena of slippage as well as cracks can be observed at various places;
- The same phenomena are observed on roads that cross the rivers of the city of Bujumbura.

Vulnerability is not limited to the level of the road network. Runways are also under threat of degradation. Like roads, tarmacs and runways can suffer from asphalt degradation and deformation of runway foundations due to changes in soil moisture.
In addition, the floods that plague the Imbo plains also do not spare the international airport of Bujumbura where its airport area continues to undergo floods.

The port of Bujumbura is often subject to siltation threats mainly caused by the Ntahangwa River flowing near the port in the north and during the rainy season. His bed widens continually and dangerously following the increase of his flow. The ravines extend and, as a result, destroy its banks and surrounding infrastructure and carry solid waste and sand all along the oil wharf between 4 m and 1 m. The whole of the deep zone of the harbor basin suffers from unprecedented silting.

b. Building area

Both public and private infrastructure are affected by the effects of climate change. The most illustrative case is that of the Bujumbura city, where many damages have been inventoried and most of them are located along the rivers crossing the city.
In addition to the private buildings, schools have also been degraded: VUGIZO High School, Mutanga Basic School (ECOFO) and the Nyakabiga District, the Public Garden Primary School (EPJP), a case that occurred in 2012 after heavy rain.

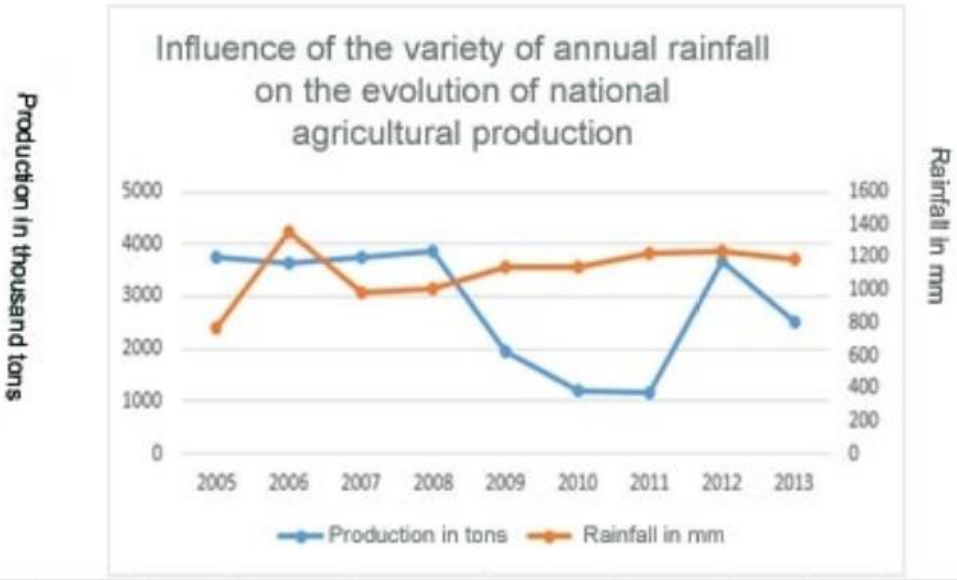
III.1.3. Vulnerability Analysis of key sectors identified since 2005 to present and the impacts of climate change on these sectors.

In Burundi, natural disasters at different times show how vulnerable the various sectors are, which has a strong impact on national economic growth.

III.1.3.1. Vulnerability Analysis in the Agriculture, Livestock and Fisheries Sector

a. Agriculture

The implications of catastrophic events due to climate change are not long in coming and often result in the drastic reduction of agricultural production. In this case, the analysis of the variability of the climatic parameters shows strong variabilities of the production over the years, materializing by a sudden rise or fall of the agricultural production from 2005 to 2016, following the increase temperature and reduced rainfall. This situation is easily observed since 2011, as shown in Figure 14 below:



	2005	2006	2007	2008	2009	2010	2011	2012	2013
Production in tons	3743	3636	3756	3846	1940	1204	1180	3677	2520
Rainfall in mm	764,5	1357,1	982,7	1011,5	1142	1142	1225,8	1235,5	1186,8

Figure 14 : Effects of variability of climatic parameters on the evolution of production

In addition to the variability of production, other impacts can be observed and are among others:

- Reductions in food crop production yields;
- Disturbance of cropping seasons ;
- Disappearance of certain crop species by extension of the dry season;
- Proliferation of plant diseases ;
- Reduction of industrial crops production including coffee and oil palm.

Nevertheless, there are sometimes increases in production yields of maize, sorghum and rice

b. Animal Husbandry

Analysis of livestock numbers found that livestock numbers in drought-affected areas are lower than in the areas least affected by drought, especially for especially for the most demanding animals in terms of feed supply, such as cattle.

Table 7 : Distribution of livestock by provinces

Province	CATTLE	GOATS	SHEEP	PIGS	RABBITS	POULTRY	HIVE
Bubanza	73472	121659	4089	38480		8273287	4219
Bujumbura	45575	116896	23851	30742	21934	139178	13549
Bururi	115270	163655	62030	25961	15116	273197	26113
CANKUZO	***59752***	***157986***	***12045***	***3095***		***171592***	***21746***
Cibitoke	19650	123012	10532	20371		119664	29527
GITEGA	58598	203653	32059	42325	39679	264747	128670
Karusi	29646	152396	28755	8939	28297	87085	21494
KAYANZA	37986	158726	31783	40572	84638	47169	27741
KIRUNDO	***27926***	***176224***	***7880***	***16556***	***31566***	***198384***	***17890***
MAKAMBA	***21551***	***105381***	***18735***	***3973***		***355939***	***6497***
MURAMVYA	36218	65873	8573	14506	22105	53564	9145
MUYINGA	***25906***	***265653***	***14703***	***49259***	***54671***	***301177***	***14959***
MWARO	51717	63238	21869	15155	14855	70660	6517
NGOZI	47887	139194	31179	25521	48413	111435	23306
RUTANA	***21221***	***181472***	***7545***	***12995***		***162705***	***12608***
RUYIGI	***23349***	***19563***	***14185***	***14794***	***10809***	***203893***	***25857***

The work of the analysis of the distribution of animals per km2 (density of animals: Table 3) in the different provinces of the country also reveals differences that reflect a reality according to the capacities producing forage biomasses, depending on the climatic state. of the region and reveals the following:

- Provinces that are vulnerable to drought (in italic and bold) have a small density of cattle (Cattle) at Km2 and a high density in small livestock (Goat, Porcine) and farmyard animals (Poultry);
- Relatively Vulnerable Provinces (lowercase) have high livestock and small livestock densities because some provinces are traditionally known as breeding areas. In addition, we find the lowlands which serve as their source of livestock feed;
- The weakly vulnerable provinces (GITEGA, KAYANZA, MURAMVYA, MWARO and NGOZI) have a relatively small livestock density, the variation in livestock density does not follow that of the relative vulnerability drought because other parameters come into play such as the demographic rate (Table 6).

Table 8 : Livestock distribution in space depending on density at Km2

PROVINCE	AREA (Km2)	CATTLE	GOATS	SHEEP	PIGS	RABBITS	POULTRY	HIVE
BUBANZA	1089	58	88	3	40	3	83	30
BUJUMBURA	1233	49	69	12	66	7	75	38
BURURI	1376	75	77	37	17	9	50	34
CANKUZO	1965	33	86	6	3	3	52	9
CIBITOKE	1636	19	80	4	14	-1	98	15
GITEGA	1979	39	80	15	30	23	92	14
KARUSI	1457	21	94	11	10	19	74	9
KAYANZA	1233	25	116	18	34	34	67	13
KIRUNDO	1703	12	144	2	13	29	107	12
MAKAMBA	1960	15	57	14	6	3	91	2
MURAMVYA	696	59	62	6	30	20	75	7
MUYINGA	1836	16	112	14	16	19	95	6
MWARO	1376	40	35	16	20	8	52	2
NGOZI	1474	28	68	3	19	57	33	14
RUTANA	1959	13	62	7	3	2	70	4
RUYIGI	2339	15	114	11	10	3	69	5
National average	**25311**	**30**	**86**	**9**	**19**	**23**	**77**	**11**

The analysis of the distribution of animals per km2 (density of animals) in the different provinces of the country also reveals differences which reflect a reality according to the capacities producing forage biomasses, depending on the climatic state according to the region as shown in the below table.

In addition to the parameter related to animal numbers, various other manifestations of the impact of climate change are:

- ✓ Decrease of milk production up to 60% because everything is dry.
- ✓ Weight loss up to 30%
- ✓ Decreased reproduction
- ✓ Appearance of diseases such as foot-and-mouth disease, colibacillosis and theleriosis for livestock.

c. Fisheries Field

For Lake Tanganyika, the ecological conditions of the pelagic zone that determine the life of aquatic organisms include nutrients and oxygen dissolved in water.

The availability and distribution of these two elements depends on the temperature and the mixing of the water in the area of a depth of 100 meters.
The analysis of the lake temperature data between 1964 and 1994 indicate a rise of 0.7 ° C in the average temperature of the lake in Bujumbura. Surface waters with an average temperature around 26 ° C show a temperature increase of 0.34 ° C in 37 years.

It also brings a temperature rise at depth that changes the nutrient distribution and reduces the thickness of the oxygen layer that was 60 meters in 1994.
For the littoral zone, the lake recorded increases in levels between 1961 and 1964 due to significant rainfall above normal, bringing the lake level from 775.09 to 777.06 meters above sea level, or 2 meters above the average level.
Comparative analysis of historical data on climate records in Lake Tanganyika environments and fish catches suggests a positive correlation between them, especially considering the average wind speed. The year 2016 recorded the highest wind speed at Bujumbura airport of 1.4m / sec and Makamba in the order of 1.6 meters / second. The same year recorded the largest amount of fish catches in the order of 21,806 tonnes over the period 2005-2017.

For the thermal surveys, the fluctuations seem to go in the opposite direction of the quantity of fish catches. This is stigmatized over the period considered by the year 2005 which is the hottest with average maximum temperatures of 30.8oC and 30.2oC respectively for Bujumbura and Nyanza-lake, and the least productive with 9605 tonnes of fish.
It should be noted that Mr. Andrew Cohen had previously reported that lake warming had begun to affect fish life in Lake Tanganyika, resulting in a reduction of the ideal habitat for fish and molluscs by 38% since 1946 mentioned in the paper "Proceeding of the National Academy of Sciences, 2016. According to the analysis of the document on the state of biodiversity of fish in the Rusizi Delta and its immediate lake environment, it was noted that 32 species of lake fish inventories in 1998 are not reviewed in 2007.

Ultimately, in the face of climate change, there will be a drop in the level of groundwater, the destruction of habitats for biodiversity, the acceleration of erosion and the increase in turbidity of water, and the loss of income from fishing. Other inventoried impacts are:

- Loss of aquaculture fish by flood
- Destruction of processing infrastructure, villages and fishing equipment,
- Abnormal decrease in water level or total drying of watercourses and bodies of water
- Weakness and absence of seasonal floods
- Pollution of Wetlands
- Acceleration of the filling of water bodies
- Loss of habitat useful for global fisheries production
- Fishermen's drowning

III.1.3.2. Vulnerability analysis in the energy sector

The effects of drought and heavy rainfall in some parts of the country have reduced the output of hydroelectric power plants. In fact, when there is no rainfall, the water level in the dams decreases and this leads to irregularities in the production of hydroelectric energy. However, there is also a decrease in the reservoir level of the Rwegura hydroelectric power station during periods of high rainfall. The latter following overexploitation of the plant when the other plants are shut down due to siltation.

Based on the evolution of these climatic parameters, the evolution of the electricity production of certain hydroelectric power stations, the analysis consisted in seeing the correlation between this production and the variability of these climatic parameters. This analysis was also made on the variability of the reservoir lake level of the Rwegura plant over the whole year for the period from 2010 to 2015 as well as the variability of the annual average level for the same period. The results of this analysis are presented in the following table:

Table 9 : Vulnerability Analysis of the energy sector in Burundi

ANALYSIS SECTOR	Key Issues / Potential Impacts	vulnerabilities	Qualifications
Energy	Disturbance in the supply of hydroelectric power	Vulnerability due to :	
		1. lower water level in the reservoirs caused by lower rainfall and prolonged droughts or other human activities in watersheds:	Strong assignment
		2. siltation of dams due to higher erosion due to higher rainfall	Strong assignment
		3. damage to production and electric transport infrastructure due to heavy rainfall causing flooding	Average assignment
		4. a strong demand for consumption due to the rise in temperature	Low assignment
	Decrease in wood energy quantity	Vulnerability due to high demand of wood energy combined with human activity causing high deforestation.	Average assignment
	Disturbance in the drinking water supply	Vulnerability due to disruption in the supply of electricity for the operation of the pumps	Low assignment

The impacts of climate change observed in the past and even currently in the field of hydropower are as follows:

- the reduction of the electricity production of the entire national electricity production system following the drought and the rainfall deficit which caused repetitive power cuts in the past;

- reduced load operation or shut down for some hydroelectric plants (Marangara case);

- siltation of hydroelectric plant and micro-hydropower dams in service due to strong erosion in dams' watersheds (case of Ndurumu hydroelectric plant at Buhiga);

- the heavy flooding of the RUVYIRONZA hydroelectric plant in Gitega and the Bujumbura Thermal Power Plant in 2017 and 2018 due to heavy rains;

- the destruction or deterioration of hydroelectric power generation and transmission equipment (in the case of BUBANZA, BURURI, MAKAMBA, RUMONGE, BUJUMBURA and KANYOSHA poles, lines and transformers, etc.);

- the additional demand for energy for conditioning buildings in warmer cities like Bujumbura. In the absence of statistics on the electrical consumption of building conditioning equipment, the vulnerability related to this equipment has not been quantified in terms of the increase in electricity consumption due to climate change. However, studies have already shown that for each additional degree of temperature, heating or air conditioning equipment consumes more energy.

III.1.3.3. Vulnerability analysis in the water resource sector

The groundwater of the capturing field is of very good quality, but this quality can be modified by the climatic change which affects the recharging of the water table. Thus, the analysis of the water level in the capturing field of Gitega equipped with 4 piezometers, is monitored since 2013 until today. The results of this monitoring allowed the manager of this field to change the operating mentality by alternating pumping.

The water level analysis in the Rumonge capturing field with 5 piezometers shows the following results:

- Because of the different clay levels encountered from the surface in Rumonge, the water table 2 is very well protected from the risks of potential pollution, which is not the case of the water table close to the surface, which was never captured in the drilling done;

- Piezometers 1 and 5 (Ru-Pz01 and Ru-Pz05) have thus confirmed that the iron content is lower as soon as the outcrops to the east of the city are approached and that a small treatment should be enough to render this water clean for consumption;

- Regarding the flow direction of the alluvial aquifer, DGPS leveling of the 5 piezometer markings made has confirmed that the equipotentials are generally parallel to the shoreline of the lake with a direction of flow, from the outcrops (hills / mountains) to the lake.

The capture field of Gihofi and Kinyinya in the Mosso region also has 5 piezometers. For the potential, the results were positive at Gihofi, with flow rates> 50m3 / h. The fractured limestones are very potential with the very interesting hydrodynamic parameters of T = 2.1E-2 m2 / s. The dolomitic limestones that make up the Kinyinya aquifer are less transmissive than those of Gihofi. The flow rates found are around 10m3 / h.

Groundwater is of good quality in the Mosso region, except for some iron pockets in a few places (Table 8).

Table 10 : Analysis of some field parameters

ID	Ec µS/cm	Temp. °C	pH	Fe (II) mg/l	O_2 dissolved mg/l	Fluorine mg/l	Redox
Gf-F1bis	502	24.4	7.0	0.8	8	0.24	259
Gf-F2	440	24.6	7.3	0.2	7	0.12	247
Gf-F3	545	23.5	7.1	0.0	6	0.06	240
Kn-F1	171	24.3	6.5	1.0	2	0.13	
Kn-F2	182	23.8	6.6	0.4	3	0.00	132

The unequal spatio-temporal distribution of rainfall across the country means that, in some regions, excess rainfall causes serious problems for crops, causing a drop in agricultural yield. In addition, the increase in temperature and rainfall leads to a deterioration of the quality of water, with the consequent proliferation of vector-borne diseases and water-borne diseases; Malaria is one of the most famous cases in Burundi. The strong erosion of the rain is the cause of the siltation of the reservoirs, and consequently of the low production of the hydroelectric power and the losses in lines due to the strong increase of the temperature.

According to the Water Resources Department of the Ministry having environment in its attributions, the quality degradation or breakage of water services caused by the effects of climate, can have impacts:

- **Social, health and environmental**: • Difficulty of the chores of drawing; increase in diarrheal diseases; the multiplication of conflicts of use during water scarcity and amplification of migratory phenomena or departure of populations no longer having access to water; degradation of the quality of the resource by less dilution of pollutants; Odor nuisance due to increased emission of nitrogen dioxide (N2O).

- **the state of infrastructure and equipment:** Fragilization of facilities, decline in efficiency and destruction of facilities;

- **Quality of service:** • Degradation of the quality of the distributed water induced by insufficient treatment of raw water highly concentrated in pathogens, physico-chemical pollutants, salt, etc., or with a high degree of turbidity; interruption of the service caused by the unavailability of the resource; Contamination of the resource by uncontrolled stormwater runoff and submersion of pits containing pollutants; interruption of service due to damage of facilities; inaccessibility to water points; weakening of saturation storage facilities as well as temporary disruption or reduction of service due to lack of available resources;

- **specific consumption:** increased water requirements and volumes collected for all uses

- **the operation of the service and the infrastructures:** • Dysfunction of biological treatment processes (mortality of certain bacteria); degradation of infrastructure and equipment due to heat degradation of concrete due to increased production of hydrogen sulfide (H2S).

III.1.3.4. Vulnerability Analysis in the Forest Ecosystems and Landscapes Sector

In terms of the potential impacts of climate change covered by the analysis, it should be noted that in case of more abundant and aggressive rainfall with excess rainfall often mixed with violent tropical storms, it is observed:

- ✓ the destruction of the ecosystem followed by windthrow and landslides. In addition, there are losses of biodiversity (fauna and flora) including agricultural biodiversity due to the development of fungal diseases.

- ✓ As a result of heavy rainfall, forest tracks and culverts are being destroyed by landslides.

- ✓ Similarly, forest nurseries and agro-forestry as well as seed stands are destroyed.

- ✓ For landscapes, floods in the lowlands are more frequent and widespread. In the mountainous watersheds Mirwa, soil erosion and landslides are amplified. Following heavy rainfall, the level of Lake Tanganyika rises.

In case of prolonged drought:

- ✓ some species of fauna and flora ecosystems are disappearing due to drying of the plant cover with possibility of new species including plant pests.

- ✓ For landscapes, the level of Cohoha, Rweru, Rwihinda and Kanzigiri lakes in the Bugesera depression drops further with the increase in drought.

- ✓ The drop in the level of these lakes causes loss of biodiversity in the pelagic zone as well as the significant decrease in fish production.

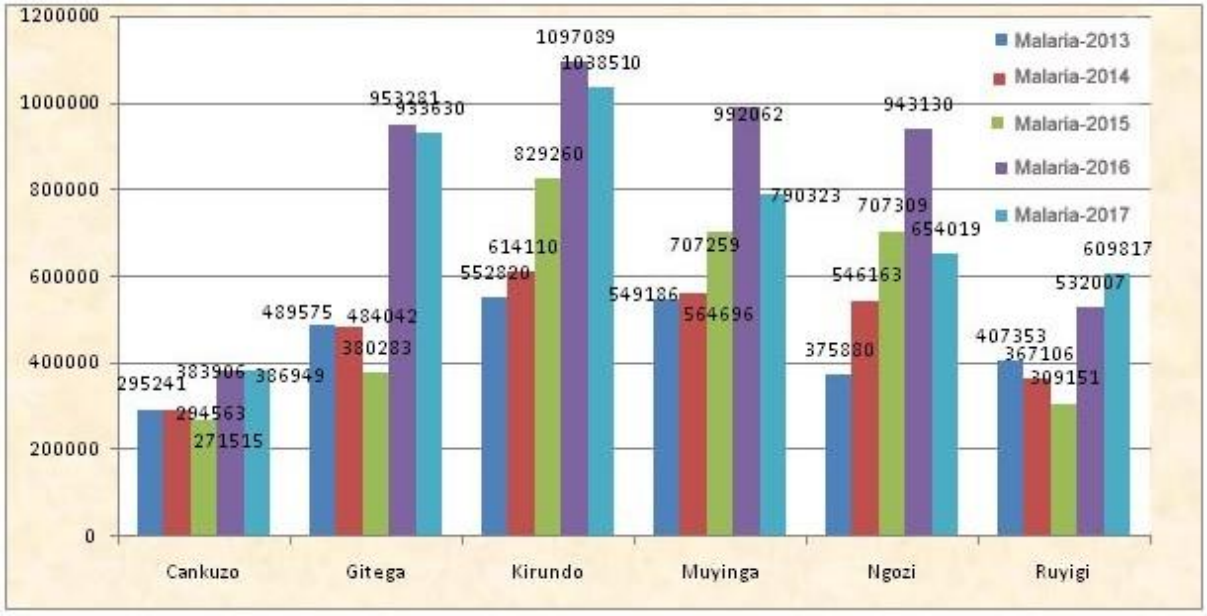
III.1.3.5. Vulnerability analysis in the health sector

Based on the epidemiological profile of the country, the relationship between climate change and the consequences for the health sector has been analyzed. Malaria and malnutrition caught our attention.

a. vulnerability Analysis to malaria

In 2017, malaria remains the leading cause of morbidity with an incidence rate of 815.2 ‰ (DSNIS) and an estimated prevalence of 27% (EDSB III, 2016-2017). It represents 45.4% of all outpatient clinic visits in 2017 and 50.5% in the under five age group (Figure 15).

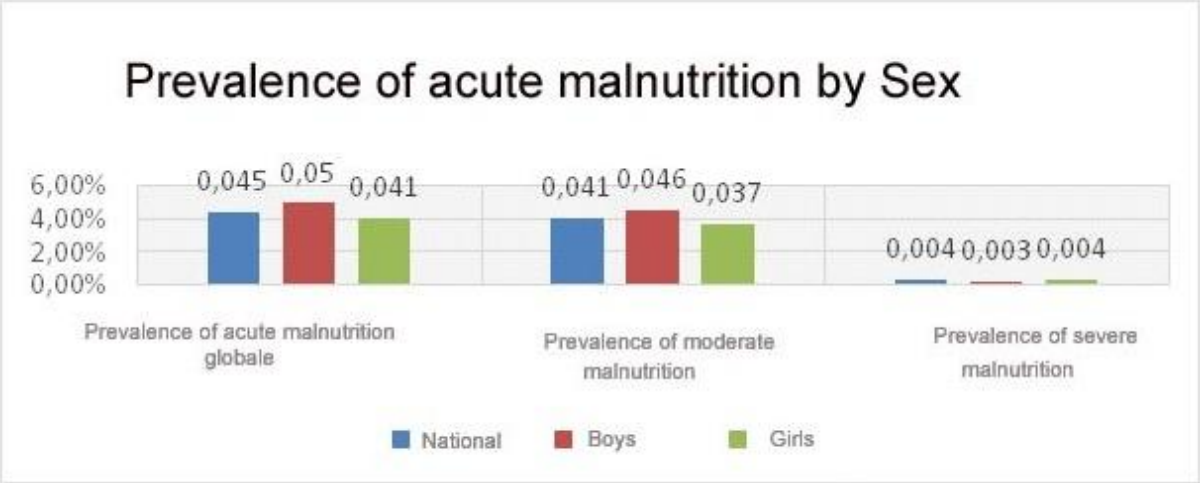
Figure 15 : The evolution of malaria in selected regions from 2013 to 2017.



b. Vulnerability analysis for malnutrition

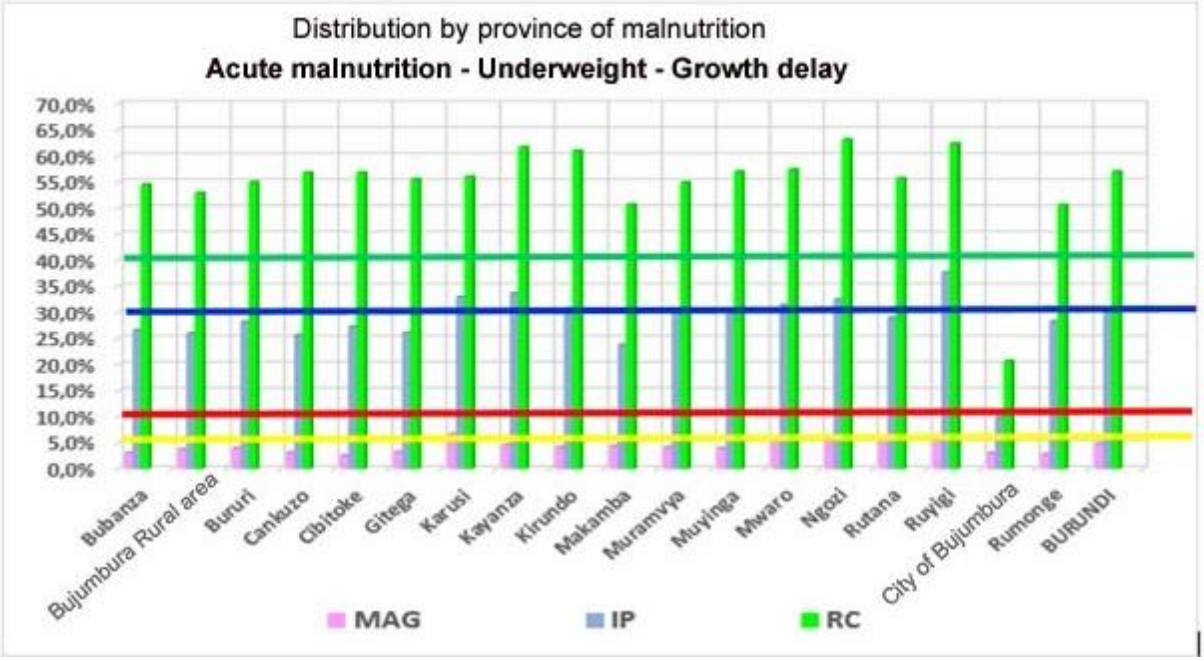
Malnutrition remains a real public health problem and is sensitive to the effects of climate change. According to the results of EDS III 2016-2017, the rate of chronic malnutrition among children under 5 years is 56%, with acute malnutrition rates of 6% (Figure 16).

Figure 16 : Prevalence of acute malnutrition by sex



The distributional analysis of malnutrition reveals a vulnerability to underweight high almost in all provinces with peak rates in Ngozi, Kirundo,
Kayanza, Ruyigi and Cankuzo, while the delay to growth is observed throughout the country except Bujumbura City.
The factors underlying these situations can be varied, but climate change has a significant role (Figure 17).

Figure 17 : Distribution of malnutrition in the country's provinces



III.1.3.6. Vulnerability Analysis in the Transport and Building Sector

The vulnerability of transport infrastructure and others is due to its physical characteristics and socio-economic environment that determine the exposure of an infrastructure to climate

change. Naturally, the scope and relative intensity of the evolution of climate averages depends largely on the location and context as well as the type of infrastructure involved (road, port, airport etc.).

In the building sector, the most vulnerable points of the real estate vary from one building to another mainly because of its location, its physical characteristics, age, condition or function.

Insofar as they are in flood zones, buildings are the most vulnerable. Landslides occur after heavy rains and endanger buildings in the affected areas.
In any case, the situation quickly becomes critical, so much so even the removal or relocation of buildings and infrastructure is unavoidable.

III.1.4. Evolution of the different sectors facing the climate change by 2050

III.1.4.1. Climate projections to 2050

As part of the development of the Third National Communication on Climate Change, IGEBU projections of climate parameters using the scenarios predict that the greatest increase in air temperature will occur during dry season and will increase during the periods.
Projection of climatic parameters in different parts of the country shows an upward trend in rainfall and temperature. Indeed, climate models with scenarios (RCP4.5 and RCP8.5) show an increase in annual rainfall between 12 and 13.15% with the same scenarios and for the 5 weather stations by 2030 and 2050. They show also an increase in the annual maximum temperature between 0.80 and 0.91 ° C by 2030 and an increase between 1.89 and 2.02 ° C by 2050.
They also show an increase in the annual minimum temperature of between 0.91 and 0.99 ° C by 2030 and an increase of between 2.04 and 2.14 ° C by 2050 for all scenarios and weather stations.
Projected changes for precipitation and maximum and minimum temperatures do not indicate significant differences between the two scenarios but differences with the horizons (2030s and 2050s).
For the Imbo station, the total annual rainfall will vary from 12.95% by 2050, while the average annual maximum temperature will vary from 0.87 ° C by 2030s and 2.02 ° C by 2050s, and the minimum temperature will vary from 0.91 ° C by 2030 and 2.12 ° C by 2050s.

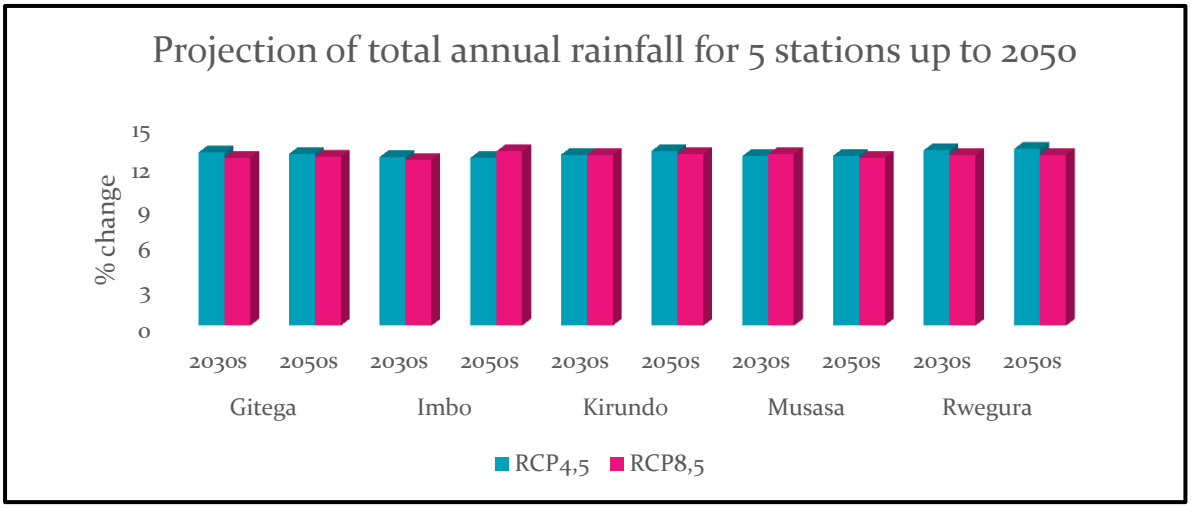
For the Rwegura station, precipitation will vary from 13.15% by 2050, while the maximum temperature will vary from 0.80 ° C by 2030s and 1.97 ° C by 2050s, and the minimum temperature will vary from 0.92 ° C by 2030 and 2.13 ° C by 2050s.

For the Gitega station, precipitation will vary from 12.88% by 2050, while the maximum temperature will vary from 0.89 ° C by 2030s and 1.95 ° C by 2050s, and the minimum temperature will vary from 0.93 ° C by 2030 and 2.09 ° C by 2050s.

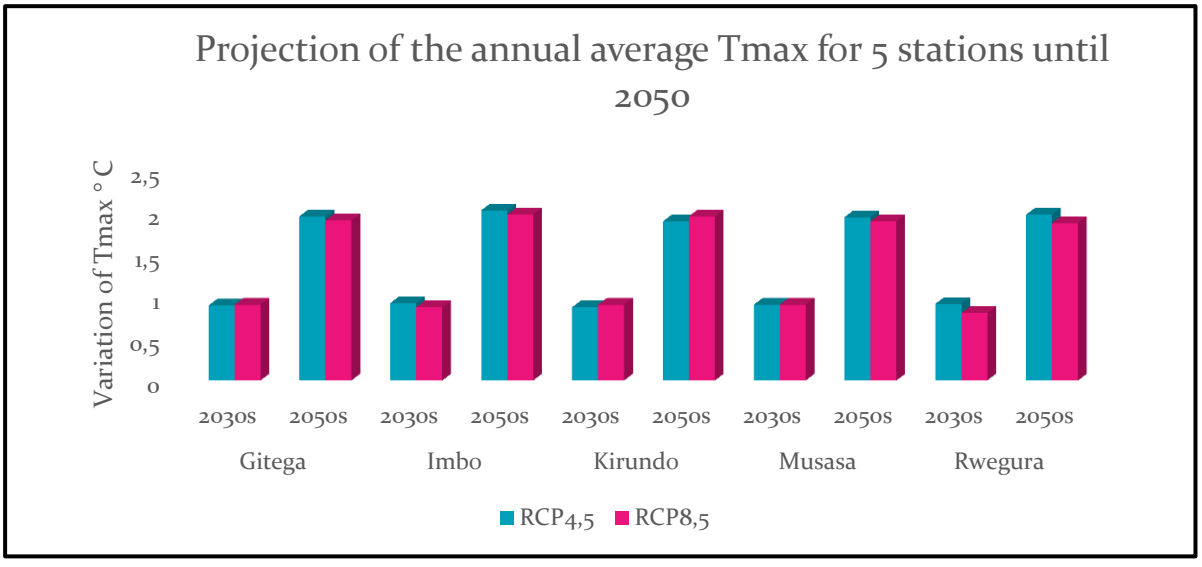
For the Kirundo station, precipitation will vary from 12.99% by 2050, while the maximum temperature will vary from 0.87 ° C by 2030s and 1.95 ° C by 2050s, and the minimum temperature will vary from 0.95 ° C by 2030 and 2.14 ° C by 2050s.

For the Musasa station, precipitation will vary by 12.75% by 2050, while the maximum temperature will vary from 0.90 ° C by 2030s and 1.94 ° C by 2050s, and the minimum temperature will vary from 0.95 ° C by 2030 and 2.11 ° C by 2050s (see figures below).

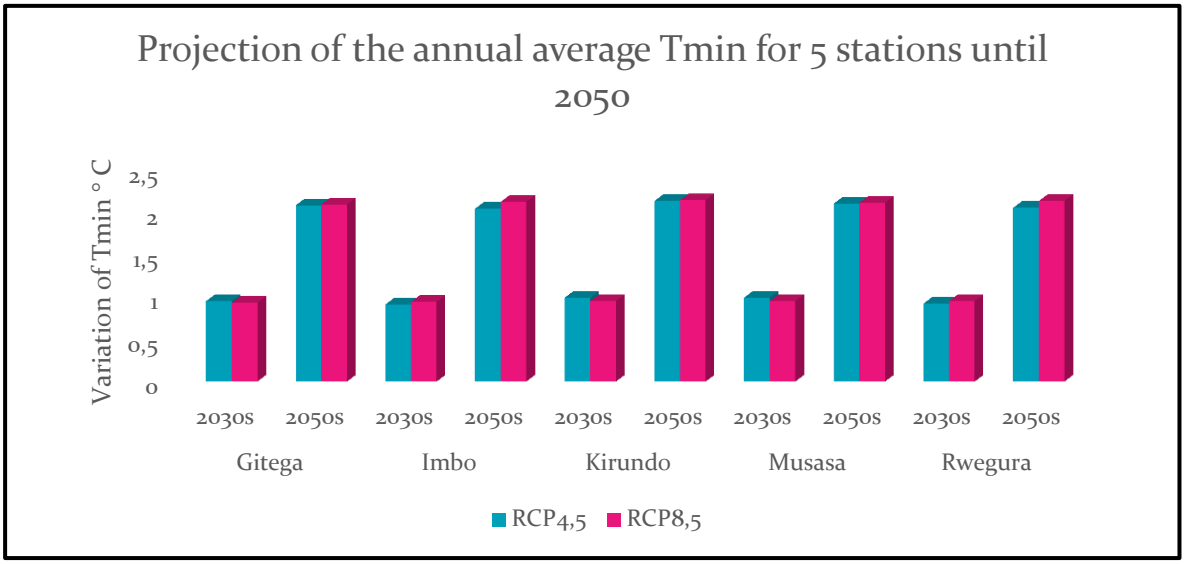
The models showed similar rainfall variations for both scenarios and at two horizons while different variations for maximum and minimum temperatures are observed. They project a variation of the minimum temperature higher than the maximum temperature. This indicates that in the future, there will be an increase in heat during the night as the increase of heat during the day. These results confirm the climate projections produced by the ACCES Project and the second national communication on climate change in 2010 (Figure 18).



Rainfall trends for 2030 and 2050 for Gitega, Imbo, Kirundo, Musasa and Rwegura



Evolution of the maximum temperature by 2030 and 2050 for the Gitega, Imbo, Kirundo Musasa and Rwegura stations;



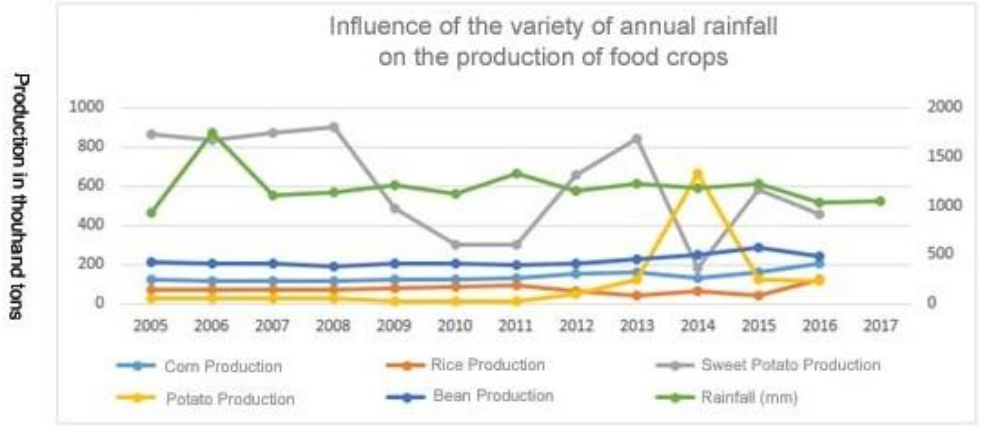
Evolution of the minimum temperature by 2030 and 2050 for the Gitega, Imbo, Kirundo, Musasa and Rwegura stations.

Figure 18 : Evolution of climatic factors by 2030 and 2050

Increases in total rainfall (over 12%) or rainfall intensity are likely to cause flooding in the western plains of Imbo and erosion in the southern zone and central highlands exposing the inhabitants hills, marshes, a considerable reduction in agricultural production, the disappearance of public infrastructures, biodiversity, silting of hydroelectric dams, etc.
There will be an increase in the risk of vector-borne diseases in the plain of Imbo, Kumoso and in the lowlands of the swamps. Prevention or adaptation efforts must be undertaken in all vulnerable sectors, otherwise material and human damage is inevitable.

III.1.4.2. Evolution of the agriculture sector facing the climate change from 2005 to 2017

The analysis of the evolution of the sector considers the evolution of the climatic parameters which are the temperature and rainfall and tries to see their implication on the evolution of the food crops throughout the years. Agricultural production and food security (including access to food) are likely to be compromised by climate change and variability if adaptation efforts are not mobilized. Indeed, it is undoubtedly obvious to observe a strong variability of the production in the periods which correspond to the increase of the temperature and the decrease of the rainfall (2011-2016). It is therefore reasonable to note a clear negative impact of climate change on food crops (Figure 19).



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Corn Production	123	117	116	118	120	126	128	152	162	128	161	201	
Rice Production	68	68	71	74	78	83	91	65	41	67	39	125	
Sweet Potato Production	867	837	874	900	484	303	300	660	840	181	581	459	
Potato Production	26	26	27	29	11	9	9	48	123	664	124	119	
Bean Production	214	206	205	190	203	202	199	206	225	252	283	238	
Rainfall (mm)	923,7	1742	1113	1131	1214	1122	1322	1150	1228	1173	1219	1025	1049

Figure 19 : Effects of variability in annual rainfall on the evolution of food crop production

Source: Author

It is therefore certainly possible to confirm that without the involvement of both, the evolution of the production of both food and industrial crops has only declined from year to year over a decade. It is therefore necessary to adopt adaptation strategies in the agricultural sector on which over 90% of the population depends.

At the breeding level, the analysis of the evolution of the sector was made on a 4 year interval from 2008 to 2016 and following the evolution of the livestock. The results show that the evolution of livestock is so low despite the efforts of the government and the PTFs who invest in the policy of stock repopulation. The results currently being achieved are not commensurate with the efforts made in terms of restocking.
This is an eloquent sign of the pressure of the various factors on this sector, among which are climate change. Animals were unable to externalize their potential because well-being in their new environment was not assured (Figure 20).

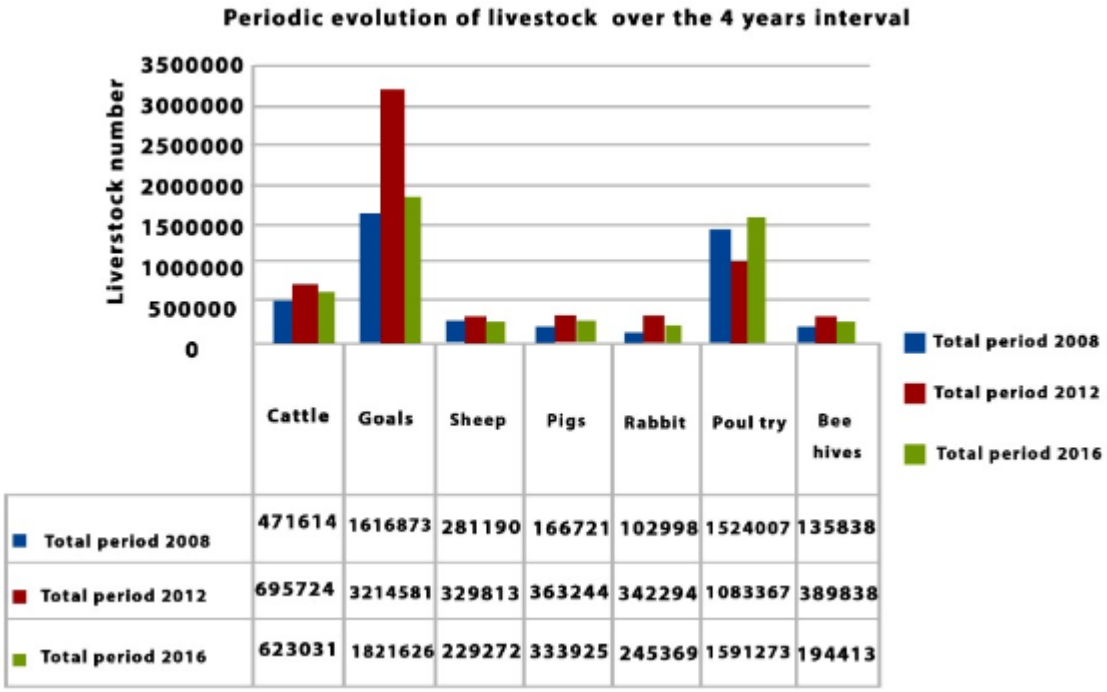


Figure 20 : Periodic evolution of livestock from 2008 to 2016

From the above, it is thus important to think of a strongly negative evolution in terms of the strength of the different categories, in the future, from where the implication of everyone in this sector proves to be more than essential in order to mitigate risks related to food insecurity.

III.1.4.3. Evolution of the energy sector

According to the analyses made by the IGEBU in the framework of the study on the variability and climate change in Burundi in 2018, the interannual rainfall anomalies observed from 1990 to 2014 indicate periods of high rainfall that can most often be flooding situation and periods of lack of rainfall leading mostly to drought.

Based on the evolution of these climatic parameters, the evolution of the electricity production of certain hydroelectric plants, such as RWEGURA for example for the period from 1996 to 2015, was analyzed in order to see the correlation between this production and the variability of these climatic parameters. The analysis was also made on the variability of the reservoir lake level of the Rwegura plant over the whole year for the period from 2010 to 2015 as well as the variability of the annual mean level for the same period. In fact, when there is no precipitation, the level of water in the dams decreases and this leads to irregularities in the production of hydroelectric energy. However, we also observe the decrease in the reservoir lake level of the Rwegura plant in periods of high rainfall. The latter due to overexploitation of the center when some other plants are off due to siltation for example.

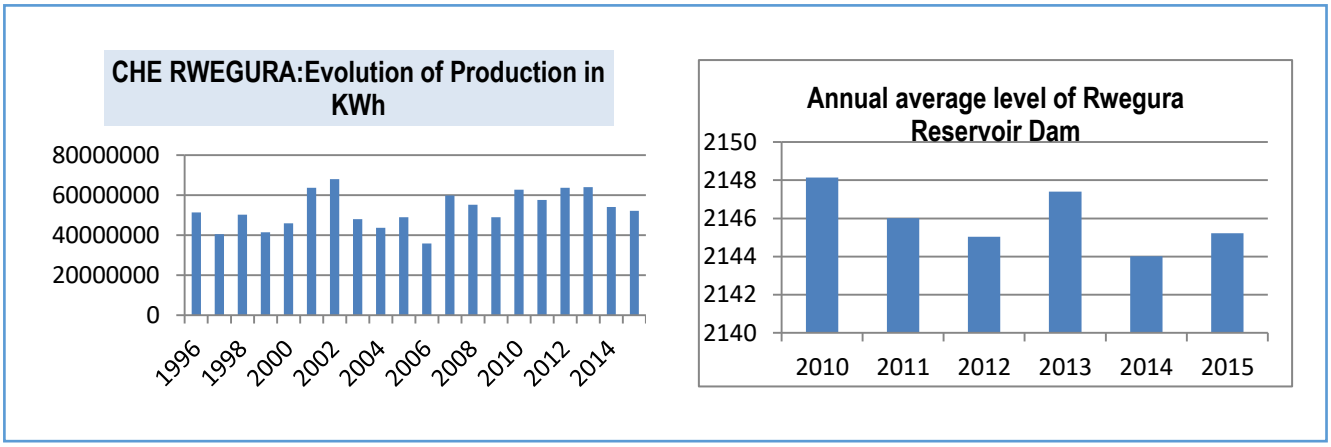


Figure 21 : Evolution of the electricity production of the Rwegura hydroelectric power station of 1996-2014 and the annual average level of Rwegura from 2010 to 2015

From the analysis of this figure, it can be observed that periods of high rainfall coincide with good electricity production, but also with catastrophic events due to climate change for the Rwegura power station. However, these periods of high rainfall have caused severe floods that have severely affected some hydroelectric plants, including the Buhiga power plant and the Ruvyironza power station which has been temporarily decommissioned since 2004. This shows that the energy sector exposes itself to the risk of flooding and siltation of hydroelectric plants in the future if measures are not taken in time. Moreover, according to IGEBU projections made with all the scenarios (high, medium and low) with climate change in some watersheds, show a significant increase in water resources since the period 2020 to 2050 for Ruvyironza and since 2030 to 2050 for the Murembwe Watershed. This situation could lead to erosion on the hills and flooding in hydroelectric plants located in the most vulnerable zones if no action is taken upstream of the watersheds in order to protect these hydroelectric power stations.

III.1.4.4. Evolution of the water resources sector

The evolution of water resources in a situation of climate change is expressed in flow rates of the rivers studied. The procedure is to use the good correlation already established between simulated annual average flows and annual rainfall in the watersheds studied. The scenarios developed at different levels of sensitivity of climate changes show a significant increase in rainfall and temperature accompanied by a significant increase in stream flows in the regions studied.

All the scenarios (high, medium and low) with climate change show that the average annual flows from Ruvyironza to Nyabiraba, from Lower Murembwe to Mutambara and from Rumpungwe to Gisuru go from 8.33 m3 / s to 9.32 m3 / s , from 11.7 m3 / s to 12.8 m3 / s and 7 m3 / s to 7.6 m3 / s from 2005-2017 (reference period), corresponding to increases of 11.88%, 8.55% and 0.57% respectively.

Thus, there is a significant increase in water resources since the period 2020 to 2050 for the Ruvyironza and from 2030 to 2050 for the Lower Murembwe. A slight increase in water resources has been observed since the period 2020 to 2050 for Rumpungwe (Figure 22).

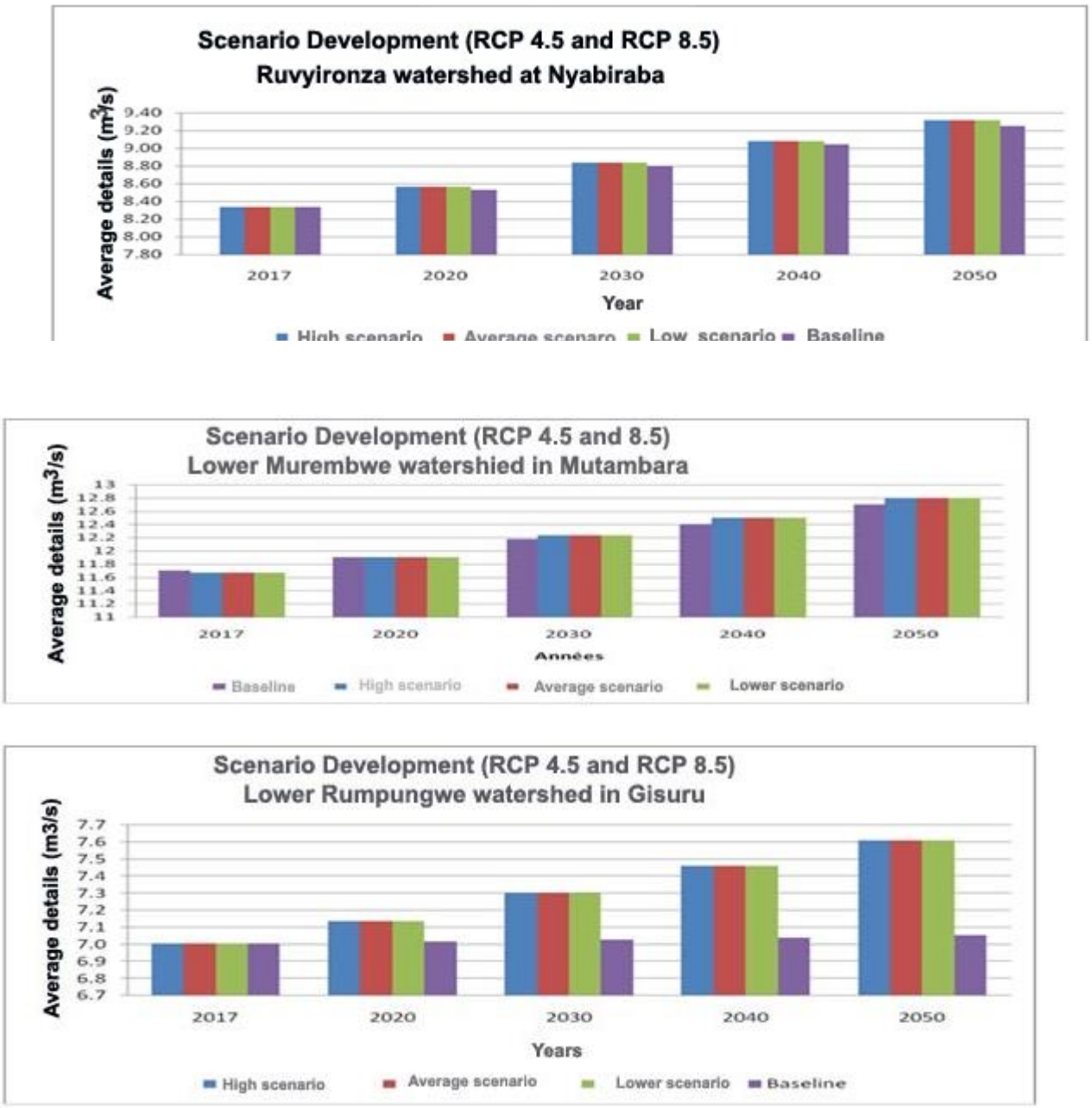


Figure 22 : Development of scenarios of average flows of water resources

III.1.4.5. Evolution of the forest ecosystems and landscapes sector

In Burundi, climate change is manifested by more abundant and excessive rainfall, as well as an increase in temperature. In the case of excessive rainfall, erosion increases, rivers carry fertile alluvium and the level of river beds rises. This situation causes flooding in the plains and marshes as well as water pollution.
In the case of a prolonged drought, the vegetation cover dries up, the bush fires are multiplied, the irrigated lowlands dry up and the disappearance of certain species is observed.

In the Imbo lowlands, prolonged droughts are causing a gradual decline in water resources, with a significant decline in river levels followed by a drying up of springs in the region and a certain tendency to desertification.

In the mountainous Mirwa basins and in the central highlands, drought is leading to a decrease in water resources and a loss of agricultural biodiversity.

In the Bugesera depressions, irregular and declining rainfall have already caused a drying up of shallow water sources and a loss of agricultural biodiversity.

III.1.4.6. Evolution of the health sector

A mapping of the incidence and the prevalence of malaria shows that the northern region (Kirundo, Muyinga, Ngozi, Kayanza) and central East (Karusi, Gitega, Cankuzo, Ruyigi, Rutana) are regularly the most affected. In 2017, the annual incidence of malaria is estimated at 815 per thousand. This high incidence indicates a deterioration of the situation, compared to the rate of 217 per thousand reported in 2012 by the national health information system. In addition, for several years, malaria remained a real public health problem; however, climate data as provided by IGEBU argues for increases and regressions in temperature and rainfall over time.
Thus, analysis of projected data in 2050 show that in the coming years, malaria cases will increase in parallel with rainfall and temperatures. Note that the malaria vector multiplies easily at temperatures above 16 ° C.
In areas where the disease is endemic with seasonal peaks; the fact is that the climatic factors that are favorable to them (temperature and precipitation) will be more so in the coming decades.
In this analysis, 2013 was chosen as the starting point because malaria cases were lower compared to other years. Also note that pre-2013 data does not appear in DHIS2. For this reason, the starting point is the 2013 data (Figure 23).
Considering the prevalence that occurred in 2014, the evolution of malaria cases until 2050 shows that as the population increases, more cases of malaria also increase. The role of climate change and adaptation of the vector of this disease is not negligible. It should be noted that several studies agree that even beyond 2050, vulnerability to malaria will weigh on the health system.

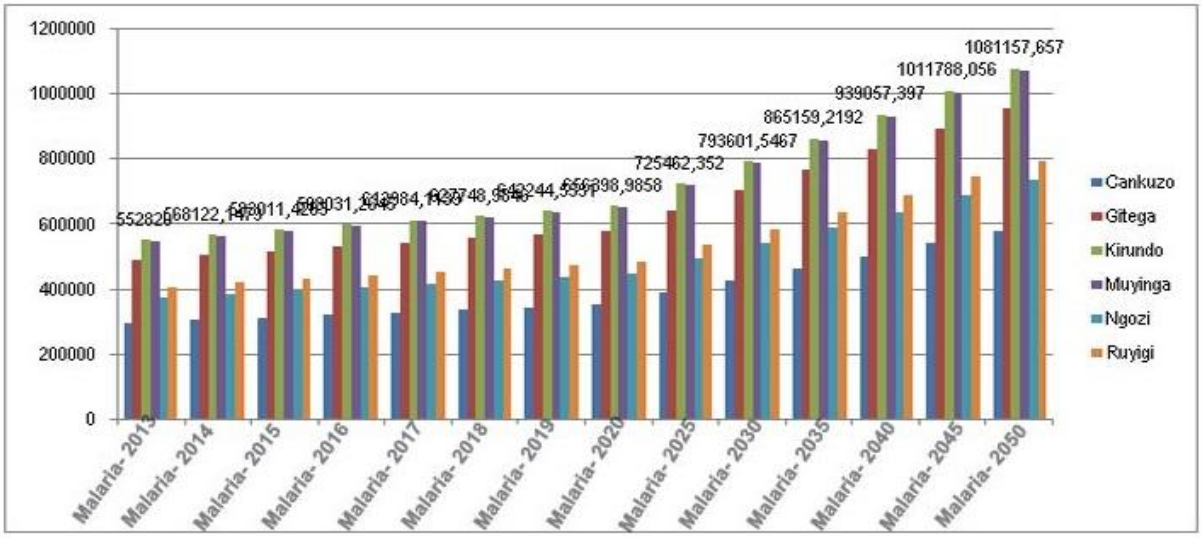


Figure 23 : Evolution of malaria cases until 2050

III.1.4.7. Evolution of the transport and building sector

Following the projections made by the IGEBU according to which season A will show an increase in rainfall of up to 10%. The impacts of climate change on infrastructure are enormous from previous years to the present. The increased frequency and intensity of extreme weather events will cause a variety of negative impacts on transport infrastructure.

Disruptions in the main road network will severely affect the economy at many levels, both at the national and local level, in communities affected by the loss of business opportunities, shortages and the high cost of household consumables especially fish products. Rising average temperatures that result in reduced soil moisture may accelerate road asphalt degradation and deterioration of road foundations.

III.1.5. Assessment of the implementation status of the strategies and adaptation of previous measures or ongoing

To mitigate the adverse effects of the impacts of climate change, the Government of Burundi has defined political orientations, notably through Vision 2025, CSLP II and various sectoral policies such as the National Water Policy, the National Strategy for Water Water, the National Agricultural Strategy (SAN), the National Strategy for Biological Diversity; National Forest Policy, National Strategy and Action Plan to Combat Soil Degradation, etc. In addition, he has developed and adopted strategies with action plans specific to climate change, including:

- Policy and National Strategy and Action Plan on climate change;
- The National Communication Strategy on adaptation to climate change;

- National Action Plan for Adaptation to Climate Change (PANA)
- National Communications on Climate Change.

These different documents propose many priority actions that contribute to adaptation to climate change. The analysis of the implementation status of these priority actions identified in these strategies and action plans is the subject of this chapter.

III.1.5. 1. Implementation Status of adaptation strategies and measures

a. Implementation of the National Action Plan for Adaptation to Climate Change (PANA)

This strategy includes 12 priority actions that should be carried out. The analysis shows that some actions have been implemented while others are not yet due to lack of financial means and weak institutional capacity. The actions that have been implemented concern:

- ✓ **Education for adaptation to climate change** where bushfire awareness sessions were expanded, radio and television programs were produced, as well as awareness sessions on the effects of climate change;
- ✓ **Capacity building in the promotion of techniques for the energy wood economy** where many people have been trained in the use of improved stoves. Also, several improved stoves have been manufactured and distributed to many people across the country. This activity is still going on ;
- ✓ **fight against erosion and stabilization of the river dynamics of the Mirwa and Imbo rivers**, where through the National Program of Anti-erosion Control (PNLAE), agro-forestry actions are carried out every year with the Government funding;

As part of the rehabilitation of degraded environments, the Forest Department is making efforts to reforest bare ridges, develop agroforestry for the large-scale integration of the tree on farms and the stabilization by the bamboo from the banks of some rivers that cross the city of Bujumbura. Thus, the Gasenyi and Nyabagere rivers have been stabilized by sustainable masonry constructions financed by the World Bank.
The areas covered by the projects are reducing the effects of climate change, conserving biodiversity, protecting international waters, reducing the impact of persistent organic pollutants (POPs) and wastes, as well as preventing soil degradation. Thus, we note the contribution of GIZ in its project "Adaptation to Climate Change for the Protection of Water and Soils". The funding mechanism that provided funding to Burundi for the implementation of most of these projects was the Global Environment Facility (GEF).
It is worth pointing out some projects that have been carried out by the private sector and civil society and that contribute to the implementation of NAPA. The latter were not taken into consideration for lack of communication with the ministry in charge of the environment.

b. Implementation of the National Communication Strategy on Climate Change

The implementation is relatively satisfactory as the establishment of the National Platform for Disaster Risk Reduction and Disaster Management (PNPRGC) has been effective and public sensitization sessions have been conducted.

c. Implementation of National Communications on Climate Change

Despite the good will of the Government and the lack of financial means, two recommendations of the first Communication have not been implemented. These are the following recommendations:
(1) Strengthen research in the field of Greenhouse Gas Inventories (technical and financial support to national institutions such as the University, ISABU, IRAZ);
(2) Support the establishment at national and sub-regional level of a permanent system for observing, monitoring and evaluating the impact of climate change in the most vulnerable sectors.

Regarding the implementation of the recommendations of the 2nd National Communication, many achievements have been recorded in different areas.

- In terms of strengthening the institutional framework:
  - ✓ Several technical ministries are involved in climate change resilience;
  - ✓ Existence of focal points within technical ministries, involved in the management of the environment in general and climate change in particular.
- In terms of capacity building:
  - ✓ Training of national experts who conducted the GHG inventories;
  - ✓ Training of national experts to carry out the assessment of vulnerability and adaptation to climate change;
  - ✓ Organization of awareness workshops on adaptation to local administrative leaders by OBPE with UNEP funding.
- In terms of projects implementation:
  - ✓ An assessment of technology needs in sectors responsible for natural resource management has been validated and forwarded to those eligible (UNEP / DTU) for funding request
  - ✓ Currently some faculties of universities and technical institutes have integrated climate change courses into their curricula;
  - ✓ A system for monitoring habitat dynamics within ecosystems and recording data in databases exists at OBPE;
  - ✓ High-performance data collection tools (GPS, GIS, etc.) are used.

The following table shows the projects completed and those not made in the implementation of the second national communication on climate change.

Table 11 : Identification of the implementation status of the projects

Projects executed or in progress	Projects not yet executed
1. BURUNDI groundwater assessment study; 2. Development of a Decision Support System (DSS) for planning and management of water resources; 3. Implementation of a pilot GIRE plan; 4. Systematic Climate Monitoring in Burundi; 5. Rehabilitation and densification of the hydrological network; 6. Monitor the quality of the water of the main rivers of the country; 7. Improvement of seasonal climate forecasts for early warning; 8. Strengthening the meteorological and hydrological data collection system; 9. Knowledge about availability (quantity and quality) and demand for water is published regularly; 10. The performance of the water and sanitation sector staff is improved. 11. Developing and popularizing rainwater harvesting techniques for agricultural or household purposes: this action was carried out but weakly from where it is necessary to pursue it because it is important 12. Rainwater Harvesting System (SCEP): project also implemented weakly, 13. Valorisation of rainwater: project implemented weakly, 14. Mumirwa Region Erosion Control Program: Project Implemented Slightly, 15. Stabilization of the river dynamics of rivers and streams in the Mumirwa including the city of Bujumbura; project implemented weakly,	1. Hydrological modeling; 2. Assessment of the water demand; 3. Development of a strategy, optimal use of Burundi's water resources; 4. Development of a water data collection and processing strategy; 5. Settlement of hill dams in the BUGESERA area; 6. Improved mechanisms for managing and disseminating data and information; 7. The Ministry of Higher Education establishes and operates a training program in techniques and sciences for water resources management, water and sanitation services; 8. The Ministry of Basic and Secondary Education establishes and operates technical secondary schools specialized in water resources management, water and sanitation services; 9. Research capacity in water resources management, water and sanitation services is strengthened.

16. Protection of buffer zones in the flood plain of Lake Tanganyika and around the Bugesera lakes;	

It is appropriate to add the realization of certain projects with regional scope such as:

- Environmental Management of the Lake Victoria Basin, Phase II (LIVEMP II);
- Regional project on the development of national action plans for artisanal and small-scale gold mines in Africa;
- Transboundary Management Program for Kagera Basin Agro-Ecosystems (PGTE Kagera);
- Capacity building for the improvement of greenhouse gas inventories (Central, West and Francophone Africa); etc.
- Climate Change Adaptation Project for the Protection of Water Resources and Soil (ACCES), (2014-2018), renewed for 2019-2021);
- Watershed Management Project and the 2013-2016 Climate Resilience Improvement Project (PABVARC);
- Improved management effectiveness of protected areas for the conservation of biodiversity in Burundi;
- Watershed approach for sustainable coffee production in Burundi;
- Community-based management of disaster risks due to climate change (2015-2019); etc.

d. Implementation of the National Strategy and Action Plan on Climate Change

This strategy was developed in 2013 and the implementation deadline is limited to 2025. The analysis of its implementation mainly focused on the activities carried out in the ministry having agriculture in its attributions. The results of this analysis show that about 90% of the activities allocated to this institution are being implemented. At the OBPE level, the results obtained from the Directorate of Environment and Climate Change, as well as the Forests Department, have shown that 10 out of the total of 25 actions are not yet implemented.

III.1.6. Priority activities identified to address future climate change in different sectors

In the case of climate change, everyone tries to adapt and the search for solutions is mostly for the modification of practices to spread the risks. The impacts of climate variability observed over the last three decades include soil erosion, landslides, forest and landscape ecosystem degradation, water pollution, the proliferation of vector and water related diseases, destruction of human habitat, destruction of socio-economic infrastructure, decline in agricultural productivity, increased food insecurity, malnutrition, etc.

Faced with these impacts, adaptation options have been proposed as shown in the table below:

Table 12 : Adaptation options in different sectors

Sector	Subsector / Field	Adaptation options
Agriculture, Livestock and Fisheries	Agriculture	1. Good practices for water and soil conservation in areas highly vulnerable to landslides and erosion 2. Promote, encourage and support community adaptation strategies. 3. Promotion of the use of organic fertilizer (green manure, manure); 4. Promotion of conservation agriculture in areas at high risk of drought; 5. Research on Crops adapted to Climate Change; 6. Production and availability of quality seeds in seed centers; 7. Development and popularization of technological practices appropriate to climatic hazards; 8. Develop a strategy that would allow the continuous supply of marsh water, particularly reforestation and contour tracing.
	Livestock	1. Training of breeders and field staff on environmentally friendly farming techniques; 2. Promote the breeding of small ruminants; 3. Dissemination of Law No1 / 21 of 4 October 2018 on "permanent stabling and prohibition of the straying of domestic animals and the backyard in Burundi", with a view to enabling effective membership; 4. Develop a regionalization project for farms; 5. Put in place incentive measures for breeders who want to practice modern breeding; 6. Promote the production of livestock feeds;
	Fisheries	1. Improving the resilience of aquatic and terrestrial ecosystems to the impacts of climate change and climate variability; 2. Improvement of knowledge bases and mechanisms for monitoring and information management in the fisheries sector; 3. Improve the management of urban water drainage systems, watersheds and rivers to avoid pollution of Lake Tanganyika; 4. Strengthen sustainable fisheries management mechanisms; 5. Protection and appropriate management of critical habitats, including lake buffer zones, spawning grounds, and pelagic areas, including the establishment of protected areas; 6. Quantitative study of the current status of biodiversity species in lakes to predict their evolution in the face of climate variability; 7. Disseminate or strengthen fisheries legislation and conventions and ensure that they are respected.
Energy	-	1. Development of new hydropower plants and rehabilitation of existing plants by including flood protection systems for these facilities and access roads, 2. Development of biogas digesters in communities,

		3. Electrification of isolated sites by solar photovoltaic systems, 4. Research on wind and geothermal potentials for the production of electrical energy, 5 Support to produce briquettes from organic waste, 6. Popularization of improved wood and charcoal fireplaces 7. Capacity building of all stakeholders for good planning and monitoring of climate change adaptation projects.
Water Resources	Policy	Integrate climate and environmental issues into water and sanitation improvement strategies
	Planning	1. Collaboratively establish territorial water and sanitation diagnostics that consider climate risks and water resources data 2. Develop and implement risk assessment plans to be updated and describe the procedures to be followed in case of emergency for service managers, managers and users of water and sanitation services 3. Provide accompanying measures: training of actors on the consideration of climate risk, user awareness on the promotion of sanitation and water saving
	Works	1. Carry out studies prior to new water and sanitation installations about climate requirements, 2. Introduce incentives to professionals in the sector to encourage high-performance companies that take climate risks into account, 3. Doubling the site monitoring systems of a quality control system integrating the issue of climate risk, for the robustness of structures confronted with climatic hazards
Forest ecosystems and landscapes	Contribution to low carbon development	1. Valuing lignocellulosic waste for energy purposes 2. Promote rational use and energy saving; particularly through the dissemination and dissemination of improved stoves; 3. Promote peat carbonization techniques to enable its use in alternative households to wood and charcoal; 4. Support ongoing reforestation programs by focusing on watershed protection and the provision of fuel for the population; 5. Change behaviors to improve energy efficiency and enhance the social value of natural ecosystems, such as forests, in effect adapting to the reality of climate change.
	Analysis of the priority actions of the national policy forester of Burundi	1. Identify and disseminate forest species adapted to climate change; 2. Recover and reforest illegally occupied spaces; 3. Arrange watersheds to control erosion; 4. Spread early and adapted silvicultural varieties to climate change; 5. Promote research in forestry / agroforestry especially with respect to species adapted to different agro-ecological zones and climate change; 6. Define the rights and obligations of stakeholders to manage forest resources rationally through participatory management, 7. Develop and implement appropriate lumber standards for different uses to best value the wood resource and produce quality lumber; 8. Popularize new wood processing techniques; 9. Make wood by-products and waste products profitable for rational use of forest products; 10. Promote techniques for making brick and tiles that consume little

		wood; 11. Popularize and disseminate improved stoves; 12. Discourage unsuitable uses of wood eg Promotion of the use of metal scaffolding instead of wooden poles in buildings
Health	-	1. Develop a joint operational plan for environmental health; 2. Develop a health and environment research program 3. Establish a coordinating body for health and environment, including sectoral programs and monitoring and evaluation systems; 4. Integrate health and environmental aspects into the poverty reduction strategy framework; 5. Identify global national indicators for monitoring health and environment programs; 6. Develop a specific legal framework for the link between health and the environment, the assessment of the health impact; 7. Establish the health impact study through appropriate tools in the context of environmental and social impact studies; 8. Provide specialized, material and financial human resources to environmental health research structures; 9. Allocate the substantial budget for health and the environment.
Transport and buildings	Transport	1. Protection of access channel and port basin; 2. Construction of a protective wall between the port basin and the mouth of the Ntahangwa River; 3. Dredging of the basin of the port of Bujumbura; 4. Deflection of the Ntahangwa River back into its original bed at its mouth in Lake Tanganyika; 5. Diversion of the gutter collecting the wastewater from the Buyenzi market and entering the port basin; 6. Development of an annual road maintenance program within the road office; 7. Allocate an enough budget for emergencies that may occur during the year; 8. Put in place effective measures to rehabilitate the existing network in order to adapt transport infrastructures to climate change.
	Building	Integration of adaptation measures and specific risks of each building into building projects.

III.1.7. New strategy to address the impacts of future climate change for different sectors

The proposed new sectoral strategies for adapting to climate change are listed in the following table:

Table 13 : New strategies to deal with climate change

Sector	Subsector/ Field	Adaptation strategy
Agriculture	Agriculture	1. Strategy to improve the profitability of activities at the local level and a system of continuous evaluation;
		2. Strategy for the sustainability of innovation achievements;
		3. Strategy aimed at improving the technical performance of all

		links in value chains;
		4. Strategy for the promotion and development of agriculture conservation;
		5. Strategy for promotion of agricultural value chains and development.
		6. Strategy to increase agricultural production and post harvest management
		7. Strategy for the valorization of research results
	Livestock	1. Agro-silvo-zootechnical integration strategy
		2. Strategy for the effective implementation of Law No. 1/21 of 4 October 2018 on "Permanent stabling and the prohibition of the wandering of domestic animals and poultry in Burundi"
		3. Livestock adaptation strategy to climate change.
		4. Strategy for the promotion of small livestock and barnyard farming
	Fisheries	Implementation strategy for the optimal management of fisheries sectors and Sustainable management of lakes where fishing is carried out as part of the fight against malnutrition and protein deficiencies
Energy	-	1. Strengthening of air transport and distribution networks
		2. Burying the cables; Energetic efficiency;
		3. Reducing reliance on a single source of energy and promoting other sources of energy
		4. Strengthening sub regional and regional cooperation in energy exchange
		5. Strengthening research and development in clean energy.
Water Resources	Water resources and sanitation	1. Promotion of the conservation and management of rainwater for domestic purposes for easy access to water resources; 2. Contribution to the stabilization of riverbanks and ravines of the Mumirwa regions and other targets for their consolidation; 3. Improving the system for monitoring the availability of national water resources for their assessment and guaranteeing their demand for all current and future uses; 4. Improvement of the climate variability early warning system to reduce socio-economic losses; 5. Protection and integral management of the buffer zones of lakes and rivers; 6. Integral management of watersheds and marshes to preserve the ecological balance; 7. Protection and management of flood zones to cushion their gravity.
Health	-	1. One Health Strategy
		2. Strengthening the integrated disease surveillance and response system at all levels of the health pyramid
		3. Epidemiological surveillance is a valuable tool in the fight against endemic epidemics
		4. Establishment of an emergency operations center / coordination framework / intersectoral collaboration
		5. Continuation of free health care for children under 5 and

		pregnant women as well as for the first line of treatment of malaria can act on the chain of transmission.
		6. Malaria vector behavior study (Gihanga Insectarium)
		7. Protection of the communities by different interventions (distribution of the MIILDAs, PID etc)

III.1.8. Adaptation projects facing climate change.

During this analysis, the experts proposed adaptation options and strategies. The prioritization of these options using a multi-criteria analysis identified priority projects or programs in each sector as shown in Table 12

Table 14 : Sector Priority Projects

Sector	Subsector/ Field	Project / Program Name	Budget (Dollars)
Agriculture	Agriculture	1. Production and dissemination of quality seeds adapted to climatic hazards	1.140.155,88
		2. Promotion and development of agriculture conservation	8.618.711,71
	Livestock	1. Agro-silvo-zootechnical integration and sustainable management of natural resources	18.392.856, 47
		2. Revegetation Program of the Hedgehogs in Environmental Conservation Systems	92.325
	Fisheries	1. Climate Change Adaptation Project and Increased Fish Production from Waterbodies.	200.000
		2. Accelerated development of integrated artisanal fish farming for food security	47. 186.062
		3. Protection and rational management of natural lakes to protect their biodiversity including fish for food security	5.000.000
Energy		1. Rehabilitation of existing hydroelectric plants	200.000.000
		2. Protection of hydropower plants against catastrophic risks (flood and siltation)	50.000.000
		3. Development of a thermal power plant based on municipal waste	90.000.000
		4. Development of biogas digesters in detention homes, boarding schools, barracks, religious congregations and other communities	110.000.000

Sector	Subsector/ Field	Project / Program Name	Budget (Dollars)
		5. Electrification of off-grid public buildings by photovoltaic solar energy	150.000.000
Water Resources		Collection and recovery of roof rainwater for domestic purposes	42.160.394
		Support project for the control and stabilization of the river dynamics of rivers in the MUMIRWA region	28.971.000
		Project for monitoring the quantity of water	2.908.256
		Project to create a specialized training center on water resources	2.620.000
		Project to implement the action plan for the transfer of technology "Anaerobic digestion to produce biogas	968,000
		implementation project of the Technology Transfer Action Plan "Optimizing Briquette Capacities	41.598.628
		Organic waste composting project	2.777.632
Forest ecosystems and landscapes		Sustainable Management of Forest Ecosystems and Landscapes for Adaptation to Climate Change	100.000.000
Health		Reducing the consequences of climate change	14.921.975
Transport and Buildings		Urgent Action Program on Climate Change.	1.000.000.
Capacity building of the Climate sector		Extension and rehabilitation of meteorological and climatological observation stations and development of knowledge of technical personnel	3.000.000
Climate, Meteorology and Hydrology		Extension, Rehabilitation and Modernization of Meteorological and Hydrological Observation Stations	5,000,000
		Capacity building in weather, climate and hydrology modeling	4,000,000
		Capacity building to cover all aspects of agro-meteorological assistance	2,000,000

In the last column, it is the estimated annual budget.

III.2. Program containing measures to mitigate climate change

III.2.1. Introduction

Burundi is part of the Non-Appendix I group of countries to the United Nations Framework Convention on Climate Change and wishes to contribute in the international effort to achieve the ultimate objective of the Convention advocated in Article 2, in order to stabilize in accordance with the relevant provisions of the Convention, the concentrations of greenhouse gases in the atmosphere at a level that prevents dangerous anthropogenic interference with the climate system. Burundi has therefore integrated climate change into its development policies and strategies, to embark on a sustainable economic path, in line with the national priorities identified in the National Development Plan (PND) 2018-2027.

The mitigation analysis is specifically targeted at the most appropriate measures according to current and projected national circumstances up to the 2030s, the period covered by this study. This report presents the results and the description of mitigation measures and strategies for anthropogenic greenhouse gas emissions. It consists of three parts, the first part of which is related to all mitigation documentation and the latter relates to the key emission areas, institutional arrangements, data sources and methodology adopted. The second part presents detailed results from mitigation measures and strategies in the sectors of agriculture, energy, forestry and other land uses and industrial processes. The waste sector is not included in the emissions projections given the uncertainties associated with the estimates of activity data related to this sector as well as the virtual absence of controlled waste management.

III.2.2. Methodological approach

Two principles guided this assessment of Burundi's mitigation potential:

- Achieving the key objective of the Convention, already mentioned above; and
- Promote a sustainable economic development of the country according to current and future policies, strategies and other plans in the medium and long term.

The purpose of this mitigation analysis is to identify the best ways to maximize emission reductions and increase greenhouse gas (GES) removals. A business as usual (CNA) scenario for the emissions and removals of the different categories within the four IPCC sectors has been developed. The CNA scenario is based on a baseline year (2010) from which socio-economic and demographic parameters make it possible to project emissions according to the model to be used. For the energy sector, LEAP (Long Range Energy Alternatives Planning System) was used. For other sectors, the experts used linear / polynomial regression.
The methodology used was based on the collection of data contained in various documents including the reports from the different institutions, strategies, development plans and the consultation of the reports used in the inventory of greenhouse gases as part of the Third National Communication on Climate Change.

The mitigation scenario is constructed by applying to the sectoral emissions of the CNA scenario, an estimate of the gains associated with the implementation of policies and projects in the sector. The synthesis of the methodological approach is summarized in Table 13.

Table 15 : Summary of the methodological approach

OBJECTIVE	REDUCTION IN% BY TARGET YEAR'S EMISSIONS IN A BASIC SCENARIO
Cover (of the country)	The whole country
Gaz covered	Carbon dioxide (CO2), Methane (CH4) and Nitrous Oxide (N2O)
Sectors / sources covered	Agriculture, Energy, Land Use Change and Forestry, Industrial Processes.
Reference scenario (CNA)	This scenario describes the evolution of GES emissions by 2030 by sector of activity according to the Government's current development strategies.
Mitigation scenario	This scenario describes the evolution of GES emissions by 2030 on the basis of low carbon orientations in the main sectors of activity, notably, energy and agriculture.
Sources for scenarios (CNA and Mitigation)	Vision 2025, PND 2018-2027, Master Plan Production and Transmission of Electric Power 2014-2030, PNIA
Potential of Global warming	The PRG values used are those determined by the Intergovernmental Panel on Climate Change (GIEC, SAR): CO2 (1), CH4 (21), N2O (310)
CNA Scenario Emission Projection Methodology	The GES inventory with the base year 2010. The base scenario (CNA) is constructed by applying to the emissions of the various sectors assumptions of evolution depending on sectoral annual growth rates, the evolution of the population, the electric mix and the trend evolution of the efficiency of the sector.
Projection methodology for the mitigation scenario	The mitigation scenario is constructed by applying to baseline scenario sector emissions an estimate of the gains associated with the implementation of sector policies and projects.
Waste approach	Emissions from this sector have a potential growth but its inventory contains a lot of uncertainties which does not facilitate an objective assessment. It is recommended to refine the activity data and emission factors during the Fourth National Communication before making projections and proposing mitigation measures.

III.2.3. Assessment of mitigation and dejection measures

III.2.3.1. General trend of emissions

Table 16 : Evolution of emissions sector by sector according to the basic and mitigation scenarios

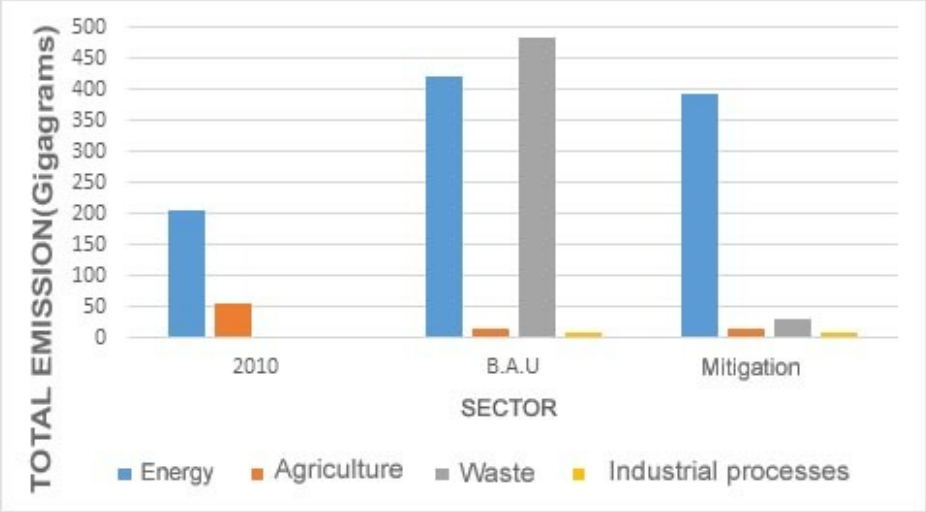
Sector	Reference	GAZ		
		CO_2	CH_4	N_2O
Energy	2010	172.183	32.52	0.34
	CNA	345.57	54.16	21.31
	Mitigation	371.47	13.45	7.54
Agriculture	2010	-	53.66	0.18
	CNA	2.66	11.1	0.11

	Mitigation	2.6	10.9	0.1
Land Use and Forestry	2010	-2249.96	2.6	0.23
	CNA	977	-	-
	Mitigation	-16709	-	-
Industrial processes	2010	0.78	0.00	0.00
	CNA	8.62	0.02	-
	Mitigation	8.13	0.02	-

Table 16 and the figures in this section show the evolution of emissions according to the baseline and mitigation scenarios, the gases and the emitting sectors.
Table 16 shows that total emissions of greenhouse gases are increasing.
For the energy sector, these emissions increase from 172.183 CO2 Gg in 2010 to 345.57 CO2 Gg in 2030, thus doubling in the NAC scenario with a slight decrease if the planned mitigation actions are implemented. Emissions from other sectors also have an upward trend, although in terms of quantity, their importance is low.

The amount of CO2 with mitigation is decreasing because by 2030 it is expected to excessively reduce energy wood in urban centers by replacing it with gas

Figure 24 : Evolution of emissions sector by sector according to scenarios and greenhouse gases



III.2.3.2. Assessment of mitigation and dejection measures sector by sector

a. Energy Sector

In the energy sector, the following sectors of activity were considered in the energy demand:

- The "Residential" sector
- The "Trade and industry" sector
- The "Government" sector
- The "Religious Confessions" sector

- The "City and Municipalities" sector
- The "Administration and personalized management" sector
- The "Diplomatic Missions" sector
- The "Self-consumption" sector
- The "Transport" sector
- The "Fishing and Agriculture" sector

It is based on the baseline scenario that the mitigation scenario was defined by integrating specific projects, sector strategies and national action plans.
For the energy sector, mitigation scenarios are based on the following strategic objectives:

- Promotion of improved wood carbonization techniques.
- Promotion of domestic improved wood-burning stoves in urban areas to reduce the number of inefficient traditional fireplaces on the market.
- Design and promotion of improved adapted domestic homes in rural areas.
- Promotion of biogas in rural areas.
- Promotion of public transportation.

In order to take into account the development needs of the country, the energy consumption will be 191.598 Million Gigajoules in 2030 and this will generate 345,577 Gg of CO2, 54,16 Gg of CH4 and 0,717 Gg of N2O. With an ambitious program to reduce greenhouse gas emissions aligned with the Burundi National Development Plan 2018-2027, energy consumption will be 54.345 million GJ. The corresponding emissions will be: 371.46 Gg of CO2, 13.45 Gg of CH4 and 0.181 Gg of N2O.

Table 17 : Evolution of Energy Consumption in Million Gigajoules

Scenario	2010	2015	2020	2025	2030
Mitigation scenario ambition	127,247	136,083	128,646	93,309	54,345
Mitigation scenario moderate	127,247	139,904	141,031	118,761	89,561
CNA	127,247	141,461	157,161	173,931	191,598

Figure 25 : Evolution of Energy Consumption in Million Gigajoules

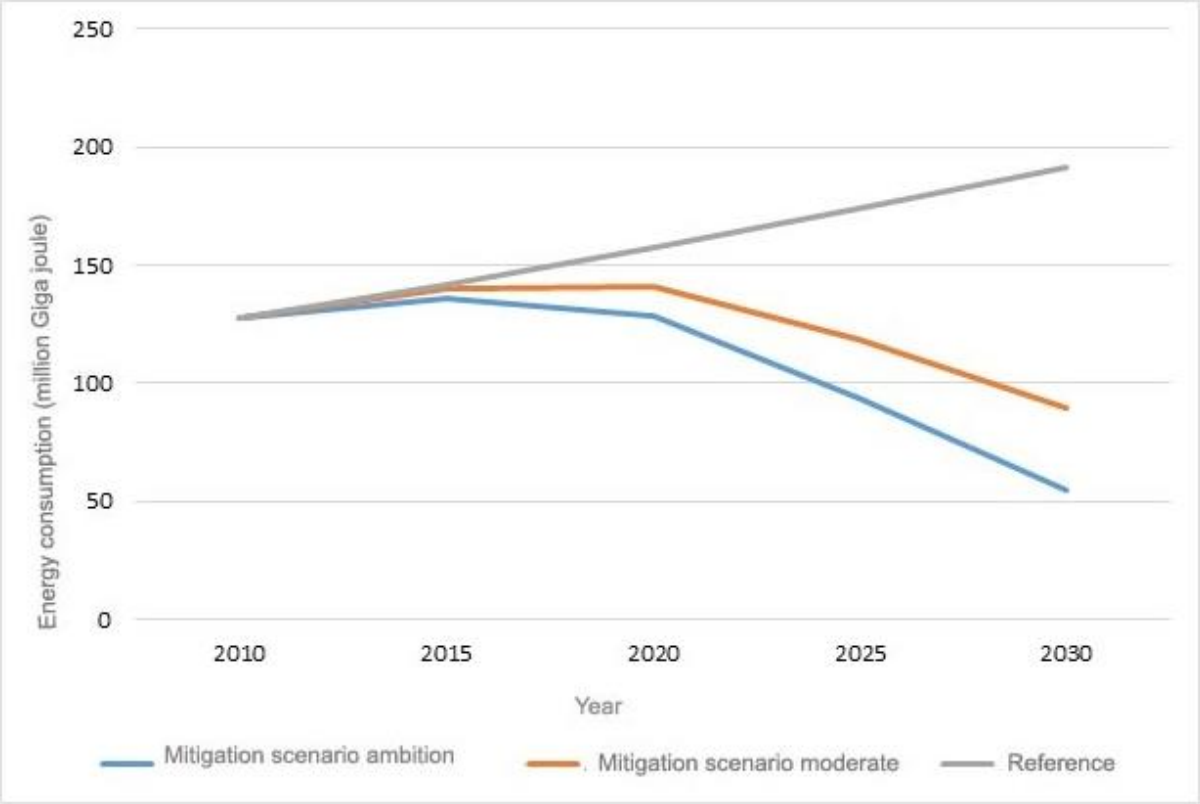
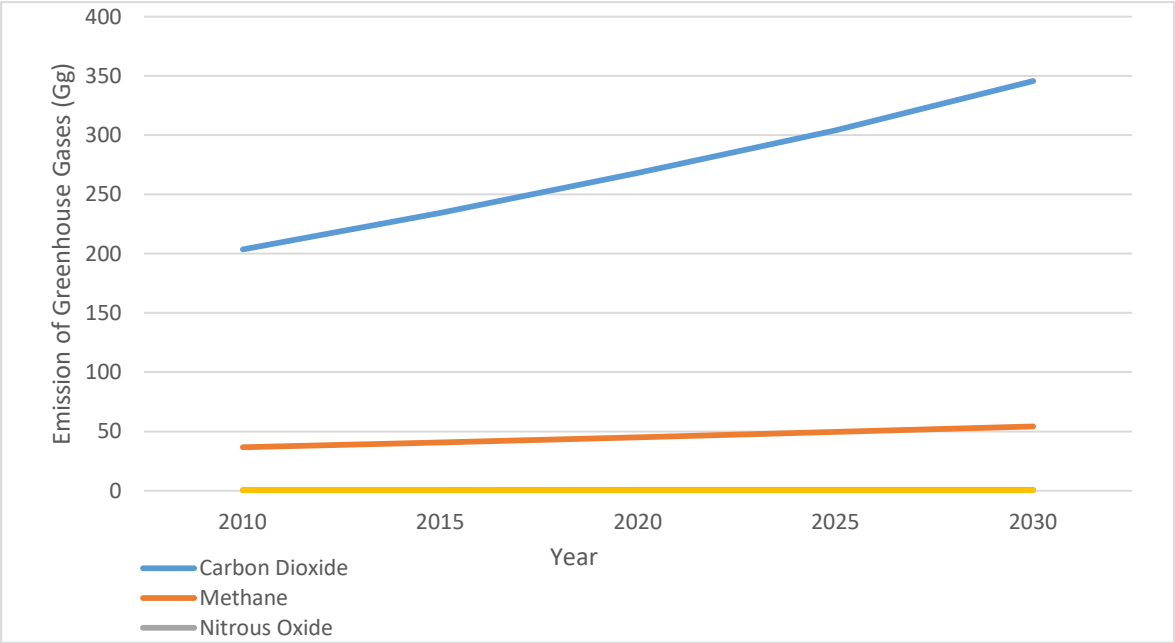


Table 18 : Emission of greenhouse gases in Gg for the CNA scenario

Effects	2010	2015	2020	2025	2030
CO_2	203.483	234.295	268.032	304.153	345.577
CH_4	36.545	40.588	44.960	49.473	54.161
N_2O	0.485	0.538	0.596	0.656	0.717

Figure 26 : Emission of greenhouse effect gases in Gg for the DAC scenario



Mitigation measures

Among the measures proposed in the second national communication, some measures have been applied, others are not yet implemented and deserve to be renewed.

Policy measures in place

- Promotion of public transport;
- Obligation of the technical control;
- Promotion of renewable energies;
- Liberalization of the energy sector;
- Promulgation of texts and laws exempting solar equipment.
- Energy saving measure (awareness and production of energy saving equipment)
- Import of new vehicles.

Economic measures

- Subsidy by the State of the connection to the REGIDESO network;

Detaxation of electrical equipment used for cooking.

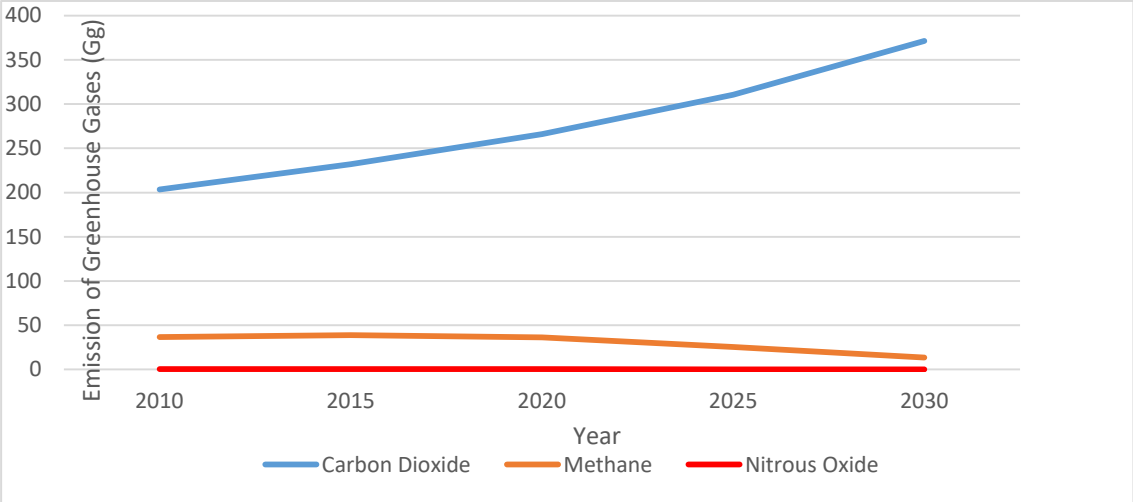
Technological measures

- Large-scale promotion of improved wood-fuel and charcoal stoves;
- Carbonization of peat to make it usable by households;
- Replacement of biomass boilers with electric boilers;
- Construction of new hydroelectric plants;
- Increased traffic lights that regulate road traffic because they reduce congestion, one of the causes of high fuel consumption

Table 19 : Emission of greenhouse gases in Gg for the mitigation scenario

Effects	2010	2015	2020	2025	2030
CO_2	203.483	232.137	266.221	310.575	371.465
CH_4	36.545	39.028	36.512	25.545	13.456
N_2O	0.485	0.517	0.484	0.339	0.181

Figure 27 : Emission of greenhouse gases in Gg for the mitigation scenario



b. Agriculture Sector

In the agriculture sector, urgent GHG mitigation measures are: (i) reducing CH4 emissions from enteric fermentation by improving animal feed, by improving the genetic traits of animal reproduction for better efficiency of animal production; (ii) Capturing CH4 from manure management systems to produce energy (Biogas); (iii) Reducing CH4 through modification of irrigated rice cultivation practices; (iv) Reduce N2O emissions through improved application of urea fertilizers.

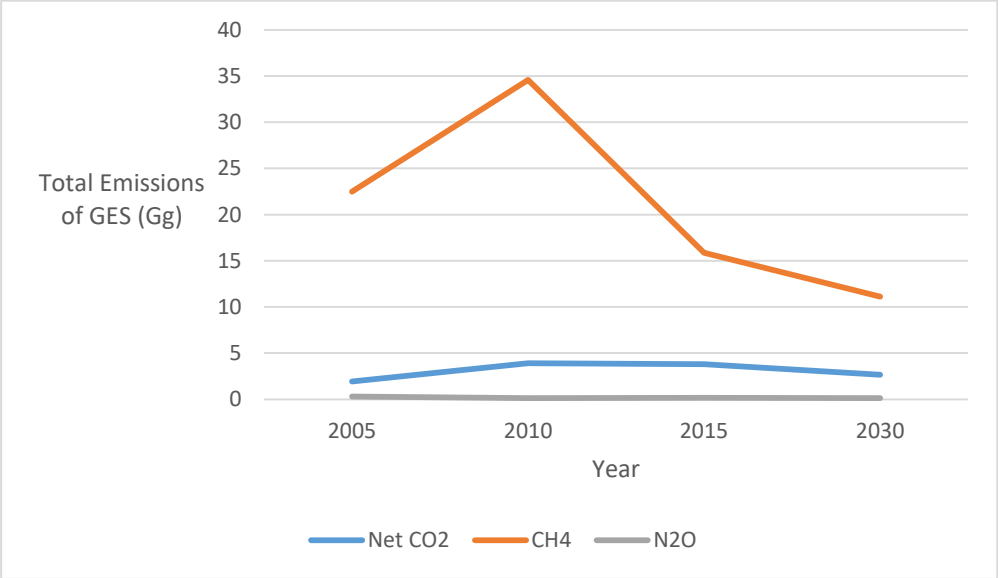
With PNIA's goal of promoting the production of alternative soil fertilizer alternatives (bio-fertilizers), the progressive use of compost in place of chemical fertilizers for sustainable agriculture development will reduce 2.4 Gg of CO2 by 2050.

In addition, the improvement in the composition of animal feed composition will prevent at least 27.97 Gg of CH4 from the enteric fermentation process in domestic animals (ruminants) in Agro-Sylvo-Zootechnical Integration IASZ by 2050.

Table 20 : Emissions of GES (Gg) projected in 2030 with the PDDAA target of a 30% reduction

Source of GES	Total Emissions of GES (Gg)			
	2005	2010	2015	2030
Net CO_2	1,91	3,90	3,80	2,66
CH_4	22,5	34,57	15,85	11,10
N_2O	0,3	0,11	0,15	0,11

Figure 28 : Emissions of GES (Gg) projected in 2030 with the PDDAA target of a 30% reduction



c. Forest Sector

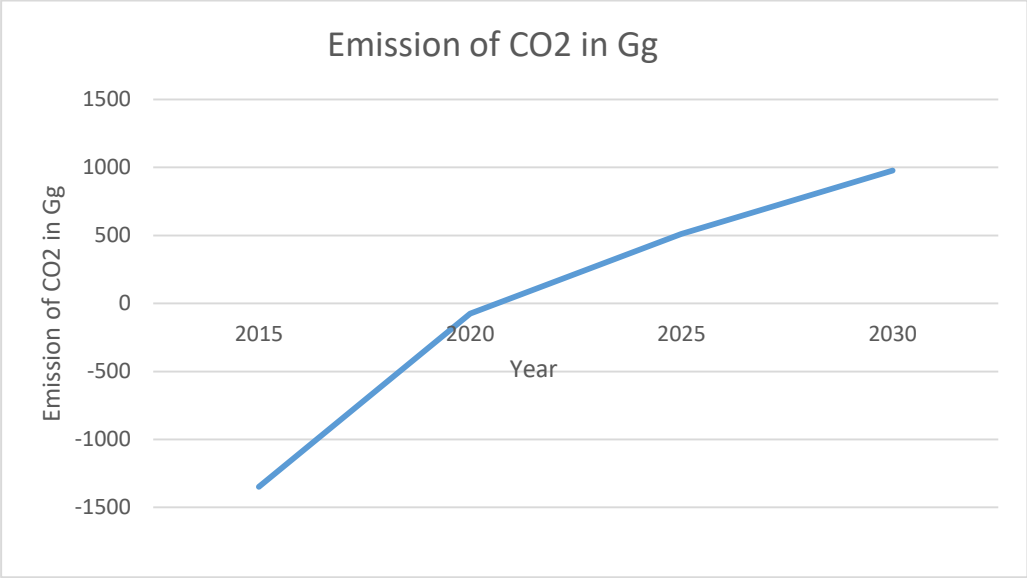
Baseline scenario or reference optimistic

The basic scenario for the forest sector assumes that the decommissioning of forest land for the benefit of other crops will be offset by the annual reforestation of 4000 hectares through the national program of reforestation supported since November 2017 by the national reforestation project entitled "Ewe Burundi Urambaye". Table 19 and Figure 30 show the evolution of emissions.

Table 21 : Evolution of CO2 emissions according to the optimistic reference scenario

Year	Emission of CO_2 in Gg
2015	-1348.48
2020	-74.76261054
2025	511.07
2030	977.17

Figure 29 : Evolution of CO2 emissions according to the optimistic reference scenario



C.1.Measures of Mitigation in the Land Use Change and Forestry Sector

Forest mitigation activities can be grouped into three categories. The first category includes activities that avoid the release of carbon emissions, such as forest conservation and protection.

The second includes activities that increase carbon stocks namely reforestation and agroforestry.

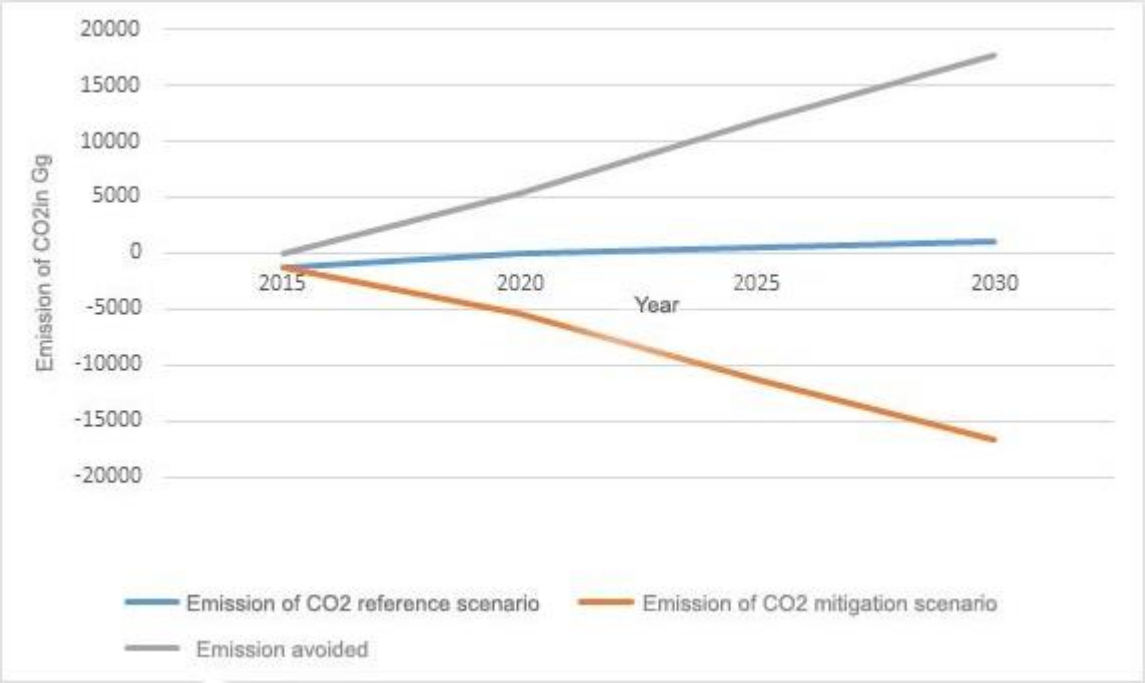
The third category relates to the sustainable management of forests, it consists in reducing the demand for wood notably through the substitution of this product by other fuels and the improvement of equipment used for wood processing and the production of energy.

Table 22 : Comparative Evolution of GHG Emissions under baseline and mitigation Scenarios through the combination of reforestation and charcoal kilns and improved stoves

Years	Emission of CO2 reference scenario	Emission of CO2 mitigation scenario	Emissions avoided
2015	-1348.48	-1348.48	0
2020	-74.76261054	-5332.08	5257.317389
2025	511.07	-11266.94	11778.01

2030	977.17	-16709.34	17686.51

Figure 30 : Comparative Evolution of GHG Emissions under baseline and mitigation Scenariosthrough the combination of reforestation and charcoal kilns and improved stoves



C.2. Ranking of options according to emissions avoided

Depending on the weight of emissions avoided, the measures identified above may be ranked in order of decreasing importance as follows:

Table 23 : Ranking of mitigation options by amount of avoided emissions

Mitigation option	**emissions avoided in Gg ECO2**
Reforestation + Ovens and improved fireplaces	112000,50
Fireplaces and ovens improved	77017,38
Improved fireplaces	64282,33
Reforestation + carbonization improved	47618,26
Reforestation + biogas	3918,45
Reforestation	34983,12
Improved ovens	12735,05
Biogas	220,16

d. Industrial processes

The quantities emitted are determined in the context of greenhouse gas inventory studies. According to the third greenhouse gas inventory in the PIUP sub-sector, the iron-making industry (6.23672 Gg ECO2) and the Lime production unit (1.206323Gg ECO2) are the only ones identified as emitting these gases.

Although negligible, a study to mitigate anthropogenic greenhouse gas emissions is necessary for Burundi to participate in reducing the effects of global climate change and identifies mitigation measures to be undertaken to participate in the low carbon development. Three sub-sectors were analyzed, namely:
(i) mineral industry, (ii) metal industry, (iii) as well as the food and beverage industries.
Given the national context, the sources of emissions for which mitigation measures will be required are based on the emission summary shown in the table below:

Table 24 : Summary of emissions in Gg

YEARS	**2010**		2015	
Categories	CO_2 (Gg)	CH_4 (Gg)	CO_2 (Gg)	CH_4 (Gg)
TOTAL EMISSION « PIUP »	0,784695		7,470043	0,01872
2.A.2 - Lime production (Lime)	0,784695		1,206323	
2.C.1 - Iron and Steel Production			6,23672	0,01872

The industry sector plays an important role in the structural transformation of the economies of nations; however, this sector remains undeveloped in Burundi despite the reforms put in place to improve the business climate, particularly the new measures adopted in the areas of industrial promotion.

Table 25 : Projection table of GES emissions according to the reference scenario

GAZ	***Coefficient***					
		2010	***2015***	***2020***	***2025***	***2030***
CO_2 in Gg (Iron, Steel Production and Lime)	*0,05*	*0,785*	*7,443*	*7,815*	*8,206*	*8,616*
CH_4 in Gg (Iron and Steel Production)	*0,05*		*0,019*	*0,020*	*0,021*	*0,022*

Mitigation Measures

The mitigation scenario focuses on technical and policy measures to reduce these emissions. These measures are of a political and technical nature allowing the good management of the sector, including measures to reduce greenhouse gas emissions.
Assuming a reduction of emissions to 3% every five (5) years, Burundi could achieve reductions, which are reflected in the table below.

Table 26 : Projection table of GES emissions according to the mitigation scenario

GAZ	***Coefficient***	***YEARS***				
		2010	***2015***	***2020***	***2025***	***2030***
CO_2 (Iron, Steel Production and Lime)	*0,03*	*0,785*	*7,443*	*7,666*	*7,896*	*8,133*
CH_4 (Iron and Steel Production)	*0,03*		*0,019*	*0,019*	*0,020*	*0,020*

III.2.4. Main barriers / constraints that impede the implementation of mitigation projects and programs

Several barriers / constraints impede the implementation of mitigation measures. These barriers are generally related to lack of financial resources but also lack of access to technologies. These constraints are listed below for the energy, agriculture, and land use and forestry sectors.

Energy Sector

- Lack of financial resources for the development of the hydroelectric potential to increase the rate of electrification
- Limitation on technology transfer for low-carbon development
- Absence of disaggregated data for the production of energy results

Agriculture Sector

- Lack of information on bio-fertilizers likely to replace mineral fertilizers to a large extent;
- Insufficient adoption of sustainable soil and water management methods and practices, or so-called smart (resilient) agriculture, which allows for a substantial and lasting way in the productivity and resilience of production systems. This is to ensure that at least 30% of agricultural land is placed under sustainable land management practices;
- Absence of an extension system of practices of intelligent agriculture

Forestry and Land Use Sector

- Weak institutional and organizational capacities
- Availability of reliable information on land and environmental degradation (degrading actions)
- Insufficient extension of GES mitigation technologies (briquettes, biogas, solar, improved stoves and improved kilns)
- Lack of data for planning and monitoring

Waste Sector

- Overall, the legal and regulatory measures in force are incomplete and partially implemented. Given the large number of sectors involved in waste management (solid and liquid waste, etc.), the existing texts and laws do not cover all the needs in terms of legislation.
- There is also a scattering of legal provisions relating to the sector, which justifies the need to codify and consolidate the texts and to eliminate inconsistencies and contradictions, while facilitating consultation and interpretation.

- Although the mandates of the various public institutions are theoretically clear, in the application, the overlaps are numerous and certain responsibilities are not assured. It is also observed that institutions often compete for certain activities that provide certain benefits. Another recurring institutional problem in Burundi is frequent changes in mission responsibilities to ministries.

- Waste management is not yet mastered. Some associations and cooperatives responsible for collecting household waste do not live up to their commitments.

- The amount of waste produced by the population of the Capital of Bujumbura exceeds the capacity of the existing dump.

Industrial Processes and Product Use Sector

This is a sector that remains less developed and the obstacles include:

(i) lack of information, (ii) lack of funds, (iii) lack of qualified staff to quote only those.

III.2.5. Proposed mitigation programs

III.2.5.1. Energy Sector

i) Optimization and multiplication of hydropower plants

Energy is considered as the engine of socio-economic development. Its availability and use play a very important role while its level of consumption reflects a level of development of a country. In Burundi, energy is both a factor of production and a support for the development of other sectors, including growth sectors such as agriculture, industry, the mining sector, and so on.

But it is clear that the energy available to Burundi does not meet the growing needs for energy and particularly hydroelectric energy. The access rate to electricity is 5.6% according to the Master Plan for Production, Transmission and Distribution of Electric Power in Burundi.

In order to remedy the situation, the Government of Burundi is building 4 new national power plants on the rivers Mpanda (10MW), Jiji and Mulembwe (49.5 MW), Kaburantwa (20MW), Ruzibazi (15 MW) and regional (Rusumo falls: 26.7MW) without forgetting the Solar Power Plant of Mubuga (7.5MW)

It should be remembered that the development of hydropower is accompanied by socio-economic benefits such as:

- The increase in the national electrification rate;
- The growth and diversification of economic activity;
- Improvement of the living conditions of the population;
- The economy of currencies if one sticks to the reduction of the quantity of the petroleum products.

ii) Decentralized electrification

Solar energy is available and well distributed on the national territory. Burundi has an excellent and very interesting solar field. The average of the insolation is at 4-5 kWh / m2 / day with the average sunshine received annually close to 2000 kWh / m²/ year.

It is within the framework of increasing the rate of access in rural areas that the project "Solar Electrification Services by Micro Networks in Africa (SESMA BURUNDI) was set up. Today five micro solar power plants with a total output of 175 kW are being built in different regions of the country.

III.2.5.2. Industrial Processes and Product Uses Sector

Even though Burundi's industry sector is less developed and there is little inventory of greenhouse gas emissions in this sector, it would be better for the Promotion of Clean Technologies and the Adoption of International Standards to be placed in the priorities of the sector to contribute to the reduction of anthropogenic emissions of greenhouse gases.

Thus, the following mitigation measures have been identified:

- Respect of international standards for the establishment of factories and clean industries by sectors;
- Humidification of flue pipes in the iron and steel manufacturing process,
- Promotion of research and innovation initiatives in the industrial sector.

III.2.5.3. Agriculture Sector

The following actions are proposed to help reduce greenhouse gas emissions:

i)Promotion of the use of biofertilizers and organic fertilizers

ii) Promote production techniques for concentrated feed for livestock and intensification of animal production

iii) To control diseases and pests

In addition, the following technology has been prioritized in the National Technology Adaptation / Mitigation Needs Assessment (EBT II) process. This is the technology of " Methanization for the production of biogas"

From this technology, 3 project files have been identified. It is :

- Strengthening organic fertilizer production units
- Promotion of livestock in permanent housing to increase substrate production;

- Capacity building for organic waste recovery for environmental sanitation, energy production and fertilizers

III.2.5.4. FAT Sector

The best options in terms of mitigation of GES emissions are provided by the application of the following measures:

1. Reforestation and improved carbonization furnaces
2. Furnaces and improved stoves
3. Biogas

Other actions proposed :

(1) Reduce the loss of water and land

(2) Increase the forest cover rate to 20% of the National Territory (27,834 km2)

(3) Sustainable management of forest resources

III.2.5.5. Waste Sector

In this sector, actions already identified in previous communications are still proposed for the good management of the sector. It is :

- Establishment of controlled solid waste landfills
- rational exploitation of the existing wastewater station and development of other stations in unserved areas, particularly the southern zone,
- Organic waste composting for the improvement of soil fertility. This program significantly reduces the amount of waste to be disposed of at landfill sites and therefore reduces greenhouse gas emissions, mainly methane.
- The Biogas Technique. this technique allows the use of liquid waste (waste water) and solid and has been tested at some boarding schools, however, lack of technical and financial resources, this project has not been very successful.

This technique is more important because it makes it possible to deal with energy problems, especially in rural areas on the one hand, and on the other hand to reduce the quantities of waste produced and the emissions of methane gas.

III.2.6. Identification of appropriate national mitigation measures for anthropogenic GES emissions (NAMAs)

Table 27 : Identification of appropriate mitigation measures for anthropogenic greenhouse gas emissions

Sectors	NAMAS identified in order of priority	Selection criteria
Agriculture	✓ Systems of exploitation of the domestic animals favoring the permanent stabling, ✓ Promotion of organic fertilizers	1. Is it aligned with government priorities? (Yes or no), 2. Does it correspond to an already existing measure? (Yes or no), 3. Does it have low, medium or high mitigation potential? (F, M, E) 4. Is its implementation feasible? (Yes or no), 5. Does it present Co benefits with: - adaptation (- / neutral / +), - means of livelihood (-/ neutral / +), - environment (- / neutral / +)
Energy	✓ Construction of micro hydropower plants, ✓ Decentralized electrification by photovoltaic solar system, ✓ Construction of biogas digesters and use of methane gas, ✓ Densification and carbonization of agricultural by-products (briquette)	
Forest	✓ Fight against forest degradation by favoring other forms of energy and other types of materials under construction, ✓ Reforestation ✓ Strengthen the conservation of the carbon stock, ✓ Sustainable Forest Management	
Waste Management	✓ Recycling of solid waste into usable products, ✓ Methanisation of fermentable waste for biogas production, ✓ Treatment and recovery of liquid waste in all urban centers	

Sectors	NAMAS identified in order of priority	Selection criteria
Transport and infrastructures	✓ Promotion of public transportation, ✓ Consider extending the traffic lanes for the promotion of non-motorized rolling stock	
Industrial Processes	✓ Compliance with international standards for setting up factories and clean industries by sector; ✓ Installation of woodlots around these units for the sequestration of CO2 gas., ✓ Apply cleaner and more modern technologies	

III.2.7. Conclusion

While considering the need to reduce greenhouse gas emissions, Burundi, like other developing countries, must take up the challenge of development in order to improve the standard of living and the quality of life of its population. This development must go through food security, access to energy and the development of the country's resources through industrialization and processing in order to add value to the production of raw materials.

While fully adhering to the objectives of the United Nations Framework Convention on Climate Change, a will fully renewed through the CDN presented at COP 21, Burundi remains dependent on the support of the international community to implement the mitigation measures of anthropogenic greenhouse gas emissions.

CHAPTER IV : OTHER RELEVANT INFORMATION TO THE ACHIEVEMENT OF CONVENTION OBJECTIVES

IV.1. Study on the identification and assessment of technology needs to face up to climate~~ic~~ change

IV.1.1. Introduction

Burundi faces significant risks related to climate change. According to the latest reports on Vulnerability and adaptation to climate change studies, Burundi could see a decrease in water supply and food production in many regions and exposure to more extreme events. Climate change is a reality and their reduction remains a great world challenge today. Technology is a key element of adaptation. Technology can help protect society against climate change, improve productivity, and use more efficiently threatened resources such as water. This report identifies a number of existing and emerging technologies which can help Burundi adapt itself to climate change in the context of sustainable development and more specifically in the implementation of Burundi's National Development Plan 2018-2027.
Of course, technology is not the only element of a good approach to adaptation. Improved risk resources management, governance and other aspects of natural resources management are also important. The under chapter focuses on the role of certain technologies in a certain number of key sectors that can significantly help Burundi cope with the increasingly remarkable effects of climate change.
Those sectors are : agriculture, water resources, infrastructure, human health, forests and waste management.

IV.1.2. Impact of climate Change on different sectors and identification of technologies

IV.1.2.1. Agriculture sector

a. Impact of climate change on agriculture

Predicted climatic changes in this sector are the scarcity of rainfall accompanied by rising temperatures in some regions. The studies carried out within the framework of the first national communication on climate changes and the evolution of climatic parameters in Burundi by 2050 on the basis of traffic model shows that the annual average temperature will increase from 1oC to 3 oC. Rainfall will increase by more or less 10% and the rainfall regime will be disrupted with the consequences of changing seasons, floods of marshes and shallows, land degradation and loss of soil fertility, shortage of groundwater resources, the advent of extreme climatic phenomena (hail, violent showers, strong wind, etc.), changes in the vegetative cycles of cultivated plants and unpredictable phytosanitary phenomena.
Other significant impacts caused by climatic change in that sector are:
-Losses of crops, cattle, goat, sheep and poultry will be increased as a result of a longer and more frequent droughts with a probability of occurrence between 40% and 60%.

- Meat and milk production yields will be even more affected and reduced, as will the production of fish in case of drought;
-Lightenig strikes occur during tornadoes will be greater and will cause additiona livestock deaths in mountains.

-Loss of quality and quantity of pastures

a. Adaptation technologies for agriculture sector

For effective adaptation to climate change in the agricultural sector, a range of adaptation tools, including behavior modification, management options and technologies, should be considered.

This section provides examples of specific technology tools that can be used as part of a broader integrated adaptation approach to (i) increase crop resilience, (ii) rational use of water in agriculture, (iii) enhance adaptation to floods, and (iv) protect livestock from the impact of climate change. The list of technologies presented here is not exhaustive and aims to show the range of technologies that can reduce climate-related vulnerabilities.

Table 28 : Agricultural Technologies for Mitigation and Adaptation to Climate Change

Predicted impact of climate change	Technology needs	Technologies
The reduction of the crops yield is caused by highest temperature	✓ The new varities of crops with great tolera nce to heat	✓ Crops selection
The reduction of crops yield in pluvial agriculture due to decreased rainfall	✓ new crop varieties with low water requirements ✓ technics of collection, stocking and distribution of improved water, ✓ Improved irrigation technics	Crops selection ✓ Irrigation so under pressure ✓ Monitoring soil moisture
Reduction of crop yield in irrigated agriculture due to reduced availability of irrigation water	✓ improved irrigation efficiency ✓ new crop varieties requiring little water ✓ real-time remote sensing capabilities and to improve water management and efficiency of use	✓ Laser leveling ✓ Irrigation under pression ✓ Monitoring soil moisture

Reduced irrigation water due to saltwater intrusion	✓ Obstacles to the intrusion of salt water ✓ New varieties of crops with a great tolerance to salinity	✓ Artificial recharging of the aquifer ✓ Salt water pumping ✓ Construction of underground screens ✓ Crops selection
Reduced crop yield due to increased flooding or water saturation	✓ New crop varieties with higher moisture tolerance ✓ Improvement of drainage and flood control techniques	✓ Crops selection ✓ Monitoring soil moisture
Increased incidence of crop pests and diseases	✓ New crop varieties with better resistance to pests and diseases ✓ Improvement of disease and pest management techniques	Crops selection
The loss of haverst due to extreme weather events	✓ Improved prediction of extreme weather events and early warning systems ✓ Improved techniques to increase crop resilience to extreme weather events	✓ Meteorological monitoring ✓ Selection of crops
Vulnerability of livestock to the impacts of climate change	✓ Improve livestock feed ✓ Protect livestock against temperature variations	✓ Improved feeds for livestock ✓ Temperature regulation for livestock

B.1.Increase the resilience of crops

Crops are particularly vulnerable to extreme temperature events, changes in historic average temperatures, increased seasonal variability in rainfall, deterioration of soil quality, and increasing pressure from pests and diseases. Increasing the resilience of crops (ability to withstand these stressors) is of fundamental importance for ensuring food security.

Crops selection

Plant breeding programs can use both traditional and modern techniques such as biotechnology to identify strains with relevant traits to climate change. Breeding programs may involve amplifying the potential of existing characters or transferring characters to other plants. This can be done to increase the varietal tolerance of factors such as increases in average minimum and maximum temperatures, high temperatures, droughts, floods and increased salinity, to help a plant cope with climate change. Reproduction, coupled with integrated pest management, can also improve tolerance to pests and diseases, which are expected to increase with climate change. Selection for biotic stresses requires determining how climate change may interact with regional pests and diseases.

b.2. Reduce the use of water and water wastage in agriculture

Climate change will have a significant impact on the quantity and quality of water. As a result, sectors that rely heavily on water, such as agriculture, need to find ways to adapt and use scarce resources more efficiently. In addition, population growth and increased water demand from non-agricultural users will leave less water for agriculture, regardless of climate change. Thus, the potential for non-regret coping approaches is high.

There are three technological approaches to reduce water use in agriculture: water conservation and water productivity.

Laser leveling

Much of the water loss in agriculture is the result of unnecessary runoff in the fields. An important approach to reduce runoff is to ensure that agricultural fields are as level as possible. Recent technologies, including the use of laser technology, have improved the accuracy of field leveling before planting. Laser leveling is the use of tripod or tower mounted lasers used in combination with a tractor to level or level agricultural fields to conserve irrigation water. Flat land facilitates control of runoff.

Pressure irrigation

Irrigation has been used for millennia to conserve water in agriculture, but advances in irrigation technologies will become increasingly important as climate change puts increasing pressure on water resources. Pressure irrigation, using sprinkler, drip, minisprinkler or high efficiency systems, is particularly promising for more efficient water distribution and reduced evaporation losses. These irrigation systems provide water directly to plant roots and can help provide an ideal moisture level for plants.

Monitoring of soil moisture

Soil moisture monitoring is the key to bringing the right amount of water to crops at the right time. Monitoring soil moisture improves irrigation decisions and has the following effects:

increased yields, better quality product, increased vigor for plants, reduced disease, increased water use (efficiency of water), a reduction in irrigation costs. Soil moisture monitoring in agriculture is done with moisture sensors.

b.3. Protect livestock from the impact of climate change

Livestock will feel the effects of climate change, including increased susceptibility to vector-borne diseases and heat stress. Their food will also face increasing threats

Improved feeds for livestock

Livestock feeds can be modified to improve their digestibility and provide the necessary nutrients. Examples of dietary supplements are: multi-nutritional blocks based on molasses and urea, low-bridged proteins, lipids and calcium hydroxide.

Although primarily a mitigation strategy, improving livestock feed also offers adaptive benefits by increasing both feed efficiency and livestock resilience. As the climate changes as food resources become more stressed, improving the quality of available nutrients will help herders maintain their herds with fewer feeds. Nutrients also help animals cope with extreme conditions. For example, animals exposed to heat stress need a specific diet to maintain normal levels of meat or milk production. Their diet can be modified to include minerals, vitamins, electrolytes, amino acids or other additives to meet these needs

Temperature regulation for livestock

Temperature control technologies focus on reproduction for heat tolerance, reducing the heat transfer between an animal and the air, and reducing the temperature of the environments to which livestock are exposed. The ability of the animal to cool depends on many genetic factors, including coat color and ear size, as well as its metabolic rate. Selecting breeds that are more heat-tolerant and then breeding based on these traits can produce animals that can better withstand a warmer climate.

IV.1.2.2. Water resources

a. Impact of climate change in the water resources sector

Ensuring adequate water supply is a challenge as water resources are unevenly distributed throughout the country, especially in a country depending on rainfed agriculture. Although the evolution of rainfall patterns, especially at the local level, remains uncertain, climate change adds to the non-climatic causes of water scarcity, including population growth, domestic per capita water use, the development of irrigated agriculture, industrial growth, and inefficient management of water resources (IPCC 2014).

The impact of climate change on water resources can be divided into three categories: too much water, not enough water and degraded quality. It is expected that most areas will experience extreme dry and wet conditions, forcing the country to cope with floods and droughts. Both extremes can lead to water stress.

Table 27 summarizes the impact and technology needs described, highlighting the potential for applying adaptation technologies to reduce the vulnerability of the water resources sector to the impact of climate change. This list of technology needs is not exhaustive.
Specific examples of technologies to address these needs are discussed in the section "Adaptation Technologies in the Water Resources Sector" in the following table.

Table 29 : Water Resources Technologies for Climate Change Mitigation and Adaptation

Anticipated impact of climate change	Technological needs	**Technologies**
Water supply		
Reduced availability of surface water due to changes in precipitation, increased evaporation,	✓ Improved water collection, storage and distribution techniques ✓ Improving the efficiency of water use	✓ Recovery of rainwater ✓ Recharging aquifers
Reduced availability of groundwater	✓ Improving the efficiency of water use ✓ Increased sustainable aquifer recharge	✓ Double the tanks to reduce infiltration. ✓ Provide forest cover for recharge aquifers
Rainwater management		
Increased flooding due to extreme weather events	✓ Improved prediction of extreme weather events and early warning systems ✓ Improving rainwater management and flooding by using gray and green infrastructure	✓ Meteorological Monitoring Network ✓ Recharging aquifers
Water quality		
Saltwater intrusion	✓ Obstacles to salt water intrusion ✓ Increase in sustainable aquifer recharge ✓ Increased water treatment	✓ Implementation of an active leak detection program ✓ Desalination ✓ Wastewater treatment at the point of use

Reduced surface water quality	✓ Increase in water treatment ✓ Improve rainwater management to prevent surface water contamination ✓ The protection of water sources	✓ Repair leaks and ruptures of walls; ✓ Dragging waterways and removing flow-blocking materials

Quantity of water

The projected impact of climate on water quantity in Burundi may be reduced rainfall (drought), increased precipitation (resulting in floods) or a change in the timing and duration of rainfall. Water resources will also be increasingly burdened by competing needs resulting from population growth, increasing urbanization, agriculture and other factors. Adaptation technologies that focus on the most efficient use of existing water resources will become increasingly important under these conditions and may include technologies such as rainwater harvesting, surface water storage, recharge aquifers, reducing water losses and reducing water demand .

Recovery of rainwater

Although practiced since Antiquity, the collection of rainwater through retention systems installed on the roofs, is a technical option more and more recommended as complementary solution for water supply of households and institutions. The increasing proportion of hard roofs (eg sheet metal or tiles) and easy access to metal and plastic for water supply have reduced the cost of implementing water collection. (CEP) at the household level.

In developing countries, CEP is most often used to collect drinking water for households. In richer areas where good quality running water is reliably available, water is usually collected for non-potable purposes, such as green space irrigation (lawns and gardens), water, and washing clothes. The range of relevant PEC options in a given context depends on the quality, cost, and viability of alternative sources of water supply for households, precipitation patterns, household income, and other factors.
A simple system of individual CEP from rooftops is shown in Figure 32. The main features of a CEP system from rooftops include: (1) A catchment area where precipitation falls; (2) a conveyance system consisting of gutters and pipes for conveying and directing water; and (3) containers for storing the water that will be used later. Water quality can be protected by adding one or more of the following: Filtration / sieving; chemical disinfection; a device for diverting the first rains.

The deviation mechanism for the first rains consists in removing the initial volume of collected precipitations in order to preserve the quality of the water. It has been suggested that, as a rule, the contamination is halved for every mm of rain removed.

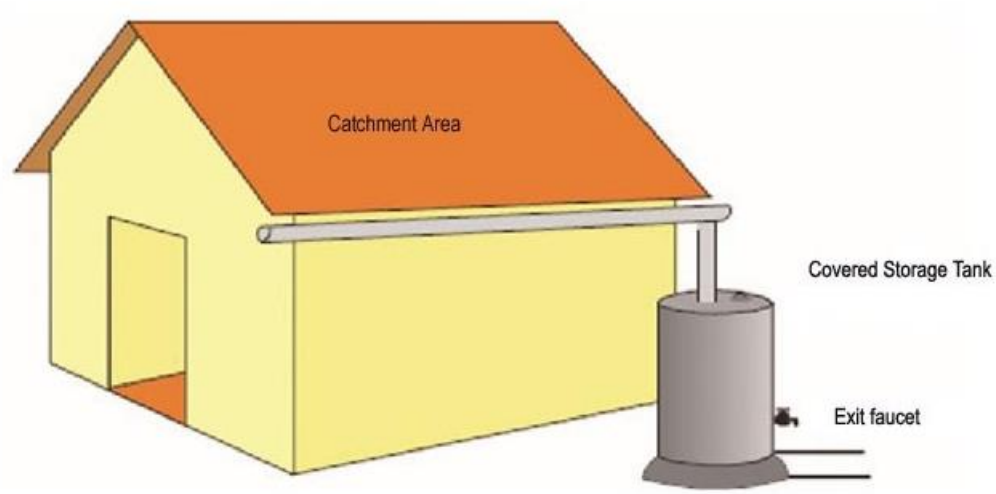


Figure 31 : Basic characteristics of a CEP system for a detached house

CEP contributes to climate change adaptation at the household level mainly through two mechanisms: (1) diversification of household water supply; and (2) increased resistance to degradation of water quality. It can also reduce the pressure on surface and groundwater resources (eg the reservoir or aquifer used for running water supply) by decreasing household demand; it has also been used as a means to replenish the groundwater. Another potential CEP benefit from rooftops is flood mitigation through the collection of roof runoff during storms.

Storage of surface water

Water storage can collect water when it is abundant and store it in tanks, tanks and ponds for future use. Tanks are artificial lakes used for the storage and regulation of water. Simple earth dams are usually built to create small tanks, which tend to be shallow, contain low volumes of water and can be drained each year with use.

Recharge of aquifers

Aquifer recharge (also referred to as groundwater recharge, managed aquifer recharge, or aquifer storage and recovery) can be used to store water, prevent saltwater intrusion and address the problem of overexploitation of water. Aquifer recharge can be useful in areas with

various seasonal runoff regimes such as the Bugesera, Moso and Imbo regions, especially if the high water demand season coincides with low runoff.

Reduction of water losses

Water losses can occur during storage, transmission or delivery, evaporation, or through leakage (often due to aging infrastructure) or inappropriate, illegal or uncontrolled use. Although estimates of these losses vary considerably by country and climate, all studies indicate that losses are substantial and are likely to increase with rising temperatures.

The different techniques to reduce water losses are as follows:

To reduce water losses from tanks:

- Provide forest cover for tanks;
- Use deeper tanks or underground water tanks to minimize exposed surface;
- Plant vegetation to reduce the impact of wind;
- Add a lid to reduce evaporation;
- using evaporation retarders and
- Double the tanks to reduce infiltration.

To reduce water loss during distribution

- Implementation of an active leak detection program;
- Identify illegal taps and reduce the loss of illegal connections;
- Installation or calibration of water meters;
- Reduce leaks and main interruptions by rehabilitating and replacing water pipes;
- Install pressure control equipment to reduce pressure at night, reducing leakage losses;
- Develop an "asset management" strategy to maintain and improve existing infrastructures.

To reduce water loss during irrigation

- Repairing leaks and ruptures of walls;
- Dredge waterways and remove flow-blocking materials.

Technologies for reducing water demand

Water demand can be reduced and efficient use of water by households and commercial entities increased through new technologies (eg reduced or low flow toilets, reduced flow showerheads, reformulated manufacturing techniques),
as well as policies (water tariffs, reduction of non-reclaimed water consumption, integrated management of water resources). The discussion here focuses on new technologies.
Proper treatment and storage of drinking water at household level, or point of use (POU English acronym), are ways to improve water quality by treating it directly on site. The most popular treatment technologies are chemical disinfectants, coagulants, ceramic filters, biological sand filters, solar disinfection (SODIS) or ultraviolet disinfection processes, as well as products combining coagulant and disinfectant.

We can see the section of two conventional POU filters with the description of each element; the ceramic water purifier (far left) is a concrete sand (BSF) concrete filter (second left). The two devices shown are positioned at 0.5 - 1 meter in height. The second image from the right is a photo of bottles placed on a roof of a house, illustrating the practice of solar disinfection (SODIS, acronym). On the far right, a picture of a Procter & Gamble coagulation / chlorination packet, PUR; a single pack contains 4g of crystals that can be used to treat 10 liters of water.

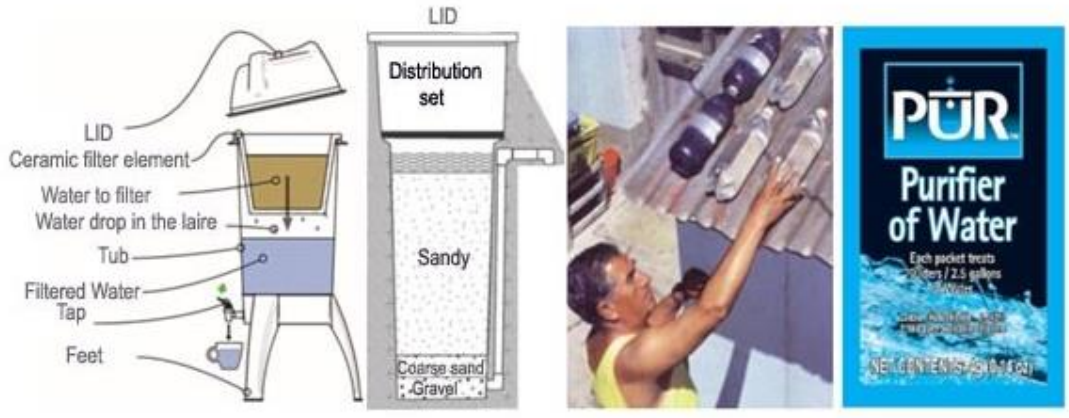


Figure 32 : Cross-sections and photographs of the four popular technologies POU.

Promote the Use of Plumbing Devices and Water Saving *Devices*

The most common water-saving appliances include dishwashers and washing machines; the most popular plumbing items are showerheads and faucets. At comparable efficiency, they simply save water (for example, reduced jet shower heads). These appliances can also be much more complex, such as plumbing fixtures that use the gray water sinks for toilet flushing (see Figure 33).

Figure 33 : Plumbing fixtures that use gray water from sinks for flushing toilets

Desalination

Desalination is the removal of sodium chloride and other dissolved constituents from brackish water, sewage, or contaminated fresh water.
Two liquids result from desalination: (1) purified water (2) and a liquid with a very high concentration of waste or brine. The main desalination methods fall into two categories: thermal processes and membrane processes.

Figure 34: A diagram illustrating the distillation of water, the simplest process of thermal desalination. In the figure below, we see a flame applied to a beaker containing salt water; the water evaporates, but the salt remains. The water vapor then moves and climbs into the adjacent tube where it condenses and then drips into the flask. It's pure water now. Modern thermal processes have a much higher efficiency than simple distillation.

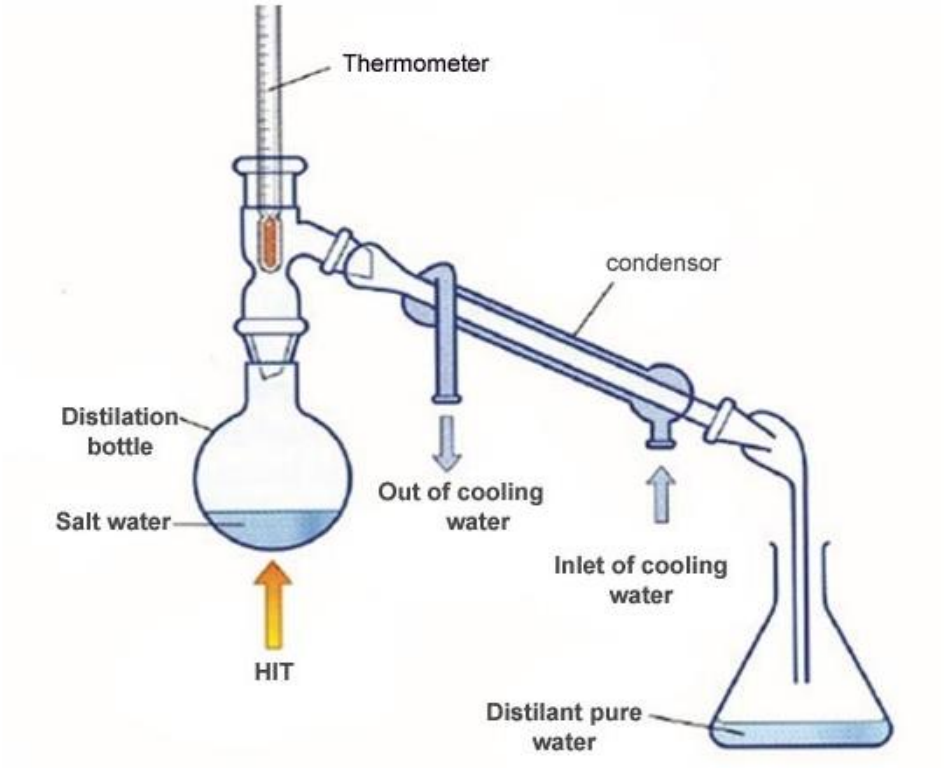


Figure 34 : Illustration of the distillation of water

Figure 34: A simple diagram of reverse osmosis, the most commonly used membrane process for desalination. In this scheme, a strong pressure is exerted on the salty water, which forces the molecules of water to cross a membrane having very small holes; the salts can not pass, and then remain behind.

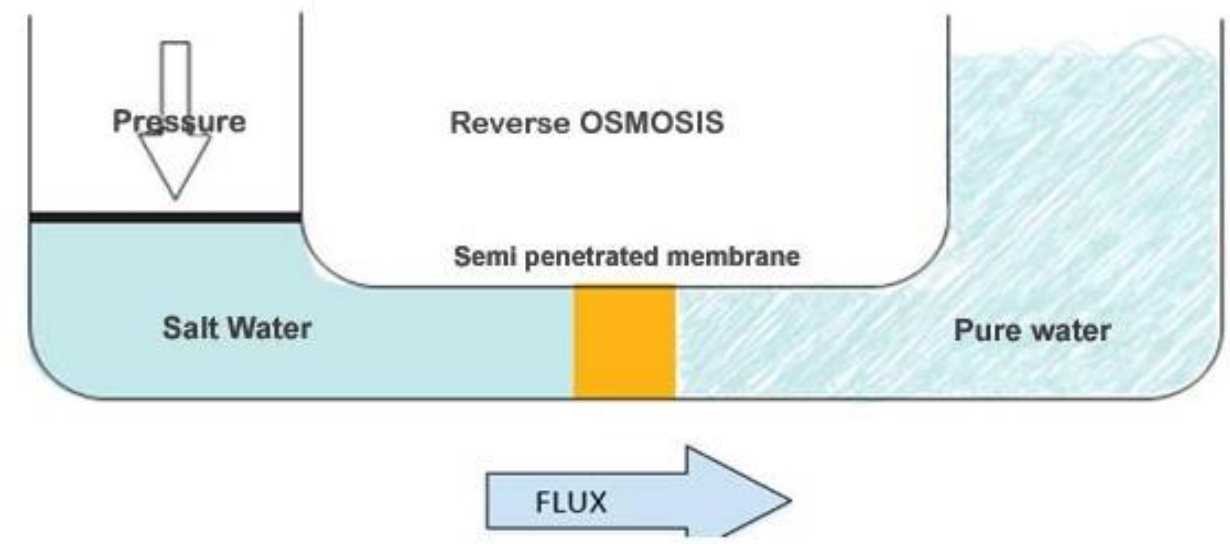


Figure 35 : Reverse osmosis

Desalination technology has been progressively developed around the world, resulting in a steady improvement in energy efficiency and sustainability. These improvements have also reduced the operational and maintenance costs of many other technologies. However, research and development of new technologies could potentially lead to substantial improvements. These new technologies include nanotubes, high-tech electrodialysis membranes and biomimetic membranes.
Desalination can play a major role in facilitating adaptation to climate change, mainly because it allows for the diversification of water supply and increases the resilience to degradation of water quality. Diversification of water supply can provide alternative or complementary water sources when current water resources are insufficient in quantity or quality. Desalination technologies also improve resistance to water quality degradation because they can usually produce very pure water, even from highly contaminated spring waters.

Point-of-use water treatment

In many parts of the world that do not have access to drinking water sources, especially those lacking efficient centralized water systems, point-of-use water purification options may be a way to effective to provide clean water. Boiling is a commonly used water treatment method, but the energy required, and the time needed to boil and cool water are persistent concerns.

Wastewater treatment

A wide variety of available water treatment technologies may previously run non-potable water sources in drinking water or water sources suitable for other targeted uses, including industrial uses. Treatment technologies can eliminate microbial and chemical contaminants.

b. Flood Reduction

The impact of climate change is also expected to include an increase in floods due to extreme weather events. Adaptation technologies to reduce the impact of flooding include improving rainwater and flood management and reducing the impact of localized flooding.

Rainwater Management

Rainwater Source Control encompasses a series of technologies designed to reduce the loads of runoff and pollutants entering the drainage system

c.Other technologies

c.1. Improve the Resistance of Protected Wells against Floods

Protected wells may include tubular wells, boreholes, and dug wells (by hand). Tubular wells and boreholes are wells with a small diameter hole that descends into an underground aquifer. A tube descends on part or the entire length of the borehole. Wells dug are generally more vulnerable to contamination than tubewells / wells, but protected wells can also provide "improved" drinking water. Among the advantages of dug wells are inexpensive construction and, generally speaking, greater volume yield relative to depth (because they are often larger in diameter).

The main features of all protected wells are: (1) a concrete deck to guide surface water away from the well; (2) a sanitary seal (normally made of clay, putty or concrete) that extends at least 1 to 3 m underground to prevent the ingress of contaminants; and (3) a water access system that can be closed after use. Handpumps can be mounted on most wells (including hand-dug wells) to improve ease of use and reduce the likelihood of contamination.

Figure 36 : Anti-flood hand pump

The apron is 1 meter high and 2.9m in diameter. The angle of inclination is 45 degrees, progressive enough to prevent the base from being damaged in case of floods.

IV.1.2.3. Energy sector

a. Climate change Impact in the energy sector

In Burundi the major impacts related to climate change in the energy sector are mentioned in the National Action Plan for Adaptation to Climate Change:

- the more frequent shutdown of some hydroelectric plants in service following the exceeding of the operating thresholds because of rainfall deficit and prolonged drought;
- the total siltation of some dams as a result of greater erosion due to increased rainfall leading to the total stopping of some hydroelectric plants, the most threatened being the Marangara, Buhiga and Kayenzi plants;
- increased runoff from land degradation in watersheds of hydroelectric power plants more frequent floods in electricity production infrastructures such as those in Mugere, stopping production for longer periods;
- increased runoff from land degradation in hydroelectric plants watersheds

- a significant fluctuation in electricity production following attacks on the water supply system and changes in rainfall patterns;
- a larger deficit in the electricity sector leading to real electricity supply problems in the various socio-economic areas of the country;
- a widespread problem of lack of firewood and charcoal due to increased and combined pressure of human activity and increasing temperatures and a change in biomass growth rates.

Table 30 : Expected Impacts of Climate Change and Technological Needs

Anticipated impact of climate change	Technological needs
More shutdown of some hydroelectric plants due to rainfall deficit and prolonged drought	✓ Better plants design by integrating climate change ✓ Reforestation of the watersheds of the construction sites of the hydroelectric plants
Total siltation of some dams resulting in production stoppage	✓ Reforestation of the watersheds of the construction sites of the hydroelectric plants ✓ Practicing zero tillage in areas close to hydroelectric plants
More frequent floods in power generation infrastructures leading to shutdown of production for longer periods	✓ Reforestation of the watersheds of the construction sites of the hydroelectric plants ✓ Improvement of flood control and management techniques ✓ Building flood protection structures
Roadwater runoff from land degradation in hydroelectric watersheds	✓ Reforestation of watersheds at hydroelectric power plants construction sites ✓ Put in place erosion control devices ✓ Practice smart farming
Significant fluctuation in electricity production following attacks on the water supply system and changes in rainfall patterns	✓ Diversify the energy electrical production means ✓ Adopt energy saving practices ✓ Plan investment in the energy sector by integrating

Anticipated impact of climate change	Technological needs
	climate change
A larger deficit in the electricity sector with its consequences for the various socio-economic sectors of the country;	✓ Diversify the means of electrical energy production ✓ Adopt energy saving practices ✓ Plan investment in the energy sector by integrating climate change
A widespread problem of lack of firewood and charcoal due to increased and combined pressure of human activity and increasing temperatures and a change in biomass growth rates	✓ Intensification of reforestation programs ✓ Biomass densification ✓ Improved carbonization techniques ✓ Cooking habits change ✓ Woodfuel substitution technologies ✓ Improving the yields of households using woodfuels

The energy sector not only causes climate change because of greenhouse gas emissions, but is also severely affected by its impacts. In particular, the energy sector in Burundi will be strongly affected by climate change, while having the weakest capacity to increase its resilience. As demand for energy continues to grow, this sector could be resiliently transformed to avoid the risk of becoming locked into unsustainable energy growth patterns.

The entire value chain of the energy system - production, transportation, distribution and consumption - is increasingly affected by climate events. Droughts and floods will significantly affect hydropower generation. Transmission and distribution lines are at risk of catastrophic damage from storms and cyclones, which could lead to costly power outages. Energy demand is also expected to increase as the warmer climate will require additional cooling requirements.

Adaptation technologies involve reducing both the exposure and vulnerability of the energy system to the hazards of climate change. Adaptation solutions, whether structural or political, exist for each energy player and each segment of the market. Diversifying sources of energy production can increase energy security and therefore the resilience of the entire energy system.

Table 31 : Technologies for adaptation to climate change in the energy sector

Subsector	Technology
	✓ Wind turbines with low wind speed as those with vertical

Subsector		Technology
		✓ Decentralized production system ✓ Photovoltaic systems at community and family level ✓ Pico hydropower plants
Biomass energy		✓ Improved carbonization furnaces ✓ Press for Biomass Briquette
Peat		✓ Boiler upgrades ✓ Carbonization furnaces
Electricity Transport		✓ Intelligent control of peak load, use of DC power for long distance transport
	Building	✓ Low consumption lamps ✓ Intelligent lighting control devices ✓ Low energy consumption devices ✓ Low energy consumption sensors with wireless communication
	Transport	✓ Traffic lights ✓ Electric vehicles ✓ Urban planning to avoid traffic congestion
	Industry	✓ efficient boilers ✓ High efficiency motors ✓ High efficiency motors ✓ Cogeneration
	Households	✓ Improved stoves ✓ Household equipment with low energy consumption ✓ Household equipment with low energy consumption

Subsector		Technology
		✓ Intelligent lighting control devices

b. Technology assessment in the energy sector.

The assessment focuses on technologies that are easily domesticated and exploitable in Burundi with a significant impact on adaptation or mitigation.

Turbines with vertical axis

The vertical axis wind turbine is a very simple device that consists of a wheel mounted on an axis. Under the effect of the wind, blades, integral with this wheel, move and produce electricity through the generator. Vertical wind turbines have a very simple operating principle.

Domestic vertical wind turbines do not require an orientation system with respect to wind direction and are not subject to major manufacturing constraints (concerning blades, bearings or axles). The construction of a vertical axis wind turbine is quite feasible by an amateur builder and the price of a vertical wind turbine is very affordable.

This type of wind turbine is very suitable for areas of winds hindered by terrain or housing, such as houses in urban areas. They also have the immense advantage of being able to catch very weak winds (for the pumping of water, they are ideal). In the case of strong and turbulent winds near the ground, they have the ability to self-regulate in speed. Their sound level is almost inaudible which can be interesting if one is easily bothered by the noise. These advantages allow the vertical axis wind turbine to be installed near buildings or even on city rooftops.

Technology: Pico-hydroelectric plants

The principle of operation of a small hydropower plant is to transform the potential energy of a waterfall into mechanical energy by means of a turbine, then into electrical energy by means of a generator. The installed capacity of the plant is a function of the turbined water flow and the height of the fall. Two types of technologies exist.

Swirl Hydraulic Plant

This type of plant developed in Austria, with immense potential and requiring little technique, does not need a big slope to work. A water supply channel from a river to a circular rotating basin of a certain diameter with a blade rotor placed in the center of the basin allows the

production of 80 to 130 MWh per year, depending on the quantity of water and the depth of the basin. The rotor works by the force of current and gravity, driving a generator that will produce electricity.
A hydraulic vortex plant can operate from a drop height of 0.7 meters and an average water quantity of 1000 liters per second. This technology is practically safe for fish as they can safely cross the small hydropower plant both upstream and downstream. Units capable of producing from 10 KW are available and a first Swiss vortex power plant was inaugurated in Schöftland, Canton Aargau, Switzerland, on September 25, 2010. This plant uses a 6.5 meter pond. diameter and a 1.7 ton rotor rotating at 20 revolutions per minute and thus being safe for river fauna. It produces 10 to 15 kW continuously, or 130 000 kWh over a year, allowing the supply of electricity.

Fluvial water

A riverine turbine is a hydraulic turbine that uses the kinetic energy of marine or fluvial currents, as a wind turbine uses the kinetic energy of the wind. The turbine of the tidal turbine allows the transformation of the kinetic energy of the moving water into mechanical energy which can then be converted into electrical energy by an alternator. The machines can take the most varied forms, ranging from the large generator of several megawatts immersed in depth in spots with very strong tidal currents to the floating micro-generator equipping small streams of river.

The different advantages of tidal turbines are:

- Lake Tanganyika and the rivers of Burundi constitute a potential of important marine and fluvial currents;
- Tidal turbines use renewable energy, do not pollute and do not generate waste (at least in their operating phase);
- Due to the high density of water (800 times that of air), the tidal turbines, with equivalent power, are much smaller than wind turbines. They have a limited visual impact and do not require complex civil engineering works unlike hydraulic dams.

Intelligent control of lighting

The goal of lighting control programs is to provide the comfort and flexibility required by users, while simultaneously ensuring active energy saving that minimizes costs by turning off lamps as soon as they stop working. to be used. For that, the techniques are numerous and their sophistication can vary enormously, but the amortization period is generally short, between six and twelve months. Many devices are currently exploitable on the market. These devices include:

- The timers, they turn off the light after a certain time, useful when the periods of occupation or activity are clearly defined such as for places of passage.
- Occupancy sensors and motion detectors turn off the light when no motion has been detected for a while. They are particularly suitable where the periods of presence and activity can not be known precisely (storage rooms, stairs, ...)
- Les cellules photoélectriques et les capteurs de lumière naturelle pour contrôler les lampes situées à proximité des fenêtres. Lorsque la lumière naturelle est suffisante, les

lampes sont éteintes ou mises en veilleuse. Photoelectric cells and natural light sensors to control lamps located near windows. When there is sufficient natural light, the lamps are switched off or are put on the back.

- Programmable clocks, they turn lights on and off at certain predetermined times (storefronts, offices for W-E's and nights).
- Luminaires with variable intensity, they provide a reduced lighting (night light) during periods of low activity (eg well lit parking until midnight, but with little light from midnight until dawn).
- Voltage regulators, ballasts or special electronic devices, they optimize the energy consumed by the lamps (fluorescent tube, high-pressure sodium lamp, etc.).
- Wireless remote controls, the application of which allows a simple and economical modernization of existing installations.

These techniques can be combined and also associated with aesthetic criteria, for example programmable lighting panels in meeting rooms that have several lighting formulas (board of directors, presentations, symposia, etc.) that can be updated by simple touch of a button.

Photovoltaic systems at community and family level

In Burundi, most community facilities dedicated to health and education do not have access to electricity. For facilities located in remote areas outside the national electricity grid, the solar photovoltaic (PV) system can provide the most convenient and cost-effective way to access electricity. The photovoltaic solar energy system uses a predictable solar resource and at competitive prices from those of diesel generators or any other alternatives. For example, in schools and health centers in rural communities outside the national power grid, the solar PV system is often the most appropriate way to operate low-voltage electrical equipment and appliances and a significant value, especially for electric lamps, vaccine refrigerators, water pumps, televisions and computers. Therefore, if the national power grid is not expected to arrive in the near future as is generally the case and fuel is not always available, the solar PV system is the preferred option cheaper to provide the service of electricity.

Similarly, solar energy can be a good source for the operation of irrigation pumps.

Technology: Production of fuel biomass briquettes

The production of biomass briquettes is done through several processes depending on the pressure to exert on the biomass.

High pressure processes generally release enough lignin to agglomerate the briquette. Medium pressure machines may or may not require binders, depending on the raw material, while low pressure machines invariably require binders. These external binders can be: starch, clay, molasses or wood tar, etc. All briquettes using inherent binders (lignin) or external hydrophilic binders (starch, molasses, gum, clay) are not watertight and disintegrate in contact with water or stored in wet conditions. Low pressure presses work more easily with previously carbonized biomass. Since the prior carbonization of biomass is difficult in the context of refugee camps under analysis, it is not taken into account in the options. Indeed, for

the carbonization of biomass, it is necessary to control the temperature in the grinding wheel (carbonization furnace) and air inlet so as to stop the flow of air when the carbonization begins.

Improved stoves and energy efficiency measures

This is the provision and encouragement of the use of materials or culinary practices to optimize energy consumption.
Among the facilities that can contribute to energy efficiency at the household level, there is the improved fireplace. Several types of improved cookstoves exist in developing countries, but in the subregion, tests have been conducted to characterize the different types of households in use.

Culinary habits change

The synthesis of test results on the effect of bean steeping has shown that fuel consumption and cooking time are considerably reduced.

Biogas (construction of digesters)
About 60% of methane by volume can be produced by anaerobic (oxygen-free) bacterial degradation of faeces with a thermal value of 25MJ / kg. This anaerobic digestion also produces about 40% of CO2. Biogas is therefore a mix of these two gases.

According to the different studies carried out in the field of biogas production; an adult person can produce an average of 200 g of feces that can generate 50 liters of methane per day if the biomethanization is done under optimum temperature conditions (Mesophilic anaerobic digestion (25-40 ° C) represents the optimal range for biogas production), pH (Bacteria involved in anaerobic digestion supports pH between 6 and 8, with an optimal activity around 7) and agitation of the anaerobic digester to enhance the methanogenic activity. Also, to make the waste biomethanizable, it is necessary to have enough water.

IV.1.2.4. Transport and infrastructures Sector

a. Impact of climate change on the infrastructures sector

The impact of climate change on infrastructure can affect the economy and other sectors, including agriculture and public health. Interruption in the movement of goods, services and citizens caused by serious damage or progressive deterioration of road networks, traffic jams or unreliable transport services may prevent access to health care, employment, markets and other critical needs. In addition, repairs made necessary by infrastructure damage have major economic implications.
Changes in precipitation and temperature regimes can stress infrastructure beyond planned capacity. Temperature changes - both average temperature changes and extreme variations - will increase the incidence of roadway, bridge and embankment damage and failure, while changing the maintenance, comfort and safety requirements passengers and take off planes. Higher humidity can lead to overloading of the drainage system, migration of liquid asphalt and impact on infrastructure foundations. Extreme events (fires, floods, landslides, mudslides, etc.) and the debris that accompanies them can block roads and bridges permanently or temporarily. Erosion and landslides leading to failure of embankments, embankments and foundations will damage and disrupt infrastructure and services. The impact of climate

change may also interfere with repair and maintenance efforts (for example, by reducing water availability during construction and thereby compromising the ability to compact materials, causing salt-related corrosion) and disrupting traffic.

Table 26 summarizes the effects of climate change and the technological needs described above, and indicates the potential for applying adaptation technologies to reduce the vulnerability of the transport sector to these effects. This list of technology needs is not exhaustive.

Table 32 : Transportation Technologies for Climate Change Mitigation and Adaptation

Projected impact of climate change	Technological needs	**Technology**
Damages to the road network due to extreme weather events	✓ Improved construction techniques to withstand heat, floods and high winds ✓ Improved disaster management	✓ Composite based on cement ✓ Intelligent Transportation System
Damages to infrastructures due to extreme events	✓ Enhanced Forecasting and Early Warning Systems * ✓ Improved construction techniques to deal with floods and high flows ✓ Improved disaster management	✓ Composite based on cement
Damages to coastal infrastructures	✓ Improved prediction of extreme weather events ✓ Improved construction techniques to deal with floods and high winds ✓ Improvement of disaster management	✓ Active motion damping system ✓ Setting up a meteorological network
Major transport disruption due to extreme events	✓ Improving the prediction of extreme weather events ✓ Integrated emergency planning ✓ Improving rainwater management ✓ Improved construction techniques to deal with floods and high winds	✓ Intelligent transport systems ✓ Cement based composite

a.1. Improve durability of pavement materials

Warming average temperatures and the potential for greater fluctuations in extreme temperatures will have significant effects on pavement pavement. Paved roads are particularly vulnerable. Materials such as asphalt expand under excessive heat, causing ruts and deformations, and even irreversible damage. Base or support layers may be degraded by poor drainage. In addition, flooding can result in property damage or service delays, and high discharge events can cause erosion and leaching.

Composite based on cement
The description.

Cement-based Composite is relatively new and is reinforced with fibers, unlike traditional concrete, reinforced with steel reinforcement bars. It is reinforced by small fibers randomly distributed throughout. Concrete can consist of "a large volume of industrial waste, including fly ash, crushed granulated blast furnace slag, waste foundry sands and carbon residues" (Lepech et al., 2008, 837).

a.2. Improve the resilience of ports

Maritime transport will also be affected by climate change. For example, rising sea levels will increase flooding in ports, more extreme or more frequent extreme events will increase the risk of structural damage to ports and ships, and possible changes in wind speed and configuration. affect the loading and unloading of containers. Strong protection can be provided to reduce this impact, or the materials can be protected against flooding.

Active motion damping systems

One of the port's primary concerns with rising seas and coastal storms is the amount of movement that occurs between ships and wharves when vessels are moored, and the resulting tension on the mooring lines. . Large movements during strong waves or storms can increase vessel downtime and create dangerous voltage on ship lines.

Active motion damping systems are automated mooring systems used in parallel or in replacement of traditional mooring techniques. They can reduce tension on the lines or even eliminate the need for conventional mooring lines, thus helping to minimize ship movements when in port.

a.3. Manage transports with technology

Intelligent transport systems

ITS apply information and communication technologies to transport. Computers, electronics, satellites and sensors are playing an increasingly important role in transportation systems. Although some components of ITS have been in use for several years, there is growing interest in how ITS can help countries adapt to climate change.

ITS has several applications, many of which will help make the transport system more resilient and improve adaptive capacity to deal with extreme events. ITS has the potential to provide adaptation benefits for road condition monitoring and for disaster preparedness, management and recovery.

Information on atmospheric and physical conditions can be integrated with Intelligent Transportation Systems (ITS), such as automated traffic control and travel advisory systems, to address transportation challenges.

IV.1.2.5. Human health

a. Impact of climate change on the human health sector

In Burundi, land use, population growth and density, and depletion of resources already have implications for human health. Interaction with the impact of climate change could amplify these effects). Unfortunately, climate change is likely to increase the size of already vulnerable populations (children, the elderly, the poor) and worsen health disparities. These populations are already experiencing an impact on climate-related health, but it is difficult to determine because of the indirect nature of much of this impact and the difficulty of separating the signal of climate change from other changes.

The potential adverse health effects of climate change span a wide range and include more direct effects. These include deaths and injuries resulting from extreme events (eg floods, prolonged heat waves), changes in the extent and seasonality of climate-related health hazards (decreased safety and availability of water and air quality), incidence of water-borne and vector-borne diseases (eg malaria, cholera, etc.). Declining productivity in labor-intensive subsistence agriculture and other activities outside the labor force, as well as crop yields that are likely to cause malnutrition, are also likely.

Table 33 : Human Health Technologies for Mitigation and Adaptation to Climate Change

Expected impact of climate change	Technological needs	**Technologies**
The increase of waterborne diseases	✓ Improved water treatment and distribution ✓ Better surveillance of disease outbreaks ✓ Improving access to health care, diagnosis and treatment	✓ drinking water well flood proof ✓ Anti-flood sanitary latrines ✓ Disease Surveillance Systems ✓ Anti-flood sanitary latrines ✓ Drinking water well flood proof
seasonality, and the impact of vector-borne diseases	✓ Integrated pest management ✓ Improving access to health care, diagnosis and treatment	✓ Mosquito nets with durable insecticides ✓ Disease Surveillance Systems ✓ Rapid diagnostic tests

a.1. Reducing the impact of climate change, a source of vector-borne diseases

Non-action insecticide-treated mosquito nets

Strengthen and expand bed net distribution programs in new areas and beyond traditionally targeted at-risk groups (eg pregnant women, young children), can serve as health interventions in light the impact of climate change. These programs rely on effective options for bed nets. This section specifically refers to so-called "long-lasting insecticide-treated bednets" or "MIILDA". Polyester, polyethylene or polypropylene MIILDA are treated with pyrethroid insecticides at the time of manufacture. Users are protected not only by the physical barrier, but also by the insecticidal action of the net.

Rapid Diagnostic Tests (RDTs)

RDTs (sometimes called "test strips") are simple tests at the place of treatment. These kits allow, through various methods, to quickly diagnose diseases such as malaria, tuberculosis, AIDS, syphilis and visceral leishmaniasis. Many work by detecting antigens or antibodies in blood samples from chronically infected or newly infected patients. Malaria RDTs currently on the market use immunochromatographic lateral banding technology. Absorbent nitrocellulose bands change color in response to the antigens or enzymes of one or more species of malaria parasites in human blood; the development of a colored line on the band indicates a positive result. Compared to traditional laboratory microscopy for diagnosis, RDTs require less time (results available in 5 to 20 minutes), less training, no additional equipment and consumables, but they have a relatively high unit cost and are designed to punctual use.

Integrate advanced information technologies into the health sector

Companies can reduce their vulnerability to climate change by improving public health through advanced information technologies. These include both disease surveillance and intervention technologies (and technologies to make high quality clinical care more accessible and robust to address stressors related to human health.

Increasing emphasis is being placed on the early detection of epidemics which, in the modern era of travel, threaten to turn into transnational incidents. In 2005, WHO updated its International Health Regulations (IHR) (legally binding for 194 member countries), which specifies and imposes improvements to national responsibility and capacity for the detection and reporting of health emergencies and significantly expands the scope of notifiable diseases. Regions are empowered to use regulation as a mechanism to address public health emergencies of international concern and to enhance global interdependence in the fight against infectious diseases (Ashar et al., 2010, Andrus et al., 2011; 2013, Lewis et al 2011, Morse 2012).

Disease surveillance systems

Disease surveillance systems refer to various types of advanced information and communication devices and applications that can help health professionals to collect, process, interpret and disseminate data more effectively to support surveillance and the response.

Anti-flood sanitary latrines

Household and community wastewater treatment facilities involve various methods of constructing permanent, elevated or otherwise flood proof latrine structures to minimize contamination of freshwater sources during floods. Latrine technologies include:

Flood-proof drinking water well

Similar to the latrine adaptations explored in the previous subsection, new technologies or design considerations can be introduced to protect drinking water wells threatened by increased risk of flooding. "The main vulnerabilities of wells during floods are: penetration or infiltration of contaminated water; lack of access to the wellhead due to flooding; and the collapse of un-coated hand-dug wells when the soil is saturated.

IV.1.2.6. Forest resources

In Burundi, forest resources are made up of artificial woodlots belonging to the State, the communes and the private sector; they are also composed of natural forest (KIBIRA), nature reserves and other protected areas, trees outside forest (diffuse wooded areas). Agroforestry accounts for about 60,000 ha. Installed since 1978, artificial afforestation was carried out as part of an extensive reforestation program undertaken by the government with the support of foreign donors.

a. Impacts of climate change on forest resources

Forests and afforestation provide the livelihood base for the vast majority of Burundi's population, providing fuelwood and charcoal needed for cooking but also providing timber for the inhabitants different uses in the various sectors of the socio-economic life. Forests and woodlands contain more than 80% of the Earth's biodiversity and help protect the watersheds that are essential for clean water supply. However, climate change is causing huge negative impacts on forests and people. Forests and afforestation provide the livelihood base for the vast majority of Burundi's population, providing fuelwood and charcoal needed for cooking but also providing timber for the inhabitants different uses in the various sectors of the socio-economic life. Forests and woodlands contain more than 80% of the Earth's biodiversity and help protect the watersheds that are essential for clean water supply. However, climate change is causing huge negative impacts on forests and people.

Adaptation and mitigation are the two main responses to climate change, mitigation seeking to combat its causes and adaptation to reduce its impacts.
In the forestry sector:

- Mitigation strategies include reducing emissions from deforestation ; reducing emissions from forest degradation; strengthening the role of forests as carbon sinks; Substitution of products, for example the use of wood instead of fossil fuels for energy production, or the use of forest products in place of materials the manufacture of which would cause high emissions of greenhouse gases ;

- Adaptation includes interventions to reduce the vulnerability to climate change of forests and the populations that depend on them.

Implementing Sustainable Forest Management (SFM) can not only reduce the risks posed by climate change, but also create opportunities such as employment in forest restoration, conservation, timber production and the manufacture of wood-based objects; land tenure reforms; and payments for forest related services. Promoting SFM and optimizing its role in mitigating and adapting to climate change will often require changes in policies, strategies and practices.

In general, impacts of climate change on silvicultural production and forest ecosystems vary according to the species in place, the ecological environment and the responses to adaptation.

Table 32 below summarizes the immediate impacts of climate change and the actions to be taken and the technology needs to reduce these impacts.

Table 34 : Summary of the immediate impacts of climate change on forest management and afforestation

Impact of climate change	Technology needs	**Technologies**
Degradation of forests and afforestation	✓ Degradation of forests and afforestation	✓ Natural regeneration ✓ Assisted reconstitution of natural stands
Shortage of wood energy due to lack of natural regeneration	✓ Use of renewable energies other than wood	✓ Biomass intensification for the production of briquettes to replace charcoal and firewood ✓ The enrichissement ✓ Assisted reconstitution of stands
No habitats for species	✓ Conservation of vulnerable species ex-situ to climate change	✓ Establishment of an agroforestry tree seed bank
Slumping forest tracks and culverts	✓ Protection of forest slopes by alignment trees, grass cover and rainwater drainage and regular maintenance	✓ Planting Alignment Trees ✓ Planting soil fixing herbs
Destruction of nurseries	✓ improvement of nursery installation techniques	✓ Direct semi-enrichment

Impact of climate change	Technology needs	**Technologies**
Destruction of the ecosystem	✓ Promotion of deep-rooted species	✓ Plant Selection
Loss of biodiversity	✓ Developing mixed reforestation that mixes species in a single wooded area	✓ Assisted rebuilding of natural *stands* ✓ Variable retention cups
Destruction of seed stands	✓ Creation of seed stands in different agro-ecological zones	✓ Agroforestry tree seed bank
Bushfires	✓ Sensitization of the population on the harmful effects of bushfires	✓ Installation of firebreaks
Desiccation of the plant cover	✓ Promotion of drought resistant species such as ficus, conifers, etc.	✓ Species selection ✓ Converting to plantations
Appearance of new species of fauna and flora including plant pests	✓ Tracking the behavior of new species	✓ Varietal SelectionS ✓ Training on the biological composition and functioning of forests

Natural regeneration

It is the existence and vitality of natural regeneration that ensures the renewal of exploited production stands. Disturbances caused by the opening of stands induce a reaction of the remnant stand. At first, this stand is destabilized with a high mortality of young stems. An opening beyond one-third of the stand (30% of the original basal area) favors pioneer, invasive and short-lived species, to the detriment of sun-loving species of structural, biological and / or commercial interest. After two to three years, mortality decreases but remains higher than in intact stands. The recruitment of young stems and the growth of medium-sized replacement trees are stimulated for about ten years.
The regeneration of most valuable species requires the maintenance of seeds regularly scattered in the forest. Selected clumps or islands are therefore to be preserved within the exploited areas in order to serve as a refuge and genetic reservoir. Corridors should connect them to the untapped parts of the forest. They must be preserved and lifted before cutting operations. This recommendation is present in ITTO guidelines, and is also advocated by IUCN. It is very difficult to enforce, despite its importance for the ecosystem and only a very effective incentive mechanism would allow its respect on the part of users of the resource.

Assisted reconstitution of natural stands

The aim is to promote the regeneration and development of commercial species through logging and cultivation, while maintaining the original structure of the stand and, if possible, its diversity.
The reconstitution of the stand is to be encouraged by the traditional silvicultural care. Short-rotation selective systems of 20 to 30 years can only be applied in stands rich in species of the future and this, provided that thinning is done at the expense of large trees in excess or unusable. Otherwise, we have to adopt longer rotations, of the order of 50 years. The lower exploitability diameter limits depend on the composition and structure of the forests (as well as other factors such as markets or processing possibilities) and no standard recommendation is valid, other than adopt safety margins. To avoid irreversible destruction of stands, in any case avoid removal of more than 30% of the basal area.

Fortification

Fortification is an extensive silvicultural method for natural stands depleted in commercial species. Fortification consists in supplementing the capital of pre-existing commercial species by tight planting (3-4 meters) of valuable species in parallel layouts open in the forest (20-30 meters wide). This method has been used all over the world, sometimes successfully, on relatively small but well-controlled areas. Indeed, its character is certainly extensive, but it requires a great rigor in monitoring. Enrichment has the merit of preserving the natural forest without disturbing it too much, but it also has drawbacks: difficult control of works, long-term planning of interventions, high manpower requirements, etc.

Conversion to plantations

The conversion to plantations is aimed at very degraded, poorly productive forest stands, which are thus replaced after clearcutting. The degree of intensification of the methods may vary according to the means available and the objectives. It is necessary to take into consideration: the appropriate choice of sites to be afforested or reforested and adapted reforestation technique, the use of efficient plant material, the maintenance of young plantations, the management of artificial stands (pruning, thinning, etc.), the protection of reforestation against phytosanitary risks and the technological quality of the timber produced. All of these measures must provide cost control that is needed to intensify reforestation efforts. Different methods can be used for the conversion of natural forests: manual, mechanized, combining reforestation / agriculture. The choice must be made according to ecological, economic, sociological and technical criteria. Manual methods require the mobilization of a large workforce that is not always available when needed. The need for long-lasting reforestation of large areas often requires the mechanization of certain tasks. The problems of intensive mono-specific plantations carried out over large areas are numerous (especially in the phytosanitary field) and especially difficult to manage logistically. Blending associations increase variability in the structure and architecture of planted stands, promote the elimination of unwanted species, limit fire risks and provide good soil protection against erosion.

IV.1.2.7. Waste management

a. Climate change Impact on waste management

In Burundi, the population does not have access to a garbage collection service and the service is irregular where it exists as in certain districts of the city of Bujumbura. This results in a proliferation of wild deposits, sources of nuisances, health and environmental risks, presence of flies, mosquitoes, rats, bacteria, parasites, spread of diseases such as cholera, lung infections, etc. ... The Buterere wastewater treatment plant is no longer functioning properly. There is also toxic gas emissions from the decomposition of hazardous, biomedical waste that is usually incinerated in incinerators in hospitals and health centers when they exist. In addition, sewers, agricultural waste, hydrocarbons and other toxic chemicals are sometimes dumped into rivers and lakes resulting in the destruction of aquatic fauna and flora.

Table 35 : Matrix of the impacts of waste management

Impact	Technological needs	Technology
N2O Emissions	✓ Management and treatment of solid and liquid waste ✓ Treatment and recovery of liquid waste in all urban centers ✓ Recovery of sludge as fertilizer	✓ Development of landfills and sewage systems in urban centers
Methane Emission	✓ Recycling usable products waste ✓ Methanization of fermentable waste for BIOGAZ production	✓ Biomethanization of biodegradable waste
Contamination of surface and groundwater	✓ Liquid waste treatment and recovery in all urban centers ✓ Recovery of sludge as fertilizer Recovery of sludge as fertilizer ✓ Developing food waste into energy	✓ Wastewater lagoon ✓ Densification of plant waste for the production of fuel briquettes

Wastewater Treatment

• Wastewater lagooning

Lagooning consists of establishing a slow gravity flow of wastewater in several shallow (0.4 to 1.5 m) retention ponds (from 3 to 5 m) by eliminating the risk of seepage into groundwater. The waste water arrives first in the pretreatments: degreasers, de-oilers, sandblasters, etc. which, as their names indicate, are responsible for removing solid particles and fats. The first basins are basins with micro-organisms, where the organic matter (OM) contained in the wastewater is degraded. The water then transits into shallower basins, macrophytes (irises, reeds, rushes ...). These absorb the mineral elements resulting from the degradation of the organic matter for their growth. This technique has the characteristic of requiring a large area, between 15 and 20 m^2 for a volume of 50 m^3 of water. The residence time must be high (minimum 30 days or more). The water that comes out of this system complies with the standards of Directive 91-271 of 21 May 1999 concerning purification parameters: Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Total Suspended Substances (MES) among others. Wastewater or polluted water is loaded with organic elements that are emitters of GHGs and which degrade the environment. This lagooning technique will treat these waters in order to eliminate these emitting elements.

The use of sludge from a sewage treatment plant for agricultural purposes

During the treatment of wastewater in a station, the sands are gradually deposited at the bottom of the basins while the fats rise to the surface thanks to air bubbles used as buoys. In the presence of oxygen sent to biological basins, naturally occurring bacteria in the water develop by consuming the dissolved pollution. The whole (dissolved matter and bacteria) forms activated sludge. In order to be recycled, sludge is dewatered in two successive stages: • flotation thickening, which separates the maximum amount of water from the sludge. • dehydration by addition of chemicals. Fine particles of flaked sludge are easily dehydrated. The sludge is then placed in centrifuges and dried.

The sludge obtained is used as compost for soil fertilization in place of chemical fertilizer in agriculture. The treated sludge during the treatment can be used as an organic fertilizer to replace the chemical fertilizers that emit more GHGs. In addition, the treatment of these sludge avoids the release of methane that would be emitted if they were not valued.

Biomethanisation of biodegradable waste or biogas production

Anaerobic digestion or methanization digestion is the biological degradation of biomass (wastewater, solid waste, organic waste, excrement of animals) in the absence of oxygen. The anaerobic bacteria ferment the biodegradable material to obtain a gaseous mixture called biogas composed of methane (CH_4), carbon dioxide (CO_2) and hydrogen (H_2). A digester refers to a tank (large closed vessel) that produces biogas through a process of methanization of organic matter. This biogas is obtained at a temperature of at least 35 degrees Celsius. The combustion of biogas releases CO_2, a greenhouse gas that is less harmful compared to its low global warming potential. As a reminder, a simple reduced scale bio-digester reduces between 3 and 5 t CO_2 eq / year.

IV.1.3. Major Constraints for Technology Transfer for Climate Change Adaptation in Burundi

The major constraints Burundi faces in strengthening its resilience to climate change are:

1) **Weak capacity in adaptation and climate risk management.**

Burundi is very vulnerable to climate change and does not yet have an adequate weather forecasting and early warning system. It will have to adopt innovative techniques to adapt and find solutions to the lack of financial means and necessary technical skills.

2) **Low GHG mitigation and sequestration capabilities and promotion of low carbon development.**

Burundi has significant potential for low carbon development including significant hydropower resources, significant potential for solar photovoltaic energy, potential for wind energy, and a favorable climate for forest development that is a GHG sink. However, it faces the initial costs, which are generally high for low-carbon investments and the lack of incentives for mobilizing private investment.
The Government has already committed to remove these constraints, particularly in the context of promoting public-private partnerships and improving the business climate, and these efforts will be continued.

3) **Weak institutional capacity.**

Several partners intervene in the fight against climate change. However, climate risks are not yet well known to all stakeholders, especially since they are not yet taken into account in sectoral policies and action plans. Institutional reforms are needed to mainstream climate change into all of Burundi's sustainable development policies.

4) Weak capacities in research and development and technology transfer

Burundi does not have the technical and financial means to carry out research and development in the field of climate change and does not have a national program related to it. With regard to the adoption of adaptation technology available on the market, the major constraint remains the high level of poverty, which means that clean techniques / technologies remain inaccessible to Burundian populations. On the other hand, developed countries do not allow the transfer of technology to developing countries preferring to sell finished products for protectionist reasons.
The solution to this situation will include measures that the Government will take and which include: promoting research development, technology adoption and domestication in the national context; strengthening the functioning of certain organizations and institutions involved in climate change; skills training and education; international cooperation, etc.

5) Lack of financial resources for climate change adaptation projects.

As already pointed out above, most of the climate change adaptation actions identified in the national and sectoral Action Plans already developed have not been implemented due to lack of financial means. This seems to be related to the weak capacity of stakeholders in the

domain of climate change (government agencies, private sector, civil society, local communities) to develop eligible projects and negotiate funding under existing mechanisms.

IV.2. Program for public awareness, education and training on climate change in Burundi

IV.2.1. Introduction

Burundi is affected by adverse effects of climate change. Ecosystems are disrupted by extreme weather events such as floods, droughts, hail, landslides. To these are added other threats such as food insecurity, population migrations, epidemics, etc. These phenomena are aggravated by very high population growth, poverty, gender inequalities and very limited preventive and resilient capacities face to climate change.

The effects of climate change combined with the livelihood vulnerability of Burundians require effective climate change mitigation and adaptation measures to be taken in the country, as well as measures for disaster risk reduction and strengthening and the resilience of the population to the effects of climate change.

The concept of "environment" in general and "climate change" in particular is not well known by all segments of the Burundian population and needs to be communicated at all levels to promote sustainable development.

The activity of man and especially the large-scale use of fossil fuels and deforestation are the most incriminated since the 20th century. No nation will be spared from the consequences of climate change and as the United Nations Framework Convention on Climate Change points out, states will have to take their responsibilities, of course differentiated because the contribution in greenhouse gas emissions is very pronounced in developed countries and still very low in the least developed countries.

The present program is intended for all Burundians, without any distinction so that they can be informed and know that climate change is a reality and do enormous damage in the world, especially in Africa and Burundi, but that the management of their harmful effects must be a challenge every day and forever.

IV.2.2. Inventory of public awareness on climate changes

According to the investigation on the public, the results showed that, on the whole, all the people who gave answers are aware of the phenomenon of climate change and its consequences. The population notes the irregularity of the rains and the damage that affects the infrastructures. They indicate that they are very concerned about this phenomenon and that climate change should be a priority in Government projects. Nevertheless, these interviews made it possible to understand that the public's knowledge is very vague. In general, the public does not understand the causes, the indicators, the possible adaptation mechanisms. The public does not feel the need for climate information even less the early warning system. Public knowledge is not pushed. It is observed that the public has not yet developed the culture of climate risk. For example, some interviewees indicated that they do not know any cause of climate change or at what time of the year can we expect the effects of

climate change that cause more damage. It is therefore difficult for the public to anticipate and adapt to climate change.

There is a lack of understanding of the interrelationship between climate change and unsustainable development processes in Burundi (especially deforestation, land degradation, construction in unsuitable places and unsuitable way, anarchic urbanization outside of the master plans of planning and urban planning).

On several occasions, local authorities converge on difficulties to raise population awareness, the mentalities of communities very difficult to convince. In addition, climate information is not reported locally. It is clear that local government at grassroots level (neighborhoods and hills) has no plans for mitigation and adaptation to climate change. There are also no committees to deal with the effects of climate change and disaster risk management.

In addition, it has been noted that the public is angry at the anarchic way in which buildings are erected in neighborhoods. For example, in the neighborhood of Carama, people indicate cases of roads that do not have the same dimensions upstream and downstream because of the particular people who exceed their plots delimited by the urban planning services. In addition, the public gives very little credit to the forecasts of the Geographical Institute of Burundi (IGEBU and many still prefer to interpret the sky themselves.In addition, with the interviews, we often find a confusion between the term of climate change and the broader issue of environmental issues Table 34 shows the strengths and weaknesses, opportunities and risks in the climate change sector in Burundi.

IV.2.3. Strengths and weaknesses, opportunities and risks

Table 36 : Strengths and Weaknesses, Opportunities and Risks

Components	Strengths	Weaknesses	Opportunities	Risks
Development of political, legal and institutional bases	- Existence of a national climate change policy - Responsibility for Climate Change (OBPE, Environment and Climate Change Direction) - Representations of the Ministry in charge of the environment, of the NFP-PRGC established at the provincial level and in the communes and hills (PFP, BPEAE) -Existence of a communication and extension structure (DGMVA) (to reach the vast majority of the vulnerable population in the CC) - Existence of the national gender policy -Existence of 12 master	-Lack of intersectoral coordination (MINING, Ministry of Public Security (MSP), Ministry of Hydraulic Energy and Mines, Ministry of Public Health, Min. Of Finance, Economic and Development Planning, Ministry in charge of home affairs, Ministry in charge of Industry) - Low intra-sectoral coordination (OBPE, IGEBU, ISABU) -Low mobilization of internal resources - Low involvement of the private sector in the area of CC - The CC sector does not reserve a space for local communities to participate - Low reporting and evaluation of public and private expenditures related to CC - lack of national expertise on climate change research	- Climate Change is a priority in PND 2018-2027 and in PAPs - Existence of sectoral groups for disaster risk management - High level of broad sectoral representation -Existence of public and private international climate finance (e.g. FVC, etc.) - Existence of 50 international public funds, 45 carbon markets and 6000 private equity investments providing international funding for the fight against climate change. - Improved stakeholder collaboration - Response and contingency plan - Support from the Global	- Deficiencies in the implementation of the National CC Policy and Strategies, -Increasing number of victims linked to climatic hazards, - Insufficient financial resources to adapt to climate change - Limited resources to implement low-carbon technologies

Components	Strengths	Weaknesses	Opportunities	Risks
	plans for teritory planning and urban planning -Existence of environmental management texts (EIA, codes, ordinances, etc.) - Existence of a variety of actors in the CC sector - Existence of UNFCCC Focal Points including IGEBU and OBPE -Burundi Ratification of International Treaties / Conventions (UNFCCC, Kyoto Protocol) - Knowledge of the international conceptual framework	- Low public awareness of policy content, CC strategies, laws, codes and master plans for environmental management - Laxity regarding compliance with environmental laws and standards	Environment Facility through UNDP, UNEP and other agencies in the implementation of the UNFCCC	
Capacity building of actors	-Existence of the national implementation entity of the UNFCCC and IGEBU: technical structure for risk assessment, seasonal forecasting and climate	- Low technical and operational capacity of IGEBU - Low capacity to identify, assess and monitor disaster risk - Climate information from IGEBU too complex, scientific and uncertain, - Low mobilization of internal	- Pilot projects for adaptation to climate change (MINEAGRI, GIZ, FAO, Oxfam, UNDP, etc.) - WMO, UNDP support to improve IGEBU equipment (studio and weather website, etc.)	- Loss of confidence in the IGEBU weather prediction -Insufficient quality climate information, - Insufficient infrastructure for hydrometeorological forecasting

Components	Strengths	Weaknesses	Opportunities	Risks
	change projection. - Experiences of climate change related to changing rainy seasons and increasing extreme climate events	and external resources - Absence of prevention fund and emergency management related to CC effects - Lack of appropiate financial, logistical and technical resources - Low gender involvement (women, youth, disabled, elderly, etc.) - For formal education, from basic education to university education, there is a lack of integration of CC issues and explicit references - Lack of information, sensitization and training programs for small and large populations on CC - Insufficient opportunities for continuing professional development for researchers at universities and / or research institutions -Research and science are not developed in Burundi to innovate in the direction of CC technology		
Sensitization of media and the population for the development of an effective early warning system	- Existence of a network of journalists on the subject of the environment - Existence of different communication	-Low knowledge and awareness of the population on CC; - Low sectoral ownership of the CC theme - Weak application of adaptation measures on CCs	-Devotion of journalists to work on the CC -progressive awareness of the effects of climate change due to climate disasters in 2014, 2015, 2016, 2017	-Increase in disasters in Burundi are related to CC (90%) - Continuation of practices that aggravate the impacts of CC (soil degradation, illegal

Components	Strengths	Weaknesses	Opportunities	Risks
	channels to reach the population, especially radio and mobile phone - Good level of organization including training mechanisms (Maison de la Press House, Associations) - Awareness on the fact that there are changes (floods, droughts, changes in the seasons beginning/end, duration)	- Low mobilization of internal and external resources - Low level of risk foresight at all levels - Absence of the early warning system - Absence of a mapping of risky or vulnerable areas - Lack of stakeholder synergy on CCs -Lack of structured access to CC information - Insufficient media coverage of hydro-meteorological forecasts -Low media involvement in aspects of CC	(due to El Nino / La Nina and others)	cutting of wood, reduction of wooded areas to the benefit of agriculture, construction in areas at risk and without adequate development, drainage of wetlands to extend agricultural areas)

IV.2.4. Target groups of awareness

According to the consulted documentary analysis and the survey carried out among officials of ministries, municipal administration and communities in flood-affected areas, many actors need to be sensitized on climate change and its effects in order to be able to play a more important role.

It was first mentioned that a top priority is the mobilization of high-level support because the formulation of adequate legislation and its implementation depend on the involvement of the executive and the legislature. Then, it was mentioned the need to sensitize the decision makers of the key ministries, the parliamentarians, the senators but also the administrative ones at all the levels (national, provincial and communal), the private sector, the industrialists, the civil society, the confessions representatives of the ministries concerned with the environment, energy, water resources, transport / infrastructure, agriculture and livestock, public health, education and communication and the vulnerable population, especially women, who play a key role in the Burundian household and in the management of natural resources. The same goes for journalists who should also be trained in these topics to better address and convey them.

It is essential to identify and set up platforms at the hill level so as to serve as a relay for local and everyday sensitization in rural communities. Hill platforms should be made up of hill chiefs, Presidents of Collective Development Committees (CDC), agricultural instructors, Community Animal Health Agents (ACSA), Presidents of hill co-ops, women's forums, young people, religious leaders, neighborhood leaders, but also the environmental associations and volunteers of the Burundi Red Cross and finally the school public. More specifically, to optimize the awareness of the rural world, it is necessary to formalize this institutional framework at the hill level.

IV.2.5. Channels of communication and awareness

According to the target group, awareness and communication channels should be different in one way or another. Sensitization at the highest level of the Government should go through an organization of regular meetings of policy makers and Ministers in vulnerable sectors to climate change, parliamentarians and senators to ensure a greater political weight to these issues but also by mobilization of financial and technical partners, both internally and externally, to fund projects to adapt to climate change and mitigate anthropogenic emissions of greenhouse gases

Executives from different ministries and administrators at different levels should be sensitized through promotion of sensitization, information, exchange, reflection on climate change and planning workshops to mainstream climate change, cross-cutting in sectoral development policies and programs to increase the security and resilience of communities to disaster risk. Outreach should also reach universities, NGOs by promoting high-level scientific and technical research to compare results, approaches and analyzes of options for complementarities and synergies of sectors. It is important to note that any planning should promote the participation of women, youth, and other special groups in climate change adaptation including decision-making bodies and recognize the different needs, capacities,

and contributions specific to each category of population (men, women, young people and the elderly).

To reach the widest audience, radio remains the most efficient vector in Burundi. They are numerous and widely listened to. Radios have in the past already had a role of awareness and even training. It therefore seems appropriate to use them, focusing on both those covering the wider territory, but also community radios and targeting the best listening moments (ie before or after the newspapers). Other channels such as television and the print media are obviously also important. To a lesser extent, online press, websites, blogs, SMS and social networks are also relevant for reaching a young and urban audience.
To reach an illiterate public, apart from radio, we can count on audiovisual aids such as posters, documentaries, or traveling films ("mobile cinema"), radio soap operas, skits, and simulation exercises hills, or even sensitization in a hill general assembly , etc.

To reach the private sector, sensitization could go through the radio of the Burundian Chamber of Commerce and Industry, CCIB FM or the CFCIB website.

Information can also go through strong social and local structures. As a result, schools play an important role in an awareness and education project for all and for the long term. Environmental clubs, extracurricular, can also be involved. In the same way, the Church is a player that gives access to a very wide audience, especially women who play a vital role in the rural world. Female agricultural workers are the first affected by climate change and very eager for adaptation options. In addition, because of their social role, women's associations and agricultural cooperatives are very good multipliers that it would be wise to associate as the Family and Community Development Centers (CDFC).

In addition, some local actors such as municipal administrators, local elected officials, communal council and hill chiefs, CDCs, agricultural instructors, ACSAs, women's and youth forums, etc. can be combined to reach a more local audience. With regard to disaster risk reduction in extreme weather conditions, the Red Cross with its network of volunteers may be involved. Similarly, once operational, the decentralized services of the Provincial Environment, Agriculture and Livestock Offices (BPEAE) and the Provincial and Municipal Platforms (PFP and PFC) can play an important role in raising awareness, mitigation / prevention, risk management, convey information from bottom to top and from top to bottom and in feedback management, etc.

In general, for awareness to be optimal, communication materials should be diversified, such as leaflets, banners, large-scale posters and public squares. In order for the whole community, including the local communities, to take ownership of it, it must be done in Kirundi and in French. It should also emphasize interpersonal communication as well as exemplary methods and participatory methods.

IV.2.6. Public awareness program on the problematic of climate changes

IV.2.6.1. Objectives of the program

a. Overall objective

The overall objective is to contribute to the reduction of anthropogenic greenhouse gas emissions and the adaptation of Burundian society to the effects of climate change as well as the reduction of damage and losses caused by extreme climate events through improved, systematic information, education and communication.

b. Specific objectives

1. Sensitization and education of the various actors on the importance and participation in the process of mitigation of anthropogenic emissions of greenhouse gases by adopting low carbon technologies and adaptation to climate change that could undermine sustainable development,

2. Improving the coherent and effective policy, legal and institutional framework to strengthen government capacity for climate change mitigation / adaptation in Burundi, including government activities and building the capacity of society at large;

c. Expected results

1. Establishment and operation of a framework for consultation, planning, effective implementation and monitoring of causes and risks related to climate change;

2. Establishment and use of channels for communication and dissemination of climate information to the local level;

3. Improved Mitigation Capacity and Climate Resilient and Low Emissions Development Strategy

4. Improved adaptive capacity and strategic management of climate-related disaster risks that can undermine sustainable development, livelihoods of communities including women in climate risk management.

d. Main activities

Component 1: Awareness and Education on GHG Mitigation and Adaptation to Climate Change

1. Organize training, sensitization and information sessions for departmental and administrative officials at all levels (national, provincial, communal and local);
2. . Organize train-the-trainer, reflective, exchange and planning workshops with departmental executives to impart the necessary knowledge to representations at the provincial, communal and hilly levels;
3. Organize mass awareness sessions for the population (hill meetings, workshops, field school, door to door, etc.);
4. Organize training sessions for journalists to raise awareness and transmit key messages through the various media (radio, print and online media, blogs / social networks, television, etc.);
5. Sensitize the media (especially radio, but also newspapers and television) on the need to reserve a free space for weather information and messages on the CC;
6. Disseminate and disseminate on the content of the political and strategic documents on the CC and 12 master plans of town and country planning;
7. Sensitize universities to include specialized curricula, basic education and higher education programs (curricula, masters) to train future professionals in the sector;
8. Produce communication tools and public awareness. These should include newsletters, fact sheets radio-TV broadcasts, radio soap operas, cinema, sketch / tumarane irungu, website;
9. Establish sector-based early warning systems (environment, health, food security, transport and infrastructure, etc.) in close collaboration with the affected population while considering existing and new communication mechanisms.

Component 2: Development of political, legal and institutional bases

10. Promote regular information and awareness-raising meetings for policy-makers, parliamentarians, senators and ministers from sectors vulnerable to climate change so that they know that climate change is a common and cross-cutting issue;
11. Conduct an institutional diagnosis to promote an adequate intra-sectoral and cross-sectoral coordination framework;

12. Set up an Interministerial Committee on Climate Change for intersectoral coordination and management of the National Environment Fund and adaptation to climate change (specifying the objectives, missions, main activities and members of the structure or organization team, the responsibilities of each actor and the mechanisms of work to be performed or accomplished);

13. Identify responsibilities within sectoral ministries for mitigating anthropogenic greenhouse gas emissions and climate change adaptation and developing accountability for an integral approach, synergies and effective cooperation;

14. Development of a Climate-Resilient and Low-Carbon Development Strategy;

15. Adapt the legal and institutional framework for the new institutional arrangements put in place.

Component 3: Capacity building of actors

16. Develop a fund mobilization strategy to operationalize action plans;

17. Set up joint awareness and communication platforms on climate risk and disaster management;

18. Strengthen the capacity of the Ministry of Education to include climate aspects in education programs (primary, secondary and university);

19. Strengthen the capacity of the OBPE to raise awareness of the public and all sectoral stakeholders on climate change policy and strategies,

20. Strengthen IGEBU's technical and operational capacity to provide accurate and useful information to all users,

21. . Strengthen the technical and operational capacity of BPEAE, PF-P and PFCs for disaster risk reduction;

22. Establish a population-based early warning system per sector (environment, health, agriculture / food),

23. Identify potential national and international partners to support the implementation of national and sectoral climate change mitigation and adaptation strategies,

24. Involve media in raising awareness about climate change.

A study on research and systematic observation of climate change has made it possible to summarize, on the one hand, the current state and, on the other hand, the constraints and solutions proposed for systematic climate research and observation. The observational system study has shown that, in most cases, climate observations suffer from shortcomings:

i) in the available climatological, synoptic and hydrological datasets,

(ii) limited capacity in the area of research and development and technology transfer.

The proposed measures are:

(a) capacity building in human, material and financial resources,

(b) the orientation of research towards development goals;

(c) the acquisition of data processing facilities to develop climate scenarios for impact and adaptation studies in the face of the adverse effects of climate change at the national level;

(d) Modernization of data collection, transmission and storage facilities;

(e) Strengthening meteorological research, including meteorological forecasts and natural disasters, and climate change issues,

f) Have a general circulation model with a network centered on Burundi and its surrounding countries.

The latter is a basic tool that will help Burundi in particular and the countries of the region in general to adapt to the climate change context.

The implementation of these measures can serve as a basis for implementing a climate change adaptation strategy and significantly reduce many negative impacts.

CHAPTER V: DIFFICULTIES AND IDENTIFIED GAPS AND FINANCIAL RESOURCES, TECHNICAL MEANS AND CAPABILITIES NECESSARY TO REMEDY

Sector experts identified gaps and constraints in different areas. At the same time, they proposed solutions or measures to deal with them, as well as stakeholders and sources of funding.

Table 37 : Identification of gaps and constraints and solutions proposed by sector

Identified Gaps and Constraints	Proposed measures and solutions to deal with them	contributors	Funding sources
1. Agriculture Sector			
Methods and tools remain empirical (no results from sector-specific studies for emission factors and coefficients)	make inventory-specific studies	Research Institutions	Government / PTFs
Insufficient specialized sector experts	Strengthen capacities to a large number of sectoral experts	MINEAGRIE	Government / PTFs
Low mastery of mechanisms for mobilizing external financing	Improve communication between the GEF Focal Point, UNFCCC and technical services	MINEAGRIE	-
Community misunderstanding at the base of the previous studies results	Sensitization of the results of previous studies related to climate change	MINEAGRIE	Government
Insufficient specific climate change programs in academic curricula	Include themes on climate change in education	EDUCATION	Government and PTF
Insufficient CC aspects in broadcasts	Active involvement of media in radio broadcasting information	MINEAGRIE /MIN	Government and

Identified Gaps and Constraints	Proposed measures and solutions to deal with them	contributors	Funding sources
by both public and private media	on CC	COMMUNICATION	PTF
Limited availability of trained experts in vulnerability analysis for climate change	Training of national experts on new techniques for vulnerability assessment and adaptation to climate change	CABINET / MINEAGRIE	PTFs
Low capacity of technical services in technology transfer	Build capacities in the acquisition of new technologies and assessment of climate change impacts	MINEAGRIE	Government / PTFs
2. **Climate and Meteorology Sector**			
a. Climate Parameter Observation Network			
Insufficient equipment	Acquire adequate equipment for in situ observations	MINIEAGRIE / IGEBU Ministry of Finance and PTF	Ministry of Finance and PTF
Insufficient inspection and maintenance of Weather Stations	Strengthen capacities both technical, material (rolling) and human	MINIEAGRIE / IGEBU	Ministry of Finance and PTF
	Organization of regular inspection campaigns of hydro-meteorological observation network	MINIEAGRIE / IGEBU	Ministry of Finance and PTF
Lack of Maintenance Laboratory	Install and equip an equipment maintenance laboratory (calibration, replacement, etc.)	MINIEAGRIE / IGEBU	Ministry of Finance and PTF
Lack of budget dedicated to maintenance of equipment;	Vote and allocate a budget for regular equipments maintenance	MINIEAGRIE / IGEBU	Ministry of Finance and PTF
Insufficient qualified technical personnel;	Train and increase service staff in charge of maintenance and	MINIEAGRIE / IGEBU	Ministry of Finance and PTF

Identified Gaps and Constraints	Proposed measures and solutions to deal with them	contributors	Funding sources
	upkeep		
The exhaustive lack of national microclimates	Install weather stations in particular micro-climate sites for the monitoring of extreme events (Hail).	MINIEAGRIE / IGEBU	Ministry of Finance and PTF
b. Transmission of data to the central collection			
Non-modernized system for transmitting and receiving collected data	Incorporate modern data transmission techniques over the internet / via call centers	MINIEAGRIE / IGEBU	Ministry of Finance and PTF
Insufficient quality control of transmission data following centralization of data	Regionalize the transmission of collected data	MINIEAGRIE / IGEBU	Ministry of Finance and PTF
Insufficient security of raw data	Digitize and store raw data	MINIEAGRIE / IGEBU	Ministry of Finance and PTF
	Acquisition of digitization equipment and raw data security	MINIEAGRIE / IGEBU	Ministry of Finance and PTF
Insufficient technical and financial capacity	Vote and allocate a substantial budget to build human and technical capacity	MINIEAGRIE / IGEBU	Ministry of Finance and PTF
Insufficient equipment needed to organize the database	Provide the service with the necessary equipment to guarantee the proper organization of the database	MINIEAGRIE / IGEBU	Ministry of Finance and PTF
Difficult access to weather information	Setting up an information dissemination system for different users	MINIEAGRIE / IGEBU	Ministry of Finance and PTF
Insufficient national capacity in climate modeling	Train technical staff on climate modeling	MINIEAGRIE / IGEBU	Ministry of Finance and PTF
	Strengthen regional and	MINIEAGRIE /	Ministry of

Identified Gaps and Constraints	Proposed measures and solutions to deal with them	contributors	Funding sources
	international collaboration in the area of climate modeling	IGEBU	Finance and PTF
Lack of monitoring system by remote sensing	Setting up a remote sensing center for climatic parameters	MINIEAGRIE / IGEBU	Ministry of Finance and PTF
	Capacity building and access to satellite data for climate monitoring	MINIEAGRIE / IGEBU	Ministry of Finance and PTF
3. Energy Sector			
a. Constraints of technical resources			
Reluctance to provide data by certain depositories;	Setting up sectoral database	Service in charge of statistics of sectoral ministries	Government of Burundi and PTF
Lack of reliable data for all energy forms	Sensitization and introduction of templates to distribute to data holders	MINHEM in collaboration with ISTEEBU	Government of Burundi and PTF
a. Financial resources Constraints			
Lack of budget allocated to climate change issues at sectoral level	Setting up a sectoral budget line related to climate change	MINHEM + Ministry in charge of finances	Government of Burundi and PTF
b. Institutional gaps			
Absence of a permanent collaboration framework for coordination of all sectors	Establish a permanent body of collaboration between the Ministry having the environment in its attributions with the sectors involved in the management of climate change	Ministry having the Environment in its attributions	-
c. Education and public sensitization			
Lack of sufficient communication on climate change	- Establishment of communication unit in all sectors on climate change - Popularize the existing texts on climate change for their	Ministry having environment in its attributions	

Identified Gaps and Constraints	Proposed measures and solutions to deal with them	contributors	Funding sources
	rigorous application - Raise awareness and train all data custodians.		
3. Transport and infrastructures sector			
Transport and infrastructure sector	- Promote public transport with spacious buses by motivating private investors in this sector; - Exemption on imported public transport buses	- - Ministries in charge of finance and transport; - Private investors.	- Private investors funds - P T F to support the OTRACO
Increased air pollution and greenhouse gas emissions from motor vehicles	- Consider extending the traffic lanes. - Finance and implement non-motorized transport projects	- Ministries in charge of transport, public works, finances and the environment.	- General budget of the State - P T F;
Failure to consider climate change in infrastructure planning and construction.	- Take into account the effects of climate change in the dimensioning of infrastructures (determine the coefficients to be applied). - Review the technical dimensioning parameters; - Develop a national infrastructure protection and stabilization program to make them resilient to climate change.	- Ministries in charge of transport, public works and the environment.	- General budget of the State - P T F;
4. Water resources sector			
Inadequate technical, human and financial capacities in data collection and management	Strengthen communication and transport means capacities and the tools needed for data collection and management	MINING / IGEBU, DGEREA	Government + PTF

Identified Gaps and Constraints	Proposed measures and solutions to deal with them	contributors	Funding sources
Regional / international climate models unsuitable for the country given its small size	Build capacity in the acquisition and use of appropriate models for the country	MINING / IGEBU, DGEREA	Government + PTF
Limited financial means to identify, analyze, treatment and publish information on Environment and Climate Change	Provide the « National Communication » project with sufficient means to record, analyze, process and publish information on climate change	MINEAGRIE / OBPE, IGEBU, DGEREA	Government + PTF (including GEF)
Lack of knowledge of external financing mechanisms and procedures	- Strengthen capacity on external financing mobilization procedures - Strengthen capacity for participation in the COP on climate change	MINEAGRIE and the Ministry in charge of National Planning, UNFCCC Focal Points	Government + PTF
5. Waste Management Sector			
a. Technical resource			
- Lack of Personal Protective Equipment (PPE) for experts and workers, - Insufficient lack of data in the waste sector, - Insufficiency in waste management and treatment	- Availability of the necessary instruments and PPE - Reinforcement of the technical capacities of the actors	- Ministry in charge of environment and CC - Private organizations	Government of Burundi - Private entrepreneurs
b. Financial resources constraints			
Little investment in waste management and treatment,	Funding Mobilization Strategy Increase the budget (allocated	Burundi Government Private investors	TFPs, the Government and private

Identified Gaps and Constraints	Proposed measures and solutions to deal with them	contributors	Funding sources
Inadequate budget allocates to the management of the sector	to the Waste Management sector		organizations
c. Institutional gaps			
-lack of coordination on waste management, - Difficult access to data, - Non-prioritization of the waste management sector, - Lack of awareness of the importance of waste management - Lack of collaboration of public / private institutions	- Respect of the GVT vision through the PNA, PNCC etc. -Capacity building of stakeholders in waste management and treatment and in ofcollaboration system	- MINEAGRIE, - Health ministry, - Ministry in charge of home affairs - Ministry in charge of environment	- - Government of Burundi and PTF, - Private organizations
d. Gaps in public awareness			
- Insufficient communication, - Insufficient extension of texts related to the management and treatment of waste, - Non-compliance with current regulations in relation to the management and treatment of waste	- Strengthen capacities in terms of sensitizing stakeholders and popularizing existing texts, - Strict application of the existing regulations	- Ministry in charge of the environment, - Health ministry, - Ministry in charge of justice	Government of Burundi and PTF and private organizations
e. Constraints of financial resources on development and transfer of adapted technologies			

Identified Gaps and Constraints	Proposed measures and solutions to deal with them	contributors	Funding sources
Lack of financial resources for technology development and transfer	mobilizing funds for adapted technology transfer	Ministry in charge of environment and Health ministry	Government of Burundi and PTF
f. Gaps in education, training and public awareness			
Ignorance of adapted technologies for waste management	Capacity Building on adapted Technology Knowledge	Ministry in charge of environment Health ministry Mayorship and the Ministry of home affairs	PTF & GVT
6. Health Sector			
The budget allocated to the Health Sector for the management of epidemics and diseases caused by climate change is still very low	Increase the budget allocated to health at least up to 15% of the general state budget (cfr Implement the Abuja Declaration) Increase the budget allocated to health research)	Ministry of Finance of Budget and Economic Development Cooperation, Ministry of Public Health and the fight against AIDS and TFPs	The Government of Burundi and the PTF
Research laboratories and adapted technical platforms are almost non-existent	Strengthen the National Reference Laboratory and other Public Health Laboratories	Ministry of Public Health and the fight against AIDS and PTFS	The Government of Burundi and the PTF Private sector
Weakness in the coordination and exploitation of information between different sectors related to climate change	Create a climate change information platform accessible to all users	MINEAGRIE Ministry of Finance of the Budget and Economic Development Cooperation and Ministry of Public Health and the fight	Government of Burundi and PTFs

Identified Gaps and Constraints	Proposed measures and solutions to deal with them	contributors	Funding sources
		against AIDS	
Insufficient community mobilization on health impacts of climate change	Setting up public awareness and mobilization programs on CC adaptation measures	Ministry of Public Health and the fight against AIDS , Ministry of Communication and Media	Government of Burundi and the PTFs, Private organizations
Insufficient infrastructure to adapt to climate change	Setting up infrastructures and buildings that can adapt to the consequences of CC	Ministry of Public Health and the fight against AIDS, Min Transport of Public Works Equipment and town Planning	Government of Burundi and the PTFs
7. Forest sector			
Non-existence of a data collection system on a regular basis to facilitate GHG inventory and mitigation	Setting up a forest data collection system in the Forestry Department	Minister in charge of environment and CC	
Insufficient national activity data and emission factors;	Strengthen the capacity of IGES experts for the determination of national emission factors and the collection of national activity data	Minister in charge of the CC	Government of Burundi and PTFs
1.3. Non-existence of a land use plan	Accelerate the process of drawing up the development plan in order to highlight the inhabited areas and areas to be afforested, etc.	Ministry in charge of territory planning	Government of Burundi and PTFs
Non-existence of a data archiving structure for greenhouse gas inventory data (IGES)	Set up a service responsible for archiving data on DCs and IGESs Implement the contents of the report on institutional arrangements for inventories	OBPE	Government of Burundi and PTFs

Identified Gaps and Constraints	Proposed measures and solutions to deal with them	contributors	Funding sources
	produced in 2005		
Inexistence of models and insufficient capacity for data processing and prediction of GHG emissions	Capacity building for models and tools for GHG treatment and prediction	OBPE	Government of Burundi and PTFs
Non-existence of a national MRV system	Set up a National MRV system	OBPE	Government of Burundi and PTFs
Insufficient data on AFOLM sector management	Make a comprehensive inventory of AFOLM sector management data	OBPE	Government of Burundi and PTFs
Difficult access to data	Sensitize data holders	OBPE	Government of Burundi and PTFs
8. UNFCCC Implementation			
Deficiencies of GHG mitigation technologies	Identify, disseminate and implement low-carbon technologies	Ministry in charge of environment and CC and all the Ministries and service partners in that sector	The government of Burundi and the private sector, PTFs
Low integration of UNFCCC objectives into national policies and strategies	*Strengthen the integration of UNFCCC objectives into policies and strategies*	Ministry in charge of the CC and the Partner Ministries	
Access to difficult financing	Do advocacy Strengthen fundraising capacities	Ministry in charge of Environment and CC	Secretariat of the Convention Government of Burundi

CONCLUSION AND RECOMMENDATIONS

While fully adhering to the objectives of the United Nations Framework Convention on Climate Change, a desire fully renewed through the INDC presented at COP 21, Burundi remains dependent on the support of the international community to implement the mitigation measures of anthropogenic greenhouse gas emissions.

To this end, a process of TCNCC preparation has just been realized. Nevertheless, significant progress has been made towards a better understanding of climate change issue (CC) and Burundi's commitment to the UNFCCC's ultimate goal of reducing GHG concentrations in the region. atmosphere dictate the choice of adapted technologies in the design of its economic and social development policies as well as in the development of corresponding strategies to work for sustainable and proper development.

It is now for Burundi to contribute to the implementation of UNFCCC recommendations at the national level, according to the principle of common responsibility but differentiated and especially to prepare for adaptation to the potential climate change impacts in different economic and social activity sectors.
Five sectors have been singled out as sources of anthropogenic greenhouse gas emissions, including the Agriculture, Energy, Forestry and Other Land Use (AFOLU) sector, the Waste sector and finaly the Industrial Processes and Product Use.

Regarding the increasing share of emissions for these five main sectors at the national level: the Agriculture, Forestry and Other Land Use sector increased from 48% to 64% in 2010 then decreased to 45% in 2015, that of the Energy sector decreased from 43% to 31% in 2010, then reached 45% in 2015, the share of the waste sector was between 5 and 10 %, and finally the PIUP sector still represents less than 1% of total national emissions.
The Agriculture, Forestry and Other Land Use sector is the most important emitting sector in Burundi followed by the energy sector.

Fortunately, Burundi remains a small emitter of greenhouse gases, but it still shows its willingness in international solidarity to reduce anthropogenic emissions of greenhouse gases.
That’s why mitigation measures relating to the increase of wooded areas and the increase of hydropower plants are being implemented, despite the financial means still precarious.

It is also continuing to implement the adaptation measures identified to cope with the ever-increasing vulnerability to climate change.
It has already implemented various strategies to respond to the various environmental problems it faces, including those specifically related to Climate Change, and is committed to implementing the identified mitigation and adaptation measures. Within the framework of this TCNCC. However, it must be admitted that the implementation of the developed strategies will lead to additional costs, such as those related to technological readjustments to be implemented.

In order to meet its obligations under the UNFCCC requirements, Burundi will of course require increased financial support from the international community to implement most elements of its response strategies and strengthen its local capacity in priority areas (vulnerability and adaptation, data bank, GHG emission limitation, appropriate national

measures to mitigate anthropogenic greenhouse gas emissions (NAMAs), technology transfer and synergy between conventions).

Finally, this TCNCC is an opportunity for the Burundian Government to reaffirm its commitments to continue the integration of climate change in national and sectoral policies to create the best conditions for the transfer of low-carbon technologies, education and public sensitization on the issue of climate change.

Burundi is aware that with the inaction face to climate change, the Earth is tending towards its disappearance, that's why the international community must take its guards and provide sanctions to states that remain indifferent to world efforts to combat climate change.

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ANNEXES

Annex 1. Completeness Table for Burundi GHG Inventory

Categories	GHG						
	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO2 equivalent conversion factors (3)
Total National Emissions and Removals							
1 - Energy							
1.A - Fuel Combustion Activities							
1.A.1 - Energy Industries	x	x	x				
1.A.2 - Manufacturing Industries and Construction	x	x	x				
1.A.3 - Transport	x	x	x				
1.A.4 - Other Sectors	x	x	x				
1.A.5 - Non-Specified	NO	NO	NO				
1.B - Fugitive emissions from fuels							
1.B.1 - Solid Fuels	NA	NA	NA				
1.B.2 - Oil and Natural Gas	NA	NA	NA				
1.B.3 - Other emissions from Energy Production	NO	NO	NO				
1.C - Carbon dioxide Transport and Storage							
1.C.1 - Transport of CO2	NO						
1.C.2 - Injection and Storage	NO						
1.C.3 - Other	NO						
2 - Industrial Processes and Product Use							
2.A - Mineral Industry							
2.A.1 - Cement production	NO						
2.A.2 - Lime production	x						
2.A.3 - Glass Production	NO						
2.A.4 - Other Process Uses of Carbonates	NO						
2.A.5 - Other (please specify)	NO	NO	NO				

Categories	GHG						
	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO2 equivalent conversion factors (3)
2.B - Chemical Industry							
2.B.1 - Ammonia Production	NO						
2.B.2 - Nitric Acid Production			NO				
2.B.3 - Adipic Acid Production			NO				
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production			NO				
2.B.5 - Carbide Production	NO	NO					
2.B.6 - Titanium Dioxide Production	NO						
2.B.7 - Soda Ash Production	NO						
2.B.8 - Petrochemical and Carbon Black Production	NO	NO					
2.B.9 - Fluorochemical Production							
2.B.10 - Other (Please specify)	NO	NO	NO				
2.C - Metal Industry							
2.C.1 - Iron and Steel Production	x						
2.C.2 - Ferroalloys Production	NO	NO					
2.C.3 - Aluminium production	NO				NO		
2.C.4 - Magnesium production	NO					NO	
2.C.5 - Lead Production	NO						
2.C.6 - Zinc Production	NO						
2.C.7 - Other (please specify)	NO	NO	NO				
2.D - Non-Energy Products from Fuels and Solvent Use							
2.D.1 - Lubricant Use	NO!						
2.D.2 - Paraffin Wax Use	NO!						
2.D.3 - Solvent Use							
2.D.4 - Other (please specify)	NO	NO	NO				
2.E - Electronics Industry							

Categories	GHG						
	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO2 equivalent conversion factors (3)
2.E.1 - Integrated Circuit or Semiconductor				NO	NO	NO	NO
2.E.2 - TFT Flat Panel Display					NO	NO	NO
2.E.3 - Photovoltaics					NO		
2.E.4 - Heat Transfer Fluid					NO		
2.E.5 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO
2.F - Product Uses as Substitutes for Ozone Depleting Substances							
2.F.1 - Refrigeration and Air Conditioning				NE			
2.F.2 - Foam Blowing Agents				NA			
2.F.3 - Fire Protection				NA	NA		
2.F.4 - Aerosols				NA			
2.F.5 - Solvents				NA	NO		
2.F.6 - Other Applications (please specify)				NA	NO		
2.G - Other Product Manufacture and Use							
2.G.1 - Electrical Equipment					NA	NA	
2.G.2 - SF6 and PFCs from Other Product Uses					NA	NA	
2.G.3 - N2O from Product Uses			NA				
2.G.4 - Other (Please specify)	NA	NA	NA	NA	NA	NA	NA
2.H - Other							
2.H.1 - Pulp and Paper Industry	NO	NO					
2.H.2 - Food and Beverages Industry	NO	NO					
2.H.3 - Other (please specify)	NO	NO	NO				
3 - Agriculture, Forestry, and Other Land Use							
3.A - Livestock							
3.A.1 - Enteric Fermentation		x					
3.A.2 - Manure Management		x	x				

Categories	GHG						
	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO2 equivalent conversion factors (3)
3.B - Land							
3.B.1 - Forest land	x						
3.B.2 - Cropland	x						
3.B.3 - Grassland	X						
3.B.4 - Wetlands	x		x				
3.B.5 - Settlements	NE						
3.B.6 - Other Land	NE						
3.C - Aggregate sources and non-CO_2 emissions sources on land							
3.C.1 - Emissions from biomass burning		x	x				
3.C.2 - Liming	X						
3.C.3 - Urea application	X						
3.C.4 - Direct N2O Emissions from managed soils			x				
3.C.5 - Indirect N2O Emissions from managed soils			x				
3.C.6 - Indirect N2O Emissions from manure management			x				
3.C.7 - Rice cultivations		X					
3.C.8 - Other (please specify)		NO	NO				
3.D - Other							
3.D.1 - Harvested Wood Products	X						
3.D.2 - Other (please specify)	NO	NO	NO				
4 - Waste							
4.A - Solid Waste Disposal		x					
4.B - Biological Treatment of Solid Waste		NE					
4.C - Incineration and Open Burning of Waste			NE				

Categories	GHG						
	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO2 equivalent conversion factors (3)
4.D - Wastewater Treatment and Discharge		x	x				
4.E - Other (please specify)							
5 - Other							
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3							
5.B - Other (please specify)							
Memo Items (5)							
International Bunkers							
1.A.3.a.i - International Aviation (International Bunkers)	X	X	X				
1.A.3.d.i - International water-borne navigation (International bunkers)	X	X	X				
1.A.5.c - Multilateral Operations							

Documentation box

Notes: Shaded cells do not require entries.
The following standard indicators should be used, as appropriate, for emissions by sources and removals by sinks of GHGs:

- X : Assessed
- NO (not occurring) for activities or processes that do not occur for a particular gas or source/sink category within a country,
- NE (not estimated) for existing emissions and removals which have not been estimated, NA (not applicable) for activities in a given source/sink category which do not result in emissions or removals of a specific gas,
- IE (included elsewhere) for emissions and removals estimated but included elsewhere in the inventory (Parties should indicate where the emissions or removals have been included),
- C (confidential) for emissions and removals which could lead to the disclosure of confidential information.

Annex 2. Key Category Analysis for 2005, 2010 and 2015

A	B	C	D	E	F	G
IPCC Category code	IPCC Category	Greenhouse gas	2005 Ex,t (Gg CO2 Eq)	|Ex,t| (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
3.B.1.a	Forest land Remaining Forest land	CARBON DIOXIDE (CO2)	-4722.440036	4722.440036	0.703963166	0.703963166
1.A.4	Other Sectors - Biomass	METHANE (CH4)	606.3961466	606.3961466	0.090394065	0.79435723
3.B.2.b	Land Converted to Cropland	CARBON DIOXIDE (CO2)	490.6087588	490.6087588	0.073133908	0.867491138
3.A.1	Enteric Fermentation	METHANE (CH4)	322.495992	322.495992	0.048073728	0.915564867
3.D.1	Harvested Wood Products	CARBON DIOXIDE (CO2)	-151.0373454	151.0373454	0.022514786	0.938079653
1.A.4	Other Sectors - Biomass	NITROUS OXIDE (N2O)	117.5475972	117.5475972	0.017522547	0.9556022
A	B	C	D	E	F	G
IPCC Category code	IPCC Category	Greenhouse gas	2010 Ex,t (Gg CO2 Eq)	|Ex,t| (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
3.B.1.a	Forest land Remaining Forest land	CARBON DIOXIDE (CO2)	-2780.556353	2780.556353	0.468027598	0.468027598
1.A.4	Other Sectors - Biomass	METHANE (CH4)	682.0596079	682.0596079	0.114805341	0.582832939
3.B.2.b	Land Converted to Cropland	CARBON DIOXIDE (CO2)	655.2472169	655.2472169	0.110292237	0.693125176
3.A.1	Enteric Fermentation	METHANE (CH4)	410.222778	410.222778	0.06904934	0.762174517
3.C.4	Direct N2O Emissions from managed soils	NITROUS OXIDE (N2O)	353.1218935	353.1218935	0.05943803	0.821612547

3.C.7	Rice cultivations	METHANE (CH4)	294.9828413	294.9828413	0.049651974	0.87126452
3.C.5	Indirect N2O Emissions from managed soils	NITROUS OXIDE (N2O)	149.8176204	149.8176204	0.025217536	0.896482057
3.D.1	Harvested Wood Products	CARBON DIOXIDE (CO2)	-136.0515927	136.0515927	0.022900417	0.919382474
1.A.4	Other Sectors - Biomass	NITROUS OXIDE (N2O)	132.2126416	132.2126416	0.022254239	0.941636712
1.A.3.b	Road Transportation	CARBON DIOXIDE (CO2)	79.20336343	79.20336343	0.013331634	0.954968347

A	B	C	D	E	F	G
IPCC Category code	IPCC Category	Greenhouse gas	2015 Ex,t (Gg CO2 Eq)	|Ex,t| (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
3.B.1.a	Forest land Remaining Forest land	CARBON DIOXIDE (CO2)	-1447.113898	1447.113898	0.35019866	0.35019866
1.A.4	Other Sectors - Biomass	METHANE (CH4)	767.9308555	767.9308555	0.185837726	0.536036386
3.B.2.b	Land Converted to Cropland	CARBON DIOXIDE (CO2)	610.2908526	610.2908526	0.147689162	0.683725548
3.D.1	Harvested Wood Products	CARBON DIOXIDE (CO2)	-522.9147843	522.9147843	0.126544329	0.810269877
3.A.1	Enteric Fermentation	METHANE (CH4)	189.524517	189.524517	0.045864553	0.85613443
1.A.4	Other Sectors - Biomass	NITROUS OXIDE (N2O)	148.8582021	148.8582021	0.036023386	0.892157816
3.C.7	Rice cultivations	METHANE (CH4)	142.0126461	142.0126461	0.034366775	0.926524592
1.A.3.b	Road Transportation	CARBON DIOXIDE	68.41715826	68.41715826	0.01655681	0.943081407

		(CO2)			5	
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CARBON DIOXIDE (CO2)	45.48060942	45.48060942	0.011006216	0.954087623
1.A.3.b	Road Transportation	CARBON DIOXIDE (CO2)	68.41715826	68.41715826	0.016556815	0.943081407
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CARBON DIOXIDE (CO2)	45.48060942	45.48060942	0.011006216	0.954087623

Annex 3: Reporting tables for non-Annex I countries

Inventory Year: 2005

Greenhouse gas source and sink categories	Net CO2 (Gg)	CH4 (Gg)	N2O (Gg)
Total National Emissions and Removals	-4230.7822	48.38	0.5684
1 - Energy	140.69338	28.926	0.387
1A - Fuel Combustion Activities	140.69338	28.926	0.387
1A1 - Energy Industries	0.7823516	0.0236	0.0032
1A2 - Manufacturing Industries and Construction (ISIC)	37.845874	0.0029	0.0005
1A3 - Transport	74.323345	0.0199	0.0034
1A4 - Other Sectors	27.741814	28.879	0.3799
1A5 - Other	0	0	0
1B - Fugitive Emissions from Fuels	0	0	0
1B1 - Solid Fuels	0	0	0
1B2 - Oil and Natural Gas	0	0	0
2 - Industrial Processes	0	0	0
2A - Mineral Products	0	0	0
2B - Chemical Industry	0	0	0
2C - Metal Production	0	0	0
2D - Other Production	0	0	
2E - Production of Halocarbons and Sulphur Hexafluoride			
2F - Consumption of Halocarbons and Sulphur Hexafluoride			
2G - Other (please specify)	0	0	0
3 - Solvent and Other Product Use	0	0	0
4 - Agriculture		19.444	0.0956
4A - Enteric Fermentation		15.357	
4B - Manure Management		0.5116	0.0945
4C - Rice Cultivation		3.5311	
4D - Agricultural Soils			0
4E - Prescribed Burning of Savannas		0	0
4F - Field Burning of Agricultural Residues		0.0443	0.0011
4G - Other (please specify)			
5 - Land-Use Change & Forestry	-4371.4756	0	0.0859
5A - Changes in Forest and Other Woody Biomass Stocks	-4722.2824		
5B - Forest and Grassland Conversion	198.03527	0	0
5C - Abandonment of Managed Lands	0		
5D - CO2 Emissions and Removals from Soil	303.80882		0.0016
5E - Other (please specify)	-151.03735	0	0.0843
6 - Waste	-	1.35727	0.472
6A - Solid Waste Disposal on Land		0.01	
6B - Wastewater Handling	-	1.349116	0.471976
6C - Waste Incineration	0	0	0
6D - Other (please specify)	0	0	0
7 - Other (please specify)	0	0	0

Memo Items			
International Bunkers	15.456834	0.0002	0.0004
1A3a1 - International Aviation	14.502346	0.0001	0.0004
1A3d1 - International Marine (Bunkers)	0.954488	9E-05	3E-05
Multilateral operations	0	0	0
CO2 emissions from biomass	10974.074		

Inventory Year: 2010

Greenhouse gas source and sink categories	Net CO2 (Gg)	CH4 (Gg)	N2O (Gg)
Total National Emissions and Removals	-2077.0001	69.837	2.3168
1 - Energy	172.18289	32.528	0.434
1A - Fuel Combustion Activities	172.18289	32.528	0.434
1A1 - Energy Industries	1.3572243	0.0171	0.0023
1A2 - Manufacturing Industries and Construction (ISIC)	47.907254	0.0036	0.0006
1A3 - Transport	81.256926	0.0234	0.0038
1A4 - Other Sectors	41.661487	32.484	0.4273
1A5 - Other	0	0	0
1B - Fugitive Emissions from Fuels	0	0	0
1B1 - Solid Fuels	0	0	0
1B2 - Oil and Natural Gas	0	0	0
2 - Industrial Processes	0.784695	0	0
2A - Mineral Products	0.784695	0	0
2B - Chemical Industry	0	0	0
2C - Metal Production	0	0	0
2D - Other Production	0	0	
2E - Production of Halocarbons and Sulphur Hexafluoride			
2F - Consumption of Halocarbons and Sulphur Hexafluoride			
2G - Other (please specify)	0	0	0
3 - Solvent and Other Product Use	0	0	0
4 - Agriculture		34.572	0.1803
4A - Enteric Fermentation		19.534	
4B - Manure Management		0.897	0.1779
4C - Rice Cultivation		14.047	
4D - Agricultural Soils			0
4E - Prescribed Burning of Savannas		0	0
4F - Field Burning of Agricultural Residues		0.0942	0.0024
4G - Other (please specify)			
5 - Land-Use Change & Forestry	-2249.9677	2.6783	1.7025
5A - Changes in Forest and Other Woody Biomass Stocks	-2780.3987		
5B - Forest and Grassland Conversion	383.86859	0	0
5C - Abandonment of Managed Lands	0		

5D - CO2 Emissions and Removals from Soil	282.61395		0.0016
5E - Other (please specify)	-136.05159	2.6783	1.7009
6 - Waste	0	0.109	0.527
6A - Solid Waste Disposal on Land		0.058	
6B - Wastewater Handling		0.099	0.527
6C - Waste Incineration	0	0	0
6D - Other (please specify)	0	0	0
7 - Other (please specify)	0	0	0
Memo Items			
International Bunkers	13.49735	0.0002	0.0004
1A3a1 - International Aviation	12.500676	9E-05	0.0003
1A3d1 - International Marine (Bunkers)	0.9966746	9E-05	3E-05
Multilateral operations	0	0	0
CO2 emissions from biomass	12335.419		

Inventory Year: 2015

Greenhouse gas source and sink categories	Net CO2 (Gg)	CH4 (Gg)	N2O (Gg)
Total National Emissions and Removals	-1189.723	53.977	0.8013
1 - Energy	152.23782	36.618	0.4875
1A - Fuel Combustion Activities	152.23782	36.618	0.4875
1A1 - Energy Industries	0.9199974	0.0199	0.0027
1A2 - Manufacturing Industries and Construction (ISIC)	45.480609	0.0037	0.0006
1A3 - Transport	69.869579	0.0221	0.0033
1A4 - Other Sectors	35.967637	36.572	0.481
1A5 - Other	0	0	0
1B - Fugitive Emissions from Fuels	0	0	0
1B1 - Solid Fuels	0	0	0
1B2 - Oil and Natural Gas	0	0	0
2 - Industrial Processes	6.38402	0	0
2A - Mineral Products	0.1473	0	0
2B - Chemical Industry	0	0	0
2C - Metal Production	6.23672	0	0
2D - Other Production	0	0	
2E - Production of Halocarbons and Sulphur Hexafluoride			
2F - Consumption of Halocarbons and Sulphur Hexafluoride			
2G - Other (please specify)	0	0	0
3 - Solvent and Other Product Use	0	0	0
4 - Agriculture		16.75	0.149
4A - Enteric Fermentation		9.025	
4B - Manure Management		0.9267	0.1481
4C - Rice Cultivation		6.7625	
4D - Agricultural Soils			0
4E - Prescribed Burning of Savannas		0	0
4F - Field Burning of Agricultural Residues		0.0356	0.0009

4G - Other (please specify)			
5 - Land-Use Change & Forestry	-1348.3448	0.6091	0.1648
5A - Changes in Forest and Other Woody Biomass Stocks	-1446.9562		
5B - Forest and Grassland Conversion	330.44978	0	0
5C - Abandonment of Managed Lands	0		
5D - CO2 Emissions and Removals from Soil	291.0764		0.0016
5E - Other (please specify)	-522.91478	0.6091	0.1632
6 - Waste	0	2.0048	0.60855
6A - Solid Waste Disposal on Land		0	
6B - Wastewater Handling		1.9979	0.60855
6C - Waste Incineration	0	0	0
6D - Other (please specify)	0	0	0
7 - Other (please specify)	0	0	0
Memo Items			
International Bunkers	9.3549507	0.0001	0.0003
1A3a1 - International Aviation	8.6115806	6E-05	0.0002
1A3d1 - International Marine (Bunkers)	0.7433702	7E-05	2E-05
Multilateral operations	0	0	0
CO_2 emissions from biomass	13890.738		

EMISSIONS SYNTHESIS IN CO2 EQUIVALENT

Global warming potential used	1 (CO_2)	21(CH_4)	310(N_2O)

Inventory Year: 2005	2005				2010				2015			
	Emissions CO2 Equivalents (Gg)				Emissions CO2 Equivalents (Gg)				Emissions CO2 Equivalents (Gg)			
Categories	Net CO2 (1)(2)	CH4	N2O	TOTAL	Net CO2 (1)(2)	CH4	N2O	TOTAL	Net CO2 (1)(2)	CH4	N2O	TOTAL
Total National Emissions and Removals	**-4230,8**	**1044**	**323**	**-2864**	**-2077**	**1467,64**	**881,47**	**272,1128**	**-1189,72**	**1175,62**	**437,06**	**422,9594**
1 - Energy	**140,69**	**607,4**	**120**	**868,1**	**172**	**683,085**	**134,554**	**989,8218**	**152,2378**	**768,978**	**151,14**	**1072,354**
1.A - Fuel Combustion Activities	**140,69**	**607,4**	**120**	**868,1**	**172**	**683,085**	**134,554**	**989,8218**	**152,2378**	**768,978**	**151,14**	**1072,354**
1.A.1 - Energy Industries	0,78235	0,4959	0,977	2,255	1,357	0,359189	0,708119	2,4245324	0,9199974	0,418192	0,82388	2,1620716
1.A.2 - Manufacturing Industries and Construction	37,8459	0,0615	0,152	38,059	47,91	0,074953	0,187047	48,169254	45,480609	0,076883	0,18831	45,745798
1.A.3 - Transport	74,3233	0,4177	1,068	75,809	81,26	0,491905	1,184584	82,933415	69,869579	0,464461	1,02252	71,356562
1.A.4 - Other Sectors	27,7418	606,46	117,8	751,96	41,66	682,1591	132,474	856,29456	35,967637	768,0188	149,103	953,08942
1.A.5 - Non-Specified	0	0	0	0	0	0	0	0	0	0	0	0
1.B - Fugitive emissions from fuels	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0	0	0	0
1.B.1 - Solid Fuels	0	0	0	0	0	0	0	0	0	0	0	0
1.B.2 - Oil and Natural Gas	0	0	0	0	0	0	0	0	0	0	0	0
1.B.3 - Other emissions from Energy Production	0	0	0	0	0	0	0	0	0	0	0	0
1.C - Carbon dioxide Transport and Storage	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0	0	0	0
1.C.1 - Transport of CO2	0	0	0	0	0	0	0	0	0	0	0	0
1.C.2 - Injection and Storage	0	0	0	0	0	0	0	0	0			
1.C.3 - Other	0	0	0	0	0	0	0	0	0			
2 - Industrial Processes and Product Use	**0**	**0**	**0**	**0**	**0,78**	**0**	**0**	**0,784695**	**6,38402**	**0**	**0**	**6,38402**
2.A - Mineral Industry	**0**	**0**	**0**	**0**	**0,78**	**0**	**0**	**0,784695**	0,1473	0	0	0,1473
2.A.1 - Cement production	0	0	0	0	0	0	0	0	0	0	0	0
2.A.2 - Lime production	0	0	0	0	0,785	0	0	0,784695	0	0	0	0
2.A.3 - Glass Production	0	0	0	0	0	0	0	0	0	0	0	0
2.A.4 - Other Process Uses of Carbonates	0	0	0	0	0	0	0	0	0	0	0	0
2.A.5 - Other (please specify)	0	0	0	0	0	0	0	0	0	0	0	0
2.B - Chemical Industry	**0**	**0**	**0**	**0**	0	0	0	0	0	0	0	0
2.B.1 - Ammonia Production	0	0	0	0	0	0	0	0	0	0	0	0

2.B.2 - Nitric Acid Production	0	0	0	0	0	0	0	0	0	0	0	0
2.B.3 - Adipic Acid Production	0	0	0	0	0	0	0	0	0	0	0	0
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production	0	0	0	0	0	0	0	0	0	0	0	0
2.B.5 - Carbide Production	0	0	0	0	0	0	0	0	0	0	0	0
2.B.6 - Titanium Dioxide Production	0	0	0	0	0	0	0	0	0	0	0	0
2.B.7 - Soda Ash Production	0	0	0	0	0	0	0	0	0	0	0	0
2.B.8 - Petrochemical and Carbon Black Production	0	0	0	0	0	0	0	0	0	0	0	0
2.B.9 - Fluorochemical Production	0	0	0	0	0	0	0	0	0			
2.B.10 - Other (Please specify)	0	0	0	0	0	0	0	0	0			
2.C - Metal Industry	**0**	**0**	**0**	**0**	0	0	0	0	6,23672	0	0	6,23672
2.C.1 - Iron and Steel Production	0	0	0	0	0	0	0	0	6,23672			
2.C.2 - Ferroalloys Production	0	0	0	0	0	0	0	0	0			
2.C.3 - Aluminium production	0	0	0	0	0	0	0	0	0			
2.C.4 - Magnesium production	0	0	0	0	0	0	0	0	0			
2.C.5 - Lead Production	0	0	0	0	0	0	0	0	0			
2.C.6 - Zinc Production	0	0	0	0	0	0	0	0	0			
2.C.7 - Other (please specify)	0	0	0	0	0	0	0	0	0			
2.D - Non-Energy Products from Fuels and Solvent Use	**0**	**0**	**0**	**0**	0	0	0	0	0			
2.D.1 - Lubricant Use	0	0	0	0	0	0	0	0	0			
2.D.2 - Paraffin Wax Use	0	0	0	0	0	0	0	0	0			
2.D.3 - Solvent Use	0	0	0	0	0	0	0	0	0			
2.D.4 - Other (please specify)	0	0	0	0	0	0	0	0	0			
2.E - Electronics Industry	**0**	**0**	**0**	**0**	0	0	0	0	0			
2.E.1 - Integrated Circuit or Semiconductor	0	0	0	0	0	0	0	0	0			
2.E.2 - TFT Flat Panel Display	0	0	0	0	0	0	0	0	0			
2.E.3 - Photovoltaics	0	0	0	0	0	0	0	0	0			
2.E.4 - Heat Transfer Fluid	0	0	0	0	0	0	0	0	0			
2.E.5 - Other (please specify)	0	0	0	0	0	0	0	0	0			
2.F - Product Uses as Substitutes for Ozone Depleting Substances	**0**	**0**	**0**	**0**	0	0	0	0	0			
2.F.1 - Refrigeration and Air Conditioning	0	0	0	0	0	0	0	0	0			
2.F.2 - Foam Blowing Agents	0	0	0	0	0	0	0	0	0			
2.F.3 - Fire Protection	0	0	0	0	0	0	0	0	0			
2.F.4 - Aerosols	0	0	0	0	0	0	0	0	0			

2.F.5 - Solvents	0	0	0	0	0	0	0	0	0			
2.F.6 - Other Applications (please specify)	0	0	0	0	0	0	0	0	0			
2.G - Other Product Manufacture and Use	**0**	**0**	**0**	**0**	0	0	0	0	0			
2.G.1 - Electrical Equipment	0	0	0	0	0	0	0	0	0			
2.G.2 - SF6 and PFCs from Other Product Uses	0	0	0	0	0	0	0	0	0			
2.G.3 - N2O from Product Uses	0	0	0	0	0	0	0	0	0			
2.G.4 - Other (Please specify)	0	0	0	0	0	0	0	0	0			
2.H - Other	**0**	**0**	**0**	**0**	0	0	0	0	0			
2.H.1 - Pulp and Paper Industry	0	0	0	0	0	0	0	0	0			
2.H.2 - Food and Beverages Industry	0	0	0	0	0	0	0	0	0			
2.H.3 - Other (please specify)	0	0	0	0	0	0	0	0	0			
3 - Agriculture, Forestry, and Other Land Use	-4371,47	408,32	56,26	-3906,9	-2250	782,2649	127,9851	-1339,714	**-1348,34**	**364,536**	**97,275**	**-886,53**
3.A - Livestock	0	333,24	15,55	348,79	0	429,0587	29,25885	458,31758	0	208,9856	24,489	233,47462
3.A.1 - Enteric Fermentation	0	322,5	0	322,5	0	**410,2228**	0	410,22278	0	189,5245	0	189,52452
3.A.2 - Manure Management	0	10,744	15,55	26,295	0	18,83595	29,25885	48,094798	0	19,46107	24,489	43,950103
3.B - Land	**-4220,6**	**0**	**0,5**	**-4220**	-2114	0	0,498055	-2113,556	-825,56755	0	0,49805	-825,0695
3.B.1 - Forest land	-4722,44	0	0	-4722,4	-2781	0	0	-2780,556	-1447,1139	0	0	-1447,114
3.B.2 - Cropland	490,766	0	0	490,77	655,4	0	0	655,40488	610,44852	0	0	610,44852
3.B.3 - Grassland	0	0	0	0	0	0	0	0	0	0	0	0
3.B.4 - Wetlands	11,0978	0	0,498	11,596	11,1	0	0,498055	11,595882	11,097827	0	0	11,097827
3.B.5 - Settlements	0	0	0	0	0	0	0	0	0	0	0	0
3.B.6 - Other Land	0	0	0	0	0	0	0	0	0	0	0	0
3.C - Aggregate sources and non-CO2 emissions sources on land	**0,1394**	**75,08**	**40,2**	**115,4**	0,141	353,2062	98,2282	451,57579	0,1411694	155,5509	72,288	227,98008
3.C.1 - Emissions from biomass burning	0	0,9313	0,356	1,2878	0	58,22334	25,08797	83,311314	0	13,53823	5,83945	19,377686
3.C.2 - Liming	0	0	0	0	0,138	0	0	0,1375	0,1375	0	0	0,1375
3.C.3 - Urea application	0	0	0	0	0,004	0	0	0,0039017	0,0036694	0	0	0,0036694
3.C.4 - Direct N2O Emissions from managed soils	0	0	18,42	18,421	0	0	33,34393	33,343927	0	0	31,9184	31,91838
3.C.5 - Indirect N2O Emissions from managed soils	0	0	7,703	7,7032	0	0	13,91198	13,911985	0	0	13,1096	13,109586
3.C.6 - Indirect N2O Emissions from manure management	0	0	13,73	13,73	0	0	25,88432	25,884317	0	0	21,4206	21,420617
3.C.7 - Rice cultivations	0	74,153	0	74,153	0	294,9828	0	294,98284	0	142,0126	0	142,01265
3.C.8 - Other (please specify)	0	0	0	0	0	0	0	0	0	0	0	0
3.D - Other	**-151,04**	**0**	**0**	**-151**	-136,1	0	0	-136,0516	-522,91478	0	0	-522,9148
3.D.1 - Harvested Wood Products	-151,037	0	0	-151,04	-136,1	0	0	-136,0516	-522,91478	0	0	-522,9148

3.D.2 - Other (please specify)	0	0	0	0	0	0	0	0	0	0	0	0
4 - Waste	**0**	**28,5**	**146**	**174,8**	0	2,288778	163,2478	165,53657	**0**	**42,1005**	**188,65**	**230,7511**
4.A - Solid Waste Disposal	**0**	**0,171**	**0**	**0,171**	0	0,203249	0	0,2032492	0	0,145313	0	0,1453126
4.B - Biological Treatment of Solid Waste	**0**	**0**	**0**	**0**	0	0	0	0	0	0	0	0
4.C - Incineration and Open Burning of Waste	**0**	**0**	**0**	**0**	0	0	0	0	0	0	0	0
4.D - Wastewater Treatment and Discharge	**0**	**28,33**	**146**	**174,6**	0	2,085529	163,2478	165,33332	0	41,95514	188,651	230,60576
4.E - Other (please specify)	**0**	**0**	**0**	**0**	0	0	0	0	0	0	0	0
5 - Other	**0**	**0**	**0**	**0**	0	0	0	0	0	0	0	0
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	**0**	**0**	**0**	**0**	0	0	0	0	0	0	0	0
5.B - Other (please specify)	**0**	**0**	**0**	**0**	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
Memo Items (5)	0	0	0	0	0	0	0	0	0	0	0	0
International Bunkers	**15,457**	**0,004**	**0,13**	**15,59**	13,5	0,003813	0,116737	13,6179	0,7433702	0,00013	0,00026	0,7437616
1.A.3.a.i - International Aviation (International Bunkers)	14,5023	0,0021	0,126	14,63	12,5	0,001836	0,108397	12,610909	0	6,02E-05	0,00024	0,0003011
1.A.3.d.i - International water-borne navigation (International bunkers)	0,95449	0,0019	0,008	0,9644	0,997	0,001977	0,008339	1,0069911	0,7433702	7,02E-05	2E-05	0,7434605
1.A.5.c - Multilateral Operations	**0**	**0**	**0**	**0**	0	0	0	0	0	0	0	0

Annex 4: Models Used for Climate Projections

The models used for climate projections are:

A = ACCESS1-0
B = bcc-csm1-1
C = BNU-ESM
D = CanESM2
E = CCSM4
F = CESM1-BGC
G = CSIRO-Mk3-6-0
H = GFDL-ESM2G
I = GFDL-ESM2M
J = HadGEM2-CC
K = HadGEM2-ES
L = inmcm4
M = IPSL-CM5A-LR
N = IPSL-CM5A-MR
O = MIROC5
P = MIROC-ESM
Q = MPI-ESM-LR
R = MPI-ESM-MR
S = MRI-CGCM3
T = NorESM1-M

Appendix 5: list of resource persons

No	*Field of Intervention*	*Name*	Contact informations
			Email/Telephone
1	National Circumstances	SABUSHIMIKE Jean Marie	Sabjm2000@yahoo.fr, Tel: +257 71 764 630
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3	Agriculture: Assessment of Vulnerability and Adaptation to Climate Change	Epaphras NDIKUMANA Serge NKURUNZIZA NTWARI Jean Claude Rose NDAYIRAGIJE	Epandikumana1982@gmail.com, Tel: +257 75 400 157 Nkurunziza.serge@yahoo.fr,Tel. +257 79 933 309 Jeanclaude.ntwari@yahoo.com, Tel.+257 68 756 390 mbakonike@yahoo.fr, +257 79 924 891
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	Health	Maurice NKURUNZIZA Léonidas MISAGO	nmaurice2008@gmail.com, Tel. 257 79971913 misagoleo11@yahoo.fr, Tel.
	Transport and	MASUMBUKO Jean de Dieu	Massopjss3@gmai.com, Tel.+257 79904437

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	Technology needs assessment	Audace NDAYIZEYE	ndayizeyeaudace@hotmail.com,Tel: +25776717703
	Awareness Action Plan on Climate Change	Olivier ABAYISENGA	abayisenga@gmail.com
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		Territory Administration General Manager	
		Agriculture General Manager (MBARUSHIMANA Jean Claude)	jeanclaudembu@gmail.com
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